FINAL REPORT

Support to Communication and Dialogue on Early Warning and Forecasting Products & Climate Information Project

Climate Information, Disaster Management and Early Warning System-Sierra Leone (CIDMEWS-SL)

June 2017

CONFIDENTIAL INFORMATION DISCLAIMER

This **Climate Information, Disaster Management and Early Warning System-Sierra Leone (CIDMEWS-SL-SL) Report** (hereafter, Report) has been prepared by Integrated Geo-Information and Environmental Management Services (INTEGEMS) under contract to the United Nations Development Programme (UNDP) Sierra Leone Country Office (CO). This Report is a product of INTEGEMS, and not of the UNDP.

This Report is a final, validated and peer reviewed deliverable from the **Support to Communication and Dialogue on Early Warning and Forecasting Products & Climate Information Project** (hereafter, the Project) that is funded and supported by the UNDP Sierra Leone Country Office and the Global Environment Facility (GEF). The key Implementing Partners of the Project are the Sierra Leone Meteorological Agency (SLMA), prior to July 2017, the Sierra Leone Meteorological Department (SLMD) in the Ministry of Transport and Aviation (MTA); the Office of National Security – Disaster Management Department (ONS-DMD); the Ministry of Water Resources (MWR); and the Environment Protection Agency-Sierra Leone (EPA-SL).

The findings, interpretations and conclusions expressed in this Report do not necessarily reflect the views of the UNDP or those of the Government of Sierra Leone (GoSL) Ministries, Departments and Agencies cooperating in the Project. Furthermore, the UNDP Sierra Leone does not guarantee the accuracy of the data and information included in this Report and accepts no responsibility for any consequence of their use. The boundaries, colours, denominations, and other information shown on any map in this work do not imply any judgment on the part of the UNDP Sierra Leone concerning the legal status of any territory or the endorsement or acceptance of such boundaries.

The sole responsibility of this Report lies with the Principal Author. INTEGEMS regrets any errors or omissions that may have been unwittingly made. Any queries on the information contained in this Report should be addressed to the Principal Author:

Julius Mattai
Integrated Geo-Information and Environmental Management Services (INTEGEMS)
8G Technical Institute Drive
Main Motor Road
Congo Cross
Freetown
Sierra Leone

Tel: +232 (0) 78 898 260
Email: info@integems.com
Website: www.integems.com

TABLE OF CONTENTS

CONFIDENTIAL INFORMATION DISCLAIMER i
TABLE OF CONTENTS ii
LIST OF FIGURES viii
LIST OF TABLES ix
CONTRIBUTORS x
ACKNOWLEDGEMENT xi
LIST OF ABBREVIATION AND ACRONYMS xii
DEFINITION OF KEY TERMS xvii
EXECUTIVE SUMMARY xxi
1 INTRODUCTION 1
1.1 Disaster Management in Sierra Leone 1
1.2 Sustainable Development and Disaster Management in Sierra Leone 2
1.2.1 Millennium Development Goals (2000-2015) 3
1.2.2 Agenda for Change (2008-2012) and Agenda for Prosperity (2013-2018) 4
1.2.3 Hyogo Framework of Action (HFA) 2005-2015 5
1.2.4 Sendai Framework for Disaster Risk Reduction 2015–2030 5
1.2.5 2030 Agenda for Sustainable Development Goals (SDGs) 6
1.3 Project Background 6
1.3.1 Project Objectives 8
1.3.2 Scope of Work 8
2 COUNTRY BACKGROUND 10
2.1 Geographical Context 10
2.2 Land Cover/Land Use 14
2.3 Climate and Weather 18
2.4 Administrative Divisions 20
2.5 Political Context 23
2.6 Socio-economic Context 23
2.7 Demography 25
2.8 Housing Infrastructure 31
2.9 Health Sector 34
2.10 Education Sector 37
2.11 Fishery Sector 37
2.12 Agriculture Sector 40
2.13 Transportation Sector 40
2.14 Energy Sector 43
2.15 Tourism Sector 43
2.16 Mining Sector 44
3 NEEDS ASSESSMENT OF EARLY WARNING COMMUNICATION NETWORK 47
3.1 Approach to the Needs Assessment 47
3.1.1 Challenges 48

3.1.2 System Architectures 49
3.1.3 Protocols 50
3.1.4 Security 50
3.2 Needs Assessment Methodology 51
3.3 Stakeholders Consultation Workshop 51
3.4 Key Informant Interviews 51
3.5 Information Technology Assessment - Hardware and Software 52
3.6 Desk-based Review of Project's Documents 52
3.7 Visit to the Sierra Leone Meteorological Department at Lungi Airport 53
3.8 Analysis of the Needs Assessment 54
3.8.1 GIS for Climate Information, Disaster Management and Early Warning (CIDMEW-GIS) 55
3.8.2 Data Creation and Maintenance 56
3.8.3 Computational Infrastructure 57
3.8.4 Client Services and Outreach 57
3.8.5 Metadata and Standards 58
3.8.6 Staffing 58
3.8.7 Training and Resources 58
3.9 Conclusion and Recommendation 59
3.9.1 Multi-hazard Early Warning System 60
3.9.2 Leverage Automatic Weather Stations and Forecasting Products 64
4 FIELD SURVEY 69
4.1 Study Areas 69
4.1.1 The Bumbuna Watershed around Bumbuna Dam 69
4.1.2 Inland Valley Swamps in Dodo Community, Kenema 69
4.2 Survey Research Methods and Tools 69
4.3 Consultations 70
4.4 Data Collection and Tools 72
4.5 Analyzing the Data 72
4.6 Key Findings 72
4.7 Recommendations and Conclusions 76
4.7.1 Recommendations 76
4.7.2 Communication with communities: Ensure government disaster management plans are quite comprehensible, accessible and shared with all communities. 77
4.7.3 Conclusions 77
5 COMMUNICATION AND AWARENESS RAISING STRATEGY 79
5.1 Contextual Background 79
5.1.1 Rationale of the Strategy 79
5.1.2 Goals and Objectives 80
5.1.3 SWOT ANALYSIS 81
5.1.4 Strategic Approach 86
5.2 Methodology for Developing the Strategy 86
6.1.1 Target Audience 86
6.1.2 Key Themes for the Strategy 88
6.1.3 Key Messages 88
6.1.4 Roles and Responsibilities 89
5.3 The Sierra Leone Red Cross Society and Partners 89
5.4 Private Sector 90

5.5 Community Leaders (Grassroots) 90
5.6 Civil Society Organisations 90
5.7 United Nations and Development Partners (DPs) 90
5.8 Media........ 91
5.9 Communication Tools and Channels 91
5.9.1 Radio 91
5.9.2 Television 91
5.9.3 Print Media 91
5.9.4 Social Media 92
5.9.5 Mobile Phones 92
5.9.6 Meetings and Social Gathering 92
5.9.7 Community Information Centres, Outreach and Fora/Platform 92
5.10 Information Generation and Flow 92
5.11 Dissemination 93
5.11.1 Weather Forecast 93
5.11.2 Advertising 94
5.11.3 Direct Engagement 94
5.11.4 Stakeholder Engagement 94
5.11.5 Advisory Services 94
5.12 Implementation of the Strategy 94
5.13 Strategy Implementation Matrix 95
5.14 Monitoring and Evaluation 112
5.14.1 Output indicators 112
5.14.2 Outcome Indicators 112
5.15 Implementation Budget 112
6 RESPONSE PLAN 113
6.1 Legislative and Policy Framework........Error! Bookmark not defined.
6.2 National Disaster Preparedness and Response Framework 113
6.3 Roles and Responsibilities of Institutions 114
6.3.1 Central Government 114
6.3.2 Local Government Councils 114
6.3.3 Relevant Local and International NGOs 114
6.3.4 The Sierra Leone Red Cross Society and Partners 115
6.3.5 Private Sector 115
6.3.6 Community Leaders (Grassroots) 115
6.3.7 Civil Society Movements 115
6.3.8 Specialize Agencies of the United Nations 116
6.4 Coordination at the Local, Regional and National Levels 116
6.5 Implementation of Disaster Preparedness and Response Plans 116
6.5.1 Policy Makers 116
6.5.2 Private Sector 117
6.5.3 Agriculturalists 117
6.5.4 Local Communities 118
6.6 Disaster Management 118
6.6.1 Levels of Disasters 118
6.6.2 Preparedness Planning 118
6.7 Disaster Response Mechanisms 119
6.8 General Measures for Disaster Response 120
6.9 Specific Measures 121

6.9.1 National Level ... 121
6.9.2 Regional Levels ... 122
6.9.3 District Levels ... 122

6.10 Response Coordination Mechanisms ... 123

6.11 Resource Allocation and Funding ... 123

6.12 Impact Assessment ... 124

6.13 Emergency Relief Services ... 125
6.13.1 Emergency Relief Centers ... 125
6.13.2 Evacuation ... 126
6.13.3 Search and Rescue ... 127

6.14 Post Disaster Response Mechanisms ... 127

6.15 Early Recovery ... 127
6.15.1 Transition to Recovery ... 128
6.15.2 Long-Term Recovery Strategy ... 129

6.16 Reconstruction and Rehabilitation ... 129

7 INFORMATION SHARING TOOLS ... 130

7.1 Overview ... 130

7.2 Purpose of Information Sharing ... 130

7.3 Methodological Approach ... 131
7.3.1 Strengthening Infrastructure and Technical Capacity of Local Community Radios ... 131
7.3.2 Information Sharing Tools ... 132
7.3.3 Key Messages ... 133
7.3.4 Awareness-Training Programme ... 135
7.3.5 Drills ... 136
7.3.6 Gender and Youth Mainstreaming ... 137

7.4 Knowledge Sharing Forums ... 138
7.4.1 Radio and Television ... 138
7.4.2 Telephones (Fixed and Mobile Phones, Social Media) ... 138
7.4.3 Megaphones & Mosque Speakers ... 138
7.4.4 Runners and Criers ... 139
7.4.5 Bells and Drums ... 139
7.4.6 Flags ... 139

7.5 Implementation of Training and Awareness Programme ... 140

7.6 Implementation Challenges ... 140
7.6.1 Radio and Television ... 141
7.6.2 Telephones (Fixed and Mobile Phones, Social Media) ... 141
7.6.3 Megaphones & Mosque speakers ... 142
7.6.4 Runners and Criers ... 142
7.6.5 Bells and Drums ... 142

8 CIDMEWS-SL ... 143

8.1 Development of the CIDMEWS-SL ... 144
8.1.1 Design and Development of the CIDMEWS-SL ... 144
8.1.2 Key Features of the CIDMEWS-SL ... 145
8.1.3 GIS-enabled and Web-based ... 146
8.1.4 Integration of Automatic Weather Stations ... 148
8.1.5 Mobile Technology ... 148
8.1.6 Crowdsourcing ... 149
8.1.7 Service-Oriented Architecture (SOA) ... 149
8.1.8 Infrastructure as a Service (IaaS) - Dedicated Cloud Server ... 150
8.1.9 Software as a Service (SaaS) - Hybrid Approach ... 151
8.1.10 Cloud-based Solution for the CIDMEWS-SL ... 151

8.1.11 ESRI ArcGIS Technology for CIDMEWS-SL 153
8.1.12 CIDMEWS-SL Data Management 155
8.1.13 CIDMEWS-SL Web Hosting and Management 156
8.2 CIDMEWS-SL Mapping Application 156
8.2.1 CIDMEWS-SL Mapping Application User Interface 159
1.1.2 Overview of the CIDMEWS-SL Widgets 161
8.3 The CIDMEWS-SL Geoportal 164
8.3.1 CIDMEWS-SL Geoportal Applications 166
8.4 CIDMEWS-SL Website 168
8.5 Sierra Leone Meteorological Services Website 172
8.6 Conclusion 173
8.7 Climate Information and Forecasting Products 173
8.8 All-in- One Automatic Weather Stations 174
8.8.1 Integrated Observation Suite 175
8.8.2 Analysis and Alerting Services 175
8.9 Hydrometeological Services 177
8.10 Multi-hazard Early Warning System 179
8.11 Dissemination of Early Warning Information 179
8.11.1 Adaptive Capacity and Sustainability Support 180
8.11.2 Applications of the AWS and CIDMEWS-SL 181
9 CAPACITY BUILDING 183
9.1 Need for Capacity Building 183
9.2 Capacity Building Objectives 184
9.3 Capacity Building Methodology 185
9.3.1 Stakeholder Consultations 185
9.4 Capacity Building Training Sessions 186
9.4.1 Training Objectives 186
9.4.2 Training Content 187
9.4.3 Training Programme 187
9.5 Capacity Building Exercises 187
9.5.1 Public Awareness 187
9.5.2 Media Campaigns 188
9.5.3 Participatory Learning 188
9.5.4 Informal Education 188
9.5.5 Plenary Sessions 190
9.5.6 Practical Demonstrations 190
9.6 Challenges 190
9.7 Recommendations and Way Forward 191
9.8 Conclusion 192
10 BIBLIOGRAPHY 193
11 APPENDIX A – STAKEHOLDER CONSULTATIVE WORKSHOP 197
11.1 Stakeholder Identification, Consultations and Workshop 198
11.1.1 Identification 198
11.1.2 Facilitation of the Stakeholder Consultative Workshop 201
11.1.3 Needs Assessment of Information Systems and Networks 215
11.1.4 Assessment of ICT Networks and Tools 215
11.2 Workshop Agenda 217

11.3 Workshop Participants ... 220
11.4 Workshop Photo Plates ... 222
12 APPENDIX C: NEEDS ASSESSMENTS RESULTS ... 228
12.1 Needs Assessment Summary Tables ... 228
12.1.1 Sierra Leone Meteorological Department (SLMD) ... 228
12.1.2 Office of National Security (ONS) ... 238
12.1.3 Environmental Protection Agency-Sierra Leone (EPA-SL) ... 243
12.1.4 Ministry of Water Resources (MWR) ... 255
12.2 Assessment of Communication Network Capability ... 261
12.3 Assessment Using the UN-ISDR Framework ... 261
12.3.1 Key Element 1: Risk Knowledge ... 263
12.3.2 Key Element 2: Monitoring and Warning Service ... 269
12.3.3 Key Element 3: Dissemination and Communication ... 276
12.3.4 Key Element 4: Response Capability ... 281
12.3.5 Key Element 5: Governance and Institutional Arrangements ... 285
12.4 Photo Plates ... 290

LIST OF FIGURES

Figure 3-1: Cross section of INTEGEMS staffs and personnel at the SLMD office in Lungi 53
Figure 3-2: Consultation with the SLMD personnel 54
Figure 4-1 Consultation with Goma Chief and Power Station Engineers at Dodo Chiefdom 71
Figure 4-2: Consultation with representatives of the EAU of BWMA 71
Figure 4-3: Emergency siren under construction in Bumbuna 74
Figure 4-4: Emergency meeting point at Kagbangona-Bumbuna 75
Figure 4-5: Emergency meeting point at Kadala- Bumbuna 75
Figure 5-1: Information Flow in the Implementation of Communication and Awareness Raising 93
Figure 6-1: Information flow in an emergency 121
Figure 6-2: Disaster victims evacuated to the National Stadium 126
Figure 6-3: Response strategies during flooding 127
Figure 8-1: Overview of the CIDMEWS-SL Architecture 147
Figure 8-2: User Interface of the CIDMEWS-SL Mapping Application on a Desktop 156
Figure 8-3: User Interface of the CIDMEWS-SL Mapping Application on an iPad 157
Figure 8-4: User Interface of the CIDMEWS-SL Mapping Application on a Samsung Galaxy Phone 157
Figure 8-5: User Interface of the CIDMEWS-SL Mapping Application with Key Tools and Widgets.. 159
Figure 8-6: CIDMEWS-SL User Interface Showing the Incident Analysis Widget 160
Figure 8-7: CIDMEWS-SL Mapping Application Showing Widgets and Tools 160
Figure 8-8: User Interface of the CIDMEWS-SL GeoPortal 165
Figure 8-9: User Interface of the CIDEWS-SL Website 169
Figure 8-10: User Interface of the CIDEWS-SL Mapping Application in the CIDMEWS-SL Website 170
Figure 8-11: User Interface of a Web Page of the CIDEWS-SL Website 171
Figure 8-12: Site Map of the CIDEWS-SL Website 171
Figure 8-13: User Interface of the SLMS Website 172
Figure 8-14: User Interface of the SLMS Website's Home Page 172
Figure 12-1: Consultations with Mr Kaindaneh at the SLMD 290
Figure 12-2: Work Stations donated for this project by UNDP and Earth Networks to the SLMD 290
Figure 12-3: Work Stations donated for this project by UNDP and Earth Networks to the SLMD 291
Figure 12-4: SLMD Server 291
Figure 12-5: SLMD Server Room/2nd Server 291
Figure 12-6: SLMD SLMD 2nd Server 291
Figure 12-7: Consultations with Mr Kamara, GIS Director, at the EPA-SL 291
Figure 12-8: Consultations with EPA-SL IT staff in the EPA server room 291
Figure 12-9: EPA-SL File Server 291
Figure 12-10: EPA-SL 2nd Server 291
Figure 12-11: Consultations with ONS GIS team 291
Figure 12-12: Consultations with ONS GIS team 291

Figure 12-13: Consultations with ONS IT team 291
Figure 12-14: ONS server room 291

LIST OF TABLES

Table 2-1: Sierra Leone land use/land cover time series 16
Table 2-2: Sierra Leone administrative entities 20
Table 2-3: Sierra Leone Country Profile 24
Table 2-4: Distribution of Population by Type, District and Sex 26
Table 2-5: Distribution of total population by region, district, sex and area of residence 27
Table 2-6: Distribution of total population by type, district and sex 28

Table 2-7: Total Population by age group, district and sex 29
Table 2-8: Stock of houses and households by region, district and area of residence 32
Table 2-9: Households by major material for construction of wall 33
Table 2-10: Number of Health Facilities by District, July 2015 34
Table 2-11: Households engaged in fishery by type of fish farming 38
Table 2-12: Length of roads by District 40
Table 2-13: Sources of Energy & Power Generated 43
Table 2-14: Major operations in the Mining Sector 46
Table 5-1: SWOT Analysis – Early Warning 81
Table 5-2: SWOT Analysis – Climate Information 84
Table 5-3: SWOT Analysis – CIDMEWS-SL 85
Table 5-4: Strategy Implementation Matrix 95
Table 7-1: 2015 Ownership of durable goods by District (Radio) 141
Table 7-2: 2015 Ownership of durable goods by District (Television) 141
Table 7-3: 2015 Ownership of durable goods by District (Mobile Phone) 141
Table 8:1 List of CIDMEWS-SL Functionality Widgets 160
Table 12:1 UN-ISDR Framework –Risk Knowledge Assessment 263
Table 12:2 UN-ISDR Framework – Monitoring and Warning Services Assessment 269
Table 12:3 UN-ISDR Framework –Dissemination and Communication Assessment 276
Table 12:4 UN-ISDR Framework –Response Capability Assessment 281
Table 12:5 UN-ISDR Framework –Governance and Institutional Assessment 285

CONTRIBUTORS

Project Management Team

Name of Organisation	Name	Designation
Integrated Geo-information and Environmental Management Services (INTEGEMS)	Julius Mattai	Principal Consultant
	Samuella Faulkner	Senior Consultant
	Koinguma Baimba	Consultant
	Mansa-Musa Kamara	Consultant
	Prince Kemoi	Consultant
	Amilia Conteh	Consultant
	Kenneth V S Koker	Consultant
	Mamoud Mansaray	Consultant
	Louisa Mattai	Consultant
	Hafisatu Sillah	Consultant
	Ibrahim Aziz Bangura	Consultant
	Sylvester Tucker	Consultant
	Mustapha Kargbo	Senior Consultant
	Abdul Steve Sesay	Senior Consultant
	Joseph Tucker	Consultant
	Donald Gbassa	Consultant
	Malal Jalloh	Consultant
	Leticia Gbondo	Consultant

Project Contribution

Name of Organisation	Name
United Nations Development Programme, Sierra Leone	Tanzila Sankoh
United Nations Development Programme, Sierra Leone	Joseph Kaindaneh
United Nations Industrial Development Organisation, Sierra Leone	Mariatu Swaray
Office of National Security	Ismail S T Tarawali
Office of National Security – Disaster Management Department	John V Rogers
Office of National Security – Disaster Management Department	Nabie Kamara
Office of National Security	Langumba Keili
Office of National Security	Mary Mye-Kamara
Sierra Leone Meteorological Agency (SLMA)	Sinneh Kamara
Sierra Leone Meteorological Agency (SLMA)	Patrick Musa
Sierra Leone Meteorological Agency (SLMA)	Gabriel Kpaka
Environment Protection Agency-Sierra Leone (EPA-SL)	Samuel Kamara
Ministry of Water Resources (MWR)	Mohamed Juana
Ministry of Water Resources (MWR)	Olaimatu S Karim

ACKNOWLEDGEMENT

We wish to extend our appreciation to the staff of the Office of National Security – Disaster Management Department (ONS-DMD), Sierra Leone Meteorological Agency (SLMA), the Ministry of Water Resources (MWR) and the Environment Protection Agency-Sierra Leone (EPA-SL), whose assistance made this Report possible. We are particularly grateful to the assistance availed to us by the United Nations Development Programme (UNDP) Sierra Leone Country Office and its staff, particularly the Energy, Environment and Natural Resource Management (EENRM) Cluster, especially for providing us with useful take off assistance and guidance to carry out the Support to Communication and Dialogue on Early Warning and Forecasting Products & Climate Information Project.

We specifically value the assistance given to us by Mr Joseph Kaindaneh, UNDP Climate Information and Early Warning System (CIEWS) Technical Consultant, who availed useful information and provided contacts for the Project and for being very cooperative during the soliciting of project information and for permission to meet and discuss with various Project stakeholders. Management and coordination for the development of the Project would not have been possible without the assistance of Mrs Tanzila Sankoh, current UNDP Programme Specialist- Environment Cluster, and Mrs Mariatu Swaray (former UNDP Programme Specialist, Energy, Environment and Natural Resource Management) who also availed INTEGEMS very useful management support, information and guidance for the Project.

We are also thankful to John V Rogers (Director, ONS-DMD), Samuel Kamara (Deputy Director of Natural Resources Management and GIS, EPA-SL), Mr Sinneh Kamara (Director of the SLMD) and Mr Mohamed Juana (Head of Water Resources, MWR) for their assistance and participation in the Stakeholders Workshop, consultative meetings and key informant interviews during the Capacity Gap Assessment phase of the Project.

We are also particularly thankful to the ONS Staff in the Districts, Members of the District Disaster Management Committees, District Council and Local Council Officers for their tireless assistance, especially in organizing and participating in the research survey and meetings in Bumbuna and Dodo, including field visits to the local areas of interest to the Project.

Lastly, but not least, we would like to thank all INTEGEMS staff and Associates and all those Government of Sierra Leone Ministries, Departments and Agencies (MDAs), non-governmental organisations (NGOs) and community-based organisations (CBOs) who, in a way or another contributed their efforts to make the Project a success.

Prepared by Integrated Geo-information and Environmental Management Services (INTEGEMS)

INTEGEMS

Integrated Geo-information and
Environmental Management Services

Julius Mattai | Project Manager and Principal Author| INTEGEMS,

Prepared for

United Nations Development Programme (UNDP) Sierra Leone Country Office

Office of National Security – Disaster Management Department (ONS-DMD)

Sierra Leone Meteorological Agency (SLMA)

Environment Protection Agency-Sierra Leone (EPA-SL)

Ministry of Water Resources (MWR)

LIST OF ABBREVIATION AND ACRONYMS

AFC	Agenda for Change
AFP	Agenda for Prosperity
API	Application Program Interface
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
AWS	Automatic Weather Station
AYV	Africa Young Voices
BEmONC	Basic Emergency Obstetric and Neonatal Care
BGS	British Geological Survey
BWMA	Bumbuna Watershed Management Authority
CAP	Common Alerting Protocol
CAS	Communications and Awareness Strategy
CBDM	Community-Based Disaster Management
CBEWS	Community-Based Early Warning Systems
CBIS	Community-Based Information Systems
CBOs	Community Based Organisations
CBWDS	Community-Based Warning Dissemination Systems
CEmONC	Comprehensive Obstetric and Neonatal Care
CERF	Central Emergency Relief Fund
CHC	Community Health Centre
CHP	Community Health Post
CHW	Community Health Workers
CIDMEWS-SL	Climate Information, Disaster Management and Early Warning System
CIEWS	Climate Information and Early Warning System
CIRDA	Climate Information for Resilient Development in Africa
CMDRR	Community Managed Disaster Risk Reduction
CMS	Content Management Systems
CRC	Constitutional Review Committee
CRED EM-DAT	Centre for Research Epidemiology of Disasters Emergency Events Database
CSOs	Civil Society Organisations
CSS	Cascading Style Sheets
CSV	Comma Separated Value
CZ	Coastal Zone
DaLA	Damage and Loss Assessment
DBMS	Database Management Systems
DC	District Council
DDMC	District Disaster Management Committee
DEM	Digital Elevation Model
DISEC	District Security Coordinator
DLG	Digital Line Graph
DM	Disaster Management
DMD	Disaster Management Department
DMIS	Disaster Management Information System
DMP	Disaster Management Policy
DMT	Disaster Management Team
DP	Demographic Profile

DREF	Disaster Relief Emergency Fund
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
DSM	Digital Surface Model
DTA	Dangerous Thunderstorm Alert
DTM	Digital Terrain Model
EAP	Emergency Action Plan
EAS	Emergency Alert System
EENRM	Energy Environment and Natural Resource Management
EEZ	Exclusive Economic Zone
EHSP	Environmental Health & Safety Plans
EIA	Environmental Impact Assessment
EIS	Emergency Information System
EMS	Environmental Management Systems
ENTLN	Earth Networks Total Lighting Network
EN	Earth Networks
EPA	Environmental Protection Act
EPA-SL	Environment Protection Agency –Sierra Leone
EPP	Emergency Preparedness Plan
ER	Emergency Relief
ESIA	Environmental and Social Impact Assessments
ESRI	Environmental System Research Institute
ETM	Enhanced Thematic Mapping
EUMETSAT	European Meteorological Satellite
EVD	Ebola Virus Disease
EW	Early Warning
EWCN	Early Warning Communication Network
EWS	Early Warning Systems
FAO	Food Agricultural Organisation
FF	Flash Flood
FOSS	Free Open Source Software
FTP	File Transfer Protocol
FY	Fiscal Year
GCM	Global Climate Models
GCP	Ground Control Points
GDEM	Global Digital Elevation Model
GDP	Gross Domestic Product
GEF	Global Environment Facility
GFDRR	Global Facility for Disaster Reduction Recovery
GIS	Geographical Information Systems
GoSL	Government of Sierra Leone
GPRS	General Packet Radio Service
GPS	Global Positioning Systems
GRNP	Gola Rainforest National Park
GSM	Global System for Mobile Communication
GUI	Graphical User Interface
HARPIS-SL	Hazard and Risk Profiles Information Systems-Sierra Leone
HEP	Hydroelectric Plant

HFA	Hyogo Framework
HTML	Hyper Text Markup Language
IaaS	Infrastructure as a Service
ICAO	International Civil Aviation Organisation
ICT	Information and Communication Technology
IEZ	Inshore Exclusive Zone
IFAD	International Fund for Agricultural Development
IFRC	International Federation of Red Cross
INGO	International Non-Governmental Organisation
INTEGEMS	Integrated Geo-information and Environmental Management Services
IP	Internet Protocol
ISDR	International Strategy for Disaster Reduction
ISP	Internet Service Provider
IT	Information Technology
ITCZ	Inter Tropical Convergence Zone
ITIL	Information Technology Infrastructure Library
IUCN	International Union for Conservation of Nature
JSON	JavaScript Object Notation
KAP	Knowledge, Attitude and Practices
KPI	Key Performance Indicator
KPP	Key Performance Parameter
LAN	Local Area Network
LHZ	Low Hazard Zone
LiDAR	Light Detection and Ranging
M&E	Monitoring & Evaluation
MAFFS	Ministry of Agriculture, Forestry and Food Security
MAP	Mitigation Action Plan
MCHP	Maternal and Child Health Post
MDAs	Ministries, Departments and Agencies
MDG	Millennium Development Goals
MEST	Ministry of Education, Science and Technology
MHEWS	Multi-Hazard Early Warning System
MHM	Multiple Hazard Maps
MIA	Ministry of Internal Affairs
MIS	Management Information Systems
MLCPE	Ministry of Lands Country Planning and the Environment
MLGRD	Ministry of Local Government and Rural Development
MLSS	Ministry of Labour and Social Services
MMRF	Ministry of Marine Resources and Fisheries
MoE	Ministry of Energy
MoHS	Ministry of Health and Sanitation
MSW	Municipal Solid Wastes
MSWGCA	Ministry of Social Welfare, Gender and Children's Affairs
MTA	Ministry of Transport and Aviation
MTCA	Ministry of Tourism and Cultural Affairs
MTI	Ministry of Trade and Industry
MWHI	Ministry of Works, Housing and Infrastructural
MWR	Ministry of Water Resources

NAPA	National Adaptation Programmes of Action
NASA	National Aeronautics and Space Administration
NBSAP	National Biodiversity Strategies and Action Plans
NDMP	National Disaster Management Policy
NDMWG	National Disaster Management Working Group
NGOs	Non-Governmental Organisations
NHA	National Hazard Assessment
NHAP	National Hazard Assessment Profile
NMHS	National Meteorological and Hydrological Services
NRIS	National Risk Information System
NSCC	National Secretariat for Climate Change
NSCIA	National Security and Central Intelligence Act
ODBC	Open Database Connectivity
ODK	Open Data Kit
OGC	Open Geospatial Consortium
OKNP	Outamba Kilimi National Park
ONS	Office of National Security
ONS-DMD	Office of National Security-Disaster Management Department
OSM	Open Street Map
PaaS	Platform as a Service
PCVA	Participatory Capacity Vulnerability Assessment
PDNA	Post Disaster Needs Assessment
PDRA	Participatory Disaster Risk Assessment
PHC	Population and Housing Census
PHU	Peripheral Health Units
PPP	Public Private Partnership
PROSEC	Provincial Security Coordinator
PSO	Public Sector Organisation
QA/QC	Quality Assurance/Quality Control
QGIS	Quantum Geographical Information Systems
RA	Risk Assessment
RADAR	Radio Detection and Ranging
RAID	Redundant Array of Independent Disks
RDBMS	Relational Database Management Systems
REDD	Reducing Emissions from Deforestation and Forest Degradation
REST	Representational State Transfer
RH	Risk Hazard
RMS	Root Mean Square
RSLAF	Republic of Sierra Leone Arm Forces
RSS	Really Simple Syndication
RWD	Responsive Web Design
SaaS	Software as a Service
SDE	Spatial Database Engine
SDG	Sustainable Development Goals
SEO	Search Engine Optimization
SIA	Social Impact Assessment
SLAA	Sierra Leone Aviation Authority
SLBC	Sierra Leone Broadcasting Corporation

SLEWRC	Sierra Leone Electricity and Water Regulatory Commission
SLMA[1]	Sierra Leone Maritime Agency
SLMA[2]	Sierra Leone Meteorological Agency
SLMD	Sierra Leone Meteorological Department
SLMS	Sierra Leone Meteorological Services
SLP	Sierra Leone Police
SLRA	Sierra Leone Roads Authority
SLTA	Sierra Leone Transportation and Aviation
SMS	Short Message Service
SNC	Second National Communication
SOA	Service-Oriented Architecture
SOAP	Simple Object Access Protocol
SOP	Standard Operating Procedures
SPI	Standard Precipitation Index
SRTM	Shuttle Radar Topography Mission
SSL	Secure Sockets Layer
SSL	Statistics Sierra Leone
SSR	Security Sector Reform
SST	Sea Surface Temperatures
STF	Sectoral Task Forces
SVG	Scalable Vector Graphic
TCP	Transmission Control Protocol
TCP/IP	Transmission Control Protocol/Internet Protocol
TOR	Terms Of Reference
UN	United Nations
UNDP	United Nations Development Program
UNECE	United Nations Economic Commission for Europe
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations Children Emergency Fund
UNISDR	United Nation International Strategy for Disaster Reduction
UNOPS	United Nations Office for Project Services
USL	University of Sierra Leone
UTF	Universal Transformation Format
VCA	Vulnerability Capacity Assessment
VDC	Village Development Committee
VLAN	Virtual Local Area Network
VNIR	Visible–Near Infrared
WAP-NAP	Western Area Peninsula National Park
WDI	World Development Indicators
WFP	World Food Programme
WFS	Web Feature Service
WIS	Warning Information System
WMO	World Meteorological Organisation
WMP	Waste Management Plan
WRA	Water Resource Areas
WSSD	World Summit on Sustainable Development
XML	Extensible Markup Language

DEFINITION OF KEY TERMS

Adaptation

The adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.

Capacity

A combination of all the strengths and resources available within a community, society or organisation that can reduce the level of risk, or the effects of a disaster. Capacity may include physical, institutional, social or economic means as well as skilled personal or collective attributes such as leadership and management. Capacity may also be described as capability.

Climate Change

The Inter-governmental Panel on Climate Change defines climate change as: “a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use.”

Disaster

A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources. Disasters are often described as a result of the combination of: the exposure to a hazard; the conditions of vulnerability that are present; and insufficient capacity or measures to reduce or cope with the potential negative consequences. Disaster impacts may include loss of life, injury, disease and other negative effects on human physical, mental and social well-being, together with damage to property, destruction of assets, loss of services, social and economic disruption and environmental degradation.

Disaster Risk

The potential disaster losses, in lives, health status, livelihoods, assets and services, which could occur to a particular community or a society over some specified future time period. The definition of disaster risk reflects the concept of disasters as the outcome of continuously present conditions of risk. Disaster risk comprises different types of potential losses which are often difficult to quantify. Nevertheless, with knowledge of the prevailing hazards and the patterns of population and socio-economic development, disaster risks can be assessed and mapped, in broad terms at least.

Disaster Risk Management

The systematic process of using administrative decisions, organisation, operational skills and capacities to implement policies, strategies and coping capacities of the society and communities to lessen the impacts of natural hazards and related environmental and technological disasters. This comprises all forms of activities, including structural and non-structural measures to avoid (prevention) or to limit (mitigation and preparedness) adverse effects of hazards

Disaster Risk Reduction

The concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events. A comprehensive approach to reduce disaster risks is set out in the United Nations endorsed Hyogo Framework for Action, adopted in 2005, whose expected outcome is “The substantial reduction of disaster losses, in lives and the social, economic and environmental assets of communities and countries.” The ISDR system provides a vehicle for cooperation among Governments, organisations and civil society actors to assist in the implementation of the Framework. Note that while the term “disaster reduction” is sometimes used, the term “disaster risk reduction” provides a better recognition of the ongoing nature of disaster risks and the ongoing potential to reduce these risks.

Early Warning System

The set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organisations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss. This definition encompasses the range of factors necessary to achieve effective responses to warnings. A people-centred early warning system necessarily comprises four key elements: knowledge of the risks; monitoring, analysis and forecasting of the hazards; communication or dissemination of alerts and warnings; and local capabilities to respond to the warnings received. The expression “end-to-end warning system” is also used to emphasize that warning systems need to span all steps from hazard detection through to community response.

Exposure

People, property, systems, or other elements present in hazard zones that are thereby subject to potential losses. Measures of exposure can include the number of people or types of assets in an area. These can be combined with the specific vulnerability of the exposed elements to any particular hazard to estimate the quantitative risks associated with that hazard in the area of interest.

Hazard

A dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage. There are hazards of natural origin and related environmental and technical hazard and risks. Such hazards arise from a variety of geological, meteorological, hydrological, oceanic, biological and technical sources, sometimes acting in combination. In technical settings, hazards are described quantitatively by the likely frequency of occurrence of different intensities for different areas, as determined from historical data or scientific analysis.

Mitigation

Structural and non-structural measures undertaken to limit the adverse impact of natural hazards, environmental degradation and technological hazards.

Natural Hazard

Natural process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage. Natural hazards are a sub-set of all hazards. The term is used to describe actual hazard events as well as the latent hazard conditions that may give rise to future events. Natural hazard events can be characterized by their magnitude or intensity, speed of onset, duration, and area of extent. For example, earthquakes have short durations and usually affect a relatively small region, whereas droughts are slow to develop and fade away and often affect large regions. In some cases hazards may be coupled, as in the flood caused by a hurricane or the tsunami that is created by an earthquake.

Preparedness

Activities and measures taken in advance to ensure effective response to the impact of hazards, including the issuance of timely and effective early warnings and the temporary evacuation of people and property from threatened locations.

Prevention

Activities to provide outright avoidance of the adverse impact of hazards and means to minimize related environmental, technological and biological disasters. Depending on social and technical feasibility and cost/benefit considerations, investing in preventive measures is justified in areas frequently affected by disasters. In the context of public awareness and education, related to disaster risk reduction changing attitudes and behaviour contribute to promoting a ‘culture of prevention’.

Recovery

Decisions and actions taken after a disaster with a view to restoring or improving the pre-disaster living conditions of the stricken community, while encouraging and facilitating necessary adjustments to reduce disaster risk. Recovery (rehabilitation and reconstruction) affords an opportunity to develop and apply disaster risk reduction measures.

Response

The provision of assistance or intervention during or immediately after a disaster to meet the life preservation and basic subsistence needs of those people affected. It can be of an immediate, short-term, or protracted duration.

Resilience

The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions. The resilience of a community in respect to potential hazard events is determined by the degree to which the community has the necessary resources and is capable of organizing itself both prior to and during times of need.

Return Period

A return period, also known as a recurrence interval or repeat interval, is an estimate of the likelihood of an event to occur. It is a statistical measurement typically based on historical data denoting the average recurrence interval over an extended period of time. The theoretical period is the inverse of the probability that the event will be exceeded in any other year. For example, a 25 year flood has a 1/25 = 0.25 or 25% chance of being exceeded in any one year. Despite the connotations of the name “return period”, it does not mean that a 25 year flood will happen regularly every 25 years or only once in 25 years.

Risk

The combination of the probability of an event and its negative consequences.

Risk Analysis

The process to comprehend the nature of risk and to determine the level of risk (ISO 31010).

Risk Assessment

A methodology to determine the nature and extent of risk by analysing potential hazards and evaluating existing conditions of vulnerability that together could potentially harm exposed people, property, services, livelihoods and the environment on which they depend. Risk assessments (and associated risk mapping) include: a review of the technical characteristics of hazards such as their location, intensity, frequency and probability; the analysis of exposure and vulnerability including the physical social, health, economic and environmental dimensions; and the evaluation of the effectiveness of prevailing and alternative coping capacities in respect to likely risk scenarios. This series of activities is sometimes known as a risk analysis process.

Single-risk assessments and multi-risk assessments Single-risk assessments determine the singular risk (i.e. likelihood and consequences) of one particular hazard (e.g. flood) or one particular type of hazard (e.g. flooding) occurring in a particular geographic area during a given period of time. Multi-risk assessments determine the total risk from several hazards either occurring at the same time or shortly following each other, because they are dependent from one another or because they are caused by the same triggering event or hazard; or merely threatening the same elements at risk (vulnerable/ exposed elements) without chronological coincidence.

Susceptibility

Refers to the propensity (i.e. a natural tendency that you have to behave in a particular way.) of a particular receptor to experience harm. It reflects an intrinsic property of an object.

Vulnerability

The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard. There are many aspects of vulnerability, arising from various physical, social, economic, and environmental factors. Examples may include poor design and construction of buildings, inadequate protection of assets, lack of public information and awareness, limited official recognition of risks and preparedness measures, and disregard for wise environmental management. Vulnerability varies significantly within a community and over time. This definition identifies vulnerability as a characteristic of the element of interest (community, system or asset) which is independent of its exposure.

EXECUTIVE SUMMARY

Sierra Leone is the third most vulnerable country in the world to the adverse effects of climate change

Sierra Leone has been ranked as the third most vulnerable country in the world to the adverse effects of climate change, after Bangladesh and Guinea Bissau. Extreme precipitation and sea level rise increasingly threatens coastal areas with flooding and erosion. In Sierra Leone, the average annual temperature is projected to increase between 1.0° C and 2.6° C by the 2060s and 1.5° C and 4.6° C by the 2090s. Sea level is projected increase between 0.4 m to 0.7 m by 2100[1]. The vulnerable population has low capacity to adapt to climate change and the rural populations will be the most affected because of their high dependence on rain-fed agriculture and natural resource-based livelihoods. According to analyses done in 2012 for the development of Sierra Leone's Second National Communication (SNC) to the United Nations Framework Convention on Climate Change (UNFCCC), climate change will lead to severe consequences in Sierra Leone including: decreased agricultural productivity, degradation of the coastline and damage to coastal structures, a shift from tropical rain forest to dry forest, food and nutrition insecurity, water stress and severe economic impacts that will undermine decades of development gains.

Growing number of manmade and natural disasters in recent decades

Sierra Leone experienced a growing number of manmade and natural disasters in recent decades, causing physical, social and economic damages and losses. The best known amongst these disasters are: the civil war (1990–2002); the cholera epidemic (2012); and the Ebola virus disease (EVD) that devastated the country from May 2014 to November 2015, during which more than 14,000 Sierra Leoneans were infected, and more than 3,000 died of the disease. Many of Sierra Leone's urban poor bear the brunt of disasters because they live in high-density conditions in degraded slums, and lack access to basic services such as a water supply, sanitation, health and education.

Disasters will remain to be a major problem in Sierra Leone and a serious threat to sustainable development. Their impacts are diverse: as well as loss of life, injury and disease and the destruction of property and other assets, disasters can also cause social and economic disruption, loss of infrastructure and other services and damage to the environment. Poverty, increased population density, urbanisation, climate change and changes in building practices and materials and access to safe land are some of the many reasons why risk of hazard, disaster and human vulnerability are increasing in Sierra Leone. Disaster damages and losses take away the hard earned development gains. On the other hand, relief, compensation and rehabilitation/reconstruction needs after disaster events utilize the meagre resources that otherwise could be used for development, and provide for education, health and other long term social investments.

Mainstreaming disaster risk reduction and disaster risk management

A number of studies have demonstrated that unplanned urbanisation, deforestation and environmental degradation and inappropriate land use are they key factors contributing to the increase in disasters in Sierra Leone. Thus, mainstreaming disaster risk reduction and disaster risk management concepts in Sierra Leone's development strategies, plans, programmes and projects are crucial and imperative. The Government of Sierra Leone (GoSL), through its national development strategies (Agenda for Change: 2008-2012; and Agenda for Prosperity: 2013-2018) and the Millennium Development Goals (MDGs) has been able to accelerate the country's development programme and also meet some of the goals and targets set by the MDGs and the Hyogo Framework of Action (HFA) 2005-2015: Building the Resilience of Nations and Communities to Disasters. Furthermore, the GoSL is currently working to achieve the goals and target of the Sendai Framework and the 2030 Agenda for Sustainable Development Goals (SDGs).

[1] https://www.gfdrr.org/sierra-leone

ONS Disaster Management Department (ONS-DMD) coordinates disaster management

In 2002, the GoSL enacted the National Security and Central Intelligence Act (NSCIA 2002) and Section 18, sub-section IV of this Act mandates the Office of National Security (ONS) to be 'the GoSL's primary coordinator for the management of national emergencies such as disasters - both natural and man-made'. The ONS Disaster Management Department (ONS-DMD) coordinates disaster management at various levels through multi-sectoral platform to address the underlying issues of disaster preparedness, prevention, mitigation, response and recovery/rehabilitation. The main strategic objectives of the ONS on risk and disaster management include improved identification and assessment of disaster risks, integrated disaster risk management into development effort, and the preparation of a National Disaster Management Plan (NDMP).

After the flooding in Sierra Leone in September 2015, the ONS-DMD started paying more attention to early warning and pre-emptive disaster management system and there has been a paradigm shift to become more proactive with emphasis on disaster prevention, mitigation and preparedness. Although the ONS-DMD and other relevant MDAs are contributing much in preventing loss of life through effective pre-disaster warning system, the communication networks are been severely damaged due to lack of robustness. The traditional ways of disseminating disaster early warnings in Sierra Leone have been through radio and television, military forces and early warning towers. However, during a disaster situation, there are important limitations – mass media channels are not always switched on, and other channels have limited reach.

Weather and climate information can help mitigate against disaster risks

While the term 'weather' is the state of the atmosphere at a given time and place with respect to variables such as temperature, moisture, wind and barometric pressure, the term 'climate' is typically defined as the average weather over a long period of time. End-users of climate and weather information produced by national, regional and international agencies face various challenges when it comes to applying the information they receive to decision-making. Some of these challenges are related to factors such as quality of the information products, not having information at appropriate scales and difficulties in communicating and interpreting the information produced. Climate information and forecasts can cover varying timescales, such as short-range (e.g. up to a few days), medium-range (e.g. from weeks up to a month) and long-range (e.g. greater than one month, including seasonal time scale). Climate information also includes projections and scenarios (e.g. decadal and longer).

The seamless integration of weather and climate information can help mitigate against disaster risks, weather and climate variability, climate extremes and other related events that threaten vulnerable communities in Sierra Leone. Climate information is generated through observation, monitoring and analysis conducted by meteorologists and climate science-related researchers. This information is becoming an integral part of disaster risk reduction and disaster risk management and is seen as vital to enhancing people's capacity to deal with the impacts of climate change. This involves decision-making on the basis of short-, medium-, and long-term scenarios, foreseeing the problems and opportunities associated with these – and the uncertainties. There are many starting points, but an obvious one is to improve the availability, quality and use of climate information. To do this, reliable, relevant, accessible, useable, credible and understandable climate information are needed.

Climate information plays a central role in robust adaptation strategies

Climate information plays a central role in the planning and development of robust adaptation strategies at all levels, and in advising decision- or policy-makers on climate-sensitive matters, disaster management and early warnings. Thus, knowledge and information about weather, climate and climate change are crucial for meaningful climate action. In order to be successful, adaptation strategies need to make use of the best available weather and climate information, including assessments of recent climatic trends and projected future climate change that may be experienced in the years to come. The weather and climate information needed by local level communities and the Government of Sierra Leone (GoSL) includes how climate variables such as temperature and rainfall, and the timing and severity of floods, storms and climate extremes may change. In order to be both useful and used, this information needs to be timely, high quality, relevant and accessible. Meeting these needs is the focus of this Report, which aims to bridge the gap between climate information, disaster management and early warning systems, including the science, policy and practice for adaptation decision-making and disaster risks, hazards and resilience.

Sierra Leone's Implementing Agencies face a myriad of challenges relating to weather and climate information

However, Sierra Leone faces a myriad of challenges relating to the deployment of weather and climate monitoring systems, maintenance and operation of hydro-meteorological monitoring stations and reaching end users with actionable early warning information that can save lives, improve productivity and foster greater resilience. These challenges invariably include lack of capacity, including out-of-date institutional structures, inadequate local financial support, lack of technical infrastructure, lack of trained and experienced staff, and poor integration between disparate donor-supported investments in the hydro-meteorological, disaster management and early warning services space. Furthermore, the lack of a robust and high-bandwidth Internet connections at the relevant ministries, departments and agencies (MDAs) and associated facilities does not allow for the rapid transmission of weather data and imagery and timely communication of warnings as well as the collection of real-time weather data, which is valuable for short-term-weather and long-term- climate forecasts. Integrating diverse observation platforms, telecommunications, data processing computers, analysis and assimilation systems, numerical models, and forecaster work stations into an end-to-end system is a persistent engineering challenge for the GoSL, especially the Sierra Leone Meteorological Department (SLMD).

One way to support effective climate change adaptation planning in Sierra Leone is to comprehensively assess the early warning communications networks to improve climate monitoring and early warning systems through the enhancement of the technical and technology capacities of the relevant mandated institutions – SLMD, Office of National Security-Disaster Management Department (ONS-DMD), Ministry of Water Resources (MWR) and the Environment Protection Agency-Sierra Leone (EPA-SL). However, the stumbling blocks in the path include the present limited or non-existence of systematic processes for packaging, translating and disseminating climate information and warnings, lack of technically skilled human resources and poor community level usage of climate information and responses to received warnings. This is as a result of a number of policies, institutional, financial, technological and informational barriers that exist in the country.

Although some form of early warning systems exists in Sierra Leone, they require assessment, monitoring and review from time to time to keep the systems updated. One way to support effective climate change adaptation planning in Sierra Leone is to comprehensively assess the early warning communications networks to improve climate monitoring and early warning systems through the enhancement of the technical and technology capacities of the relevant mandated institutions – SLMD, ONS-DMD, MWR and the EPA-SL. However, the obstacles in the path include the present limited or non-existence of systematic processes for packaging, translating and disseminating climate information and warnings, lack of technically skilled human resources and poor community level usage of climate information and responses to received warnings. This is because of a number of policies, institutional, financial, technological and informational barriers that exist in national, provincial, district and community levels in Sierra Leone:

- Obsolete and inadequate weather, climate and hydrological monitoring infrastructure, which limits data collection, analysis and provision of meteorological services;
- Limited knowledge and capacity to effectively predict future climate events as a result of an acute shortage of technology and skilled human resources;
- No systematic process for packaging, translating and disseminating weather/climate information and warnings – including different information sources across – and within country borders;
- Lack of maintenance of observational infrastructure and limited technically skilled human resources to operate the systems; and
- Poor community level usage of climate information because of the limited consolidation of effective dissemination channels including physical mechanisms and limited trust in warnings received.

UNDP's Support to Communication and Dialogue on Early Warning and Forecasting Products & Climate Information Project

The UNDP's Multi Country Programme, "Climate Information for Resilient Development and Adaptation to Climate Change in Africa (CIRDA)", supports Climate Information and Early-Warning Systems (CIEWS) Projects in 11 of Africa's Least Developed Countries[2] in their missions to save lives and improve livelihoods. The Multi Country Programme is being implemented by the UNDP with funding from the Global Environment Facility (GEF) Least Developed Country Fund (LDCF) and is an example of the concrete actions that the UN is taking to reduce the impacts of climate change in all development sectors. The CIRDA Programme[3] aims to strengthen the capacity of Africa's 11 Least Developed Countries and the region to develop and operate modern climate information and early warning systems by making available technical assistance and providing access to new technologies.

Hence, in September 2016, the United Nations Development Programme (UNDP) Sierra Leone Country Office contracted Integrated Geo-information and Environmental Management Services (INTEGEMS)[4] to provide consultancy services for a Support to Communication and Dialogue on Early Warning and Forecasting Products & Climate Information Project.

To avail Sierra Leone with the opportunity to better manage climate hazards, food security and agricultural production, scarce and dwindling water resources and make its socioeconomic development process less vulnerable to climate-related risks, the Support to Communication and Dialogue on Early Warning and Forecasting Products & Climate Information Project aims to:

- Enhance the capacity of hydro-meteorological services and networks in Sierra Leone to monitor and predict weather and climate events and associated risks e.g. floods, droughts and severe storms;
- Develop effective and efficient ways of packaging weather and climate information, including contextualising with other environmental and socio-economic data to produce early warnings/alerts and advisories; and
- Support improved and timely preparedness and response to weather and climate information and early warnings, including efficient delivery mechanisms using radio.

Earth Networks All-in-One Automatic Weather Stations installed across Sierra Leone

Earth Networks[5], under a contract with the UNDP, in late 2016 installed a baseline network of integrated compact automated weather and lightning sensors on communications towers in eight secured locations across Sierra Leone. These automatic weather stations (AWS) exploit the capabilities of the latest generation of smart, integrated, all-in-one (AIO) AWS, supplemented where necessary, by even more powerful stand-alone data loggers, to provide sustainable observing. These AWS also exploit the cell-phone network to link the AWS to a central data collection facility that provides the foundation for real-time nowcasting and advance storm warnings; precipitation monitoring and accumulation estimates; and forecasting on a variety of timescales.

This has eliminated the need for human observers, handwritten observing forms, and calling or mailing in the recorded observations to a central office. Within a few seconds of being made, observations from these AWS spread across a wide region are collected at a central location, quality-checked using a consistent set of rules, archived, and made available for use by forecasters, climatologists and other users. The AWS are now 'smart', incorporating an on-board computer that autonomously provides for the generation and transmission of formatted meteorological reports, changing sampling rates and/ or special observations when preset environmental thresholds are crossed, and providing alert messages when preset thresholds in key variables are exceeded.

[2] Benin, Burkina Faso, Ethiopia, The Gambia, Liberia, Malawi, Sierra Leone, Sao Tome and Principe, Tanzania, Uganda and Zambia

[3] http://undp-cirda.blogspot.com/p/about.html
[4] http://www.integems.com
[5] http://www.earthnetworks.com

Sustainable solutions for local weather, water and climate monitoring and forecasting

Sustainable solutions for local weather, water and climate (collectively known as 'hydrometeorological') monitoring and forecasting to produce timely and reliable local hydrometeorological information are critical to Sierra Leone, as it is highly vulnerable to climate change. Modern national hydrometeorological systems, with end-to-end systems for monitoring, analyzing, and skilfully predicting weather, water and climate events, are needed as they can save lives and reduce the costs of disaster relief and reconstruction on the one hand, while improving the daily lives of a large portion of the population and Sierra Leone's economic vitality on the other. These localized hydrometeorological and disaster management information are also essential for protecting lives, sustaining and improving livelihoods, and building local and national resilience. At a minimum, early warnings are needed to protect lives and livelihoods from hazardous weather and water events in the short term. From a broader perspective, climate information, disaster management and early warning systems are critical to supporting the adaptive measures necessary to ensure Sierra Leone's survival in the longer term.

In the Project, the data streams from the AWS are merged with other spatial data such as terrain/elevation, soil type and vegetative cover, as well as the output of Numerical Weather Prediction (NWP) models, to produce weather, water and climate information. These information are then used to produce a host of products and services with a wide range of applications. These services can be as diverse as a warning based on a short-term forecast, or 'nowcast' of the projected path of an evolving, moving thunderstorm.

Effective early warning system needs effective communication network systems

With the advent of information and communication technologies (ICT), there has been increased demand of ICT-based disaster management, meteorological, climatic and hydrological data and early warning information system at the national, regional and local platforms. At the national level, several GoSL ministries, departments and agencies (MDAs), non-governmental organisations (NGOs), community-based organisations (CBOs) and actors are playing increasingly crucial role in the overall disaster management, meteorological, climatic and hydrological data and information systems and community-based disaster preparedness activities.

An effective early warning system needs effective communication network systems, which have two main components: 1) communication infrastructure hardware that must be reliable and robust, especially during the disaster; and 2) appropriate and effective interactions among the main actors of the early warning process, such as the scientific community, stakeholders, decision makers, the public, and the media. Many communication tools are currently available for disaster management, hydrometeorological and climate data and early warning information dissemination, such as Short Message Service (SMS), social media (WhatsApp, Twitter, etc.), and email, radio, TV and web service. Disaster warning/alerting authorities like the SLMD and ONS have long relied on media, such as radio and television to help disseminate public warnings. Television stations like Sierra Leone Broadcasting Corporation (SLBC), African Young Voices (AYV) and STAR TV insert crawl text with the warning message, and radio stations like SLBC and Radio Democracy insert a recording.

Despite the urgency, the conventional ways of doing things at the SLMD and the ONS has yet to deliver critical climate information and early warning services to key stakeholders—including farmers, vulnerable communities and policymakers—to enable them to understand and manage their hydrometeorological risks. The Project is already changing conventional ways of doing things, creating custom-built solutions, ensuring the long-term sustainability of investments, incapacitating an existing lack of trust between the public and private sectors, and creating different ways of operating that focus on going beyond the procurement of technologies to an end-to-end systematic approach.

A Paradigm Shift: Climate Information, Disaster Management and Early Warning System-Sierra Leone

The Climate Information, Disaster Management and Early Warning System-Sierra Leone (CIDMEWS-SL) integrates Geographic Information Systems (GIS) and Management Information System (MIS) systems and mobile data collection technology to provide a family of sophisticated tools and Web services for collecting, managing, visualizing, mapping, analysing, monitoring, evaluating and reporting on various aspects of climatological, hydro-meteorological, disaster management and early warning information in Sierra Leone.

The CIDMEWS-SL has been developed to standardize, interoperate, integrate and centralize information, responses and early warnings, about all disaster management, meteorological, climatological, environmental and hydrological hazards that are pertinent to a given level/entity with careful attention to resilience and vulnerability. The CIDMEWS-SL has been developed on the basis of a systematic analysis and prioritization of a set of threats and hazards to develop and disseminate weather and forecasting products, climate information and early warnings to the GoSL, MDAs; international and national NGOs; CBOs; Development Partners; private sector organisations; academia and the general public to enable early preparation against disasters such as floods and other severe weather stresses.

The CIDMEWS-SL comprises tools to allow users to report information about unfolding disaster using mobile devices and Internet/Web based enabled devices. It makes it easier to plot disaster location on Web map without necessarily having mapping skills. The reported information becomes readily available to both survivors and disaster management personnel so that they can make well informed decisions about unfolding events of a given disaster that is being reported. The CIDMEWS-SL platform also allows collection of data through crowdsourcing with the use of mobile and Internet/Web enabled device applications. This information gathering and sharing can be effectively achieved through voluntary data collection by use of mobile devices and social media which currently dominate the revolution of Web 2.0 and growth in Internet use.

CIDMEWS-SL provides new ways of collecting, analysing, mapping and communicating weather, water, disasters and climate information. It also provides opportunities to enhance the capacity of the SLMD, ONS-DMD, MWR and the EPA-SL to issue early warnings of fast-acting storms and extreme weather events and to prepare for climate change, and to achieve other economic, environmental and social goals simultaneously. CIDMEWS-SL can be used to disseminate authoritative weather information and warnings to the public, media and disaster management authorities.

CIDMEWS-SL provides the SLMD, ONS, EPA-SL, MWR and other relevant organisations with the ability to anticipate the onset of severe weather later in the day, then monitor it in real time and deliver effective warnings for the imminent arrival of hazardous events such as severe thunderstorms and flash flooding. Accomplishing this task requires a well-synchronized forecast centre able to blend real-time observations with radar or lightning-locating data, hydrologic data, and satellite imagery to identify the onset of hazardous weather, monitor the developments and movements that are indicative of severe weather, carry out continuous nowcasting of the future path of the hazard, and communicate warnings to the regions in the path of the storms.

CIDMEWS-SL Website: Information resources from any device, anywhere, at any time

The CIDMEWS-SL Content Management System (CMS) Website (https://www.cidmews-sl.solutions) takes full advantage of the flexibility of features offered by Joomla CMS with array functions and modules that can be easily added to over time without costly redesigns to interfaces and templates. Designed with end users in mind, the CIDMEWS-SL Website's responsive web design (RWD) and multi-device design technologies uses the gantry framework to ensure the site is highly mobile-accessible and viewable on all screen sizes (from desktops to smartphones). The CIDMEWS-SL Website promotes the SLMD, ONS-DMD, EPA-SL and MWR to all stakeholders using media (picture, audio, and video) to highlight climate, disaster management, hydrometeorological and early warning systems events at SLMD, ONS-DMD, EPA-SL and MWR.

Acting as a discussion forum on on-going climate, disaster management, hydrometeorological and early warning systems projects, CIDMEWS-SL CMS informs and connects to a larger audience by integrating social media (Twitter, Facebook). Visitors to the site can access relevant CIDMEWS-SL information in a timely and consistent manner. Climate, disaster management, hydrometeorological and early warning systems information are presented in a non-technical and visually appealing manner incorporating a well thought out site-flow and information architecture. Information is organised clearly to facilitate access to relevant information and content easily searchable. All pages feature similar and consistent navigation controls with a minimum number of clicks required for navigation. Clear and intuitive labels, controls are grouped into logical units.

CIDMEWS-SL Mapping Application: Visualizing climate information, disaster management and early warning data and information

The CIDMEWS-SL Mapping Application (accessed via **https://cidmews-sl.solutions**) is a GIS Web mapping application that provides easy and convenient ways to collect, map, explore, query, analyze and freely share available climate information, disaster management and early warning data and information resources from any device, anywhere, at any time. The integrated and interactive CIDMEWS-SL Web Mapping Application has been embedded in the CIDMEWS-SL CMS Website's Home Page and menu to allow users to interactively and effectively create, edit, publish, review, and collaborate on climate information, disaster management and early warning mapping, updating and managing development project locations and attributes through a robust, easy-to-use Web browser. The CIDMEWS-SL Web mapping application exposes SLMD meteorological data and geospatial services from the server and streams the results, expediting the discovery, transfer and utilisation of climate information, disaster management and early warning data and information by the ONS-DMD and SLMD to various stakeholders.

The ability of stakeholders to make sound disaster management decisions – to analyze risks and decide upon appropriate counter-measures - is greatly enhanced by the cross-sectoral integration of information within the CIDMEWS-SL. For example, to understand the full short- and long-term implications of floods and to plan accordingly requires the analysis of multiple and combined data on meteorology, topography, soil characteristics, vegetation, hydrology, settlements, infrastructure, transportation, population, socio-economics and material resources.

CIDMEWS-SL Geoportal Applications: Creating a collaboration platform across disaster and emergency management organisations

The CIDMEWS-SL GeoPortal enables registered ONS, SLMD, EPA-SL and MWR staff to create, store and access both locally hosted and Cloud-hosted contents, which are comprised of GIS Web services, maps and configurable applications. It specifically allows the ONS-DMD to use the entire platform to collaborate, catalogue and share maps and applications with members of other hydrometeorological, disaster management and early warning organisations or constituents of Sierra Leone. Additionally, the CIDMEWS-SL GeoPortal can be used by various organisations to lay the foundation for creating a collaboration pattern across disaster and emergency management organisations, establish a pattern for each disaster and emergency management organisation to use the platform and fosters sharing and collaboration across each pattern.

The Implementing Partners (i.e., ONS, SLMD, EPA-SL and MWR) have been fully subscribed to the CIDMEWS-SL GeoPortal and can use it to manage, create, store, and access hosted services, maps and applications. Other GoSL MDAs, Development Partners, NGOs and INGOs, CBO and other organisations can subscribe to the platform through the ONS and use it to access various hosted services, maps and applications.

The CIDMEWS-SL Geoportal includes the following Applications:

- Preparedness: Empowers the relevant MDAs to map and model potential plans, communicate with citizens regarding resources within their communities, analyze hazards and critical vulnerabilities, and plan for special events.
- Mitigation: Assess and analyze risk and vulnerabilities, evaluate potential impacts, engage organizations in mitigation efforts, understand the status of mitigation projects, and communicate the status of mitigation plans.
- Response: Deliver situational awareness, assess impacts to the community post-event, communicate state of infrastructure with the public, and understand the impact of an event using focused applications and common tools.
- Recovery: Provide applications for the public to report information about the community, and deploy tools within the organization to collect and communicate status regarding debris and damage.

Disseminating Climate Information and Early Warning Information

Earth Network's StreamerRT Web-Based Display System (StreamerRT) is a real-time weather decision system that provides a fully interactive mapping platform with a comprehensive collection of weather data. CIDMEWS-SL users have the ability to monitor real-time station observation data from the WeatherBug network and overlay numerous enhanced data sets to stay up-to-date with significant weather events before and after they develop.

MDAs and other stakeholders can use StreamerRT to create the customized Views that are important to them and then monitor the weather through easy access to Views, Slideshows of Views and animations. StreamerRT has a comprehensive and user-friendly tool for visualization of live and forecast weather conditions and real-time situational awareness at local, regional, national and international levels for critical decision-making.

StreamerRT has a Mobile Phone Weather Content and Alerting functionality for:

- Location based warning for feature / smart phones
- All mobile platforms like iOS, Android, Win 8, etc.
- Push notification
- Hazard proximity alerts
- Current weather conditions
- Detailed forecast content

On-line Communications Portal Setup

- Regular blog postings of important weather information and alerts
- Communication vehicle for technology transfer
- Intergovernmental exchange of best practices

Automated and manual content delivery to decision-makers and the general public using unique early warning system data that is collected locally and analyzed in real-time. Automated alert types can include: current weather observations, lightning strikes, flooding, DTAs and severe weather alerting, hourly forecast information. The early warning system technology enables the SLMD and other MDAs and stakeholders to deliver alerting via multiple optional channels:

- GIS display systems for the SLMD and third parties (including APIs)
- SMS, text, email as well as mobile applications
- TV, radio, internet, and bulletin broadcast
- Specialized outdoor alerting devices
- In combination with other information (agriculture, health, energy)

The Project has propelled the challenging work of modernizing the SLMD's hydrometeorological services forward over both the short and long term. Through the Project, stock was taken of existing assets, identified obstacles and looked critically at the past in rehabilitating the SLMD's hydrometeorological monitoring and forecasting infrastructure, and creating sustainable solutions that leverage better hydrometeorological information to improve the livelihoods of Sierra Leone's poorest, most vulnerable communities.

Structure of this Report

This Report is divided into 12 chapters as outlined below:

Chapter 1 presents the contextual background to this Report.

Chapter 2 presents country background and information necessary for contextualising the hazard profile and vulnerability and risk assessments described in this Report. It provides a synopsis of the geography, climate, administrative divisions, socio-economic and political contexts, demographic information and land cover/land use in Sierra Leone, including housing, health, education, fishery, agriculture, transportation, energy, tourism and mining sectors in Sierra Leone with their spatial distributions.

Chapter 3 provides a detailed assessment of the early warning communications network within and between the four relevant MDAs and gap assessment in existing early warning system at the institutional levels was carried out through key informant interviews and consultative meetings.

Chapter 4 discusses the field survey that generated significant findings in terms of knowledge attitudes and practices regarding natural disasters across Bumbuna and Dodo communities using representative sample of the study population as a whole. This consisted of focus group discussions, key informant interviews and direct observations focusing on the four key areas of UNISDR people centred approach for disaster risk reduction including risk knowledge, monitoring and prediction, communication and dissemination and response capacity.

Chapter 5 discusses the communication strategies employed to realize the Project's objectives at various levels, including policy, institutional national and local. The method and tools employed in this strategy includes the effective issuance and packaging of early warnings as well as the creation of supportive communications products and outreach efforts that will support the long-term sustainability of investments in the climate information, disaster management and early warning systems.

Chapter 6 discusses integrated disaster management authorities, policies, procedures and resources of the central and local government, UN Agencies as well as NGOs, private sectors, local communities and international sources constitute the national disaster response framework for assistance delivery following major disasters.

Chapter 7 presents the approach to sharing climate and hydrometeorological information by leveraging ICT; especially, mobile telephone short messaging services (SMS). The Chapter explores some of the ways in which stakeholders can collaborate with the local communities to generate and share local information.

Chapter 8 elaborates the design and development of the Climate Information, Disaster Management and Early Warning System-Sierra Leone (CIDMEWS-SL) that integrates GIS and MIS systems and mobile data collection technology to provide a family of sophisticated tools and Web services for collecting, managing, visualizing, mapping, analysing, monitoring, evaluating and reporting on various aspects of climatological, hydro-meteorological, disaster management and early warning information in Sierra Leone.

Chapter 9 discusses the need for Improvements in public weather services, by creating awareness and education programmes, campaigns, targeted initiatives and media outreach to help effectively communicate climate, disaster and early warning information.

Chapter 10 provides the bibliography used in the compilation of this Report.

Chapter 11 and **Chapter 12** contain Appendices A and B, which concludes the Report with a summary of the proceedings of the Stakeholders Workshop held in Freetown in October 2016, including photo plates; and the analysis and results from the Needs Assessments.

1 INTRODUCTION

1.1 Disaster Management in Sierra Leone

Sierra Leone experienced a growing number of manmade and natural disasters in recent decades, causing physical, social and economic damages and losses. The best known amongst these disasters are: the civil war (1990–2002); the cholera epidemic (2012); and the Ebola virus disease (EVD) that devastated the country from May 2014 to November 2015, during which more than 14,000 Sierra Leoneans were infected, and more than 3,000 died of the disease. The EVD outbreak resulted in a huge and complex burden on the health system as well as causing ripple effects across the whole of the Sierra Leonean society. In September 2015, sustained heavy downpours caused serious flooding that damaged homes and properties in Freetown, Western Area - 14,000 people were affected and 10 were reported dead. During this same period, torrential downpour of rain breached river banks in the Southern Province of Sierra Leone, causing serious destruction in eight communities in Bo District and two Chiefdoms in Pujehun District[6].

Sierra Leone has already invested heavily on key sectors such as transport, agriculture, health, education and infrastructure with the vision of making Sierra Leone a green middle-income country where 80% of the population will be above the poverty line with gender equality; a well-educated and healthy population; good governance and rule of law; well-developed infrastructure; macroeconomic stability with private-sector and export-led growth generating wide employment opportunities; good environmental protection; and responsible natural resource exploitation. However, the aforementioned vision and on-going development programmes will be at risk if disaster risk reduction (DRR) and disaster risk management (DRM) measures are not meaningfully factored into national development planning. This is especially so given that climate change patterns and various natural disasters, brought on by global warming, will have a more severe impact on poor and developing countries like Sierra Leone. A number of studies have demonstrated that unplanned urbanisation, deforestation and environmental degradation and inappropriate land use are they key factors contributing to the increase in disasters in Sierra Leone. Thus mainstreaming DRR and DRM concepts in Sierra Leone's development strategies, plans, programmes and projects is crucial and imperative.

The aforementioned disaster events have the potential to destroy, stall or even reverse development and Sierra Leone's economies, health and education facilities, public infrastructure, and cultural heritage sites. Furthermore, they also show that as people and assets concentrate in cities like Freetown and Bo, there is more to lose when hazards and disasters strike and that urban dwellers and central and local governments will be forced to cope with rising incidents of disasters in Sierra Leone. Many of Sierra Leone's urban poor bear the brunt of disasters because they live in high-density conditions in degraded slums, and lack access to basic services such as a water supply, sanitation, health and education. Unfortunately, the Government of Sierra Leone (GoSL) and its development partners had previously focused their efforts on responding to disasters rather than preventing or minimizing their impacts.

However, following the recent disaster events in Sierra Leone, the GoSL and its development partners are now more united in the belief that greater urgency is required to address the factors that are driving the increase in disaster risks, such as rural and urban poverty and vulnerability, unplanned and poorly managed urban growth and declining ecosystems. Urgent action is necessary not only to reduce disaster risks, but also to maintain momentum in achieving the targets and goals articulated by various national and global development strategies and programmes, including poverty reduction, adaptation to climate change and better health outcomes.

In 2002, the GoSL enacted the National Security and Central Intelligence Act (NSCIA 2002) and Section 18, sub-section IV of this Act mandates the Office of National Security (ONS) to be 'the GoSL's primary coordinator for the management of national emergencies such as disasters - both natural and man-made'. The ONS coordinates disaster management at various levels through multi-sectoral platform to address the underlying issues of disaster preparedness, prevention, mitigation, response and recovery/rehabilitation. The main strategic objectives of the ONS on risk and disaster management

[6] The number of people affected by the floods in Bo District and Pujehun Districts were 2,630 and 272, respectively.

include improved identification and assessment of disaster risks, integrated disaster risk management into development effort, and the preparation of a National Disaster Management Plan (NDMP).

In 2004 the ONS established the Disaster Management Department (DMD) and gave it the central responsibility of coordinating the management of national emergencies. The ONS-DMD is the national coordinator for disaster risk reduction and it has the mission to develop a highly proficient mechanism for preventing, mitigating, securing, monitoring, recovering, and responding to disasters in a timely manner in order to promote management of natural and man-made disasters.

The key objectives of the ONS-DMD are to ensure the integration of disaster-risk management into sustainable development programmes and policies, ensuring a holistic approach to disaster management; improve the identification, assessment, monitoring, and early warning of risks; and improve effectiveness of response through stronger disaster preparedness. So far, the ONS-DMD has prepared a National Disaster Preparedness and Response Plan; the Sierra Leone Disaster Management Policy: Identification of Disaster-prone Areas in Freetown; and the Sierra Leone Disaster Management Policy (Final Draft) June 2006. The Disaster Management Plan covers disaster prevention, preparedness, and response and it clearly spells out the roles and responsibilities of agencies and institutions in disaster preparedness, mitigation and response.

The ONS-DMD also provides a coordinating role in establishing and implementing early warning programmes through development of a robust early warning system and capacity building of its staffs. This allows the ONS-DMD to partner with the Sierra Leone Meteorological Agency (SLMA) in the Ministry of Transport and Aviation (MTA), the Ministry of Water Resources (MWR), the Environment Protection Agency-Sierra Leone (EPA-SL) and various stakeholders involved in the end to end early warning system from community to national levels, sectoral MDAs, the Provincial Security Coordinator (PROSEC), District Security Coordinator (DISEC), community committees and humanitarian agencies as well as the Sierra Leone Red Cross Society. At the same time, investments have been made to improve the existing early warning system in Sierra Leone to make it more efficient and an integrated part of mainstream DRM by taking into account the activities and policies of Sierra Leone's line MDAs and strengthening its institutional and legal basis.

The ONS-DMD has established 12 District Disaster Management Committees (DDMC) across the country. These DDMC and the ONS in tandem develop response capacity according to a nationally agreed set of Standard Operating Procedures (SOPs) for each partner agency, at the time of a disaster. This collection of SOPs covers the activities around the occurrence of the hazard and the development and implementation of disaster management plans for provinces, districts and local authorities.

1.2 Sustainable Development and Disaster Management in Sierra Leone

The GoSL, through its national development strategies (Agenda for Change: 2008-2012; and Agenda for Prosperity: 2013-2018) and the Millennium Development Goals (MDGs)[7] has been able to accelerate the country's development programme and also meet some of the goals and targets set by the MDGs and the Hyogo Framework of Action (HFA) 2005-2015: Building the Resilience of Nations

[7] The Millennium Development Goals (MDGs) were the eight international development goals for the year 2015 that had been established following the Millennium Summit of the United Nations in 2000, following the adoption of the United Nations Millennium Declaration. All 191 United Nations member states at that time, and at least 22 international organisations, committed to help achieve the following Millennium Development Goals by 2015. Sierra Leone implemented the MDGs during 2000-2015. The MDGs were operationalized within the framework of the country's national development plans, such as the poverty reduction strategy papers (PRSPs), which have been implemented since the end of the civil war in 2002.

and Communities to Disasters[8]. Furthermore, the GoSL is currently working to achieve the goals and target of the Sendai Framework[9] and the 2030 Agenda for Sustainable Development Goals (SDGs)[10].

DRR is an integral part of social and economic development and is essential if development is to be sustainable for the future. Disaster is closely linked with development in that disasters can both destroy development initiatives and create development opportunities and that development projects and programs can both increase and decrease disaster risks. Disasters can reverse gains made in poverty reduction, throwing large numbers of vulnerable and marginalised households, previously above the poverty line, into poverty. However, disasters can also become opportunities for building back better development practices - rebuilding after a disaster provides opportunities to implement positive changes to enhance the safety of urban communities, through revision and development of new policies, awareness raising activities, relocation, etc.

Sierra Leone faces multiple risks from natural and manmade hazards and climate change that threaten key economic sectors and increase the potential for wider environmental degradation. The socio-economic progress made after the end of civil war in 2002 was undermined by the EVD outbreak in 2014 and a contraction of mining activities, leaving the country in a weakened position to address the impacts of natural and man-made disasters and climate change. Sierra Leone is particularly vulnerable to the impacts of natural hazards and its impacts, especially on its chronically vulnerable communities. Even modest hazard impacts on communities with marginal food production and health care capabilities can overwhelm the capacity of the country to cope. Disasters affect the poor and vulnerable disproportionately, especially women, children, the elderly and those recovering from the impact of conflicts. Very often, it is those living on the fringe of society without adequate coping mechanisms (savings, insurance, social safety nets, family etc.) who are most vulnerable to the impacts of disasters, and are most likely to fall into poverty through the consequences of disasters.

Disasters will remain to be a major problem in Sierra Leone and a serious threat to sustainable development. Their impacts are diverse: as well as loss of life, injury and disease and the destruction of property and other assets, disasters can also cause social and economic disruption, loss of infrastructure and other services and damage to the environment. Poverty, increased population density, urbanisation, climate change and changes in building practices and materials and access to safe land are some of the many reasons why risk of hazard, disaster and human vulnerability are increasing in Sierra Leone. Both natural and manmade hazards damage and destroy properties, assets, infrastructure and livelihoods, and disrupt economic activity. Disaster damages and losses take away the hard earned development gains. On the other hand, relief, compensation and rehabilitation/reconstruction needs after disaster events utilize the meagre resources that otherwise could be used for development, and provide for education, health and other long term social investments.

1.2.1 Millennium Development Goals (2000-2015)

Prior to the MDGs, Sierra Leone's capacity to timely respond to and manage disaster was very nominal because of the lack of a comprehensive disaster management strategy, lack of coordinated and clear lines of roles and responsibilities, lack of financial and material resources, poor capacity on the part of national and local government and poor integration of civil societies into effective disaster management. However, global calls for disaster management to become an integral part of sustainable development

[8] In January 2005, at the World Conference on Disaster Reduction, 168 Governments adopted the Hyogo Framework for Action (HFA); a 10 year plan to make the world safer from natural hazards. From the global blueprint for disaster risk reduction efforts, the HFA offered guiding principles, priorities for action and practical means for achieving disaster resilience for vulnerable communities.

[9] The Sendai Framework for Disaster Risk Reduction 2015-2030 was adopted at the Third UN World Conference in Sendai, Japan, on March 18, 2015. It is the outcome of stakeholder consultations initiated in March 2012 and inter-governmental negotiations from July 2014 to March 2015, supported by the United Nations Office for Disaster Risk Reduction at the request of the UN General Assembly. UNISDR supports the implementation, follow-up and review of the Sendai Framework.

[10] The 2030 Agenda for Sustainable Development Goals (SDGs) call for action by all countries to promote prosperity while protecting the planet. The SDGs contain 17 goals with 169 targets covering a broad range of sustainable development issues. These included ending poverty and hunger, improving health and education, making cities more sustainable, combating climate change, and protecting oceans and forests. The SDGs emphasize the integration of the social, economic and environmental dimensions for supporting sustainable development and recognize that ending poverty must go hand-in-hand with strategies that build economic growth and address a range of social needs while tackling climate change and environmental protection

plus the bitter experience of prosecuting a ten-year civil conflict with an uncoordinated security approach served as a wake-up call for the GoSL to review its national security structure.

Sierra Leone has concluded the implementation of the MDGs (2000 - 2015). The MDGs, which were integrated into the World Summit on Sustainable Development (WSSD)[11] made particular reference to disaster reduction as necessary and integral factor to achieving the goals of sustainable development. It was believed that such a proactive approach to disaster management would go a long way in maximizing disaster risk reduction, which will ensure sustainable development. The WSSD encouraged an integrated, multi-hazard, inclusive approach to address vulnerability, risk assessment and disaster management, including prevention, mitigation, preparedness, response and recovery, as an essential element of a safer world in the 21st century.

Despite the country's weak start in the implementation of the MDGs, it recorded notable progress towards the achievement of a number of the MDG targets. Unfortunately, while the GoSL was on the verge of finalizing the implementation of the MDGs, EVD broke out in May 2014. This caused unprecedented devastation to the socio-economic fabric of the country until Sierra Leone was declared Ebola-free on 7 November 2015. This catastrophe certainly undermined the acceleration of progress made towards the achievement of the MDGs. Nonetheless, Sierra Leone has generally made laudable strides in the implementation of the MDGs, despite enormous remaining and emerging challenges.

While the need to tackle disasters was a feature of the original MDGs, it did not translate into a disasters goal, target or indicator in the MDGs. Furthermore, the MDGs framework was risk blind, not taking into account the impact of natural hazards, conflict and climate change on sustainable development. Disaster management and reducing vulnerabilities to hazards remain a high priority and it is recognised that Sierra Leone continues to grapple with both manmade and natural disasters, some of which are of increased intensity, including as a result of the effects of climate change.

1.2.2 Agenda for Change (2008-2012) and Agenda for Prosperity (2013-2018)

Both the GoSL's Agenda for Change (2008-2012) and the Agenda for Prosperity (2013-2018)[12] have successfully raised popular and political support for poverty reduction in Sierra Leone and they represent tools for measuring development progress in Sierra Leone. One key factor supporting national development progress has been that the national priorities – as set out in the Agenda for Change, the Agenda for Prosperity, and most recently the National Ebola Recovery Strategy – all three have mirrored and complemented the MDGs. In line with sustained efforts to meet the MDGs for Sierra Leone, the government has revised and consolidated long-term targets for development as exemplified by the pillars of the Agenda for Prosperity, which include the following: Pillar 1 – Economic Diversification to Promote Inclusive Growth; Pillar 2 – Managing Natural Resources; Pillar 3 – Accelerating Human Development; Pillar 4 – International Competitiveness; Pillar 5 – Labour and Employment; Pillar 6 – Strengthening Social Protection Systems; Pillar 7 – Governance and Public Sector Reform; and Pillar 8 – Gender Equality and Women's Empowerment.

However, the increasing propensity for disasters and the failure of these national development strategies to reduce the impact of these disasters on society and the economy still remains unresolved. Sadly, exposure and vulnerability to hazards and disasters in Sierra Leone is rising as more people and assets are located in hazard-prone locations and the frequency and severity of most of these hazards are influenced by a range of factors, including population growth, deforestation and land degradation, urbanisation and climate change.

---

[11] Johannesburg Summit 2002 - the World Summit on Sustainable Development - brought together tens of thousands of participants, including heads of State and Government, national delegates and leaders from non-governmental organisations (NGOs), businesses and other major groups to focus the world's attention and direct action toward meeting difficult challenges, including improving people's lives and conserving our natural resources in a world that is growing in population, with ever-increasing demands for food, water, shelter, sanitation, energy, health services and economic security.

[12] The Agenda for Prosperity (AFP) is Sierra Leone's Third Generation Poverty Reduction Strategy Paper-2013-2018. The AFP consists of eight pillars and it includes diversified economic growth, managing natural resources, accelerating human development, international competitiveness, labour and empowerment, social protection, governance and Public Sector Reform and gender and women's empowerment.

1.2.3 Hyogo Framework of Action (HFA) 2005-2015

In 2005, Governments around the world committed to take action to reduce disaster risk, and adopted a guideline to reduce vulnerabilities to natural hazards, called the Hyogo Framework for Action (HFA). The HFA assisted the efforts of nations and communities to become more resilient to, and cope better with the hazards that threaten their development gains. Since the adoption of the HFA, as documented in the National Progress Report on the Implementation of the Hyogo Framework for Action (2009-2011)[13], a modest progress has been achieved in reducing disaster risk at local and national levels by the GoSL and other relevant stakeholders, leading to a decrease in mortality in the case of some hazards. Reducing disaster risk is a cost-effective investment in preventing future losses.

Sierra Leone continues to enhance its capacities in disaster risk management and the HFA was instrumental in the development of policies and strategies and the advancement of knowledge and mutual learning with regards disaster management. Overall, the HFA was an important instrument for raising public and institutional awareness, generating political commitment and focusing and catalysing actions by a wide range of stakeholders at all levels in Sierra Leone. While significant progress was made in implementing the HFA, much more needs to be done to integrate disaster risk reduction into sustainable development policies and planning.

1.2.4 Sendai Framework for Disaster Risk Reduction 2015–2030

The Sendai Framework for Disaster Risk Reduction 2015-2030 is the successor instrument to the HFA and it is built on elements which ensure continuity with the work done by governments and other stakeholders under the HFA and introduces a number of innovations as called for during the consultations and negotiations. The Sendai Framework focuses on DRR and DRM as opposed to disaster management only; the definition of seven global targets; the reduction of disaster risk as an expected outcome; a goal focused on preventing new risk; reducing existing risk and strengthening resilience, as well as a set of guiding principles, including primary responsibility of states to prevent and reduce disaster risk; and all-of-society and all-of-State institutions engagement. In addition, the scope of disaster risk reduction has been broadened significantly to focus on both natural and man-made hazards and related environmental, technological and biological hazards and risks. Health resilience is also strongly promoted throughout.

The Sendai Framework also articulates the following: the need for improved understanding of disaster risk in all its dimensions of exposure, vulnerability and hazard characteristics; the strengthening of disaster risk governance, including national platforms; accountability for disaster risk management; preparedness to “Build Back Better”; recognition of stakeholders and their roles; mobilisation of risk-sensitive investment to avoid the creation of new risk; resilience of health infrastructure, cultural heritage and work-places; strengthening of international cooperation and global partnership, and risk-informed donor policies and programs, including financial support and loans from international financial institutions.

Taking into account the experience gained through the implementation of the HFA, and in pursuance of the Sendai Framework’s expected outcome and goal, there is a need for the GoSL to meaningfully integrate DRR into its development agenda to reflect the following four priority areas:

- Priority 1: Understanding disaster risk.
- Priority 2: Strengthening disaster risk governance to manage disaster risk.
- Priority 3: Investing in disaster risk reduction for resilience.
- Priority 4: Enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation and reconstruction.

[13] http://www.preventionweb.net/files/16241_sle_NationalHFAprogress_2009-11.pdf

1.2.5 2030 Agenda for Sustainable Development Goals (SDGs)

The 2030 Agenda for Sustainable Development Goals (SDGs) call for action by all countries to promote prosperity while protecting the planet. The SDGs contain 17 goals with 169 targets covering a broad range of sustainable development issues. The SDGs provide a very timely opportunity to overcome and meaningfully address the remaining and emerging national and global challenges, including DRR and DRM. Specifically, the following SDG goals are directly related to DRR, DRM and hazards:

- 1.5: By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters
- 11.5: By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations
- 13.1 Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries
- 11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels.

1.3 Project Background

The UNDP's Multi Country Programme to strengthen "Climate Information for Resilient Development and Adaptation to Climate Change in Africa" supports Climate Information and Early-Warning Systems Projects in 11 of Africa's Least Developed Countries[14] in their missions to save lives and improve livelihoods. The Multi Country Programme is being implemented by United Nations Development Programme (UNDP) with funding from the Global Environment Facility (GEF) Least Developed Country Fund (LDCF) and is an example of the concrete actions that the UN is taking to reduce the impacts of climate change in all development sectors.

The Climate Information for Resilient Development in Africa (CIRDA) Programme[15] aims to strengthen the capacity of Africa's 11 Least Developed Countries and the region to develop and operate modern climate information and early warning systems by making available technical assistance and providing access to new technologies. The ability of decision-makers to understand and communicate the likely impacts of climate change is of critical importance in adapting development plans to new climate realities and the increasing rate of climate related shocks. By building capacity to issue extreme weather warnings, sharing new technological advances in weather monitoring and forecasting, and facilitating innovative partnerships with the private sector, the CIRDA Programme works to foster regional cooperation, support strong institutions and build resiliency to climate change. These Africa's 11 Least Developed Countries and the region will also benefit from regional coordination and a knowledge sharing platform.

Sustainable solutions for local weather, water and climate (collectively known as 'hydrometeorological') monitoring and forecasting to produce timely and reliable local hydrometeorological information for government entities, the private sector, and the public are critical to Sierra Leone, as it is highly vulnerable to climate change. Government agencies, private sector businesses, and the general public are still unable to access critical local hydrometeorological and disaster management information to make better informed decisions. This localized hydrometeorological and disaster management information are essential for protecting lives, sustaining and improving livelihoods, and building local

[14] Benin, Burkina Faso, Ethiopia, The Gambia, Liberia, Malawi, Sierra Leone, Sao Tome and Principe, Tanzania, Uganda and Zambia

[15] http://undp-cirda.blogspot.com/p/about.html

and national resilience. At a minimum, early warnings are needed to protect lives and livelihoods from hazardous weather and water events in the short term. From a broader perspective, climate information, disaster management and early warning systems are critical to supporting the adaptive measures necessary to ensure Sierra Leone's survival in the longer term.

Sierra Leone faces a myriad of challenges relating to the deployment of weather and climate monitoring systems, maintenance and operation of hydro-meteorological monitoring stations and reaching end users with actionable early warning information that can save lives, improve productivity and foster greater resilience. These challenges invariably include lack of capacity, including out-of-date institutional structures, inadequate local financial support, lack of technical infrastructure, lack of trained and experienced staff, and poor integration between disparate donor-supported investments in the hydro-meteorological, disaster management and early warning services space. Furthermore, the lack of a robust and high-bandwidth Internet connections at the Sierra Leone Meteorological Agency (SLMA) and associated facilities does not allow for the rapid transmission of weather data and imagery and timely communication of warnings as well as the collection of real-time weather data, which is valuable for short-term-weather and long-term- climate forecasts. In the past, the SLMA purchased equipment without sufficient consideration of how it will be integrated into its operations. Integrating diverse observation platforms, telecommunications, data processing computers, analysis and assimilation systems, numerical models, and forecaster work stations into an end-to-end system is a persistent engineering challenge for the SLMA.

Cohesive and comprehensive disaster management, meteorological, climatic and hydrological information data and information and the provision of standardized, value-added data products for assessing, predicting, and forecasting environmental change is key to climate change adaptation and planning. Thus, one way to support effective climate change adaptation planning in Sierra Leone is to improve climate monitoring and early warning systems through the enhancement of the technical and technology capacities of the relevant mandated institutions – Sierra Leone Meteorological Agency (SLMA), formerly the Sierra Leone Meteorological Department (SLMD) in the Ministry of Transport and Aviation (MTA), the Office of National Security – Disaster Management Department (ONS-DMD), the Ministry of Water Resources (MWR), the Environment Protection Agency-Sierra Leone (EPA-SL). However, the stumbling blocks in the path include the present limited or non-existence of systematic processes for packaging, translating and disseminating climate information and warnings, lack of technically skilled human resources and poor community level usage of climate information and responses to received warnings. This is as a result of a number of policies, institutional, financial, technological and informational barriers that exist in the country.

To avail Sierra Leone with the opportunity to better manage climate hazards, food security and agricultural production, scarce and dwindling water resources and make its socioeconomic development process less vulnerable to climate-related risks – it is essential to:

- enhance the capacity of hydro-meteorological services and networks to monitor and predict weather and climate events and associated risks e.g. floods, droughts and severe storms;
- develop effective and efficient ways of packaging weather and climate information, including contextualising with other environmental and socio-economic data to produce early warnings/alerts and advisories; and
- Support improved and timely preparedness and response to weather and climate information and early warnings, including efficient delivery mechanisms using radio and telecommunications networks.

After the flooding in Sierra Leone in September 2015, the ONS-DMD started paying more attention to early warning and pre-emptive disaster management system and there has been a paradigm shift to become more proactive with emphasis on disaster prevention, mitigation and preparedness. Although the ONS-DMD and other relevant MDAs are contributing much in preventing loss of life through effective pre-disaster warning system, the communication networks are been severely damaged due to lack of robustness. The traditional ways of disseminating disaster early warnings in Sierra Leone have been through radio and television, military forces and early warning towers. However, during a disaster situation, there are important limitations – mass media channels are not always switched on, and other channels have limited reach.

With the advent of information and communication technologies (ICT), there has been increased demand of ICT-based disaster management, meteorological, climatic and hydrological data and early warning information system at the national, regional and local platforms. At the national level, several GoSL ministries, departments and agencies (MDAs), non-governmental organisations (NGOs), community-based organisations (CBOs) and actors are playing increasingly crucial role in the overall disaster management, meteorological, climatic and hydrological data and information systems and community-based disaster preparedness activities.

An effective early warning system needs effective communication network systems, which have two main components: 1) communication infrastructure hardware that must be reliable and robust, especially during the disaster; and 2) appropriate and effective interactions among the main actors of the early warning process, such as the scientific community, stakeholders, decision makers, the public, and the media. Many communication tools are currently available for disaster management, hydrometeorological and climate data and early warning information dissemination, such as Short Message Service (SMS), social media (WhatsApp, Twitter, etc.), and email, radio, TV and web service. Disaster warning/alerting authorities like the SLMD and ONS have long relied on media, such as radio and television to help disseminate public warnings. Television stations like Sierra Leone Broadcasting Corporation (SLBC), African Young Voices (AYV) and STAR TV insert crawl text with the warning message, and radio stations like SLBC and Radio Democracy insert a recording.

One way to support effective climate change adaptation planning in Sierra Leone is to comprehensively assess the early warning communications networks to improve climate monitoring and early warning systems through the enhancement of the technical and technology capacities of the relevant mandated institutions – SLMD, ONS-DMD, MWR and the EPA-SL. Hence, in September 2016, the UNDP Sierra Leone Country Office contracted INTEGEMS, a Sierra Leone-based multidisciplinary consultancy, to provide consultancy services for a **Support to Communication and Dialogue on Early Warning and Forecasting Products & Climate Information Project**.

1.3.1 Project Objectives

The Support to Communication and Dialogue on Early Warning and Forecasting Products & Climate Information Project [Ref: SLE/RFP/2016/003], implemented by the SLMD, ONS-DMD, EPA-SL and MWR, aims to establish a functional network of meteorological and hydrological monitoring stations and develop and implement an integrated **Climate Information, Disaster Management and Early Warning Systems-Sierra Leone (CIDMEWS-SL)** for disaster management, climatological, hydrometeorological and early warning information to help understand better the weather and climatic changes overtime and provide timely information to avert any weather and climate related disasters.

The CIDMEWS-SL aims to integrate Geographic Information Systems (GIS) and Management Information System (MIS) systems and mobile data collection technology to provide a family of sophisticated tools and Web services for collecting, managing, visualizing, mapping, analysing, monitoring, evaluating and reporting on various aspects of climatological, hydro-meteorological, disaster management and early warning information in Sierra Leone.

CIDMEWS-SL also provides the basis for a systematic analysis and prioritization of a set of threats and hazards to develop and disseminate weather and forecasting products, climate information and early warnings to the Government of Sierra Leone MDAs; NGOs; CBOs; development partners; private sector organisations; academia and the general public to enable early preparation against disasters such as floods and other severe weather and agricultural stresses.

1.3.2 Scope of Work

The scope of work for the Support to Communication and Dialogue on Early Warning and Forecasting Products & Climate Information Project is as follows:

1. Carry out needs assessment of early warning communication network;
2. Develop communication channels between SLMD and ONS-DMD for dissemination of forecasting products;

3. Establish institutional mechanisms for collection of feedback from community end-users on the usefulness of warning messages;
4. Develop a communication and awareness raising strategy, pilot application and implementation of local level responses.
5. Support SLMD, MWR, EPA and ONS-DMD to establish in partnership with local NGOs and CBOs to communicate and disseminate response plans;
6. Organise field visits and stakeholder consultations undertaken to understand how users of early warning advisories and warnings.
7. Establish a community-based communication and information sharing tool using local languages.

2 COUNTRY BACKGROUND

2.1 Geographical Context

Sierra Leone is a small country located on the West Coast of Africa with an area of about 72,000 km^2. It lies between latitudes 6^0 0' N and 10^0 0' N and longitude 10^0 16' W and 13^0 18' W. Bounded on the south-west by the Atlantic Ocean, it stretches along the coastline for approximately 400 km, by Guinea on the north and north-east, and by Liberia on the south-east (see Figure 2-1) . Sierra Leone is divided into four main physical regions, namely coastal plains, interior lowland plains, interior plateau, and hills and mountains (see Figure 2-2).

The landscape of Sierra Leone is characterised by topography ranging from mountainous slopes in the north-east to low relief floodplains in the southwest (Figure 2-3). The coastline or coastal plains is relatively gentle and comprises of estuarine swamps subject to tidal flooding; coastal terraces; alluvial plains are subject to freshwater flooding during the rainy season. Beach ridges, fringe the alluvial plains on the seaward side (Allan 1990).

The interior lowland plains, the largest of the four physical regions, extend from the coastal terraces in the west to the east of Sierra Leone, occupying approximately 43% of the total land area. They rise gently from the coastal terraces to elevations of 200m in the east, where they are separated from the plateaux by distinct escarpments. West of the plateau region and interior lowlands, is the Freetown Peninsula, which is also made up of dissected peaks, with the two highest peaks being the Sugar Loaf Hill and Picket Hill. The hills on the Freetown Peninsula are unique to this region, and found nowhere else in the sub-region. The rocks are resistant to erosion, resulting in dissected ridges of moderate to high relief. The high content of iron and aluminium results in the formation of laterites, either as a surface crust or as densely packed ironstone gravel.

At the edge of the lowland plains are the interior plateaux, which covers approximately 22% of the total land area and made up of granite that runs from the northeast of the country to the southeast. The plateau region seldom rises above 700 m and is comprised of alluvial ironstone gravel in the south-eastern region, while the northern end is comprised of weathered outcrops of granitic rocks. Stretches of wooded hill country lead east and northeast to a plateau region generally ranging in elevation from 300 m to 610 m. The eastern and southern parts comprise of dissected hills. In the north and east of the country are two of the highest mountains, with the Loma Mountains being the highest in West Africa. The highest peak on the Loma Mountains is Bintumani, which rises to 1,945 m while Sankan Biriwa on the Tingi Hills, rises to 1,805 m.

Figure 2-1: Location of Sierra Leone in West Africa

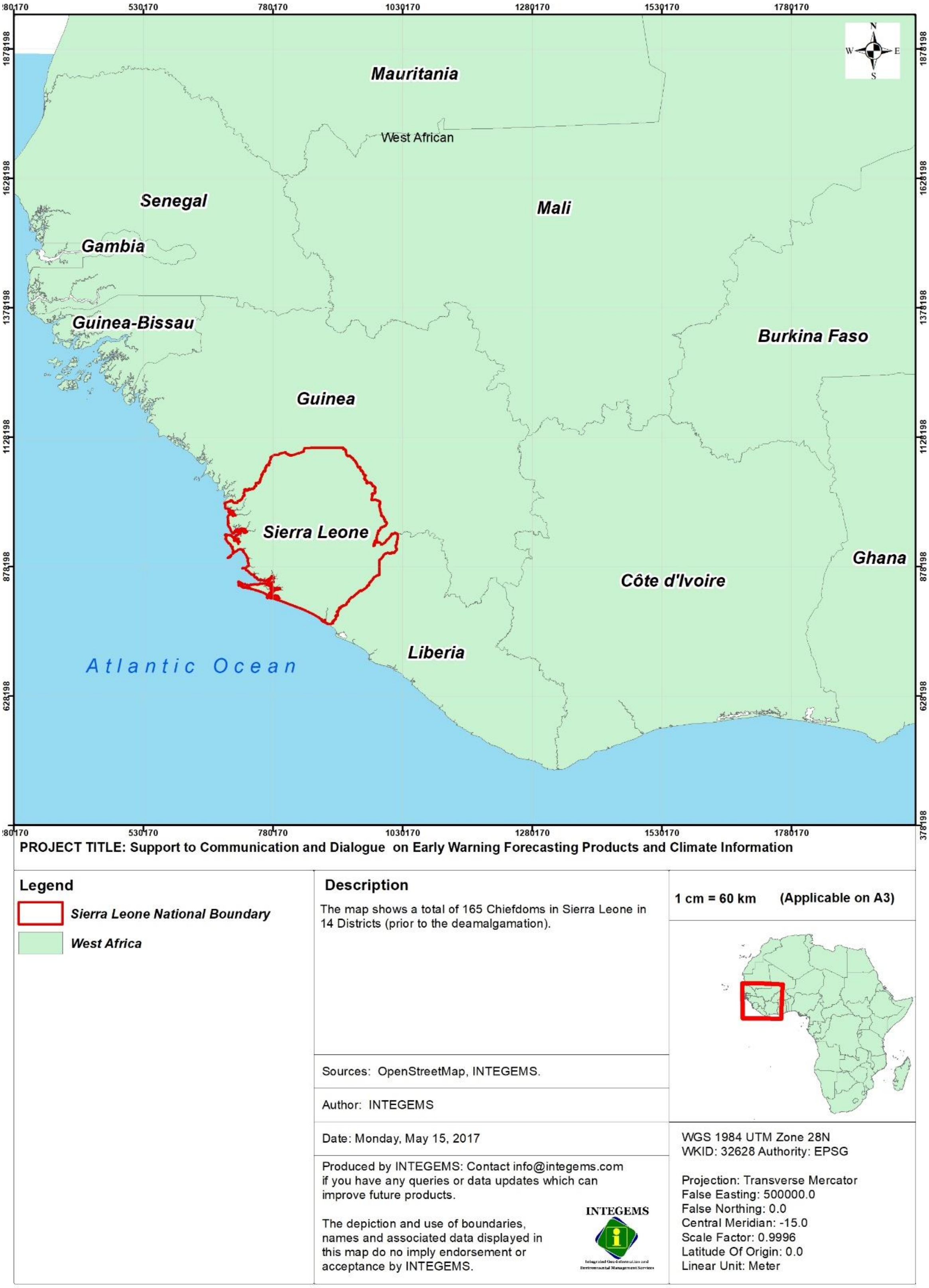


Figure 2-2: Physical geography of Sierra Leone

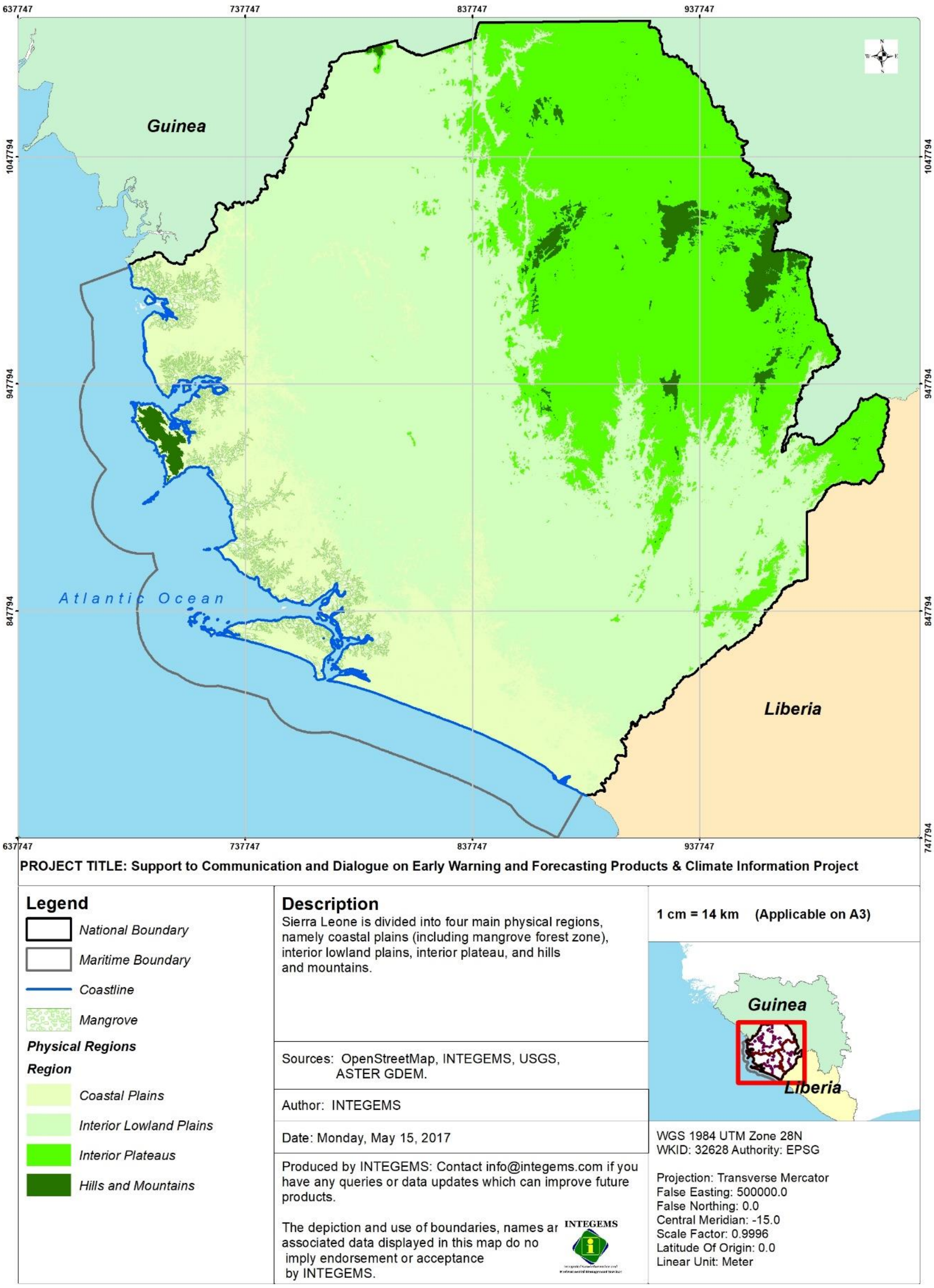
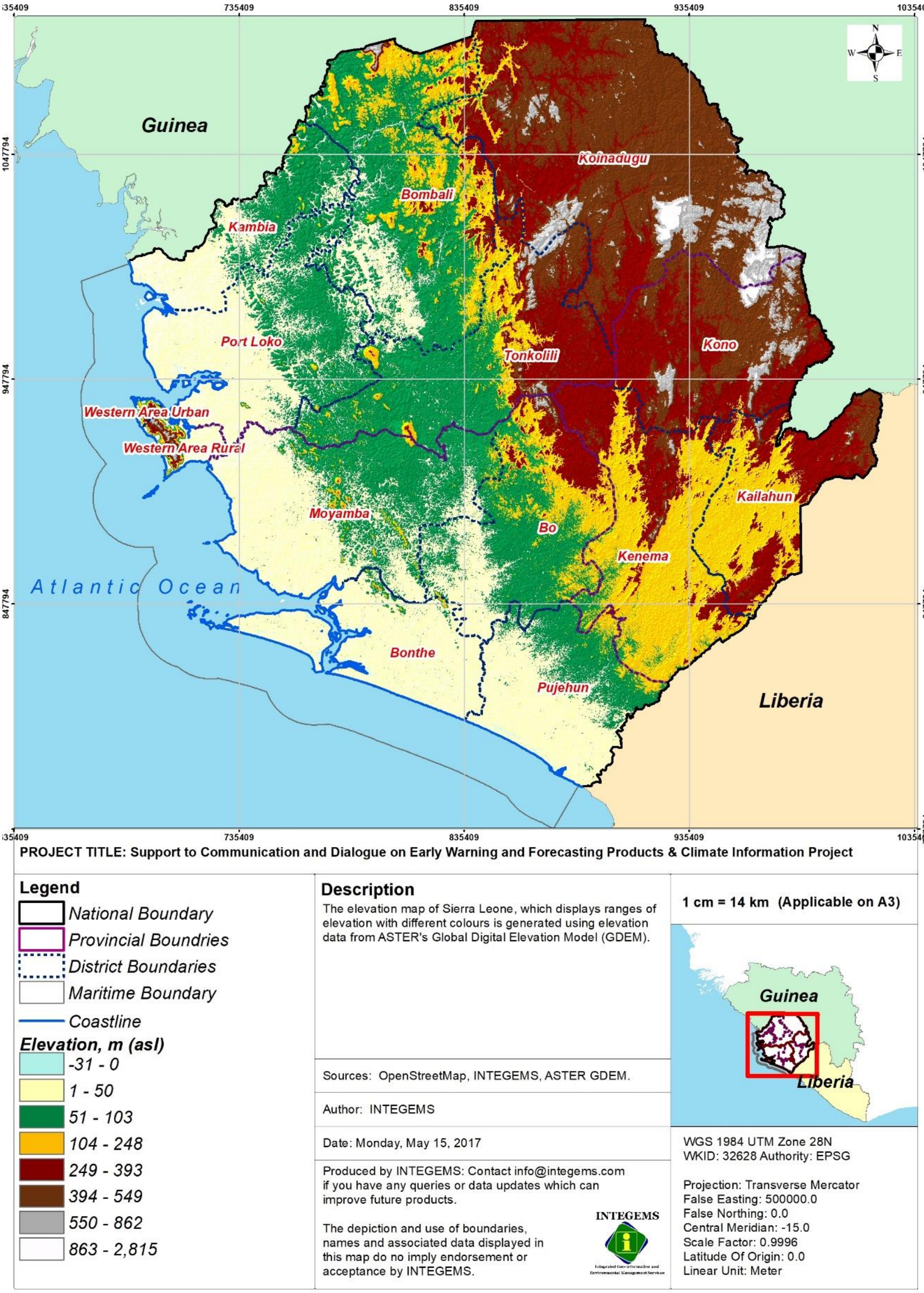


Figure 2-3: Elevation map of Sierra Leone



2.2 Land Cover/Land Use

Sierra Leone's land cover or vegetation zones can be broadly classified into forest, savannah woodland and the swamps or marsh. The country was originally a forested country with over 60% of its land covered by closed forest, the rest being woodland savannah of the guinea type[16]. Currently, about 70% of its forest has been lost due to human activities - clearing for use in 'slash-and-burn' or shifting cultivation farming, timber and firewood. Patches of rain forest can be found scattered in the northern, eastern and southern provinces

The most extensive land cover change in Sierra Leone was the loss of woodland and forested area across the country. Dense forest is rare and mainly found on hill slopes in the Montane Forest Zone. Even though the country is located within the Upper Guinean forest ecosystem, it is unlikely that it was ever heavily covered by dense forest (Munro and van der Horst, 2012) (see Figure 2-4). Between 1975 and 2013, Sierra Leone lost 30 % of its forest cover, or about 1,100 km^2, at an average annual rate of 0.8 %. However, this rate has slowed since the end of the civil war, averaging 0.4 percent of annual forest loss between 2000 and 2013. The main loss of forest occurred in the Tama-Tonkolili and Nimini Hills highlands.

In 1975, these tracts of dense forest were located among a patchwork of degraded forest, gallery forest, and woodland — none of which has been spared by deforestation. Degraded forest decreased by 26 percent, or about 2,000 km^2, and gallery forest by 22 %, or 700 km^2. Woodland is one of the dominant land cover types in Sierra Leone. It is found on the slopes and uplands of the Koinadugu and Kono Plateaus, and on the Interior and Coastal Plains, among the savannas and thickets. In 1975, woodland was the second largest land cover class in terms of area after the savannas, covering 15.5 percent of the country. Over the 38-year period, its area decreased by 48 %, or 5,400 km^2, shrinking to a mere 8 % of the country in 2013. Accounting for all the forest classes together, Sierra Leone lost a total 36 % of its forest and woodland habitats since 1975 (Tappan, 2016).

Cropland expansion, slash-and-burn agriculture, logging, mining, and cattle grazing activities were the dominant factors affecting vegetation and land use. Indeed, resulting from an increasing demand for forest products and food production, half of the lost forest and woodland habitats were converted to savannas, and one-third to agriculture. Shifting agriculture has long been practiced in Sierra Leone. Under this system, a patch of forest is burned, cleared and cultivated usually for a short period of time (1–2 years), after which it is left fallow for several years. The rate of cropland expansion quadrupled after the end of the civil war, going from an average of 32 km^2 per year in the 1975–2000 period to 130 km^2 per year between 2000 and 2013.

Overall, agricultural area progressed by 35 %, or 2,400 km^2, between 1975 and 2013, mostly in the Interior Plains and in the northern part of the Koinadugu and Kono Plateaus. In Sierra Leone, where water is an abundant resource, bottomland and flood recessional agriculture is also very common. Many of the wetland areas mapped in 1975 have been converted to cultivated bottomland which has doubled in area, reaching 1,180 km^2 by 2013 (see Figure 2-5 and Table 2-1).

Because a large part of the population in Sierra Leone obtains its substance from farming, agriculture expansion was mostly driven by population growth. Whereas population increased steadily from 2.7 million to 6.1 million, a rise of 123 %, the area occupied by settlements — towns and cities — only grew by 36 %, or 140 km^2, from 1975 to 2013.

[16] Larbi Asamoah. (accessed via http://www.fao.org/ag/agp/agpc/doc/counprof/Sierraleone/Sierraleone.htm, 26 October 2017)

Figure 2-4: Vegetation and land cover types in Sierra Leone

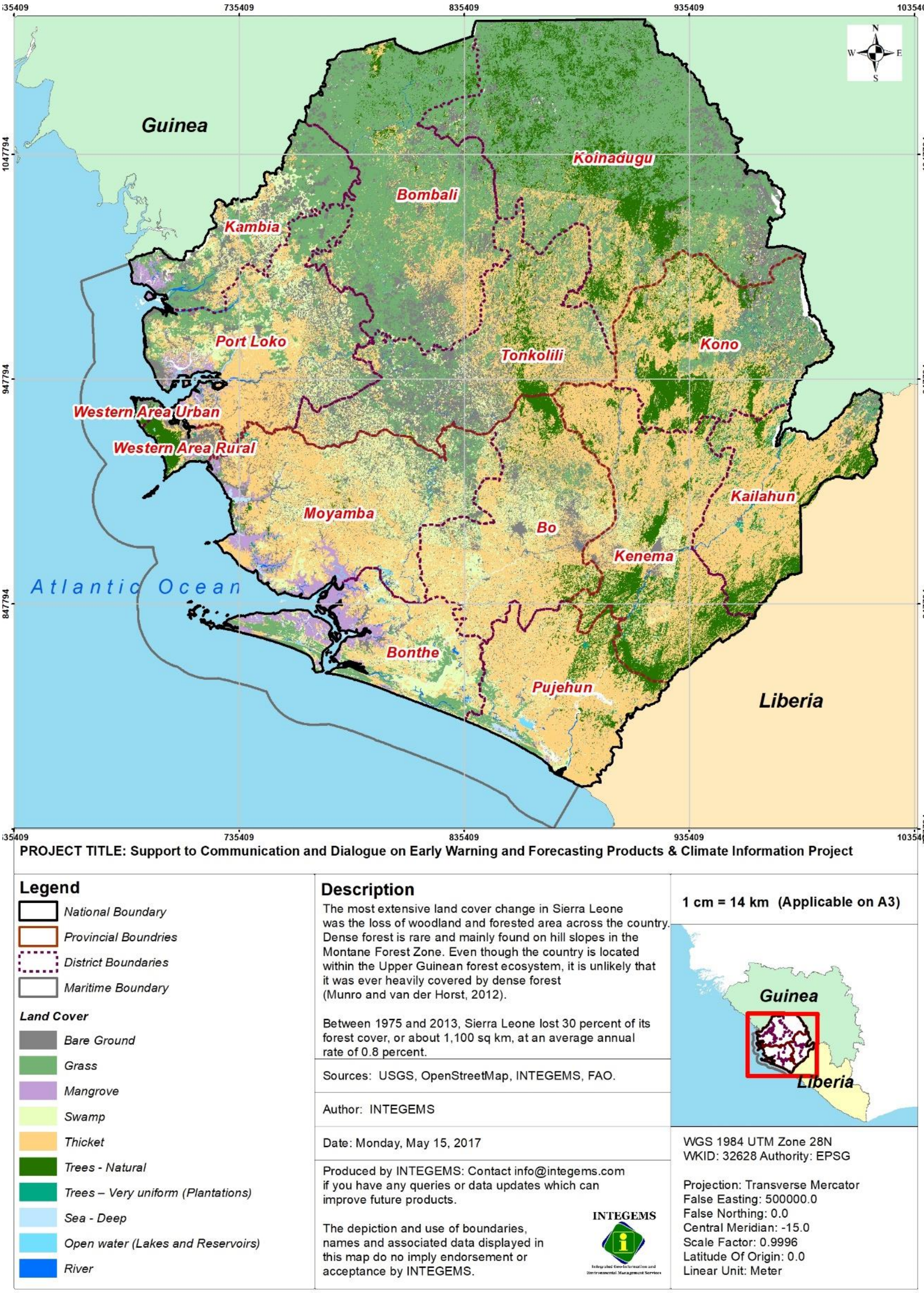
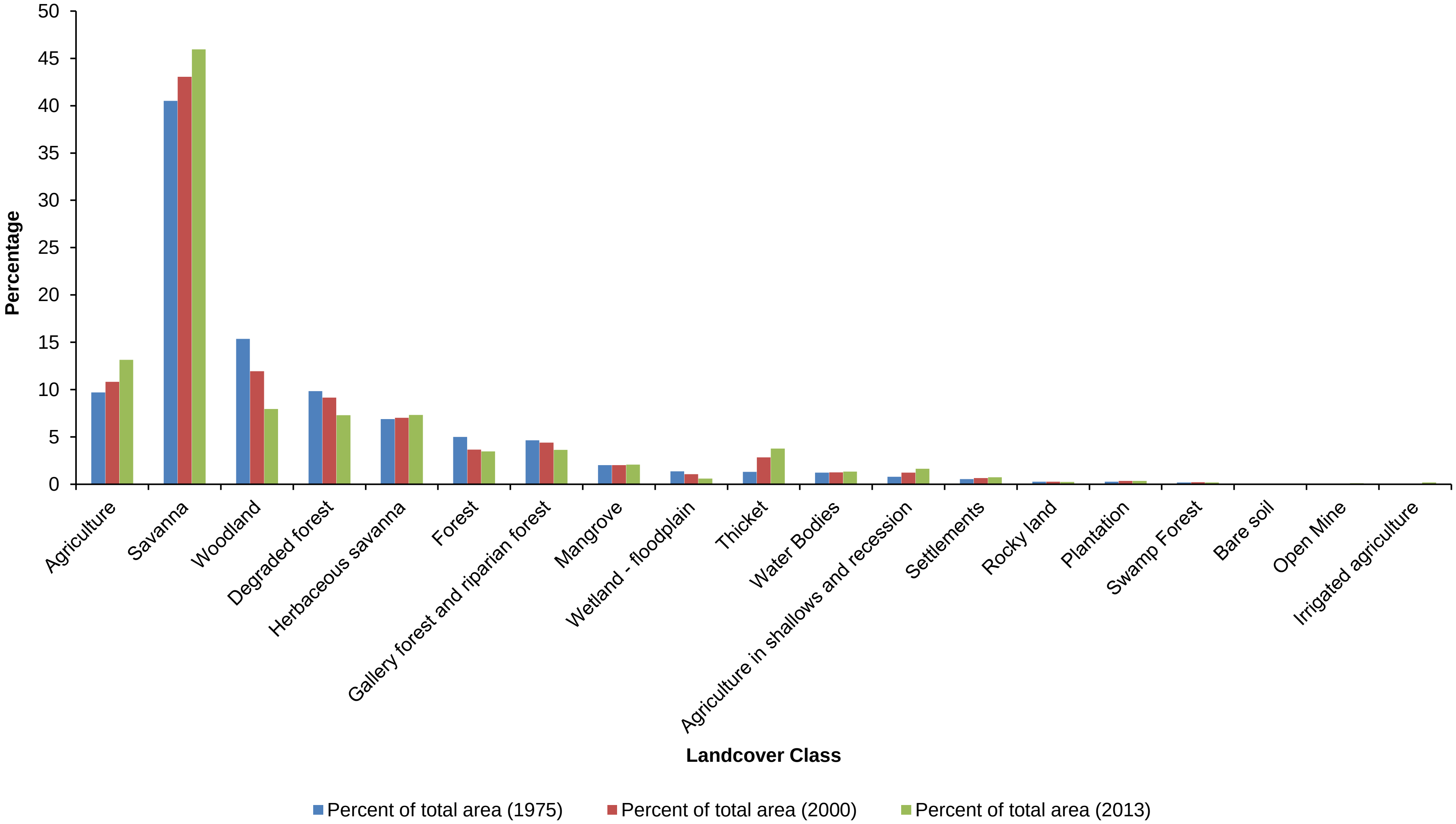


Table 2-1: Sierra Leone land use/land cover time series

Land cover classes	1975		2000		2013	
	Area (km^2)	Percent of total area	Area (km^2)	Percent of total area	Area (km^2)	Percent of total area
Agriculture	7,028	9.71	7,832	10.82	9,512	13.14
Agriculture in shallows and recession	576	0.80	888	1.23	1,188	1.64
Bare soil	32	0.04	32	0.04	24	0.03
Degraded forest	7,124	9.84	6,620	9.15	5,284	7.30
Forest	3,616	5.00	2,644	3.65	2,512	3.47
Gallery forest and riparian forest	3,360	4.64	3,180	4.39	2,620	3.62
Herbaceous savanna	4,980	6.88	5,080	7.02	5,304	7.33
Irrigated agriculture	20	0.03	40	0.06	140	0.19
Mangrove	1,460	2.02	1,460	2.02	1,496	2.07
Open Mine	24	0.03	28	0.04	72	0.10
Rocky land	184	0.25	184	0.25	180	0.25
Plantation	184	0.25	252	0.35	252	0.35
Savanna	29,320	40.52	31,156	43.05	33,252	45.95
Settlements	388	0.54	464	0.64	528	0.73
Swamp forest	140	0.19	144	0.20	140	0.19
Thicket	948	1.31	2,044	2.82	2,728	3.77
Water bodies	888	1.23	900	1.24	956	1.32
Wetland - floodplain	976	1.35	772	1.07	424	0.59
Woodland	11,120	15.37	8,648	11.95	5,756	7.95
Total mapped area (km^2)	**72,368**		**72,368**		**72,368**	

Figure 2-5: Land use/land cover time series (1975, 2000, and 2013)



2.3 Climate and Weather

Sierra Leone has a wet tropical climate, marked by distinct wet and dry seasons. The wet or rainy season extends from May to October and the dry season from November to April. Both seasons may have some variations in their commencement and duration. The wet season is dominated by the southwest tropical maritime monsoon which is a mass of moisture-laden air that originates over the south-Atlantic ocean. The rains fall steadily in the wet season with the heaviest in the months of July and August, with some months recording virtually no rain. The wet season has an average rainfall of 3,000 mm, with coastal and southern areas receiving from 3,000 to 5,000 mm annually and inland areas between 2,000–2,500 mm in the drier areas of the north–west to the north –east (see Figure 2-6).

Due to heavy rainfall in the wet season, discharges and runoff are high and ranges from 20% to 40% of total annual rainfall. Rivers overflow their banks during this period. Average annual rainfall over Sierra Leone has decreased since 1960 but it is difficult to determine whether this is part of a long term trend because of the variable nature of rainfall in this region. The dry season is prone to dusty and hot Harmattan winds and drought conditions. However, there is pronounced dry season from November to March when flows may be sufficiently reduced to be a constraint.

The temperatures are consistently high throughout the country, roughly averaging from 25–27°C, with slightly lower temperatures (22–25°C) during the wet season. Diurnal temperatures vary from 25°C to 34°C although they could be as low as 16°C at night during the Harmattan. Average annual temperature has increased by 0.8° C since 1960. Data is limited but available data shows significantly increasing trends in the frequency of 'hot' nights. The humidity, like the temperature is usually high as a result of the heavy rains coupled with high temperature and maritime influences. Humidity rises up to 93% in the wet season and decreases inland to about 47% as the rainfall declines.

There is little variation in the day length due to the near equatorial location, but sunshine hours are affected during the wet season. Sunshine is plentiful and varies substantially with the amount of cloudiness. During the dry season (November to March) mean monthly solar radiation is high, 380 cal/ cm^2/day (480 lux); mean hours of sunshine varies from 7-9, and pan evaporation is about 4.5 mm per day. The wet season is generally dull and cloudy with a mean monthly solar radiation of 280 cal/ cm^2/day, mean hours of sunshine is 3 hours/day in July and August, and pan evaporation generally less than 2.0 mm/day, due to high diurnal humidity.

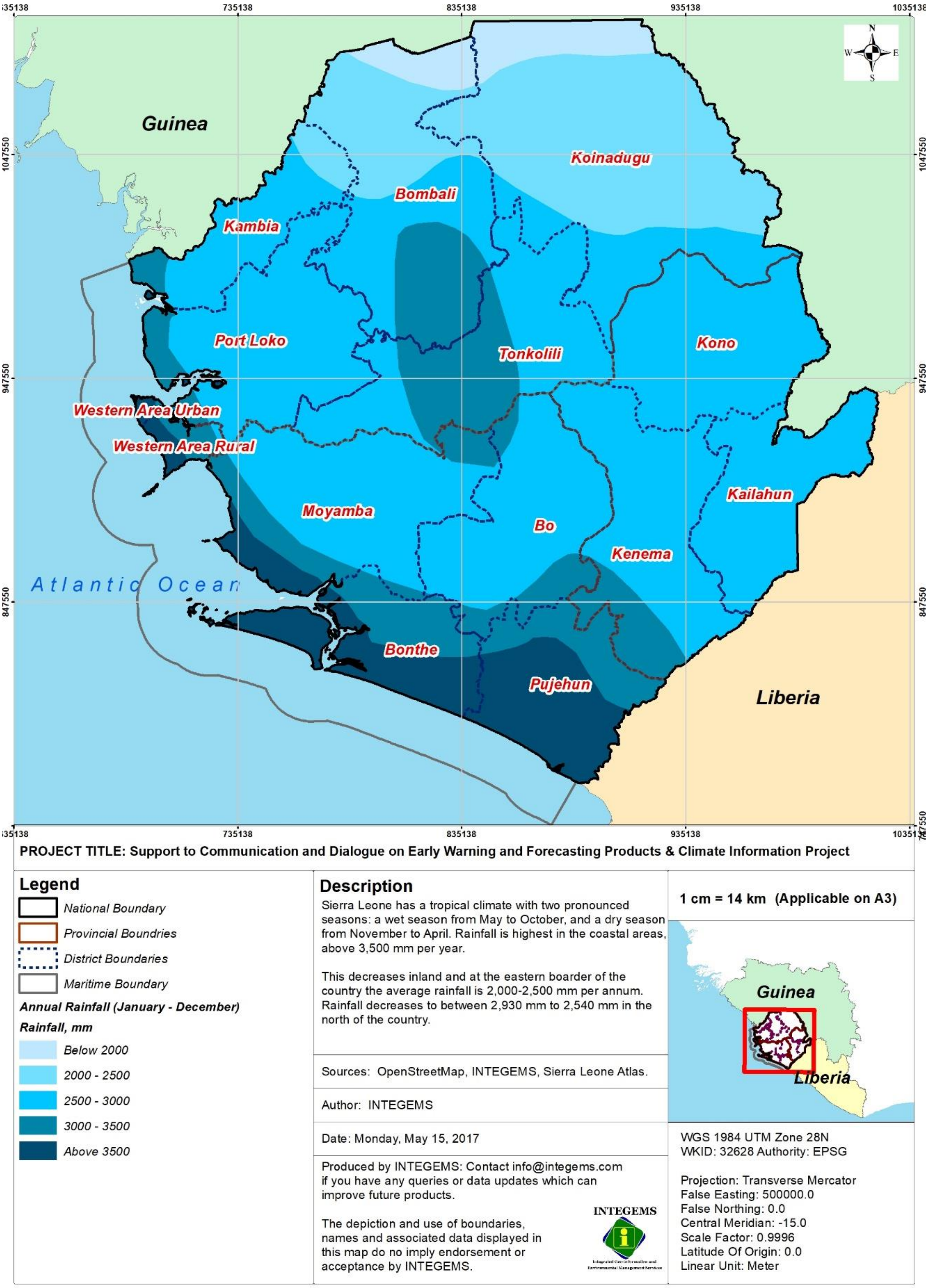
Key climate change trends since 1960 include:

- Higher temperatures (+0.8°C), an average increase of 0.18°C per decade.
- Increased night-time temperatures.
- Reduced annual precipitation overall, with significant decadal variability (1960s–1970s show increased rainfall while 1980s show drier conditions).
- Increased variability in the rainy season, with some observations suggesting a later onset/shorter duration and increased intensity of single rainfall events.

Projected changes include:

- Increase in temperatures of 1.0–2.5°C by 2060, with more rapid warming inland.
- Although rainfall projections are less certain, the trend will be toward an overall increase, particularly between July–December.
- The intensity of single rainfall events will continue to increase.
- The level of the Atlantic Ocean will rise (0.1– 0.56 m by 2100, relative to 1980–1999 levels), coupled with an increasing risk of storm surges from June to September.

Figure 2-6: Climate of Sierra Leone, Annual Average Rainfall



2.4 Administrative Divisions

Administratively, Sierra Leone is divided into four Regions. Eastern, Northern and Southern Provinces, and the Western Area, which is the peninsular on which the capital, Freetown, is situated. Each Region is subdivided into Districts, and the Districts further divided into Chiefdoms (see Figure 2-7 and Figure 2-8). Overall, there are 14 Districts and 149 Chiefdoms. In addition to this, the 2004 Local Government Act established 19 Local Councils, SIX City Councils, and 13 District Councils.

Table 2-2: Sierra Leone administrative entities

Province	Districts	Chiefdoms	Sections
Northern	Tonkolili	11	87
	Bombali	14	148
	Port Loko	11	152
	Koinadugu	11	106
	Kambia	7	64
Southern	Bo	16	111
	Bonthe	12	78
	Moyamba	14	142
	Pujehun	12	95
Eastern	Kailahun	14	89
	Kenema	17	105
	Kono	15	82
Western	Western Area Urban	8	64
	Western Area Rural	4	25

In 2017, the GoSL proclaimed the de-amalgamation of Chiefdoms and an attendant re-division of the Northern Region into two distinct Regions, namely: Northern Region and North-Western Region. The two new Northern Regions now consist of seven electoral Districts in place of the previous five. The North-West Region covers Port Loko, Karene and Kambia Districts, while the Northern Region covers Bombali, Tonkolili and Koinadugu 1, and Koinadugu 2 Districts.

Figure 2-7: Administrative Divisions of Sierra Leone

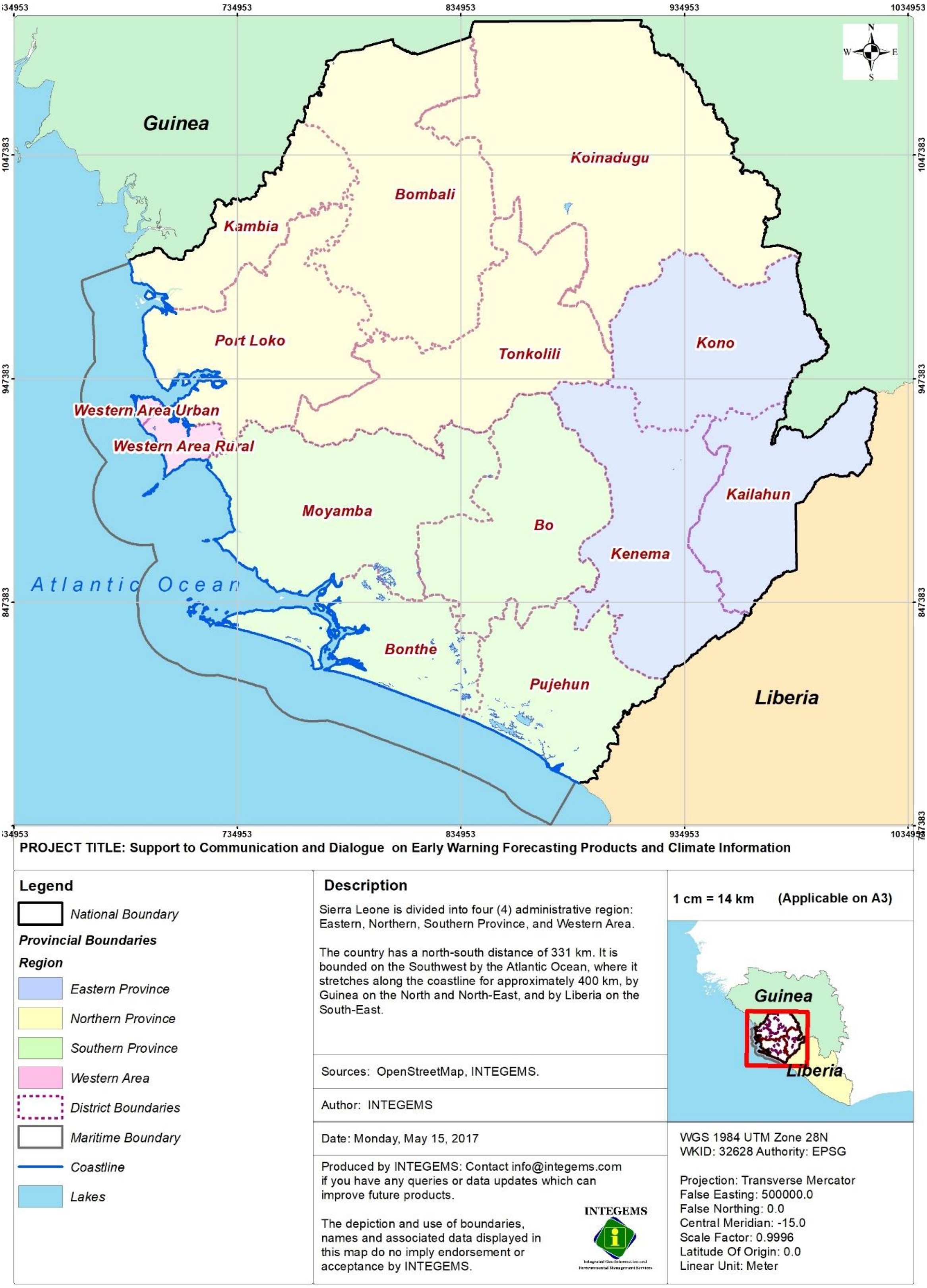
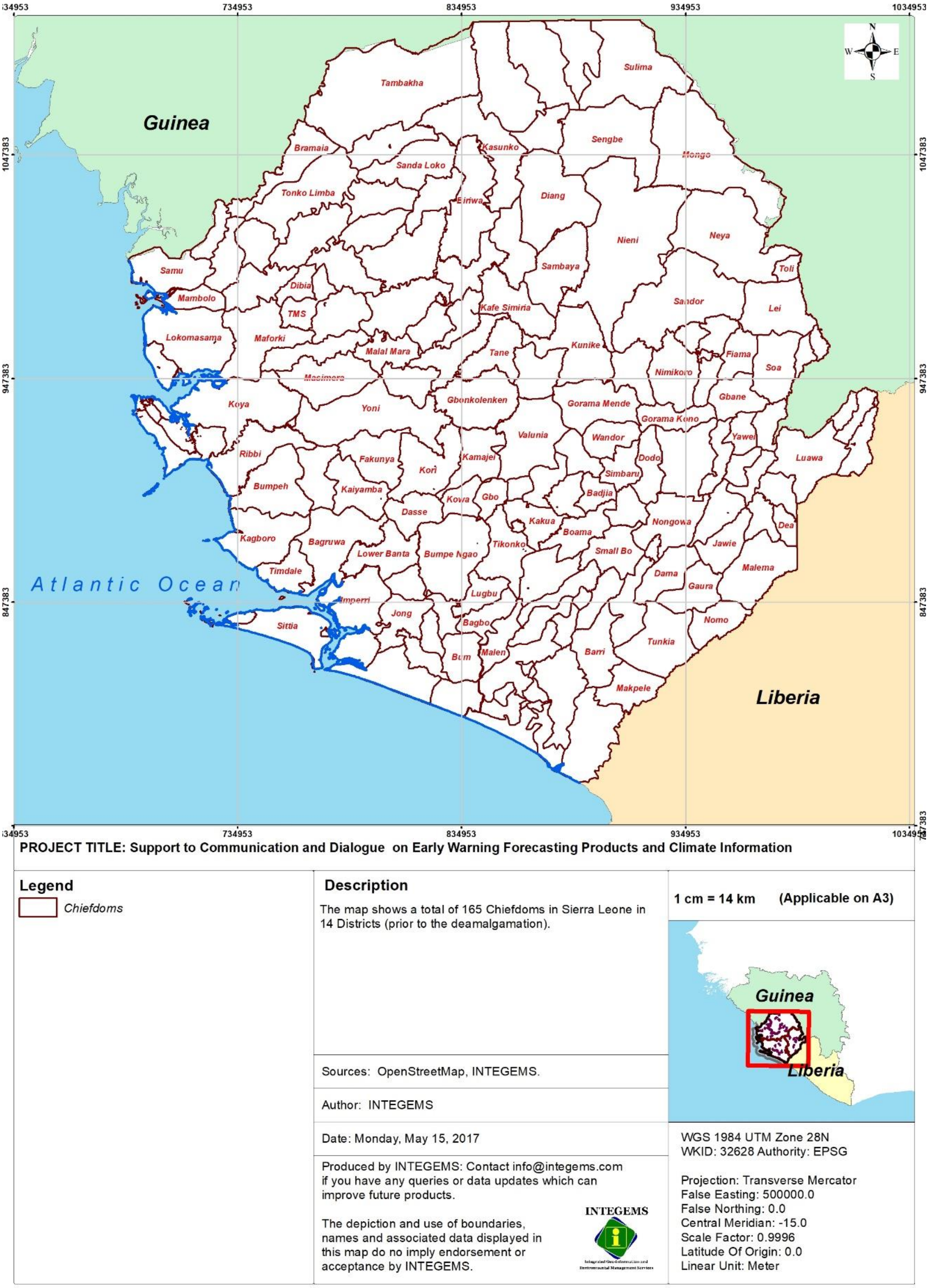


Figure 2-8: Administrative Divisions of Sierra Leone – Chiefdom level



2.5 Political Context

Sierra Leone is a constitutional republic with a directly elected President and a unicameral legislature. The 1991 Constitution established three main branches of Government, namely an Executive, a Legislature and a Judiciary. The 1991 Constitution is being reviewed and a draft has been presented by the Constitutional Review Committee (CRC). Once Parliament has enacted the new Constitution, a referendum to vote on the new Law will take place.

The President, who is the head of state, the head of Government and the Commander-in-Chief of the Sierra Leone Armed Forces and the Sierra Leone Police, leads the executive branch. The President appoints and leads a cabinet of ministers, which Parliament approves. Popular vote elects the President for one or a maximum of two five-year terms. The Parliament of Sierra Leone has 124 seats and is Sierra Leone's legislature. Parliament includes representatives from all 14 districts, with 112 members elected for four-year terms through proportional representation; there are also twelve Paramount chiefs in Parliament. There are various parliamentary committees responsible for the main sectors including a health sector committee. Sierra Leone's highest court, the Supreme Court, leads the judicial branch. The President appoints judges on the advice of the Judicial and Legal Service Commission with the approval of Parliament. In 2012, Sierra Leone conducted its third democratic elections since the end of the 11-year civil war in 2002. President Ernest Bai Koroma is serving his second and final term, which ends in 2018. Elections will be held on 7 March 2018.

2.6 Socio-economic Context

Sierra Leone's civil war (1991-2002) eroded infrastructure and human capacity throughout the country. Over a decade after the war Over a decade after the war ended, the effect of the conflict on the health infrastructure and HRH remained prominent. Efforts made remained prominent. Efforts made in the post conflict phase to improve the health sector suffered a major blow in the Ebola crisis major blow in the Ebola crisis (2014-2015), which created an additional burden on the health sector and the country as a whole. These the country as a whole. These two crises resulted in a range of social and economic challenges. As a result, real GDP growth in 2014 result, real GDP growth in 2014 was 7.0%, compared to the pre-Ebola forecast of 11.3% (World Bank Group, 2016). As of 2015, GDP Group, 2016). As of 2015, GDP per capita in Sierra Leone was USD 653 (see

Table 2-3). The 2015 UNDP's Human Development Index rank for Sierra Leone was 179 out of 187 countries (UNDP, 2016).

With or without Ebola, the lack of domestic resources in Sierra Leone, one of the world's poorest and least-developed countries, leaves the country dependent upon international support in terms of finance, technology and other forms of aid. Sierra Leone remains largely dependent upon its minerals economy, including iron, diamonds and rutile, which are major sources of foreign exchange. Sierra Leone boasts extensive natural resources, but these are under pressure from population growth, dependence on biomass for energy, water pollution, and environmentally unsound mining activities, leading to high rates of deforestation, increased rates of soil erosion, and occurrence of landslides. High dependence on agriculture and natural resources, coupled with high rates of poverty, unemployment and environmental degradation, leave Sierra Leone vulnerable disasters and climate change impacts.

Sierra Leone suffer from mass poverty (more than half of the population lives under conditions of "severe" poverty), widespread malnutrition, high infant and child mortality rates, low life expectancy, deficient infrastructure, a poor education system, and insufficient availability of basic medical services to cope with tropical diseases malaria, cholera, tuberculosis, HIV/AIDS and EVD. While the majority of the population is poor, there is a high level of gender inequality, with women affected far more dramatically by the consequences of poverty than are men.

Table 2-3: Sierra Leone Country Profile

	1990	2000	2010	2016
World view				
Population, total (millions)	4.31	4.56	6.46	7.4
Population growth (annual %)	1.5	2.8	2.3	2.2
Surface area (sq. km) (thousands)	72.3	72.3	72.3	72.3
Population density (people per sq. km of land area)	59.7	63.2	89.5	103
Poverty headcount ratio at national poverty lines (% of population)	..	66.4	52.9	..
Poverty headcount ratio at $1.90 a day (2011 PPP) (% of population)	65.5	58.5	52.3	..
GNI, Atlas method (current US$) (billions)	0.8	0.66	2.73	3.61
GNI per capita, Atlas method (current US$)	190	140	420	490
GNI, PPP (current international $) (billions)	3.11	3.2	7.79	9.75
GNI per capita, PPP (current international $)	720	700	1,210	1,320
People				
Income share held by lowest 20%	..	6.6	7.9	..
Life expectancy at birth, total (years)	37	39	48	51
Fertility rate, total (births per woman)	6.7	6.3	5.2	4.6
Adolescent fertility rate (births per 1,000 women ages 15-19)	182	159	133	117
Contraceptive prevalence, any methods (% of women ages 15-49)	3	4	11	17
Births attended by skilled health staff (% of total)	..	37	61	60
Mortality rate, under-5 (per 1,000 live births)	264	236	160	120
Prevalence of underweight, weight for age (% of children under 5)	25.4	24.7	21.1	18.1
Immunisation, measles (% of children ages 12-23 months)	..	37	81	83
Primary completion rate, total (% of relevant age group)	..	..	75	66
School enrollment, primary (% gross)	51.9	67.7	125	128
School enrollment, secondary (% gross)	18	27	44	43
School enrollment, primary and secondary, gender parity index (GPI)	1	1	1	1
Prevalence of HIV, total (% of population ages 15-49)	0.4	1	1.7	1.7
Environment				
Forest area (sq. km) (thousands)	31.2	29.2	27.3	30.4
Terrestrial and marine protected areas (% of total territorial area)	0.9	2.6	..	3.8
Annual freshwater withdrawals, total (% of internal resources)	0.2	0.1	0.1	0.1
Improved water source (% of population with access)	37	47	57	63
Improved sanitation facilities (% of population with access)	10	11	13	13
Urban population growth (annual %)	2.2	3.5	3.1	3.1
Energy use (kg of oil equivalent per capita)	..	..	..	..
CO_2 emissions (metric tons per capita)	0.11	0.09	0.11	0.18
Electric power consumption (kWh per capita)	..	..	..	..
Economy				
GDP (current US$) (billions)	0.65	0.64	2.62	3.67
GDP growth (annual %)	3.3	6.7	5.4	6.1
Inflation, GDP deflator (annual %)	70.6	3.3	17.2	4.2
Agriculture, value added (% of GDP)	47	58	55	61
Industry, value added (% of GDP)	19	28	8	6

	1990	2000	2010	2016
Services, etc., value added (% of GDP)	34	13	37	33
Exports of goods and services (% of GDP)	35	18	17	24
Imports of goods and services (% of GDP)	34	39	34	54
Gross capital formation (% of GDP)	13	1	31	18
Revenue, excluding grants (% of GDP)	5.6	11.4	9.7	9.8
Net lending (+) / net borrowing (-) (% of GDP)	..	..	-6.1	-3
States and markets				
Domestic credit provided by financial sector (% of GDP)	36.3	54.4	17.1	18.1
Tax revenue (% of GDP)	5.3	10.2	8.9	8.6
Military expenditure (% of GDP)	1.9	3.7	1	0.8
Mobile cellular subscriptions (per 100 people)	0	0.3	34.8	97.6
Individuals using the Internet (% of population)	0	0.1	0.6	11.8
High-technology exports (% of manufactured exports)	..	28	..	0
Overall level of statistical capacity (scale 0 - 100)	..	..	52	63
Global links				
Merchandise trade (% of GDP)	44	25	42	60
Net barter terms of trade index (2000 = 100)	..	100	71	44
External debt stocks, total (DOD, current US$) (millions)	1,197	1,248	931	1,378
Total debt service (% of exports of goods, services and primary income)	10.1	76.4	2.7	2.3
Net migration (thousands)	-450	500	-21	..
Personal remittances, received (current US$) (millions)	0	7	44	59
Foreign direct investment, net inflows (BoP, current US$) (millions)	32	39	238	519
Net official development assistance received (current US$) (millions)	59.3	181	458	946

Source: *World Development Indicators database, World Development Indicators: 09/18/2017*
Figures in blue refer to periods other than those specified.

2.7 Demography

The 2015 Census revealed a population of 7,092,113 spread across four administrative regions. Sierra Leone's population has been on the increase since 1963 census. It increased from 2,180,355 in 1963 to 2,735,159 in 1974 and 3,515,812 in 1985. Sierra Leone 2015 Population and Housing Census, conducted in December 2015, is the second post-war enumeration exercise conducted by the GoSL with financial and technical support from UNFPA and partners. The 2015 Census data indicates that the population grew from 4,976,871 in 2004 to 7,092,113 in 2015, registering an average annual growth rate of 3.2 percent. At the regional level, the growth rate followed the same pattern since 1963. Between 2004 and 2015, the growth rates per region were as follows: Eastern Region - 2.9 %; Northern Region – 3.3 percent; Southern Region – 2.5 percent and Western Area – 4.2 percent. The population figures for the Districts are outlined in Table 2-4 below.

Males represented 49.1% of the total population and females 50.9%. The 2015 PHC results reflect the demographic profile of a young population, where 40.9 percent are less than 15 years, and only 3.5 percent are 65 years and above. The working age population (15-64 years) represents 55.6 percent. By type of residence, the 2015 Census reveals that 4,187,016 people live in the rural areas (59.0%), and 2,905,097 people live in the urban areas (41.0%) (see Table 2-4 - Table 2-7).

Table 2-4: Distribution of Population by Type, District and Sex

District	Total Population			Household Population			Institutional Population		
	Total	Male	Female	Total	Male	Female	Total	Male	Female
Kailahun	526,379	260,586	265,793	525,674	260,060	265,614	705	526	179
Kenema	609,891	301,104	308,787	609,427	300,755	308,672	464	349	115
Kono	506,100	252,751	253,349	505,491	252,295	253,196	609	456	153
Bombali	606,544	296,683	309,861	605,741	296,123	309,618	803	560	243
Kambia	345,474	165,541	179,933	344,095	164,749	179,346	1,379	792	587
Koinadugu	409,372	204,498	204,874	408,687	203,951	204,736	685	547	138
Port Loko	615,376	294,954	320,422	612,920	293,456	319,464	2,456	1,498	958
Tonkolili	531,435	263,152	268,283	531,140	262,910	268,230	295	242	53
Bo	575,478	280,569	294,909	574,026	279,640	294,386	1,452	929	523
Bonthe	200,781	99,014	101,767	200,771	99,007	101,764	10	7	3
Moyamba	318,588	153,699	164,889	318,002	153,467	164,535	586	232	354
Pujehun	346,461	168,869	177,592	346,366	168,803	177,563	95	66	29
Western Area Rural	444,270	221,351	222,919	443,068	220,536	222,532	1,202	815	387
Western Area Urban	1,055,964	528,207	527,757	1,050,711	523,881	526,830	5,253	4,326	927
Total Country	**7,092,113**	**3,490,978**	**3,601,135**	**7,076,119**	**3,479,633**	**3,596,486**	**15,994**	**11,345**	**4,649**

Table 2-5: Distribution of total population by region, district, sex and area of residence

District	Total Population	Male	Female	Rural	Urban	Share Of Population (%)	Proportion Urban	Sex Ratio
Province								
Eastern	1,642,370	814,441	827,929	1,092,723	549,647	23.2	33.5	98.3
Northern	2,508,201	1,224,828	1,283,373	1,893,227	614,974	35.4	24.5	95.3
Southern	1,441,308	702,151	739,157	1,157,428	283,880	20.3	19.7	94.9
Western	1,500,234	749,558	750,676	43,638	1,456,596	21.1	97.1	99.3
Total Country	**7,092,113**	**3,490,978**	**3,601,135**	**4,187,016**	**2,905,097**	**100**	**41**	**96.8**
District								
Kailahun	526,379	260,586	265,793	373,093	153,286	7.4	29.1	97.9
Kenema	609,891	301,104	308,787	338,192	271,699	8.6	44.5	97.4
Kono	506,100	252,751	253,349	381,438	124,662	7.1	24.6	99.6
Bombali	606,544	296,683	309,861	433,486	173,058	8.6	28.5	95.6
Kambia	345,474	165,541	179,933	244,630	100,844	4.9	29.2	91.9
Koinadugu	409,372	204,498	204,874	335,847	73,525	5.8	18	99.6
Port Loko	615,376	294,954	320,422	455,159	160,217	8.7	26	91.9
Tonkolili	531,435	263,152	268,283	424,105	107,330	7.5	20.2	98
Bo	575,478	280,569	294,909	380,397	195,081	8.1	33.9	95
Bonthe	200,781	99,014	101,767	162,796	37,985	2.8	18.9	97.3
Moyamba	318,588	153,699	164,889	295,891	22,697	4.5	7.1	93.3
Pujehun	346,461	168,869	177,592	318,344	28,117	4.9	8.1	95.1
West Area Rural	444,270	221,351	222,919	43,638	400,632	6.3	90.2	99.1
West Area Urban	1,055,964	528,207	527,757	1,055,964	0	14.9	100	99.4
Total Country	**7,092,113**	**3,490,978**	**3,601,135**	**4,187,016**	**2,905,097**	**100**	**41**	**96.8**

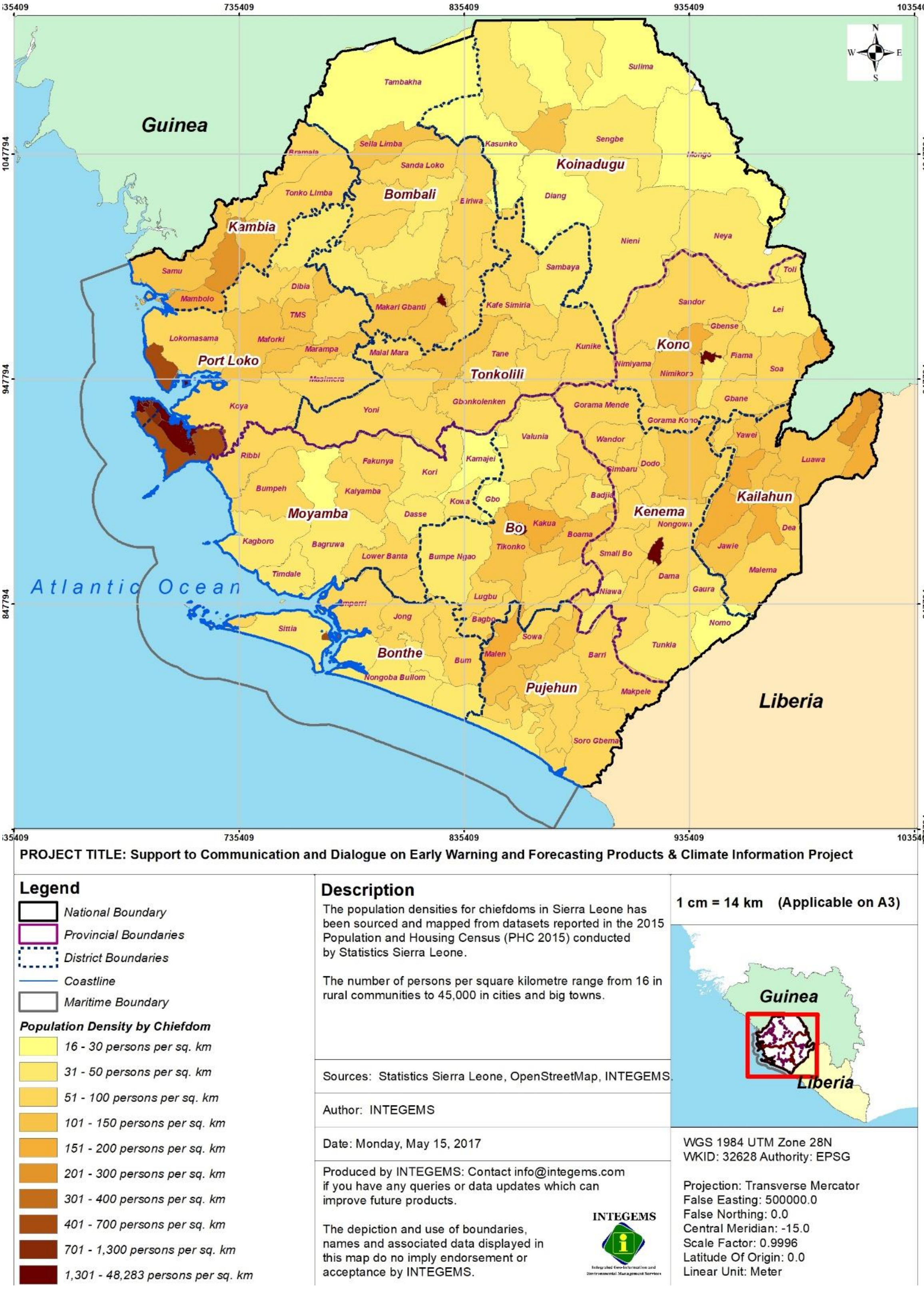
Table 2-6: Distribution of total population by type, district and sex

District	Both Sexes			Male			Female		
	Total	Household	Institutional	Total	Household	Institutional	Total	Household	Institutional
Kailahun	526,379	525,674	705	260,586	260,060	526	265,793	265,614	179
Kenema	609,891	609,427	464	301,104	300,755	349	308,787	308,672	115
Kono	506,100	505,491	609	252,751	252,295	456	253,349	253,196	153
Bombali	606,544	605,741	803	296,683	296,123	560	309,861	309,618	243
Kambia	345,474	344,095	1,379	165,541	164,749	792	179,933	179,346	587
Koinadugu	409,372	408,687	685	204,498	203,951	547	204,874	204,736	138
Port Loko	615,376	612,920	2,456	294,954	293,456	1,498	320,422	319,464	958
Tonkolili	531,435	531,140	295	263,152	262,910	242	268,283	268,230	53
Bo	575,478	574,026	1,452	280,569	279,640	929	294,909	294,386	523
Bonthe	200,781	200,771	10	99,014	99,007	7	101,767	101,764	3
Moyamba	318,588	318,002	586	153,699	153,467	232	164,889	164,535	354
Pujehun	346,461	346,366	95	168,869	168,803	66	177,592	177,563	29
Western Area Rural	444,270	443,068	1,202	221,351	220,536	815	222,919	222,532	387
Western Area Urban	1,055,964	1,050,711	5,253	528,207	523,881	4,326	527,757	526,830	927
Total	**7,092,113**	**7,076,119**	**15,994**	**3,490,978**	**3,479,633**	**11,345**	**3,601,135**	**3,596,486**	**4,649**

Table 2-7: Total Population by age group, district and sex

Age Group/Sex	Total	Kailahun	Kenema	Kono	Bombali	Kambia	Koinadugu	Port Loko	Tonkolili	Bo	Bonthe	Moyamba	Pujehun	Western Area Rural	Western Area Urban
Total Country															
0-4	938,453	61,120	79,417	64,030	83,325	54,951	49,993	95,349	81,322	77,864	28,098	50,919	44,476	57,353	110,236
4-9	1,108,715	90,907	94,476	83,385	98,712	59,813	77,175	97,810	94,514	89,943	34,408	50,906	61,038	57,148	118,480
10-14	847,292	67,171	71,741	65,438	73,921	39,550	57,265	72,912	62,375	67,609	23,291	35,186	44,153	51,078	115,602
15-19	873,620	72,956	79,007	64,033	72,356	39,566	55,929	66,800	62,610	71,159	24,055	32,653	47,510	54,023	130,963
20-24	662,819	45,341	55,526	42,726	53,828	27,312	35,590	49,761	44,404	52,822	17,326	23,725	29,774	50,424	134,260
25-29	607,983	40,765	50,165	41,678	49,155	26,278	29,965	50,020	43,851	46,659	15,495	23,751	26,419	44,784	118,998
30-34	434,203	31,331	37,537	29,375	34,544	19,272	22,275	35,942	29,684	33,755	12,149	17,817	20,376	29,926	80,220
35-39	421,172	30,335	37,005	31,928	33,606	18,595	20,490	36,521	29,713	34,279	11,076	19,076	19,433	28,624	70,491
40-44	299,215	21,463	26,476	21,299	24,545	14,015	16,356	26,205	20,438	23,858	8,484	14,166	13,854	19,800	48,256
45-49	242,188	18,029	21,561	18,487	20,829	11,021	12,747	20,962	17,231	20,137	6,493	12,084	10,676	15,391	36,540
50-54	186,793	12,685	16,161	12,807	16,112	9,094	9,581	17,032	13,199	15,595	5,283	9,675	8,195	11,530	29,844
55-59	110,449	7,259	9,320	7,298	10,097	5,412	5,069	10,428	7,357	9,364	3,008	6,236	4,279	6,746	18,576
60-64	112,682	8,700	10,213	7,121	10,568	6,303	6,047	10,758	7,724	9,418	3,567	6,395	5,106	5,815	14,947
65-69	73,722	5,263	6,507	5,151	7,278	3,855	3,359	6,864	4,680	6,649	2,187	4,394	3,117	4,052	10,366
70-74	65,568	5,115	5,874	4,119	6,464	3,756	3,223	6,971	4,562	5,836	2,038	4,138	3,044	3,090	7,338
75-79	39,728	2,773	3,317	2,874	4,244	2,127	1,588	3,953	2,699	3,785	1,218	2,693	1,782	1,916	4,759
80-84	31,359	2,430	2,650	1,944	3,311	2,112	1,312	3,378	2,382	3,003	1,189	2,192	1,466	1,181	2,809
85-89	15,888	1,158	1,288	1,062	1,678	1,000	597	1,615	1,159	1,559	527	1,118	742	694	1,691
90-94	9,984	847	803	661	1,018	693	436	1,088	741	984	441	680	522	312	758

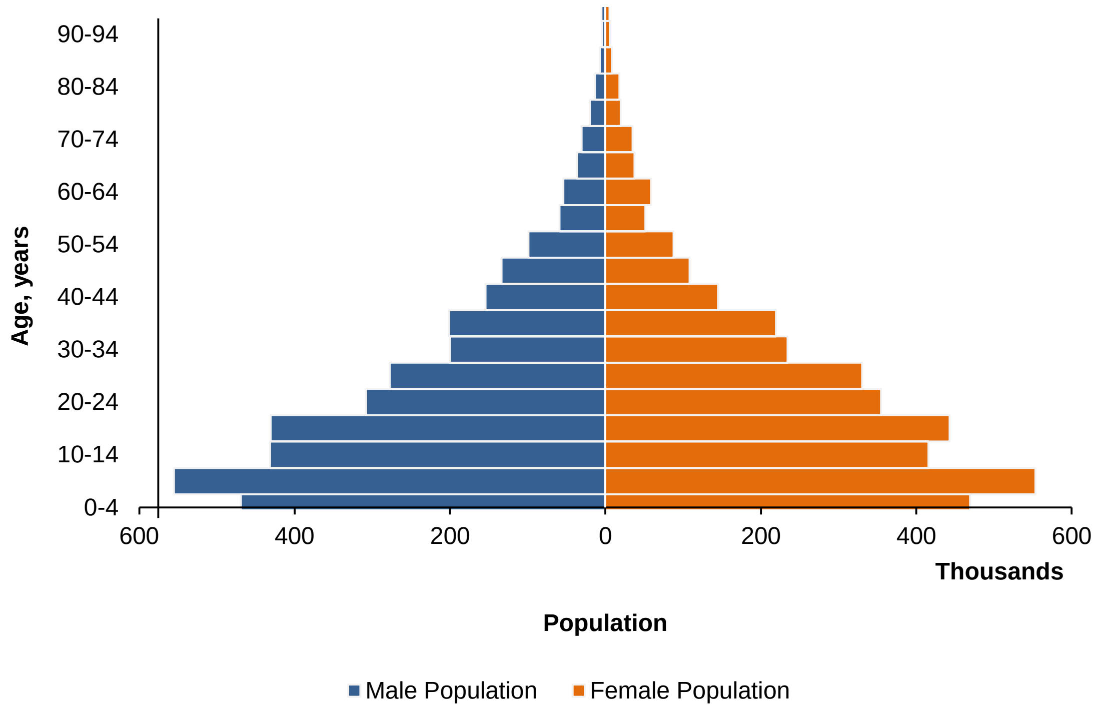
Figure 2-9: Population Density at Chiefdom Level in Sierra Leone



The aged dependency ratio is an important indicator of population structure and is defined as the number of aged persons (65+ years) and children under 14 years of age per 100 persons of age 15 to 64 years. This indicator assists in understanding the situation of the aged population in the country. The aged dependency ratio for Sierra Leone as recorded during the 2015 Population and Housing Census (PHC 2015) range from 55 (Western Area Urban) to 95 (Kambia District) With a national average of 79.

Information of age dependency can help on disaster management to reach efficient assessment and relief when disaster occurred.

Figure 2-10: Population Pyramid of Sierra Leone (Population and Housing Census 2015)



2.8 Housing Infrastructure

The 2015 PHC results reveal that the total stock of houses in the country is 801,417. The proportion of houses in rural areas (60.6%) is higher than that in urban areas (39.4%). The regional distribution shows that Eastern region counts for 21.8 % of the stock of houses, Northern region 34.3 % Southern region 22.7 % and Western Area 21.1 percent. The population per house is 8.8 persons and ranges from a low of 7.9 persons in the Southern region to a high of 9.4 persons in the Eastern region. On average, Sierra Leone has 1.6 households per house and ranges from a low of 1.4 in the Southern region to a high of 1.9 in the Western Area (see Table 2-8).

The common material used for the construction of walls nationally is mud bricks, followed by cement blocks mud & wattle ,clay bricks and zinc .In the rural areas, the data shows that mud bricks accounts most of the wall construction followed by mud & wattle ,cement blocks, clay bricks and zinc. In the urban areas, the predominant material used for construction of walls is cement bricks while construction is done with other materials like mud brick zinc and clay. The use of zinc for roofing is highest nationwide with 81.6 percent, followed by thatch (13.3%), asbestos (2.0%), concrete (1.6%) and the rest accounting for 1.4%. The data also shows that the use of zinc is high in rural (73.3%) and urban (92.1%) areas, followed by thatch (23.4%) in rural areas and concrete (3.2%) in urban areas. The use of mud floors nationally is 46.4%, followed by cement (44.0%), tiles (6.4%) and others (3.2%) (Table 2-9). In the rural area, 74.4 % of floors are made of mud, followed by cement (21.2%) and tiles (0.8%). In the urban areas, 72.0 % of the floors are cement, followed by tiles (13.3%) and mud (12.0%).

Table 2-8: Stock of houses and households by region, district and area of residence

Region/ District/ Urban-Rural	Household Population	Number of Houses	Number of Household	Percentage Distribution of Houses	Households per House	Population per House	Average Household Size
Eastern	**1,640,592**	**174,687**	**281,201**	**21.80**	**16**	**94**	**58**
Kailahun	525,674	53,166	83,348	6.60	16	99	63
Kenema	609,427	64,751	111,734	8.10	17	94	55
Kono	505,491	56,770	86,119	7.10	15	89	59
Northern	**2,502,583**	**275,225**	**414,377**	**34.30**	**15**	**91**	**60**
Bombali	605,741	71,056	105,902	8.90	15	85	57
Kambia	344,095	37,870	53,826	4.70	14	91	64
Koinadugu	408,687	42,029	56,108	5.20	13	97	73
Port Loko	612,920	69,675	111,701	8.70	16	88	55
Tonkolili	531,140	54,595	86,840	6.80	16	97	61
Southern	**1,439,165**	**182,075**	**248,655**	**22.70**	**14**	**79**	**58**
Bo	574,026	69,009	102,723	8.60	15	83	56
Bonthe	200,771	27,129	32,538	3.40	12	74	62
Moyamba	318,002	53,516	61,880	6.70	12	59	51
Pujehun	346,366	32,421	51,514	4.00	16	107	67
Western	**1,493,779**	**169,430**	**321,235**	**21.10**	**19**	**88**	**47**
Western Area Rural	443,068	63,087	91,284	7.90	14	70	49
Western Area Urban	1,050,711	106,343	229,951	13.30	22	99	46
Rural	4,182,489	485,664	697,706	60.60	14	86	60
Urban	2,893,630	315,753	567,762	39.40	18	92	51
Total Country	**7,076,119**	**801,417**	**1,265,468**	**100.00**	**2**	**9**	**6**

Table 2-9: Households by major material for construction of wall

Region/ District/ Area of Residence	Major Material for Construction of Wall												
	Total	Stone	Cement Blocks	Clay Bricks	Sand	Zinc	Timber	Mud Bricks	Poles/Reed	Tarpaulin	Burned Bricks	Mud & Wattle	Other
Total Country													
Number	1,265,468	2,815	2,815	313,454	9,765	79,482	9,421	543,495	5,938	11,874	4,897	187,936	5,156
Percent	100	0.20	24.80	7.20	0.80	6.30	0.70	42.90	0.50	0.90	0.40	14.90	0.40
Region													
Eastern	281,201	446	43,905	25,427	2,116	7,113	1,589	145,587	1,392	1,848	1,907	48,949	922
Northern	414,377	976	58,171	23,592	2,149	12,641	2,072	264,330	2,223	6,799	1,359	38,497	1,568
Southern	248,655	481	33,735	20,559	2,601	3,398	1,653	81,338	2,158	1,803	1,393	98,454	1,082
Western	321,235	912	177,643	21,657	2,899	56,330	4,107	52,240	165	1,424	238	2,036	1,584
Urban/Rural													
Rural	697,706	1,536	44,986	46,075	4,498	18,939	3,602	383,353	5,420	8,485	3,759	173,851	3,202
Urban	567,762	1,279	268,468	45,160	5,267	60,543	5,819	160,142	518	3,389	1,138	14,085	1,954
District													
Kailahun	83,348	108	6,165	6,388	555	2,439	567	55,113	378	661	627	10,214	133
Kenema	111,734	236	24,762	11,868	1,039	2,274	508	39,045	751	593	827	29,401	430
Kono	86,119	102	12,978	7,171	522	2,400	514	51,429	263	594	453	9,334	359
Bombali	105,902	263	23,789	6,677	835	2,477	294	63,175	231	2,325	240	5,347	249
Kambia	53,826	55	5,413	1,787	173	2,158	338	40,982	75	1,023	55	1,561	206
Koinadugu	56,108	55	2,623	4,662	244	1,563	192	39,259	293	2,243	220	4,320	434
Port Loko	111,701	364	18,968	5,832	615	3,658	307	75,390	743	570	322	4,682	250
Tonkolili	86,840	239	7,378	4,634	282	2,785	941	45,524	881	638	522	22,587	429
Bo	102,723	202	24,123	9,050	1,575	1,459	603	31,328	578	652	350	32,540	263
Bonthe	32,538	39	2,187	3,691	159	335	212	12,572	125	193	208	12,500	317
Moyamba	61,880	124	4,585	4,845	251	947	346	22,988	383	613	412	26,137	249
Pujehun	51,514	116	2,840	2,973	616	657	492	14,450	1,072	345	423	27,277	253
West Area Rural	91,284	231	36,998	8,389	893	10,511	867	30,774	70	896	101	1,141	413
West Area Urban	229,951	681	140,645	13,268	2,006	45,819	3,240	21,466	95	528	137	895	1,171

2.9 Health Sector

The Ministry of Health and Sanitation is the major health care provider in Sierra Leone and operates all government health facilities in the country. Sierra Leone is divided into 13 health districts that correspond to the districts of Sierra Leone except for the Western Area Rural and Western Area Urban districts which are combined into the Western Area Health district. Each district has a health management team and an average of 50 peripheral health units (PHU) and over 100 technical staff. The structure of public sector health service delivery involves a multi-level primary, secondary and tertiary care system through which cases of increasing complexity are referred to facilities with increasing capacity. The public delivery system starts from the peripheral health units (PHU) which are recognized and standardized. At the base, community health workers (CHWs) work out in the community providing a fixed package of health promotion and health care services, as well as conducting surveillance activities.

The primary care system comprises three levels of progressively larger facilities with increasingly skilled HCWs. From smallest to largest, these include Maternal and Child Health Posts (MCHPs), Community Health Posts (CHPs), and Community Health Centres (CHCs). CHCs also provide basic emergency obstetric and neonatal care (BEmONC) services. Whilst there are staffing, supply chain, and infrastructure challenges at every level (but especially at the primary care level), this structure provides a solid foundation for health service delivery in the country. The secondary care system comprises district hospitals and regional hospitals that provide a comprehensive range of services, including comprehensive obstetric and neonatal care (CEmONC) services. The tertiary care system comprises a number of hospitals in Freetown that provide the most specialised of services in their area, e.g. paediatric care at Ola During Children Hospital; maternity care at Princess Christian Maternity Hospital; and general medicine and surgery at Connaught Hospital.

Sierra Leone suffered a devastating and historic Ebola outbreak in 2014 (see Figure 2-12). The major contributing factor to the failure to contain the epidemic as rapidly as other countries was the severe weakness it's health care system. The country simply lacked the knowledge, the human resource capacity as well as infrastructure to spot, track and control the epidemic. Although the first in scale and length of the epidemic, two years earlier, Sierra Leone experienced the country's largest cholera outbreak in fifteen years, revealing the serious weaknesses in the country's health system.

Table 2-10: Number of Health Facilities by District, July 2015

Organisation Unit	MCHP	CHP	CHC	Government Hospital	Private Clinic	Private Hospital	Total
Bo	69	24	28	1	2	3	127
Bombali	55	32	15	1	5	3	111
Bonthe	15	26	14	1	4	2	62
Kailahun	18	42	14	1	1	1	77
Kambia	40	15	13	1	2	1	72
Kenema	60	33	26	1	2	2	124
Koinadugu	43	18	10	1	2	0	74
Kono	44	25	16	1	1	0	87
Moyamba	55	26	18	1	2	1	103
Port Loko	70	21	15	2	1	2	111
Pujehun	49	14	13	1	0	0	77
Tonkolili	75	15	12	1	1	2	106
Western Area	39	28	39	11	22	10	149
Total	632	319	233	24	45	27	1,280

Source: Sierra Leone Basic Package of Essential Health Services (2015-2020)

Figure 2-11: Health Facilities in Sierra Leone

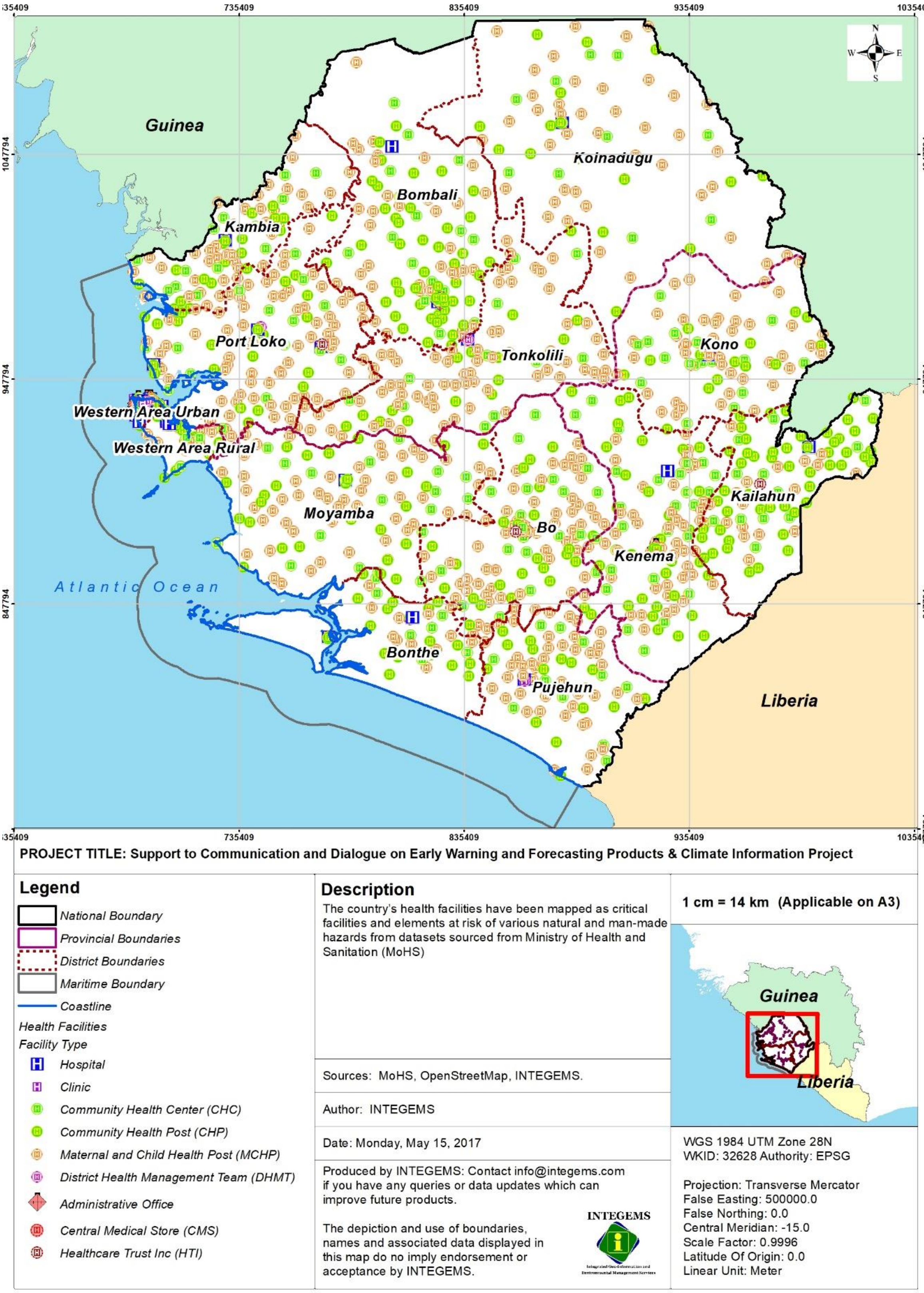
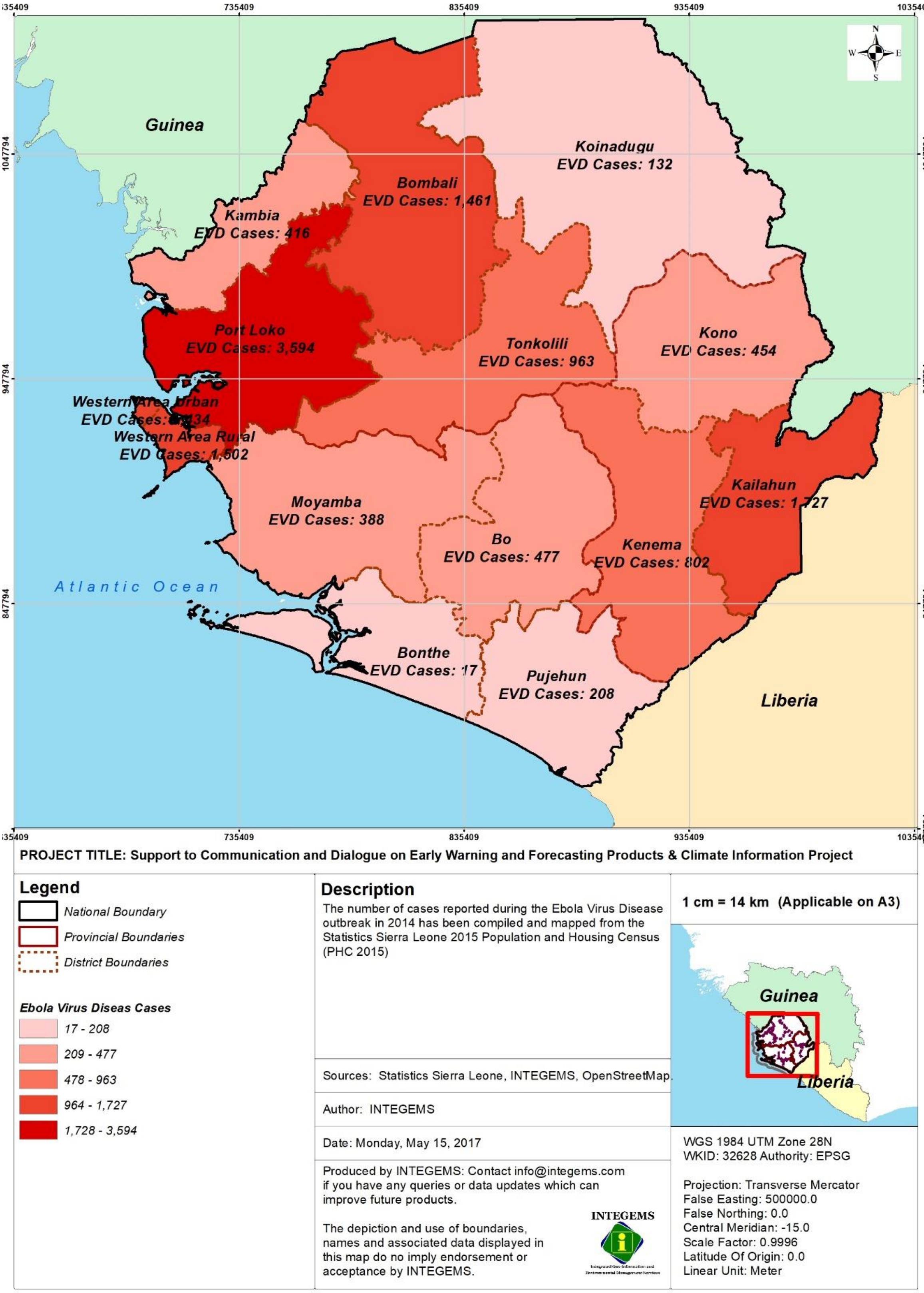


Figure 2-12: Ebola Virus Disease (EVD) Cases in Sierra Leone



2.10 Education Sector

In 1993 the government adopted a four stage approach 6-3-3-4 education system and created the National Commission for Basic Education. The 6-3-3-4 education system is composed of 6 years of formal primary education, 3 years of junior secondary school(JSS), 3 years of senior secondary school (SSS) and 4 years of tertiary level education(colleges, universities, polytechnics and teacher training).

The Ministry of Education Science and Technology changed the 6-3-3-4 system of education to 6-3-4-4 after the government white paper on the recommendation of the Professor Gbamanja Commission of Inquiry was revealed in 2010. Additionally, the Ministry of Education, Science and Technology has focused on pre-primary education in the past few years because of the overwhelming evidence that early childhood care, health, and education profoundly influence events later in life. There are four universities in Sierra Leone: The Fourah Bay College, University of Sierra Leone (1827); Njala University (1910 and became a university in 2005); University of Makeni (2005); and Limkokwing University of Creative Technology (2016) (see **Error! Reference source not found.**).

The 2015 Census revealed that out of the 6,589,838 people aged 3 years and above, 55.4 % have attended school and 44.2 % have never attended school. Whereas of those persons 3 years and above who ever attended school, 37.2 % are currently in school. The percentages of males currently in school (39.1%) and those ever attended school (60.0%) are more than their female counterparts (35.3% and 50.9% respectively). The percentage of the population that has never attended school in rural areas (32.7%) is almost three times more than those in the urban areas (11.5%).

2.11 Fishery Sector

Sierra Leone has an extensive coastline with a sizeable continental shelf (covering an area of over 25,000 square kilometres and a width of up to 140 kilometres in the north) that is fed by substantial rivers and rainfall, providing the basic elements for extremely productive marine fisheries. Based on these resources, the fisheries sector provides direct employment to an estimated 100,000 persons and indirect employment to some 500,000 persons (almost 10 percent of the population) (Ministry of Fisheries and Marine Resources, 2016) More specifically, in coastal areas an estimated 25 percent of the male population of working age are reported to be involved in fishing at least part-time. The sector contribute almost 10 % to the country's Gross Domestic Products (GDP)[17].

The fisheries sector in Sierra Leone constitute of three major activities:

- Artisanal Fishing Activity: It operates in estuaries and coastal waters extending from the shoreline to a depth of 15-45 m. This activity comprises of variety of dugout and planked canoes which employs diverse ranges of fisheries gears, which include cast nets, ring nets, driftnets, set net, beach seines and hooks. This fishery contributes significantly (up to 80%) of the total national fish production.
- Industrial Fishing Activity: Industrial fishing activity operates in the deep waters, out- side the Inshore Exclusive Zone (IEZ) and it is characterized by multinational fleet which include trawlers, shrimpers, long liners, canoe support vessels (mother ship) and carriers. It is largely export–oriented.
- Inland Fishing and Aquaculture: Inland fishery operates in rivers, a few lakes, flood plains and swamps. Aquaculture is mostly practiced in inland valley swamps and wetlands and has great potential for development.

[17] (Government of Sierra Leone, 2013)

Table 2-11: Households engaged in fishery by type of fish farming

Province/District/ Type of Residence	Total	Fish Pond	Artisan Fishing	Coastal fishing
TOTAL COUNTRY				
Total	245,957	18,876	212,938	14,143
Rural	227,709	17,312	199,310	11,087
Urban	18,248	1,564	13,628	3,056
PROVINCE				
Eastern				
Total	75,175	3,219	70,117	1,839
Rural	67,529	2,621	63,411	1,497
Urban	7,646	598	6,706	342
Northern				
Total	81,943	11,685	63,890	6,368
Rural	76,320	11,084	60,141	5,095
Urban	5,623	601	3,749	1,273
Southern				
Total	84,428	3,578	76,432	4,418
Rural	82,997	3,504	75,162	4,331
Urban	1,431	74	1,270	87
Western				
Total	4,411	394	2,499	1,518
Rural	863	103	596	164
Urban	3,548	291	1,903	1,354
DISTRICTS				
Kailahun				
Total	28,318	1,122	26,552	644
Rural	23,597	665	22,473	459
Urban	4,721	457	4,079	185
Kenema				
Total	28,423	1,041	26,707	675
Rural	25,783	934	24,327	522
Urban	2,640	107	2,380	153
Kono				
Total	18,434	1,056	16,858	520
Rural	18,149	1,022	16,611	516
Urban	285	34	247	4
Bombali				
Total	10,626	1,593	8,583	450
Rural	10,225	1,556	8,233	436
Urban	401	37	350	14
Kambia				
Total	11,896	3,912	6,216	1,768
Rural	10,262	3,591	5,603	1,068
Urban	1,634	321	613	700

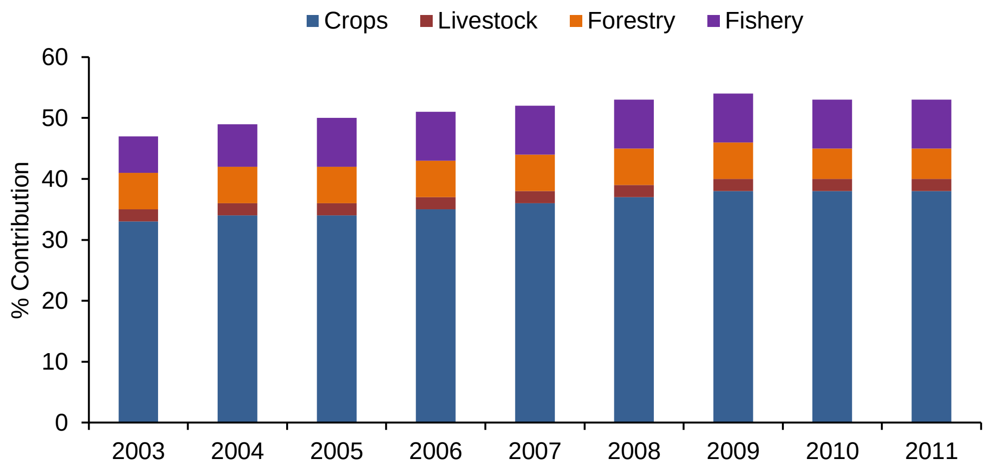
Province/District/ Type of Residence	Total	Fish Pond	Artisan Fishing	Coastal fishing
Koinadugu				
Total	22,417	489	21,327	601
Rural	20,941	428	19,966	547
Urban	1,476	61	1,361	54
Port Loko				
Total	16,821	3,351	10,687	2,783
Rural	15,704	3,269	10,107	2,328
Urban	1,117	82	580	455
Tonkolili				
Total	20,183	2,340	17,077	766
Rural	19,188	2,240	16,232	716
Urban	995	100	845	50
Bo				
Total	28,356	878	26,961	517
Rural	27,792	826	26,477	489
Urban	564	52	484	28
Bonthe				
Total	11,345	478	9,761	1,106
Rural	11,027	477	9,462	1,088
Urban	318	1	299	18
Moyamba				
Total	26,127	1,499	23,232	1,396
Rural	25,840	1,482	22,999	1,359
Urban	287	17	233	37
Pujehun				
Total	18,600	723	16,478	1,399
Rural	18,338	719	16,224	1,395
Urban	262	4	254	4
Western Area Rural				
Total	3,498	315	1,977	1,206
Rural	863	103	596	164
Urban	2,635	212	1,381	1,042
Western Area Urban				
Total	913	79	522	312
Rural	-	-	-	-
Urban	913	79	522	312

Source: Statistics Sierra Leone; Sierra Leone Population and Housing Census, 2015

2.12 Agriculture Sector

Agriculture has been the backbone of the Sierra Leone economy for several decades. It contributes 40 to 50% of GDP, about 10% of exports, and provides employment to approximately two-thirds of the population. Whilst agricultural growth has significant poverty reduction effects, the sector is characterized largely by smallholders, practicing mainly subsistence agriculture. In recent years, efforts have been made to introduce mechanized farming practices, through provision of tractors, power tillers and other agricultural tools to farming communities. In 2011, 56.6% of households in Sierra Leone were crop-producing households compared with 65.3% in 2003 (see Figure 2-14).

Figure 2-13: Contributions of Agriculture to Gross Domestic Product (%) by Subsector



Source: Statistics Sierra Leone, 2013

2.13 Transportation Sector

Table 2-12: Length of roads by District

District	Length of Road, km					
	Trunk	Primary	Secondary	Tertiary	Residential	Total Length
Bo	66.8	37.5	137.1	298.8	333.5	**873.7**
Bombali	0	128	268	422.7	175	**993.7**
Bonthe	0	0	54.9	151.2	56.8	**262.9**
Kailahun	111.3	106.1	217.9	406.3	118.8	**960.4**
Kambia	28	0	84	487	81	**680**
Kenema	146.6	74.8	171.5	478.3	301.1	**1172**
Koinadugu	0	125.5	181.8	402.3	99.9	**809.5**
Kono	0	198.4	77.2	371.3	167.1	**814**
Moyamba	48.7	0	267.6	304	69.7	**690**
Port Loko	136.3	119.2	91	349.1	221.1	**916.7**
Pujehun	53.7	67	161.7	269.1	17	**568.5**
Tonkolili	55.1	80.4	159.5	166.6	69.7	**531.3**
Western Area Rural	41	65.3	7.2	131.2	570.1	**814.8**
Western Area Urban	10.4	55.6	35.4	44.7	525.2	**671.3**
Total	**697.9**	**1057.8**	**1914.8**	**4282.6**	**2806**	**10759**

Figure 2-14: Length of roads by District

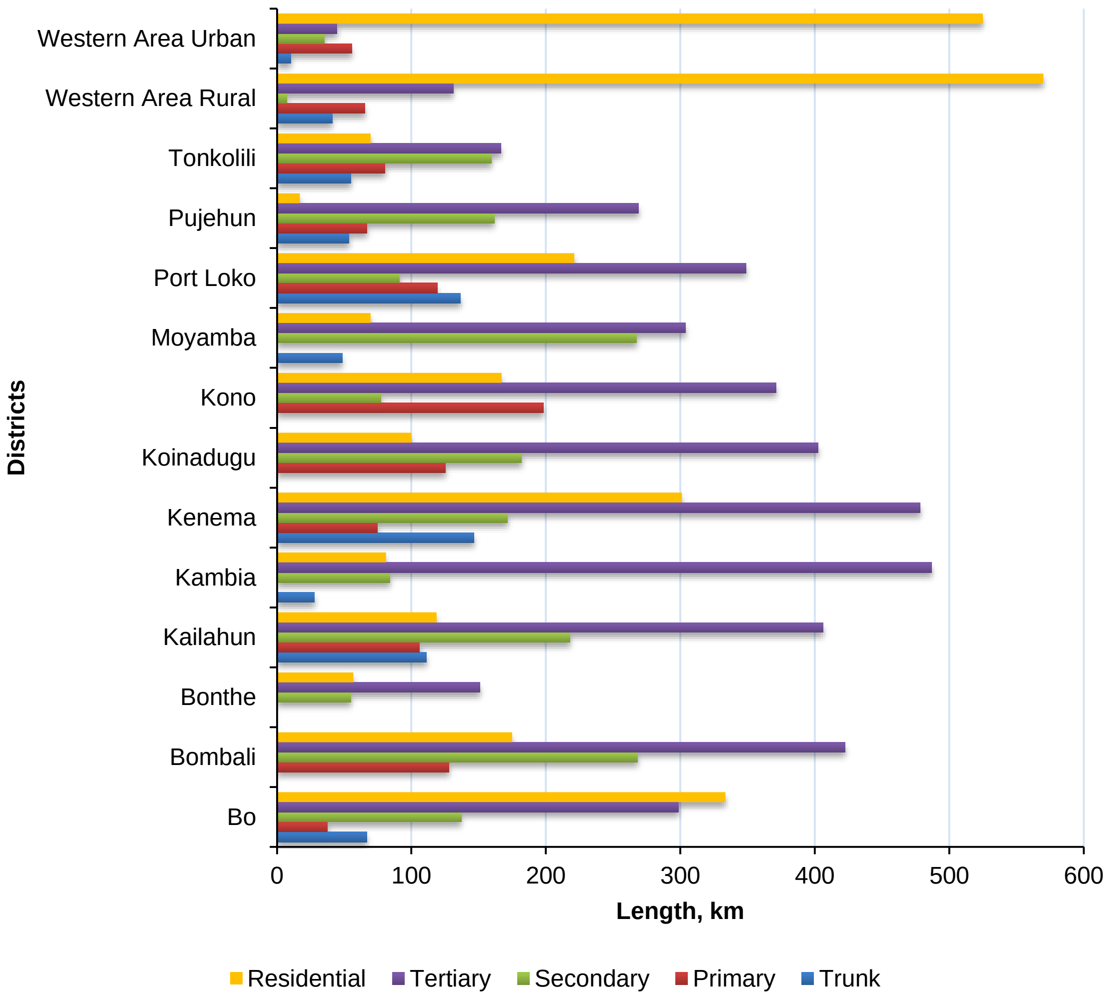
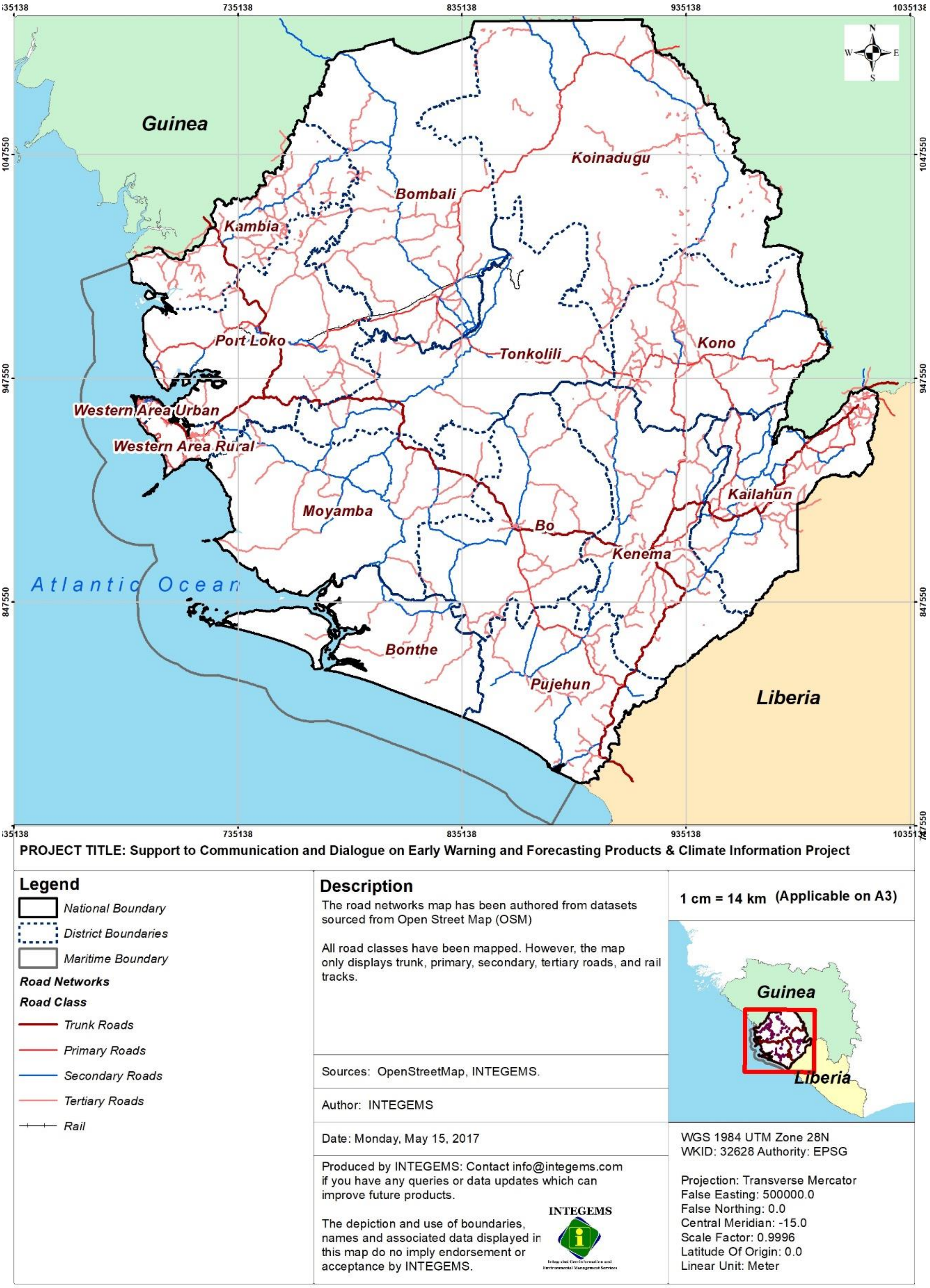


Figure 2-15: Road Network in Sierra Leone



2.14 Energy Sector

Sierra Leone is reasonably well endowed with energy resources, particularly biomass energy (forestry), hydroelectricity and other renewable energy sources (e.g. solar energy). There is an extensive network of rivers and tributaries that provide a large hydroelectric power potential conservatively estimated at 1,200 MW. Technically and economically, the most promising site is at Bumbuna on the Seli River, whose development started with a 50 MW installed capacity (first stage), and an ultimate installed capacity of about 300 MW.

The energy situation in Sierra Leone is significant improved over the last five years but still short of meeting the country demand. Over the past years, the sector is being transformed and reformed to meet the ever increasing demand of our time and moving towards the productions of clean form of energies with the daunting challenge to make energy reliable and accessible. Energy consumption in Sierra Leone is dominated by biomass, mainly in the form of fuel wood and charcoal which accounts for over 83% of energy used. Imported petroleum products are the next largest source of power at approximately 15.8%. Grid-generated electricity accounts for the remainder of the power supplied to the country's citizens. Currently, the electricity sub-sector in Sierra Leone faces challenges with less than 13% access. Currently, there are operational hydro power dam– Dodo (6MW) a regional grid linking thermal power plants in Bo and Kenema in the south-east and Bumbuna Falls (50MW in the wet & 18MW in the dry) in the north its supply Makeni and also linked to the Freetown electricity grid. The current installed capacity of solar PV is about 25 kW, which provides solar systems for hospitals, schools, domestic and commercial use.

Efficiency and access are constrained by high technical losses on the transmission and distribution network, which are further compounded by low voltage quality due to overburdening of infrastructure by illicit users. The stock of energy efficient appliances and equipment also remains low. Further, the development and use of renewable energy from hydro, solar, biomass and other facilities has been a slow process but there has been meaningful interventions with the contributions from DFID and UNDP.

Table 2-13: Sources of Energy & Power Generated

Region	Solar	Biomass	Heavy Fuel Oil	Diesel	Hydro	Coal	Total
Western Area			26.5	25.0			51.5
Northern Province		30.25	6.0	7.18	50.3		93.73
Southern Province				10.0			10.0
Eastern Province				2.0	6.0		8.0
Total	**0**	**30.25**	**32.5**	**44.18**	**56.3**	**0**	**163.2**

Source (Mainstreaming Of Energy Policy within Sustainable Development Goals (SDGs) In Sierra Leone; John Angel Turay and Rev.Ing. Paul Charles Saffa, June 27th-29th, 2016.

2.15 Tourism Sector

The Ministry of Tourism and Cultural Affairs is one of the key Ministries in Sierra Leone because of its mandate of promoting, developing, and preserving tourism and cultural activities in Sierra Leone. As the central authority for the promotion and development of tourism in Sierra Leone, the Ministry supervises and controls the component branches of the sector and generates policy guidelines and objectives for growth management and marketing and devise strategies to achieve objectives, particularly provision of tourism amenities/facilities and attraction.

Estimates indicate that tourism's annual contribution to GDP was around $25 million in 2007, growing to around $37 million in 2011. Tourist arrivals (which include all arrivals of foreigners into Sierra Leone) almost doubled from 32,000 in 2007 to 60,000 in 2012. In 2012, of the 59,730 visitors who arrived at Lungi International Airport, 23,619 were on business, 14,074 were visiting friends and relatives, 9,464 visited for leisure purposes, 6,034 for conferences, and 6,539 for other reasons. Visitors from Europe accounted for 26% of arrivals in 2012, compared to 21% from ECOWAS countries, 18% from the Americas, and the remaining 35% from elsewhere.

The tourism sector accounted for $42 million of Government revenue generated in 2012, coming from local hotel accommodation, restaurants, transportation, and souvenirs. The number of employees in the tourism sector reached an estimated 5,600 in 2012, and if the sector's potential is unleashed, employment is projected to reach close to 10,000 people in the near future. Over the last few years, Government has developed a seven-year strategic plan for tourism, a marketing programme, and a tour guide training programme, among other activities.

Sierra Leone, according to the latest report released by the United Nations World Tourism Organisation (UNWTO), has earned the status of the fastest growing tourist destination in the world, following its recording 310 per cent more overseas arrivals in 2016 compared with 2015, a rise that has been attributed to the country being declared Ebola free in November 2015. In 2015 the country recorded 24, 000 visitors but UNWTO indicated that about 74,400 visited the country last year. There is clear potential for growth of Sierra Leone's tourism industry, but it is being held back by several challenges including limited infrastructure, Sierra Leone's international image ,relatively high costs of travelling to Sierra Leone and weak institutional and legislative frameworks for the sector.

2.16 Mining Sector

Sierra Leone has historically been a significant producer of iron ore and diamonds. The country's mineral resources also include rutile, bauxite, ilmenite, zircon, gold and coltan. Diamond productions are concentrated in Kono, Kenema and Bo Districts. Bauxite deposits and production sites include those between Moyamba and Mano, Freetown Peninsular; KrimKpaka, and Port Loko. Rutile production is distributed around Gbangbama, Sembehun, Rotifunk and Kambia. Iron ore has long been mined at Marampa and recently mining activities have begun in Tonkolili. Gold is mined artisanally and presently production comes from alluvial deposits (see Figure 2-17). Iron-ore projects are seen as key contributors to Sierra Leone's GDP growth with over US$ 1bn in exports in 2013 (Bank of Sierra Leone). Diamond is one of the country's largest exports. There is large scale mining operations in diamonds, rutile and bauxite and continued small-scale and artisanal mining of gold and diamonds.

Figure 2-16: Location of Mining Operations in Sierra Leone

Table 2-14: Major operations in the Mining Sector

Name of Mine/Project	Owner(s)	Location	Type Of Mineral	Project Phase
Koidu Diamond Mine	Octea Mining (Koidu Ltd)	Kono	Diamond	Production
Tonkolili Iron Ore	-African Minerals -- Shandong Iron & Steel Group (25%)	Bumbuna, Mabonto & Bendugu In Tonkolili District	Hematite Concentrate Iron Ore	Production
Marampa Project	Cape Lambert	Lunsar	Iron Ore	Exploration
Komahun	Nimini (90%) Plinian (10%)	Kono	Gold	Development
Baomahun Gold Project	Cluff /Amara Plc	Baomahun	Gold	Exploration
Sierra Rutile Natural	Iluka Sierra Rutile Ltd	Lanti, Gangama & Sembehun	Rutile	Production
Vimetco Sierra Minerals Holding	Sierra Minerals/ Vimetc O N.V	Upper Banta, Lower Banta, Dasse, Bumpe Kpanda Kemoh	Bauxite	Production

Source: Sierra Leone Extractive Industries' Transparency Initiative (SIEITI) 2013 Report: Feb 2016

3 NEEDS ASSESSMENT OF EARLY WARNING COMMUNICATION NETWORK

According to the United Nations International Strategy for Disaster Reduction (UNISDR), an early warning system is the set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by hazards to take necessary preparedness measures and act appropriately with sufficient time to reduce the possibility of harm or losses (UN-ISDR 2009). This definition encompasses the range of factors necessary to achieve timely warnings for effective response. A people-centered early warning system necessarily comprises four key elements:

1. **Risk Knowledge:** Risk assessment provides essential information to set priorities for mitigation and prevention strategies and designing early warning systems.
2. **Monitoring and Predicting:** Systems with monitoring and predicting capabilities provide timely estimates of the potential risk faced by communities, economies and the environment.
3. **Disseminating Information:** Communication systems are needed for delivering warning messages to the potentially affected locations to alert local and regional governmental agencies. The messages need to be reliable, synthetic and simple to be understood by authorities and the public.
4. **Response:** Coordination, good governance and appropriate action plans are key points in effective early warning. Likewise, public awareness and education are critical aspects of disaster mitigation.

Failure of any part of the system will imply failure of the whole system. The basic idea behind early warning is that the earlier and more accurately we are able to predict short- and long-term potential risks associated with natural and human-induced hazards, the more likely we will be able to manage and mitigate a disaster’s impact on society, economies, and environment.

Early warning systems help to reduce economic losses and mitigate the number of injuries or deaths from a disaster, by providing information that allows individuals and communities to protect their lives and property. Early warning information empowers people to take action prior to a disaster. If well integrated with risk assessment studies and communication and action plans, early warning systems can lead to substantive benefits. Effective early warning systems embrace the following aspects: risk analysis; monitoring and predicting location and intensity of the disaster; and communicating alerts.

After the September 2015 flooding in Sierra Leone, the ONS-DMD started paying more attention to early warning and pre-emptive disaster management system and there has been a paradigm shift to become more proactive with emphasis on disaster prevention, mitigation and preparedness. Although the ONS-DMD and other relevant MDAs are contributing much in preventing loss of life through effective pre-disaster warning system, the communication networks are been severely damaged due to lack of robustness. The traditional ways of disseminating disaster early warnings in Sierra Leone have been through radio and television, military forces and early warning towers. However, during a disaster situation, there are important limitations – mass media channels are not always switched on, and other channels have limited reach. In designing the CIDMEWS-SL, then, the intention was – via the combination of cell phones (many of which are constantly switched on) and alarm devices – to enable early warning information to reach the last mile more effectively but also at relatively low cost.

3.1 Approach to the Needs Assessment

The Needs Assessment involved a detailed assessment of the early warning communications network within and between the four relevant MDAs (i.e., SLMD, EPA-SL, ONS-DMD and MWR) and gap assessment in existing early warning system at the institutional levels through key informant interviews and consultative meetings. The meetings were conducted with the aim to understand the MDAs and their staff’s knowledge towards early warning systems and their awareness towards warning dissemination, including the ICT infrastructure, early warning data and information systems, and information products with regards disaster management, meteorological, climatological, hydrological issues.

A six stage review, data collection and assessment process were involved in conducting the Needs Assessment of Early Warning Communications Network (NAEWCN):

1) Desk-based Review of Project's Documents
2) Assessment of Communication Network Capability
3) Consultations with Stakeholders
4) Assessment Using the UN-ISDR Framework
5) Needs Assessment of Information Systems and Networks
6) Assessment of ICT Networks and Tools

This was followed by a gap assessment for each stage of an early warning system, including specific indicators that revealed the gaps and needs of the existing system through reconnaissance, consultations and meetings with key informants from the four MDAs. During the Needs Assessment, several aspects of early warning communication networks in terms of disaster management, meteorological, climatological and hydrological hazards and disasters, and were assessed and classified as follows:

- **Challenges**: Examined the three major types of challenges (technological, sociological and organizational.) in establishing early warning communication networks in terms of disaster management, meteorological, climatological and hydrological hazards and disasters. These three major challenges are all critical for the MDAs to develop and maintain an effective early warning communication network.
- **System architecture design**: Groups of early warning communication networks.
- **Protocols**: Due to the heteronomous nature of early warning communication networks, specific network protocols have to be proposed.
- **Security**: Fake warning messages can render the whole system useless. To avoid that, security issues are extremely critical in early warning communication networks.

3.1.1 Challenges

Three categories of communication challenges were assessed as these were all critical for the four MDAs to develop and maintain an effective early warning communication network.

3.1.1.1 Technological Challenges

When a disaster is occurring, the primary technological challenge is to rapidly deploy a warning system for quick response and disaster management. Regardless of whether early warning communication networks are destroyed or partly destroyed (such as power, telephone, mobile base station, and/or other network connectivity infrastructure), the warning system should be able to connect to the network outside the disaster areas. If the communication network is destroyed, it needs to be restored quickly.

Several potential solutions to technological challenges are proposed in this Report. The first one is to employ a dual-use technology - devices with dual-use technology could work in two operational modes, normal and emergency operational modes. During normal circumstances, the device works on normal mode while during disasters, the device would enter the emergency operational mode, in which the user may have limited access to the network and get specific information from the network. The second one is to utilize built-in architectural and protocol redundancy. Devices have multiple network capabilities. Failure of one type of network does not disconnect the device from the network. For example, cellular phones have IEEE 802.11 (WLAN) or Bluetooth interfaces that can form a local network even when the mobile base station are destroyed. Another alternative is to use a hybrid wireless mesh network.

Several specific technological challenges are proposed in this Report. It presents a hybrid distributed wireless networking architecture and provides large set of performance observations collected from a real distributed hybrid wireless mesh network used for supporting disaster management, meteorological, climatological and hydrological hazards and disasters response application.

3.1.1.2 Social Challenges

Since the early warning communication networks serve to save lives and property, it may intervene residents' daily life or affect public behaviour. Sometimes residents might refused to evacuate. To the opposite, the local government may order public evacuation although the legal authority may be lacking. Also the "to warn or not to warn" dilemma is always surrounding us. The warnings are sometimes withheld to avoid negative social and economic effects. The reason is that it is a widespread belief, though unfounded, that the public becomes unnecessarily informed if the disaster would occur with low probability but severe-consequence. This results in the reluctance to announce the warning to the public until it is definitely necessary. This kind of dilemma will persist for short-term emergency warnings because most disasters cannot be predicted with 100% accuracy or even high accuracy. Thus, early warning communication networks design should "incorporate an understanding of human activity and communication behaviour model". Also the early warning communication networks should be affordable, available, and applicable to ensure that they will be used during disasters.

3.1.1.3 Organisational Challenges

Organisational challenges arise from several reasons. One problem is the conflicts among the relevant MDAs and orgnisations in terms of responsibilities. Another problem is in disaster response, MDAs need to make decision based on a flatter, dynamic and ad-hoc organisation. As the MDAs use collaborative technologies such as mobile applications, Web-based email, and communications networks such as wireless mesh networks, there may be too many resources and too much information that restricts the MDAs' ability to manage emergency and affects the capacity of early warning communication systems. The CIDMEWS, a collaboration technology, enables groups across organisations to monitor communication and data flow across locations in a time-pressured situation.

3.1.2 System Architectures

Many technologies are introduced in early warning communication networks. Based on the mainly adopted technology, communication networks for early warning systems are grouped into four categories, which can be integrated to establish a more reliable emergency communication network:

3.1.2.1 WiFi

This group of early warning communication networks uses wireless transmission techniques such as Wi-Fi and WiMAX. A combination of different communication infrastructure is used to transport and share information among operators; for example, wireless sensor network systems are used for monitoring in local areas, broadband wireless networks such as WiMAX based networks are used as secure and reliable communications network. Furthermore, cellular gateways can be used as alternative remote communication means when local networks reaches a working cellular base station.

3.1.2.2 P2P

P2P-based emergency communication networks use P2P technology to quickly deploy a serverless network even there is no pre-existing networking infrastructure. The nodes in P2P networks can be laptops, cell phones, PDAs and so on.

3.1.2.3 Cellular Network

Cellular early warning communication networks leverage the existing cellular infrastructure. The basic idea of cellular early warning communication networks is that cell phones are able to work in dual mode: normal mode and emergency mode. In normal circumstance, cell phones can connect to the base station so that traffic is transmitted by the base station while in emergencies, once cell phones lose the connection to the base station, it enters emergency mode and work as a mobile ad-hoc network.

3.1.2.4 Satellite

The satellite communication networks are better suited in the wide area, broadcasting, and anti-disaster applications for nationwide disaster emergency communication networks build-up than the other communication networks. Satellite solution relies on the underlay transmission of low power emergency signals in the frequency band of a primary transparent satellite telecommunication system. In other types of early warning communication networks, satellites can also perform as the gateway to gain access to Internet. If the communication infrastructure is greatly damaged, it is necessary to consider satellites as a part of the network.

A majority of early warning communication networks makes use of wireless devices. Also early warning communication networks are often heterogeneous, consisting of different types of devices such as laptops, cell phones, PDAs and so on, which use different protocols such as WiFi, Bluetooth, GSM and so on. Also early warning systems have some uniform communication pattern:

- **Real-time requirement**: The warning message should be transmitted to residents in real-time (i.e. in tens of seconds or seconds).
- **Redundancy:** To guarantee assured communication, multiple lines such as text-message, radio, and Internet, may be used simultaneously to transmit the same warning message.
- **Large coverage of population**: A warning message may be transmitted to millions of residents.

3.1.3 Protocols

Early warning communication networks are mostly made up of ad-hoc networks. The network devices contains cell phone, laptop, PDA, and so on. Each of the devices works with some specific (and usually different) protocol(s). The heterogeneous networks naturally requires a novel protocol that could integrate all the devices and protocols.

3.1.4 Security

Security is an important issue in the networks. Networks for early warning communication put even more emphasis on security issues in that emergency communication networks should guide people's behaviours in emergencies. Threats of security can cause tremendous negative social and economic effects to the society. Below are the generic security properties and issues considered in early warning communication networks:

- **Authentication**: Authentication relates to the ability of a host or system to correctly identify another host or system.
- **Data confidentiality and secrecy**: Data confidentiality and secrecy aims to hide the content of a message to unauthorized users. It can be implemented with asymmetric or symmetric cryptography.
- **Data and origin authentication**: Data and origin authentication is the capability of a system to identify the sender of a message correctly.
- **Authorization and access control and accountability**: Authorization is related to the granting of access rights to the resources of the system (or the network) to only specific users. It is usually performed after the authentication procedure, and is related to the accountability property.
- **Data integrity**: Data integrity is the capability of a user to verify if a message sent over a network, or data stored in a memory, has been modified since its creation. Data integrity can be achieved by using secure hash functions.
- **Non repudiation:** Non repudiation is related to the capability of a system to prevent a user from denying the sending (or the reception) of a given message.
- **Availability**: This is the ability of a system to be prompt and usable when the user needs it. This property is particularly important in emergency communication networks.

3.2 Needs Assessment Methodology

A systematic approach was taken for the purpose of acquiring and analysing the various pieces of information required to support the needs assessment, analysis and recommendations presented in this section. Each of the completed tasks is outlined below:

1. Desk-based Review of Project's Documents
2. Consultations with Stakeholders
    a. Stakeholder Identification
    b. Facilitation of a Stakeholder Consultative Workshop
3. Assessment of Communication Network Capability for CIDMEWS
4. Assessment of CIDMEWS Systems Using the UN-ISDR Framework
5. Needs Assessment of Information Systems and Networks
6. Assessment of ICT Networks and Tools

3.3 Stakeholders Consultation Workshop

INTEGEMS, in collaboration with the UNDP and the 4 Implementing MDAs, hosted and facilitated a Stakeholders Consultation Workshop at the INTEGEMS Geo-innovations Centre in Freetown on 13 October 2016 (See Appendix A for details). All the relevant MDAs and organisations were invited to attend, and the goals of the Workshop were to:

- Educate attendees on the Project's technology and the implementation process
- Define the Project's overall objectives, scope and deliverables
- Identify the CIDMEWS's desired system functionality and core application requirements
- Identify the Project's critical success factors
- Identify primary and secondary users of the planned CIDMEWS systems

3.4 Key Informant Interviews

Following the Stakeholders Consultation Workshop, an electronic Key Informant Interview Questionnaires were developed and distributed by INTEGEMS to the four MDAs' relevant key staff by e-mail and in person. The questionnaires were administered for the purpose of gathering information about various aspects of climatological, hydro-meteorological, disaster management and early warning systems and related data and work processes currently in place in the four MDAs. Specifically, INTEGEMS staff had two (2) weeks to clarify and expand upon the issues discussed during the Workshop; complete the questionnaire and submit the following information:

- Participant information
- MDA's mission
- Interdepartmental interactions
- External interactions
- Relevant departmental workflows
- Job responsibilities
- Early warning communications network needs assessment
- ICT (computer & software) use

- Information and data used (inventory), maintained & desired
- Existing & desired early warning, communication networks, GIS and ICT functionality (applications)
- Map-related data usage, maintenance, and distribution requirements/protocols
- Related individual and department job functions and workflows
- Intra-departmental and inter-MDA relationships and workflows
- Desired mapping, analysis, maintenance, and distribution applications and system functionality
- Individual and department visions of the planned Project implementation

The information collected through the Key Informant Interviews and copies of the key informant interview questionnaire are included in a separate report (Needs Assessment of Early warning and Communications Network).

INTEGEMS also evaluated the existing four MDA staff's ability to successfully meet the staffing requirements for successfully owning and sustainably implementing the Project's deliverables. This evaluation considered the resource availability, use of technology and ICT/GIS knowledge and capacity.

3.5 Information Technology Assessment - Hardware and Software

Information on the existing computer hardware and software resources gathered during the interviews was compared to the CIDMEWS-SL requirements. This resulted in recommendations for upgrades, updates and/or acquisition of ICT and GIS hardware and software.

The GIS/ICT assessment was conducted to:

- Access the early warning communication networks
- Assess the MDAs' existing ICT architecture
- Quantify the available servers and workstations
- Assess the WAN and LAN configurations/throughput capacities
- Identify CIDMEWS and GIS integration opportunities

Through the Consultation Workshop, consultative meetings and questionnaires, a number of potential Project applications and solutions were considered and recommended.

3.6 Desk-based Review of Project's Documents

INTEGEMS undertook a comprehensive review and meta-analysis of existing documents and studies of climate change (mitigation and adaption), disaster management, meteorological and hydrological projects implemented by a wide range of partners from Government MDA's, NGOs and CSOs, academic institutions, including the Ministries of Transport and Aviation, Ministry of Agriculture Forestry and Food Security (MAFFS), Ministry of Lands Country Planning and the Environment (MLCPE), MWR, EPA-SL, ONS-DMD, UN agencies, representatives of the University of Sierra Leone and Fourah Bay College, local Press and bi-lateral donors. In addition efforts were made to look outside of Sierra Leone for success stories and lessons from similar projects implemented elsewhere, including various UN publications such as the Hyogo Framework (2005-2015) for Action: lessons learned, gaps identified and future challenges; Sendai Framework 2015-2030 for Disaster Risk Reduction; and the Vulnerability and Capacity Assessments jointly conducted by the Sierra Leone Red Cross Society and the ONS-DMD and the National Hazard Profile developed by the ONS-DMD.

3.7 Visit to the Sierra Leone Meteorological Department at Lungi Airport

The purpose of the visit (on 9 December 2016) was to familiarize with the operations, understand the work process and assess the technical infrastructure in the SLMD at Lungi Airport. The SLMD at Lungi Airport has five forecasters who currently work on a shift basis to ensure a 24 hour monitoring .There was a display of old equipment around the building at that time of the visit but most of these equipment were dilapidated or obsolete with few functional and as such there was nothing much to observe. These equipment were used for receiving processing, displaying and printing forecasting products.

The visit included field survey to the observatory where the Research Team were introduced to the use and working of meteorological instruments like the Stevenson screen, max-min thermometer, wet-dry bulb thermometer, rain gauge, automatic weather station, automatic rain gauge, wind vane, anemometer and a collection of weather data. The main receiver, a Telefazio brand, which was used in operation was damaged by lightning in 2015. However, the World Meteorological Organisation (WMO) has provided some new and upgraded computers and accessories which will help enhance effective monitoring and also increase productivity .These computers are currently stacked in the office awaiting software installation by WMO Technicians.

Currently the only forecasting/monitoring done in the office is for the aviation industry and the intermittent Internet connectivity service is provided by Sierra Leone Airport Authority (SLAA). In terms of data/information dissemination, the Flight Information Region (FIR) is sent to Liberia every thirty (30) minutes and every six (6) hours through a dedicated line which was set up in 2012. An interactive session was also held with the staffs where they expressed their concerns and constraints in performing their daily tasks. The SLMD staff at Lungi Airport are serious constrained by the lack of requisite resources and skills for proper and effective monitoring and one major drawback is the lack of internet service.

Figure 3-1: Cross section of INTEGEMS staffs and personnel at the SLMD office in Lungi

Figure 3-2: Consultation with the SLMD personnel

3.8 Analysis of the Needs Assessment

The existing early warning system in Sierra Leone follows a structure which is largely built on governmental services structured around the key Departments under the MTA (i.e., SLMD) and ONS (i.e., DMD). The EPA-SL and the MWR also play key roles in the provision of early warning information in terms of disaster management, meteorological, climatological and hydrological hazards. While the SLMD acts as the source agency for meteorological observation, detection and warning formulation, the ONS remains as the central agency to disseminate the early warning information to the provincial and district security committees (i.e., DISEC and PROSEC) for disaster management and subsequently to the other entities of the last mile communication that are coordinated for emergency operations and response towards the early warning.

This chain apparently starts from the national level and ends at the community level. However, from the Needs Assessment discussions, it was clear that the operational chain remained problematic and in many cases were not performed effectively during disaster situations resulting in variable impacts and damages. The main cause of these was due to the presence of several layers of gaps and weaknesses existing within the current system. Although the early warning and preparedness capacities exist in Sierra Leone, they are still insufficient and not systematically designed, leading to ineffective provision and unreliable information to the public, especially to the communities at risk.

The Needs Assessment showed that there exist numerous gaps in the existing setups for effective warning dissemination in Sierra Leone. It also showed that the present system is more focused towards hydro-meteorological hazards rather than multi-hazard. The system in its present form lacks a multi-hazard approach (Multi-Hazard Early Warning System) and the Needs Assessment and consultations suggest that there are gaps in the existing system in terms of systematic warning and response.

In terms of warning capability, the assessment showed that at the national level, warning formulation and validation does take place; however, interpretation of information and use of early warning standard operating systems (SOPs) are found to be lacking. Sierra Leone does have a poor communication system and effective and efficient notification procedures during any emergency situation seems to be lacking. Also there is the absence of systems in place as required for 24 x 7 operation which could also be seen as a major gap. In terms of response capability, the assessment results showed that the existing systems do not have the required steps from SOP's to incident command system. However, they do have response plans, volunteers as well as the trust, on the early warning information received from the authorities. Other areas where gaps were observed are in case of simulations and drills which are lacking in the present system as well as lack of awareness in terms of risk perception and local knowledge. Gaps in the existing early warning system, starting from warning generation to disseminating to the communities at risk, were identified as a lack of human resources, reliable information, equipment and budget through this Assessment.

In terms of weather and flood monitoring, warning issuing and dissemination both at national and local levels, the gaps mostly includes aging and insufficient observation networks and data communication facilities, ineffective data sharing or dissemination among the relevant MDA, lack of skilled human resources in using the modern computing tools (numerical weather prediction, flood forecasting models and so on) to produce reliable information and interpreting newly generated forecast products. The unpredictability and increasing severity of extreme weather events clearly require significant improvement in capacity for early warning and preparedness.

For the purposes of improving management of extreme weather events in the context of a changing climate, early warning system should consider both previous problems associated with insufficient warning information and potential future problems associated with social vulnerability, capacity, and disaster event variability in terms of increased frequency, severity, unpredictability and their spread to areas that were previously relatively unaffected. In terms of dissemination of the early warning to the public and particularly to the communities at risk, the main gaps observed were lack of SOPs, lack of capacity to make use of generated forecasts to explain to the public, lack of adequate funding and means of transportation and communication. Investments should be made to improve the existing early warning system in Sierra Leone to make it more efficient and an integrated part of mainstream disaster risk management by taking into account the activities and policies of Sierra Leone's line MDAs and strengthening its institutional and legal basis.

3.8.1 GIS for Climate Information, Disaster Management and Early Warning (CIDMEW-GIS)

The use of GIS technology for climate information, disaster management and early warning interventions (i.e., CIDMEW-GIS) is either lacking or implemented slowly throughout the four MDAs. Often, there is little to no communication between and/or within these MDAs about their use of CIDMEW-GIS and no infrastructure in place to support climatological, forecasting, hydro-meteorological, disaster management and early warning data/information sharing or collaboration.

The creation of a CIDMEW-GIS Users Group, hiring of a CIDMEW-GIS Coordinator and creation of a CIDMEW-GIS Advisory Committee, was recommended to help the MDAs initiate efforts to coordinate and centralize CIDMEW-GIS activities. There was much support for this centralization among MDA staff and managers, although there was a modicum of apprehension that centralization will take resources away from the MDAs that had previously invested in CIDMEW-GIS.

It was revealed that several MDA staff have experience and background knowledge about GIS through their schooling or encounters at conferences and meetings. Others have heard of GIS but have no experience using GIS software. Many others have no familiarity at all with GIS. The EPA-SL, ONS-DMD and MWR staff generally have more staff that know about and have used GIS but staff in all four MDAs recognize the utility of mapping their data even if they do not know how to go about doing it. Many MDA managers and staff can benefit from basic GIS training to have the knowledge on which to base their requests for climatological, forecasting, hydro-meteorological, disaster management and early warning maps or spatial analysis. There is no need to train all employees in the use of GIS software; however, basic education for everyone could help to orient them to the GIS technology so that it can be used.

The missions and goals of MDAs climatological, forecasting, hydrometeorological, disaster management and early warning interventions cover a broad spectrum. It is difficult to grasp all the climatological, forecasting, hydro-meteorological, disaster management and early warning services provided by the MDAs. However, in almost all interventions, climatological, forecasting, hydrometeorological, disaster management and early warning data and information are geographically or spatially referenced in some way or business processes are related to geography. In most cases, GIS has the potential to interact with those climatological, forecasting, hydro-meteorological, disaster management and early warning data to augment current analysis and decision-making.

Partly due to the size and diversity of the MDAs, there is much duplication in effort for climatological, forecasting, hydrometeorological, disaster management and early warning activities. The same geographic data files are created or obtained independently by different projects/programmes simply because of a lack of knowledge about what everyone is doing with CIDMEW-GIS. Maps and data are created in one climatological, forecasting, hydro-meteorological, disaster management and early warning project/programme that could also be used by another projects/programmes but there has not been any way to easily make those available to each other. By centralizing climatological, forecasting, hydro-meteorological, disaster management and early warning data/information and CIDMEW-GIS resources, the MDAs can overcome the challenges that diversity places upon them.

During the Needs Assessment exercise, senior leadership and management of the 4 relevant MDAs were approached for their opinions on hiring a CIDMEW-GIS Coordinator and all of those interviewed supported the idea and some pledged to identify funding to upgrade and centralize the proposed CIDMEW-GIS software licenses and applications. They were informed of the costs and benefits and chose to support the software centralization with funding and encouragement of their staff to participate in the process. They also offered visible support for the Needs Assessment process by urging participation by their staff as well as participating themselves in the interview process.

The senior leadership of the EPA-SL and MWR have already made monetary and enterprise investments in GIS without immediate and highly visible returns on their investments. While the GIS is still in its infancy, it will be difficult to fully use all the potential of CIDMEW-GIS applications right away; nevertheless, emphasis was placed from the start on key CIDMEW-GIS applications that will demonstrate the utility of CIDMEW-GIS to streamline procedures or improve outcomes. Those applications that provide MDA-wide benefits were also prioritized.

A CIDMEW-GIS Users Group was proposed to provide an avenue for the MDAs to meet, share data, and share experiences/problems with using the technology. Furthermore, a CIDMEW-GIS Advisory Committee was proposed to provide a group environment in which to develop the centralized CIDMEWS and GIS system and develop policies and procedures related to the use of climatological, forecasting, hydro-meteorological, disaster management and early warning data/information in the MDAs and to continue to provide input and support for the centralized CIDMEWS-SL application systems.

3.8.2 Data Creation and Maintenance

Although various projects/programmes within the relevant MDAs have been using GIS for several years, many of them and most other MDA still rely on using PowerPoint maps, paper maps or other map products to visually display climatological, forecasting, hydro-meteorological, disaster management and early warning data and information in a geographic format. These maps have served their purpose but fail to take advantage of modern ICT that allows for easily updating and sharing climatological, forecasting, hydro-meteorological, disaster management and early warning maps. These maps are difficult for staff to update.

By centralizing CIDMEW-GIS software and data and training staff to use them, maps can begin to be more easily shared and updated. The centralization could take some burden off the few GIS staff by streamlining mapping processes. However, the centralization will require oversight by the CIDMEW-GIS staff to keep data layers maintained, in an accurate and timely manner so MDA staff can have confidence in their maps that are created with central data stores. The centralized CIDMEW-GIS database could be incorporated into the MDAs data warehouse to facilitate mapping data in the data warehouse. This will also facilitate incorporating climatological, forecasting, hydro-meteorological, disaster management and early warning maps into data queries, cubes or web interfaces that originate with the data warehouse or databases.

Although the GoSL MDAs only has “jurisdiction” in Sierra Leone, political boundaries are many times irrelevant when it comes to climatological, forecasting, hydro-meteorological, disaster management and early warning systems. People will travel across political boundaries in their quest to locate appropriate health care; emergency response teams will look for the closest resources available; and communicable diseases are not constrained by political boundaries alone. In light of these things, it is extremely important to consider climatological, forecasting, hydro-meteorological, disaster management and early warning resources and populations in the countries (i.e., Liberia and Guinea) that border Sierra Leone. The centralized CIDMEW-GIS database may not be considered fully functional without the inclusion of data from neighbouring countries. The CIDMEW-GIS staff can take advantage of existing relationships between MDAs programs and corresponding programs in border countries and also forge new relationships to obtain as much data as is needed to address border climatological, forecasting, hydrometeorological, disaster management and early warning issues.

Many datasets within MDAs' climatological, forecasting, hydro-meteorological, disaster management and early warning projects/programmes were not designed to accommodate rigorous analysis or complex spatial data manipulation as is required for CIDMEW-GIS mapping and analysis. Many climatological, forecasting, hydro-meteorological, disaster management and early warning datasets are not normalized or cleaned to be useful for mapping, although there is a need to map those data. Normalization and data cleaning standards can improve this situation.

The EPA-SL GIS is working on creating an Agency-wide identifier for environmental and climate change information, but nationwide facility identifiers do not yet exist. Linking climatological, forecasting, hydro-meteorological, disaster management and early warning data and information nationwide between datasets is very difficult since there are not common identifying numbers and names are not standardized. It would be helpful for the CIDMEW-GIS staff to play a role in developing these identifiers to facilitate easier data maintenance and linking.

There are two primary concerns that MDA staff had when they perceived that the CIDMEWS-GIS database will store their climatological, forecasting, hydro-meteorological, disaster management and early warning data. The first concern is about data security. Many ONS staff believe that they would have to give up their datasets to the CIDMEWS-GIS database, thereby losing control of data security and ownership. The second concern is that data will be duplicated in the MDAs if climatological, forecasting, hydro-meteorological, disaster management and early warning data are stored in the CIDMEW-GIS database. Even when staff understand that specific climatological, forecasting, hydro-meteorological, disaster management and early warning data should not reside in the CIDMEW-GIS database (only geographic data will reside there), they still have concerns about who might have access to the geographic data, some of which is confidential and security sensitive or protected.

There will be much more MDA-wide support and confidence in a centralized CIDMEW-GIS database if it is made clear what types of data will be stored in it. There will also be more buy-in if data access and security safeguards (such as restricted access settings and user-specific read/write privileges) are clearly communicated.

3.8.3 Computational Infrastructure

The computational infrastructure (both hardware and software) at all MDAs, except the SLMD, is fairly suited to inter MDA-wide CIDMEW-GIS implementation. It can be considered a huge benefit to the MDAs that already have this infrastructure in place, as the potential cost of purchasing these resources at one time could be very high. The EPA-SL GIS staff are fortunate to have high-powered computing resources, cutting edge GIS software (ArcGIS 10.4.1 for Desktop and ArcGIS for Server 10.4.1, including ArcGIS Online Organisational Account) and specialized GPS tools and tablets available to them as they begin to implement or expand their Integrated Environmental Information Management System (IEIMS) and CIDMEW-GIS use. GPS-enabled tablets and high grade GPS receivers are currently under-utilized but setting up a system in which units can be shared with regional field staff via centralized distribution points could increase their use.

In spite of the adequacy of current infrastructure in the ONS and EPA-SL, these MDAs would benefit from planning for improving and growing the CIDMEWS infrastructure as needed and as funds allow. Having a plan for future hardware and software acquisition that aligns with CIDMEWS goals will support the growth of CIDMEWS in the MDAs. The CIDMEWS plan for future hardware acquisitions should take into consideration and align with the MDAs' ICT long-term plan for hardware acquisition and architecture.

3.8.4 Client Services and Outreach

Within all the MDAs, there is a desire for interactive web-based mapping. This type of mapping is not common among government MDAs in Sierra Leone, so the relevant MDAs do not have their own interactive climatological, forecasting, hydro-meteorological, disaster management and early warning web maps. This mapping for MDAs could serve to provide a visual means of communicating climatological, forecasting, hydrometeorological, disaster management and early warning information to MDA staff, clients and partners. There are several climatological, forecasting, hydro-meteorological, disaster management and early warning projects/programmes that would like to integrate web mapping into existing systems, and many others that would like to implement web-mapping into their programs outside of any existing GIS system.

There is broad support for having one MDA-wide interactive web-mapping application (like the proposed CIDMEWS) that could display geographic data from many climatological, forecasting, hydro-meteorological, disaster management and early warning projects/programmes. This same web mapping application could be used to customize and communicate EWS to various stakeholders. The public is becoming more and more web oriented and Internet savvy, and they turn to the Internet to discover information often before consulting any other resources. The relevant MDAs are in an ideal position to offer an authoritative Internet source for geographically referenced climatological, forecasting, hydro-meteorological, disaster management and early warning in Sierra Leone.

3.8.5 Metadata and Standards

Due to the fragmented and de-centralized implementation of CIDMEW-GIS at MDAs, there has not been any adoption of standards for CIDMEWS-GIS use to this point. This can tend to be a problem in many MDAs, even those with much longer GIS histories like the EPA-SL and ONS-DMD. However, standardization is essential to establishing and maintaining the value of CIDMEW-GIS products produced in the MDAs. Standardization of geocoding and map projections contributes to reliable and accurate spatial analysis. Standardization of map presentation and metadata preserves the MDAs image as a professional agency and makes CIDMEW-GIS products more useful and effective. As more staff begin to use CIDMEW-GIS, the MDAs can benefit from implementing and communicating climatological, forecasting, hydro-meteorological, disaster management and early warning data and information standards to establish uniformity and reliability to CIDMEWS-GIS outputs, especially those that will be communicated externally.

3.8.6 Staffing

Staff of the four MDAs, especially GIS, ICT, meteorologists, hydrologists, disaster management workers, and researchers, including senior managers, have taken a keen interest in using CIDMEWS-GIS as a tool to help them accomplish their primary work responsibilities. These staff are enthusiastic and willing to put in time and effort to learn to apply CIDMEWS-GIS technology to the problems they face in their work. They have asked for more training, hardware and software resources and have been very receptive to incorporating CIDMEWS-GIS into their work even when the utility was not immediately clear to them.

This staff enthusiasm for CIDMEWS-GIS can be fostered through the provision of appropriate training and resources. There is a need for more fulltime CIDMEWS-GIS staff to support the centralized system and CIDMEWS to ensure that CIDMEWS-GIS resources are available to interested staff. Geospatial data quality and timeliness can be best preserved by the work of qualified CIDMEWS-GIS Technicians who can devote their work time to ensuring that the CIDMEWS is available and reliable.

3.8.7 Training and Resources

Meaningful CIDMEW-GIS training can be costly. Some MDAs do not have the funds to allow staff to pursue much outside training. Additionally, CIDMEW-GIS implementation in the relevant MDAs is fairly new so there is not much training designed specifically for climatological, forecasting, hydro-meteorological, disaster management and early warning staff. For these reasons, it will be helpful to MDAs to continue to support the availability of CIDMEW-GIS trainings that are developed and taught by in-house CIDMEW-GIS staff. In addition to the full introductory CIDMEW-GIS trainings that have already been developed, MDAs can benefit from shorter “manager” trainings and specialized software extension trainings to expand overall understanding of CIDMEW-GIS technology and utilization of current software resources. A CIDMEW-GIS library can facilitate this sharing by providing a central location to store reference materials and a system to track materials and borrowers. All CIDMEW-GIS users in the MDAs can benefit from an established system that allows everyone to share their resources.

3.9 Conclusion and Recommendation

Considering the present gaps in the existing CIDMEWS-GIS system, it is felt that for effective warning and response dissemination, it is essential that the early warning system is tailored to the requirements of the end-users, and fits within the existing and expected institutional resources. For this to happen, a programme needs to be implemented which will improve the quality, efficiency and utility of existing systems in the country through a multi-hazard approach. An automated multi-hazard early warning system is also recommended with structured early warning focused sections and other types of interaction with decision-makers such as on-demand briefings and unstructured interaction. This program once established will also require the need to consider and integrate early warning information concerning emerging natural and humanitarian disasters.

The Needs Assessment presented an assessment of the early warning communications network within and between the four relevant MDAs (i.e., SLMD, EPA-SL, ONS-DMD and MWR) and gaps in existing early warning system at the institutional level so as to strengthen the system to make it more effective for disaster management, meteorological, climatological and hydrological disaster mitigation. The Needs Assessment was conducted through site visits, consultation meetings with officials and staffs and key informant interviews based on questionnaires developed for understanding early warning communications networks, including the linkages within early warning systems. The main purpose of these meetings was to assess the gaps in existing early warning systems, including ICT, through a questionnaire survey as well as reviewing the existing documentations and systems available with the SLMD, EPA-SL, ONS-DMD and MWR. The meetings were conducted with the aim to understand the people’s knowledge towards early warning systems and their awareness towards early warning dissemination.

The outcome of the Needs Assessment also suggested that the SLMD is responsible for monitoring the weather conditions in the country and region; for issuing weather forecasts and providing warnings on weather conditions to relevant MDAs, including the ONS-DMD, EPA-SL and MWR, by phone, fax, email, web page, TV/radio, newspaper and SMS. However, the warning information is still limited - for example, locations vulnerable to the events are not adequately mapped or specified. The ONS-DMD, through the PROSEC and the DISEC at the local level further disseminates the warnings to communities through its networks by phone and radio-communication.

The Needs Assessment also showed that Sierra Leone’s early warning systems are in place but at the same time also highlighted the needs to conduct assessments considering the limited capacity of the SLMD as well as lack of sufficient funding, outdated communication systems, and lack of equipment. Furthermore, the coordination between the SLMD, ONS-DMD, MWR and the EPA-SL was found to be very weak as the ONS-DMD uses its own early communications network from national to community level to disseminate warnings. Barriers to information dissemination are also related to low capacity knowledge about warning information, communication devices, transportation, and use of advanced forecasting models and tools.

The Needs Assessments also showed that there are great opportunities and challenges available upon which a truly effective and nationally comprehensive early warning capacity can be built. An early warning communications network of interacting systems and components, drawing on the expertise and technical capacities of the different hazard fields and the knowledge and insight of the relevant MDAs and associated social and economic fields. Moreover, what needs to be done to address the shortcomings is not a mystery, but has been already laid out in general terms in a succession of documents and meetings over the last decade. Implementing these changes does not have to be expensive.

The Needs Assessment concludes that strong early warning communications network and linkages are very essential from national to community levels as well as greater coordination between the SLMD, ONS-DMD, EPA-SL and MWR and with a wide range of partners from other Government MDA’s, NGOs and CSOs, academic institutions, UN agencies, local Press and bi-lateral/multi-lateral donors.

3.9.1 Multi-hazard Early Warning System

The ability of the ONS-DMD to make sound disaster management decisions – to analyze risks and decide upon appropriate counter-measures - can be greatly enhanced by the cross-sectoral integration of information within the CIDMEWS-SL. For example, to understand the full short- and long-term implications of floods and to plan accordingly requires the analysis of combined data on meteorology, topography, soil characteristics, vegetation, hydrology, settlements, infrastructure, transportation, population, socio-economics and material resources. This information comes from many different sources and at present it is difficult in the ONS-DMD to bring it all together.

The usage of the CIDMEWS-SL will be in:

- Preparedness planning
- Mitigation
- Response & recovery

The hazard and vulnerability assessments and mapping components of the CIDMEWS are the cornerstone of preparedness planning as well as planning and implementation of mitigation programmes. All data will be of critical use in the preparedness plan as well as in the actual response operations. The development of the CIDMEWS-SL was built bottom up from the lowest administrative unit (administrative section) to the level of the disaster preparedness plan. The district databases feed into the provincial database and then into the national database.

Multi-hazard approach benefits from:

- More stable levels of dialogue on early warning and climate information activity throughout the year: during the off-season when one hazard is dormant another hazard may require monitoring. When two hazards are off-season (e.g., flood and landslide in the dry season), vulnerability (or resilience) may still be monitored.
- Greater efficiency of limited human and financial resources: centralizing CIDMEWS at any level minimizes system maintenance and number of required staff/volunteers.
- More clarity: a one-stop-shop that has been given authority will result in less confusion for users on where to seek early warning information.

Key components of the CIDMEWS-SL include the following, but not limited to, databases of:

- Hazard assessment mapping
- Vulnerability assessment
- Socio-demographic distribution
- Infrastructure, lifelines and critical facilities
- Logistics and transportation routes
- Human and material response resources
- Communication facilities
- Environmental, natural resources
- Meteorological
- Hydrological, topographical and geological

Setting up the CIDMEWS-SL at any level without clear links to other DRR and DRM efforts and entities will inevitably result in inefficient or unsustainable products and less effective.

3.9.1.1 GIS-enabled and Web-based CIDMEWS-SL

GIS-enabled and Web-based early warning and decision support system like the proposed CIDMEWS-SL enables timely insights and better communication, thus making the information rapidly available for better preparedness and action. Early warning and preparedness heavily depends on inputs like reliable, accurate real/near real data on the hazard causing parameters, forecasting, data analyses, alert recognition and dissemination of alerts. Geospatial databases have been developed for the decision making and management in an event of natural hazards, envisage a system to capture the data in a near real-time manner and automate the generation of reports, alerts and early warnings to various stakeholders and end user communities by:

- Generating auto-mode customised alerts, early warnings, advisories based on the high density and high resolution near real-time data collected from telemetric systems and semi-auto mode.
- Issuing timely auto alerts, early warnings and advisories related to natural disasters to government bodies and communities via SMS, help desk, email, social media and web portals.
- Ensuring data integrity for delayed/no response and build an interactive system to conveniently manage SLMD stations, perform analysis, search, compare current and forecasted data
- Viewing weather information (temperature, humidity, wind speed and direction) and forecast data for weather and rainfall for periodical reports, e.g. actual rainfall vs. weighted average rainfall information and sending alerts if advised.
- Integrating historical data with data from installed meteorological and weather stations.

3.9.1.2 Mobile Technology

The role of mobile technology and mobile phones in improving early warning and emergency response has greatly expanded due to adoption of 3G/4G, social networking, video, voice over internet protocol (VoIP) which has led to massive growth in communication and improved channels of communication. The expansion of bandwidth, especially 3G/4G and Wi-Fi networks across various parts of Sierra Leone has provided users of mobile phones and mobile devices with value added services.

Use of smartphones has greatly improved due to reduced cost impacted by android technology which has allowed such devices to have improved capability in providing location using GPS, quick internet access and in some mobile devices pre-disaster warning. The users of mobile devices have the ability to receive updates about the early warning or disaster in question and are likely to spread the information to their neighbours, relatives and friends through messages on various platforms. Through Wi-Fi and Web 2.0, various users can connect in public places which can be useful in getting updates about issue. This can be feasible by installing mobile wireless masts at public centres.

The current advancement in computation technology has led to proliferation of mobile smart phones, tablets, laptops and androids which are used for communication. Such devices are valuable in disseminating information about unfolding events about a given disaster suitable for disaster communication because of the following:

- Small size allows portability and can be used in the field without any weight burden on the user due to their light weight.
- Mobile devices are chargeable which makes them suitable for use in areas without power supply for several hours.
- Multifunctional capability of mobile phones allows delivering multiple types of information such as messages, emails, data and calls to other remote users.
- Customized web applications on mobile platforms make it easier to enter information on mobile devices on various application shortcuts such as Facebook, twitter, without necessary launching various browsers.

The current mobile devices have geo-tagging and geocoding capabilities. Therefore, information gathered from mobile devices is very rich because audio, video, pictorial from mobile devices can be transmitted with geo-location codes. The open access communication in disaster management promotes inflow of information from the general public and other private entities on unfolding important updates. Recent development in technologies has shown that mobile technologies can be used to deliver disaster management information and hydro-meteorological forecasts and warnings, and climate information to customers, partners, and the public in graphic and digital formats. When there are no warnings, the consequences of unfolding disaster can very tragic and costly. Warnings are very effective in predictable disasters like flooding. However, unpredictable disasters like wildfires, and manmade disasters, will only benefit from effective disaster reporting through mobile technology to get information from survivors.

Tools have been developed to allow users to report information about unfolding disaster using mobile devices and Internet/Web based enabled devices. It makes it easier to plot disaster location on Web map without necessarily having mapping skills. The reported information becomes readily available to both survivors and disaster management personnel so that they can make well informed decisions about unfolding events of a given disaster that is being reported. The CIDMEWS-SL platform was created to allow collection of data through crowdsourcing with the use of mobile and Internet/Web enabled device applications. Information gathering and sharing can be effectively achieved through voluntary data collection by use of mobile devices and social media which currently dominate the revolution of Web 2.0 and growth in Internet use.

3.9.1.3 Crowdsourcing

Crowdsourcing is seen as a major breakthrough in information sharing and data collection through techniques known as voluntary geographic information. CIDMEWS-SL has been developed to allow interactive information sharing through three major information blocks i.e. submit reports, get alerts and view reports. The CIDMEWS-SL platform creates a new era of disaster communication through use of mobile technologies. The role of the user of the CIDMEWS-SL platform is reduced to interaction with the interface; since no computation knowledge or mapping skills are required. Instead, a customized interface with clear instruction on how to report information will be provided. Summarization algorithms for crowdsourced climatological, hydro-meteorological, disaster management and early warning information and data will be incorporated with geo analytical statistical summary.

In the design and development of the CIDMEWS-SL, attention was paid to climatological, hydro-meteorological and disaster reporting, especially information dissemination with geo-location on Web maps through the developed application to report disasters without GPS-enabled phones (provided they have internet). The users of CIDMEWS-SL can zoom to the location of the disaster, mark it and report it with possibility of uploading video and picture of the type of disaster which unfolds. This approach was elaborated to exclude the role of phone operators or service providers in negotiation for information retrieval which can be frustrating to access in most cases, since the users have to wait for long before they talk to operator. The primary role of service provider is to ensure the victims have access to network or restoring damaged communication masts and probably a request can be made to service providers to allow victims to have free GPRS/3G data.

The role of social media has been fully integrated in the CIDMEWS-SL to allow the users of CIDMEWS-SL to share information about a given disaster on their social network. The information can also be verified easily at no cost as people post their comments about disasters reports on the social network. Integration of the role of mobile technologies with social media in disseminating disaster information will be achieved and it will be recommended that the SLMD, ONS, EPA-SL and MWR incorporate the CIDMEWS-SL paradigm in their approaches towards disaster reporting and information dissemination. During disaster management, timely delivery of the right information to the right group of people is the primary goal. The CIDMEWS-SL provides seamless delivery of such information at no cost provided the targeted audiences are informed about the CIDMEWS-SL.

3.9.1.4 Service-Oriented Architecture (SOA) of CIDMEWS-SL

CIDMEWS-SL involved the integration of a broad spectrum of free and open source software (FOSS) and proprietary software and hardware technologies, including database servers, Web servers, map servers, desktop and server GIS software, Web services, storage area networks, etc. - all connected by Local Area Network (LAN)/Wide Area Network (WAN) communications that are integrated with existing and legacy applications to support a balanced MIS/GIS environment. Thus, a Service-Oriented Architecture (SOA)[18] technical approach was used for successfully delivering the CIDMEWS-SL.

Building a CIDMEWS-SL that leverages SOA to author, publish and serve intelligent data and maps empowers the MDAs to utilize best-of-breed components in delivering the right data, information and services to the right beneficiaries at the right time in the right place in a robust, scalable and efficient manner. The SOA approach improves business interoperability and integration – CIDMEWS-SL is integrated at a service level reducing requirements for data level integration and enabling agility. Furthermore, the CIDMEWS-SL can be increasingly delivered as a composition of reused services allowing faster adaptation to new business requirements.

The SOA approach includes multiple access layers connecting the SLMD, ONS, EPA-SL and MWR with various stakeholders, based on client/software technology and service communication tiers. With desktop and enterprise server-based GIS and data management solutions, the MDAs and partners can integrate mapping into their existing workflows and solve the challenges of providing Web and mobile access to MIS/GIS-based data and information and mapping services.

The CIDMEWS-SL is based on the integration of both open-source and proprietary software - ESRI ArcGIS for Server 10.5/GeoEvent Processor, ESRI ArcGIS for Desktop 10.5/QGIS, PostgreSQL/PostGIS Database Management Systems (DBMS), Joomla 3.x Content Management System (CMS) and/or Microsoft Internet Information Services (IIS)/Apache Tomcat, employing a multi-tier server configuration. The backbone of the CIDMEWS-SL is cabled and wireless LAN/WAN interconnected via the Transmission Control Protocol (TCP)/Internet Protocol (IP). The foundation of the CIDMEWS physical data storage architecture is a storage device that has the capacity to store terabytes of data, utilize a RAID system and intelligent backup mechanisms.

In addition, interactive maps and data are available from the CIDMEWS-SL Website through various web browsers (e.g., IE, Safari, Chrome, FireFox, etc.). Compressed files of data, maps, and metadata are available by direct download from data catalogue and atlas/map gallery pages on the CIDMEWS-SL Website, which also provides a gateway to interactive map services built with ESRI ArcGIS API for JavaScript, HTML, and CSS. Basic map services allow visualization of pre-packaged sets of data layers (vector and raster) and metadata. Users are able to zoom and pan maps, turn on and off layers, and query the attribute tables associated with the data and metadata. The CIDMEWS-SL Website also provides feature-streaming capabilities, in which data are downloaded and/or streamed to the client machine to allow advanced GIS and MIS functionality, including data import/export capabilities, direct download of public-access data and maps, and interactive visualization of CIDMEWS-SL related spatial and non-spatial data.

3.9.1.5 Infrastructure as a Service (IaaS) - Dedicated Cloud Server

The Project procured (on an annual per-use basis) Infrastructure as a Service (IaaS) - Dedicated Server, from a reliable Internet Service Provider (ISP) that hosts the CIDMEWS-SL hardware, software, servers, storage and other infrastructure components. This pay-as-you-go model eliminates the capital expense of deploying expensive in-house hardware and software at the MDAs' premises.

The IaaS is hosted in the Cloud by a UK-based ISP, Fasthosts UK (www.fasthost.co.uk) - a provider of Internet access and Web hosting services that provides all the hardware and peripherals needed to get the CIDMEWS-SL up and running 24/7. Extensive environmental controls employed by the ISP to make sure the IaaS works to its full potential and delivers high performance day-in, day-out. The ISP ensures the very highest levels of uptime and security, with the power to cope with surges in demand, plus unexpected power or network outages.

---

[18] Services-oriented architecture (SOA) is an approach for building distributed computing systems, based on encapsulating business functions as services which can be easily accessed in a loosely coupled fashion. The core components supporting a service-oriented architecture (SOA) are: Service Providers - developers provide component services available for consumption over the web; Service Consumers - Web applications are developed from the available component services; and Service Directory - connects web applications with available component services. Common web protocols and network connectivity are essential to support this type of architecture.

The IaaS model also offers highly scalable resources that can be adjusted on-demand, making the IaaS model well-suited for the CIDMEWS-SL workloads that are high, varied and demanding. The ISP also hosts the CIDMEWS-SL's applications and handle tasks, including system maintenance, backup and resiliency planning, automation of administrative tasks, dynamic scaling and policy-based services. In addition to offering a powerful, easy-to-use analytical tool for the CIDMEWS, the ISP fully supports the operation of the application, data and associated resources on a Dedicated Server in the IaaS. This includes managing the hardware, software, infrastructure and technical staff required to support a sophisticated interactive CIDMEWS-SL Website and pertinent ArcGIS for Server/GeoEvent Server systems on a 24/7 basis.

3.9.1.6 Software as a Service (SaaS) - Hybrid Approach

The Project procured Software as a Service (SaaS) through which the CIDMEWS applications are hosted by the ISP and made available to the stakeholders over a network, typically the Internet. SaaS supports the CIDMEWS-SL’s Web services and service-oriented architecture (SOA) and also host both free-open source software (FOSS) and proprietary software (using a hybrid approach); i.e., ArcGIS for Server, ESRI ArcGIS Online for Organisation and Google Cloud Services) for the MDAs and deliver them over the Web. The ISP gives the ONS network-based access to a single copy of an application created specifically for SaaS distribution.

Benefits of the SaaS model include: easier administration; automatic updates and patch management; all users will have the same version of software; easier collaboration, for the same reason; and global accessibility.

3.9.2 Leverage Automatic Weather Stations and Forecasting Products

Earth Networks (http://www.earthnetworks.com) , under a contract with the UNDP, has installed a baseline network of integrated compact automated weather and lightning sensors on Africel’s mobile communications towers in eight secured locations across Sierra Leone. For more than 20 years Earth Networks has operated the world’s largest and most comprehensive weather observation, lightning detection, and climate networks. By leveraging the installed automatic weather stations and weather forecasting and meteorological information data, information and services, the MDAs, especially the SLMD, can leverage various services and solutions and benefit from the following:

3.9.2.1 Integrated Observation Suite

A baseline network of integrated compact automated weather and lightning sensors on mobile communications towers:

- Mobile communication towers provide optimal security, power, and communications
- Leveraging Earth Networks regional and global networks
- This critical infrastructure provides foundation for:
    - Real-time nowcasting and advance storm warnings
    - Precipitation monitoring and accumulation estimates
    - Forecasting on a variety of timescales

3.9.2.1.1 Earth Networks Total Lightning Sensor

- Total lightning detection (in-cloud and cloud-to-ground)
- Wideband electrical field recorder (1 Hz to 12 MHz)
- Records and transmits lightning flash waveforms
- Real-time data transmission
- Compatible with mounting on mobile telecom towers

3.9.2.1.2 Automatic Weather Station (AWS)

- Integrated AWS with no moving parts or maintenance
- Measures all weather parameters with high precision
- Real-time data transmission with hours of data storage
- Integrated with total lightning sensor for storm tracking

3.9.2.1.3 Earth Networks Network Appliance (ENNA)

- ENNA is a microprocessor-controlled computer
- Provides key connectivity, diagnostic, calibration and data archival functionality
- Ensures high quality data is transmitted from weather stations and lightning detection networks

3.9.2.2 Analysis and Alerting Services

3.9.2.2.1 Dangerous Thunderstorm Alerts (DTAs)

Dangerous Thunderstorm Alerts (DTAs) by Earth Networks provide advanced notification of the increased threat of severe weather moving into an identified area. A DTA alert is issued when there is a high frequency of lightning detected by the Earth Networks Total Lightning Network™ (ENTLN) indicating the increased potential for: lightning strikes, heavy rain rates, high winds, hail and tornadic activity. The alert is updated every 15 minutes until the dangerous weather activity is no longer a threat and the alert expires. The advanced technology used within ENTLN enables the detection of both in-cloud and cloud-to ground lightning (otherwise known as total lightning). High rates of total lightning activity serve as precursory indicators of the potential for severe weather activity.

Earth Networks issues a Dangerous Thunderstorm Alert when the lightning detection rate exceeds high levels. These alerts are available through a data application programming interface (API) that will return the alert information in common alert protocol (CAP) format. The alert CAP feed includes a polygon encompassing the area at risk, direction and speed of the severe lightning activity, cities in the route of the storm and current observations from weather stations near or in the affected area. A ready to use weather bulletin text is also provided within the CAP feed.

- Severe storms identified by monitoring lightning flash rates and rate changes
- DTA is 45 minute threat zone based on storm vector; re-analyzed every 15 minutes
- Early warning for: severe thunderstorms, high winds, hail storms, tornadoes, and cloud-to-ground lightning

3.9.2.2.2 PulseRadSM Rainfall Monitoring and Estimating

- Radar imagery (dBz) using solely lightning activity data
- Visually identify and track severe weather and rainfall
- Monitor aggregate rainfall in real-time and monthly/annual for flood and drought warning
- Inexpensive (many times less!) alternative to radar with comparable imagery

3.9.2.3 ENcast Hourly Forecasts

The Earth Networks ENcast 15-Day Hourly Sensor Forecast Feed provides the MDAs and various stakeholders with a variety of hourly forecast variables up to 15 days in the future that helps in making informed decisions. The ENcast 15-Day Hourly Sensor Forecast is available through Representational State Transfer (REST) endpoints. This is an efficient and guaranteed delivery method utilizing web service (HTTP) explicitly where stakeholders can choose a file type, structure, and data variables from a menu of options. The forecast data are available through REST in JavaScript Object Notification (JSON) format.

- Forecasts for two weeks out: updated hourly based on latest forecast model runs;
- Hyper-Local: uses data from existing and new stations;
- Fastest Updates: use of real-time AWS data or tuned to latitude/longitudes where no station data exists;
- Lowest Forecast Error: accuracy and nowcast advantage;
- Data hosting and delivery system ensures data quality control checks and sensor operability to deliver highest quality data at lowest maintenance cost;
- Streaming total lightning detection (in-cloud and cloud-to-ground) data, recorded observations, and calculated weather data: 27 different variables;
- Total lightning data is used instead of costly radar for storm cell identification, tracking, and alerting as well as real-time rainfall monitoring and estimating; and
- Hourly forecasts using ensemble of top global models and weather and total lightning data to localize and enhance performance.

Web-based display allows the user to view forecast information for specific locations, timescales, and variables:

- Temperature
- 24 hour High Temperature
- 24 hour Low Temperature
- Wind Direction
- Wind Speed
- Dew Point
- Cloud Cover
- Thunderstorm Probability
- 1 Hour Precipitation Probability
- 1 Hour Accumulated Precipitation
- Fog Probability
- Visibility
- Rain Probability
- Surface Pressure
- Surface Insolation

3.9.2.4 Dissemination of Early Warning Information

StreamerRT Web-Based Display System (StreamerRT) is a real-time weather decision system that provides a fully interactive mapping platform with a comprehensive collection of weather data. Users have the ability to monitor real-time station observation data from the WeatherBug network and overlay numerous enhanced data sets to stay up-to-date with significant weather events before and after they develop.

MDAs and other stakeholders can use StreamerRT to create the customized Views that are important to them and then monitor the weather through easy access to Views, Slideshows of Views and animations. StreamerRT has a ccomprehensive and user-friendly tool for visualization of live and forecast weather conditions and real-time situational awareness at local, regional, national and international levels for critical decision-making.

StreamerRT has a Mobile Phone Weather Content and Alerting functionality for:

- Location based warning for feature / smart phones;
- All mobile platforms like iOS, Android, Win 8/10, etc.;
- Push notification;
- Hazard proximity alerts;
- Current weather conditions; and
- Detailed forecast content.

On-line communications portal setup

- Regular blog postings of important weather information and alerts;
- Communication vehicle for technology transfer; and
- Intergovernmental exchange of best practices.

Automated and manual content delivery to decision-makers and the general public using unique EWS data that is collected locally and analyzed in real-time is highly recommended.. Automated alert types can include: current weather observations, lightning strikes, flooding, DTAs and severe weather alerting, hourly forecast information.

EWS technology enables the SLMD and other MDAs and stakeholders to deliver alerting via multiple optional channels:

- GIS display systems for NMHS and 3rd parties (including APIs);
- SMS, text, email as well as mobile applications;
- TV, radio, internet, and bulletin broadcast;
- Specialized outdoor alerting devices; and
- In combination with other information (agriculture, health, energy).

3.9.2.5 Adaptive Capacity and Sustainability Support

- EWS installation hosting, and program management:
    - Utilizing private/national investments made into mobile telecom infrastructure;
    - Engaging NMHS technicians for instrument installation, maintenance, and operations; and
    - Program management: national design, implementation, regional coordination and support.
- Training and capacity building component:
    - Gradual technology transfer taking place alongside country-specific training;
    - Initial and continuing observation network field engineering training; and
    - Initial and continuing early warning system platform user training.
- Sustainability planning and business development:
    - Development of sustainability plan based on products and services for the private sector using EWS information;

    - Transferred technology and expertise drive applications for industries; and private sector partners, government agencies, and NGOs.

- Protection of life and property – support the overall key mission of NMHS organization.
- Climate change adaptation – warnings for increasing incidence of climate hazards.
- Disaster risk reduction – ability to automatically alert at the local level in real-time.
- Food Security – early warning of severe weather damage to agricultural production.
- Flood and drought warning – long term rainfall totals in areas with no radar.
- Water resource management – monitoring impact of thunderstorms on water levels.
- Energy security – electrical grid stability, power outage management, demand response.
- Hydropower – operation of power plants, localized real-time rainfall totals without radar.
- Aviation – flight safety, air traffic control, ground crew safety at airports
- Development of infrastructure – inclusion of localized storm and rainfall statistics in planning.
- SLMD sustainable operation – revenue from provision of information to stakeholders.

4 FIELD SURVEY

The Project adopted a multi-method approach in order to collect data that was grounded in existing knowledge attitude and practice across multiple information sources, while ultimately being representative of the study population as a whole. This consisted of desk literature review, field study (focus group discussions and key informant interviews), and direct observations and data analysis.

4.1 Study Areas

4.1.1 The Bumbuna Watershed around Bumbuna Dam

The Bumbuna Dam is located in Bombali District, approximately 200 km from Freetown on the Seli River. It was designed to generate 50 MW of electricity and is connected to Freetown through a 200 km long high voltage (161 kV) transmission line (T-line). After the impounding of the dam and as expected, patterns of the river both upstream and downstream keep changing depending on the rainfall pattern. Currently the Bumbuna Watershed Management Authority (BWMA) runs an Emergency Preparedness Plan (EPP) to assist communities to take precautionary measures against flood emergency and overflow or excessive discharge of water affecting the downstream river flow.

The hydrology of the watershed reflects the seasonal rainfall pattern characterized by very wet periods, followed by 4-5 months of markedly dry periods. Since 1970, the stages of the Seli River have been recorded at Badela and Bumbuna locations by two gauges installed under a UNDP Program. The highest peak flows are reached between August and October and normally range between 600 and 1,200 m^3/s. There are 18 communities downstream as well as the 20 upstream that benefit from this emergency preparedness plan to protect their livelihoods established on approximately 96 farm plots in 117 ha of cultivated lands that can be partially or fully inundated, affecting about 150,000 people in nine wards in three districts: Bombali, Tonkolili and Koinadugu. Therefore, there is an urgent need to establish a network for permanent monitoring of the river flow upstream and downstream of the Dam.

4.1.2 Inland Valley Swamps in Dodo Community, Kenema

Rice is one of the elected crops cultivated in the Inland Valley Swamps (IVS) in the drought prone district of Kenema. However, farmers are increasingly vulnerable to the impact of climate change induced seasonal droughts and unpredictable extreme rainfall events. Very few of the on-going and planned programmes and projects addresses the effects of changing weather and climate on Sierra Leone's rice-based agriculture.

4.2 Survey Research Methods and Tools

The research survey was undertaken to get feedback from community end-users on the usefulness of warning messages and on how communities understand their risks; respect the warning service and know how to react. The results from this survey provided a better understanding of the knowledge attitudes and practices of the local communities in Bumbuna and Dodo towards early warning systems and responses.The data collection for the study happened from 21 to 26 March 2017. The research design was based around a disaster risk reduction framework consisting of four key elements of an early warning system. Criteria were developed for site selection for the case study and guiding questions and checklists formulated for the focus group discussions and key informant interviews. The research helped in identifying local and community level communication and establish appropriate authoritative voices to collect feedback from community end-users on whether as many people as possible are warned, to avoid failure of any one channel, and to reinforce the warning message. The survey assessed the four main components of early warning systems in line with the UNISDR:

- Risk Knowledge
- Monitoring and Prediction
- Communication and Dissemination
- Response Capacity

The research survey tools consisted of quantitative and qualitative methods, primarily focus group discussions (FGD), key informant interviews (KIIs) and participatory exercises. The qualitative component utilised a total of five different focus group discussions: three in Bumbuna and two in Dodo.

- **Desk Review:** In advance of fieldwork, the team undertook a rapid desk review of secondary data sources of available existing research documents and report on disaster management and early warning before undertaking primary data collection. Key documents reviewed include background documents on government DRR and DRM; mapping and analysis of hazards and vulnerability to manmade and natural disasters in the various communities.

- **Focus Group Discussions (FGDs):** Participants were organized in a group of 8-10 people, to hold a constructive dialogue with a given stakeholder group for each community visited. The participants represented local community members, particularly those with an active role and a broad understanding of the topic. The focus group conversations resulted in an identification and better understanding of the issues the communities are experiencing and how best they should address those issues. The FGD were facilitated by INTEGEMS consultants with one of the community members as translator.Some of the focus group participants were also interviewed as key informants.
- **KAP Survey**: This mainly targeted key informants such as the chiefs, village heads, and community development officers, among others. Their views, observations, and experiences with regard to the research problem were sought. Face-to-face interviews were carried out with respondents who participated in the study as key informants
- **Observations and Recording:** The research team also used direct observation in addition to other research instruments such that non-verbal communication is documented. Observations were backed up by recordings, which included photography.

4.3 Consultations

All components of the survey were underpinned by discussions and consultationS with local stakeholders, particularly the chiefs at Dodo and Bumbuna who has authority over the Bumbuna Hydro Dam. This ensured that all actions complied with community needs and expectations.

On arrival at each community, a meeting was organized for each of the visited towns and villages, to seek approval for the intended work, to explain the objectives and schedule of the fieldwork and to gather information about existing traditional management, community needs and expectations. At these initial meetings, the team members were introduced, the methodology to be used during fieldwork was explained, logistical concerns associated with our activities were addressed and the future use of the project data in management, education and communication purposes was highlighted. The relevant stakeholders and authorities of each visited locations were consulted once fieldwork was finished. This closing meeting allowed the field staff to debrief the community representatives on the fieldwork and the problems encountered, and to present their initial results.

The questions were set into various sections; first presents an overview of the demographic information of the sample and then provides data on people's perceptions on the incidence and prevalence of natural hazards in their areas; furthermore their perceptions on hazards' impacts and peoples' vulnerability to them as well as sources of information sources regarding natural disasters was also assessed. Their understandings of roles and responsibilities of different disaster management actors and their household and community-level disaster preparation, mitigation and management approaches were also included considered in the study.

Figure 4-1 Consultation with Goma Chief and Power Station Engineers at Dodo Chiefdom

Figure 4-2: Consultation with representatives of the EAU of BWMA

4.4 Data Collection and Tools

The survey data collection comprised both qualitative and quantitative data that have been appropriately formatted, coded, pilot tested and translated where necessary. This was done using a random sampling strategy to ensure inclusion of women and youth, whilst ensuring that the survey sample is representative of the general population. Demographic interviews were conducted to gather data about their household and its members. The data collection was conducted using Open Data Kit (ODK) - an open source comprehensive survey design and implementation toolkit, which improves the quality and accuracy of data as it eliminates the whole separate data entry phase from data collection, producing data that is ready for analysis straight from the field. The ODK is used on mobile technologies such as smartphones and tablets with Apple iOS and Android operating systems.

4.5 Analyzing the Data

Statistical analysis of the data collected from the survey was conducted using International Business Machines Statistical Package for Social Sciences (IBM SPSS). Results were analyzed by conducting a comprehensive analysis, including descriptive statistics. Valid percentages and frequencies distribution were used to describe the sample demographic data and the factors that influence the respondents' knowledge, attitudes and practices concerning climate information, disaster management and early warning. Cross-tabs were used to highlight differences between male and female respondents as well as provide sex-disaggregated statistics.

4.6 Key Findings

4.6.1.1 Demographics

Study participants were individuals 18 years and older. The average age of respondents was 34 with seventy seven percent male representation and twenty three percent female representation. The vast majority of them have never attended any form of formal schooling with a very small percentage (6%) have had tertiary education. Over half of the respondents are self-employed, either involved in farming or mining activities. Older women were found to be less likely to have attended any kind of schooling, while teenage males were most likely to have attended at least primary school.

4.6.1.2 Risk Knowledge

Knowledge and awareness about floods and other natural disasters are important for preparedness for climate and climate related disasters. Data from the study indicates that the majority of the people in Bumbuna and Dodo are aware of the natural disasters that they experience in their communities. Many have heard the term risk and hazard and were able define in simple their understanding whilst others especially the women have little or no understanding at all.

Over seventy percent of the respondents in both communities were able to name at least one natural hazard occurring in their area, with the majority identifying either flood as the primary hazard; stating the regularity and impact locally. Most of them had already experienced a flood; been victims or have relations that that have been victims of flood in their communities. The participants in the focus group discussions were able to give a clear account of impacts of disasters on their communities, from damage of properties and crops to loss of lives. The participants also mentioned other hazard that are impacting their communities. In general, people were able to clearly state which the key hazards were, and the serious problems that they posed to their communities. There was a general knowledge about floods and other disasters amongst men and women. The responses indicates that the male respondents have better knowledge about floods than women. Little more than half of female respondents claimed that women have some knowledge about floods. This response indicates that EWS preparedness programmes need to focus on those women and men who do not feel confident about their knowledge about floods. Older male respondents shared traditional knowledge about flood warning signs, such as changes in the sound of the river, people tending to sleep more, and the unusual movement of some animals.

When asked about the impacts of and vulnerability to hazards, according to the respondents, women and children and the elderly were reported to be the most vulnerable to the impact of disasters, followed by people with disabilities. In the FGDs, participants exclusively discussed their experiences of flooding. In Bumbuna, participants focused their discussions on the hydro dam and how it has contributed to their increased vulnerability. In Dodo community, the younger participants were equally concerned about landslide as that of flooding and were able to recall some of their experiences. There were however varied responses as to the reason for the frequent flooding in their communities. Participants were asked to identify any change in their area that might have made the impacts of disasters worse. The most frequently cited cause for the people in the Bumbuna community was the construction of the Dam. Majority of the people in the Dodo community feels that the poor planning and construction of roads (no drainages) and buildings is a major reason. Some of the representative from Bumbuna indicated that there has been a significant change in the amount of rainfall over the last couple of years and they can attribute it to climate change. They mentioned that this year the rains even lasted until late January which is unusual and this is affecting their farm activities.

4.6.1.3 Monitoring and Prediction

Monitoring possible flood hazard and developing warning services for early warning is a socio-technical effort as it includes technical means mobilized through and managed by people. The participants of the FGDs at both Bumbuna and Dodo mentioned that the communities are indirectly engaged in risk monitoring. There are few old instruments installed in the rivers and lakes which are supposed to monitor the water levels but almost all are dysfunctional or defective. For the communities in Bumbuna they mentioned that they are aware that some monitoring is being done in their communities but have no knowledge of how it's been done and who is responsible. Participants in both communities mentioned that there are water gauges installed to show the river level and will serve as an indicator or sign of impending flood.

4.6.1.4 Communication and Dissemination.

Survey respondents and FGD participants were asked which sources of information they depended on for hazards and disasters; whether their communities had a structured early warning system in place; and how reliable they felt their information sources were. More broadly, they were also asked if they had received any training or education about natural disasters in general.

When asked about their sources of information the most popular was radio as 80% of the respondents and participants have or have access to one. A considerable number of the community mentioned that they also use mobile phones to communicate and disseminate information. Occasionally some of the receive information from other sources such as mobile phones or through friends and families. However, mobile phone systems are not always reliable, as phone connectivity can become jammed in times of disaster. Many informed that they would like to watch or listen to information more often in their local languages

As with the survey data, the most commonly discussed source of warnings on impending floods in all FGDs is the siren. In Bumbuna, participants also discussed listening to the community radio directly whilst some participants in Dodo communities said that they had only heard information second-hand via other people listening to the radio. However, there are some limitations in responding to the siren as some have heard the sound of the siren, but they did not know what to do next, which raises concerns about their response capacity. There was mixed opinion among participants about whether or not the siren was functional at the moment.

Warnings about floods in most of the study area are usually disseminated by megaphone. The research team asked respondents what they thought about this method. In Bumbuna, respondent said that they prefer siren for alert warnings about flood. Some others also preferred to receive risk information via mobile phone; this is possibly due to the multiple engagement of women in domestic and non-domestic work, which may mean that they may miss an alert by siren if they are not located in range of the siren. In all of the study areas, siren is the primary medium of communication of flood alerts. Some of the local volunteers help the community to verify the correctness of siren alerts by contacting concerned authorities outside their village/towns. In general, FGD participants felt that the information they received via the radio or village authorities was reliable but sometimes not quite comprehensible. Some male participants in Dodo reported that villagers had not necessarily been able to understand the 'technical' components of radio warnings and broadcasts,

With regards to existing structured early warning systems, almost all the participants and respondents stated that they are not aware of any. They have, however had some meetings with the Watershed

Management Authority an Emergency Action Unit (BWMA EAU) to educate them on disaster management, particularly relating to floods. The BWMA EAU has been set up to manage disasters, particularly floods in the Bumbuna communities both up and down stream. The respondents also mentioned that they are aware that a flood hazard map existed and had attended a mock drill organized by the District Disaster Management Team. The BWMA EAU has also organised a lot of sensitization meetings and workshop in each community about early warning system and disaster management.

Figure 4-3: Emergency siren under construction in Bumbuna

4.6.1.5 Response

Participants were asked about their individual and community response capacity in terms of preparedness and readiness to react. Most male participants of the FGD said that when they hear the siren, they immediately try to bring all family members and neighbours together in one place before moving together to a safer place. They expressed the view that the action at the time of disasters does not take gender into account, which makes the 'vulnerable' more vulnerable. Hence, those rescued by community leaders in times of disaster are often those who are physically fit and receive information the fastest. Generally, women do not participate in the information dissemination process within the village, nor are they community volunteers for flood disasters; hence, they may be missed in the rescue process. This indicates that there is a need for gender sensitization training at the community level. Some other participants stated that they did not know what to do.

Participants of both communities mentioned that they would gather some emergency bags of food, dry clothes and important papers, including land documents, during a disaster event. During a disaster only one third of the people reported having a place to evacuate to. This results was markedly lower among older women because majority of them reported that they have no idea about an evacuation point.

In the Bumbuna there are emergency meeting points in all the downstream communities. Some participants in the FDG stated that during an emergency event, they can relocate to bigger houses or school buildings and sometimes even to neighboring village to stay with friends or relatives. However, participants highlighted that their experience of evacuation had not necessarily been a smooth one.

Figure 4-4: Emergency meeting point at Kagbangona-Bumbuna

Figure 4-5: Emergency meeting point at Kadala- Bumbuna

4.6.1.6 Participants' Concerns, Comments and Suggestions for Improvement

The issue that received the most responses from all communities as a drawback is the lack of timely or no early warning information which makes them very vulnerable when these disasters strike. Also the lack of public awareness with regards DRR and DRM activities was stressed as they feel that they should be made fully aware of the DRR and DRM activities in their localities to ensure effective disaster management.

Finally, participants were asked to supply comments on early warning systems in their communities and also identify gaps and suggest ways to improve existing early warning systems, if any. Quite a few respondents indicated that they should build more drainages that will allow storm and runoff water to flow freely. One other issue raised was the lack of evacuation planning in all the communities visited but more especially those in the downstream communities in Bumbuna.

A greater percentage of the respondents suggested that the GoSL should play a stronger role in addressing the disasters in their communities. Also the communities themselves should employ some mitigating measures to reduce the level of deforestation and land degradation. They also emphasized the need for broader and inclusive participation of all relevant MDAs in disaster management. In all of the communities, common cause of flooding as indicated by respondents include blocked rivers and drainages obstructing the free flow of water especially when there is heavy rains. In Bumbuna the Dam is seen to be the main contributor to flooding, especially for those in the downstream. The rest of respondents are not sure. Another major concern in all of the communities is the ability to manage the effects and impacts of disasters, particularly flooding and storms. They require the support of the government or institutions dealing with disaster management to enhance their capacity to mitigate the impacts. However a good number of the respondents from the various communities were not sure how they would manage the effects and impacts of disasters.

There was a common perception within the Bumbuna community that their community is more vulnerable because of the construction and operation of the Dam. They stated that before the construction of the Dam they were doing well with their farming activities and disasters were minimised. They also stated that insufficient attention is paid to their complaints and they would request that the authorities responsible take the necessary actions needed to mitigate the impacts of these disasters in their communities. Whilst some of the respondents disclosed that they have no idea or were not sure what could be done, others recommended community support, increased public awareness, disaster preparedness, keeping drains and gullies clean, and tree planting as some actions that could be taken to prevent or lessen the effects of disasters in their communities.

4.7 Recommendations and Conclusions

4.7.1 Recommendations

The results of this study point to a number of aspects of people's knowledge and attitudes regarding natural disasters, including risk knowledge, monitoring and prediction, communication and dissemination and response capacity. The people in the Bumbuna and Dodo communities have lived through multiple disasters, especially floods and droughts, and are aware of the threats they pose. Most view dealing with the impact of natural disasters as a high priority and are interested in taking part in DRR and DRM activities.

The results from the survey indicates that the existing capabilities are very weak and non-existent in some areas and thus suggest the following recommendations to ensure effective early warning and disaster management:

- **Increase awareness-raising on early warning and disaster management:** Less than 10% of survey participants reported receiving education on natural disasters. Given the high frequency of natural hazards these communities are exposed to, community education and awareness raising activities on early warnings and disaster management, especially DRR and DRM, should be ramped up by the GoSL, NGOs and CBOs involved in disaster management as an urgent priority. In particular, actors should consider leveraging the widespread popularity of mobile phones and radio as a means to broadcast early warning messages faster to large numbers of people.
- **Incorporate gender and age vulnerability in all aspects of EWS:** Responses from the survey participants indicates that women, both young and old, are more vulnerable than others to the effects of natural disasters. The responsible authorities should ensure that these groups in particular are actively included in the design and implementation of all future early warning and disaster management activities.

- **Improve accessibility of information and method of dissemination:** The participants pointed out that disaster warnings broadcast via radio and mobile phones in particular were not always easy to understand. The ONS which has the sole mandate for disseminating disaster information should therefore develop appropriate targeting strategies to ensure that disaster warnings are accessible and understandable to all at risk.
- **Ensure the community understand the disaster management plans including roles and responsibilities of relevant authorities:** Majority of the participants stated that they had little or no idea of who was responsible for performing which functions, and almost none had any knowledge of any government policies or plans regarding disaster management. As the GoSL and partners work to develop disaster management plans at different administrative levels, they should ensure that they keep communities involved and informed of how these will work in practice. This is important for ensuring that disaster response can occur smoothly, and that those involved can be held accountable.
- **Encourage community-based early warning initiatives and volunteerism:** Given the relative absence of early warning practices such as disaster drills, the authorities responsible should work to extend the coverage of early warning initiatives. Where possible, such process should involve existing or 'emergent' local groups who have previously fulfilled roles in disaster response.
- **Strengthen the capacity of communities for EWS:** Continuously strengthen the capacity of communities for EWS, with particular attention to the involvement of women, to ensure the sustainability of the EWS. Affirmative action should be used to ensure women's involvement in capacity building activities, such as training and exposure visits, to enhance their capacity to respond to floods. Women should also be involved in infrastructure management teams for local early warning systems to enhance women's leadership in EWS.
- **Increase community ownership of EWS for greater sustainability and effectiveness:** Consult stakeholders while planning, designing, and implementing EWS to avoid any mismatch between the needs of different social groups, including women, and to instill ownership of the system in local communities.
- **Extend coverage of community-based DRR initiatives**: Mainstream DRR into livelihoods and early recovery programming.

4.7.2 Communication with communities: Ensure government disaster management plans are quite comprehensible, accessible and shared with all communities.

4.7.3 Conclusions

The study researched disaster risk reduction ad management and EWS-related practices at the community level in Bumbuna and Dodo communities to understand the gaps and challenges in establishing an effective and inclusive EWS. The study highlighted a number of gaps in people's capacity and resources to cope with natural disasters when they do occur. Very few people have received any education or training either on early warning or disaster management. Some of these people indicated to have received early warning messages via radio broadcasts and mobile phones, but most of these warnings are not always easy to understand and interpret. While many people do prepare for natural disasters within their own households, structured preparedness mechanisms within the community are substantially less apparent: very few people report ever taking part in disaster preparedness drills, or the presence of disaster management committees working in their communities. This means that when disasters happen, as they all too frequently do especially during the rainy season, people are unsure about how to respond and how the roles and responsibilities for managing them are designated. Considering the gendered differences between women and men with respect to mobility and illiteracy, which restricts some women from actively participate in EWS activities at the community level, affirmative action is needed to enhance women's capacity to empower them to make better use of EWS services; thus save their lives and properties during disasters.

With respect to the communities taking ownership of EWS structures in the their respective communities, the participants in the survey and focus group discussions expressed willingness to do so if the facilities were handed over to them. They also showed willingness to be trained. It is possible that community involvement in and responsibility for the EWS could enhance its efficiency, if managed properly. The participation of several key community stakeholders underscores the commitment to and concern for disaster mitigation measures. It is clear that the two communities have quite a high level of awareness of the climate change effects taking place within their communities. They agree that flooding and drought events, as well as temperatures, are increasing. Community members can clearly identify the negative impacts and are aware of many of the human activities that increase the likelihood of disasters associated with climate change. They are therefore aware of many of the actions necessary to reduce the likelihood of disasters

We conclude that there is a need for coordination and linkages among institutions and the local communities to strengthen early warning practices. More efforts are needed to ensure that EWS information reaches and is understandable to all end users, particularly the vulnerable groups. Furthermore, methods used to disseminate warnings should be simple and specific taking into consideration the needs of different members of the community. Based on the study findings it is clear that the concept of an early warning system in relation to disasters and hazards needs to be broadened to integrate gender, exposure, vulnerability and capacity issues to maximize their effectiveness.

5 COMMUNICATION AND AWARENESS RAISING STRATEGY

5.1 Contextual Background

Sierra Leone is particularly vulnerable to the increasing frequency and severity of various hazards and disasters and has put in putting in place sectoral initiatives that aim at addressing the impacts of disasters and strengthen resilience of communities through early warning systems. Despite these initiatives, the availability of climate information, disaster management and EWS communication in Sierra Leone is still inadequate and the level of awareness and understanding are still very low among stakeholders.

A lot of data and information related to climate information, disaster management and EWS are being collected but there is lack of effective coordination of their dissemination. Therefore, there is a need to have effective mechanisms for communicating climate information, disaster management and EWS. Effective communication and knowledge sharing about climate information, disaster management and EWS and their impacts are crucial for the development of appropriate adaptation and mitigation measures. It is important therefore to enhance communication to the society through a well thought integrated communication and awareness raising strategy.

The Communication and Awareness Raising Strategy identifies and develop methods and tools of communication that would promote awareness among policy makers, media practitioners, development partners and the local communities. This communications strategy includes the effective issuance and packaging of early warnings as well as the creation of supportive communications products and outreach efforts that will support the long-term sustainability of investments in the climate information, disaster management and EWS and services sector. These supportive strategies serve to engage actors, build political support, engage the private sector and present a true value proposition to end users. The strategy explores best practices, defines roles and expands on the tools that are necessary to create an integrated climate information, disaster management and EWS communications strategy.

5.1.1 Rationale of the Strategy

Both natural and manmade disasters have impacted nearly all dimensions of socio-economic development and yet there is still low level of awareness and a number of myths on natural and manmade disasters, including climate change, at national, regional, district, village and community levels. The unfolding crisis demands urgent, efficient and coordinated responses and requires a widespread mobilization for action individually and collectively.

In spite of the extraordinary increase in DRR, DRM and climate change information available at the different scales, and outreach being undertaken by various actors at national and subnational levels, there is still insufficient information on DRR, DRM and climate change available about the challenges and potential solutions for climate information, disaster management and EWS, and to bring about the changes in attitudes and lifestyles needed to tackle it. This is partly contributed by inadequate communication mechanisms at national and local levels. Citizens, governments, and businesses need an accurate understanding of the problem and its causes, the likelihood and severity of the impacts, how the risks may affect them personally and collectively, and the costs and benefits of taking action. Thoughtful and purposeful communication and awareness raising can build in-house collaboration, foster knowledge sharing between the ONS, EPA-SL, SLMD and MWR which will support technology transfer and build political support.

Communication, education, and outreach are powerful tools that government agencies, private organizations, and non-profits can use to dispel misconceptions and to bring disaster impacts and hazards to the attention of the public. Integrating communications into the everyday activities of the four key MDAs and other key stakeholders can save lives, support sustainability and build livelihoods. Hence, the strategies and actions outlined in this section will facilitate communication and awareness raising about climate information, disaster management and EWS processes to stakeholders. It is also meant to strategically facilitate sharing of best practices on climate information, disaster management and EWS as well as to prepare its citizens at all levels to take appropriate measures on adaptation and participate in mitigation in the context of sustainable development.

5.1.2 Goals and Objectives

The overall objective of the Strategy is to facilitate effective communication on climate information, disaster management and EWS at all levels in order to empower individuals and communities to respond in a timely and appropriate manner.The Strategy aims at ensuring learning and raising awareness of the community at all levels on how to prevent, mitigate, prepare, respond and recover from disasters.

This Communication Strategy seeks to realize a number of objectives at various levels, including policy, institutional national and local. Specific objectives of the strategy are to:

- Significantly raise the level of awareness of the community of the opportunities and threats brought about by disasters, and to accept their responsibilities to adapt to, and mitigate against their impacts;
- Create coordinated and cohesive communication messages and tools on climate information, disaster management and EWS, and ensure they are effectively distributed to a wide variety of people and professionals across all levels of government and the public;
- Leverage existing education and outreach networks and integrate communication about climate information, disaster management and EWS, providing best practice of how to communicate climate information, disaster management and EWS messages;
- Increase stakeholders' access to information on climate information, disaster management and EWS;
- strengthen institutional capacity to integrate weather and climate information into development policy and planning frameworks; and
- Engage the public in climate change conversations and solutions for addressing impact;

5.1.3 SWOT ANALYSIS

The SWOT analysis identifies the strengths, weaknesses, opportunities and threats that will affect the success of the Communication Strategy. The objective of the Strategy is to maximize on the strengths and opportunities and minimize or avoid the effects of weaknesses and threats to the programmes.

Table 5-1: **SWOT Analysis – Early Warning**

Strengths	Weakness	Opportunities	Threats
A legal institutional policy framework is in place, providing directives on how to address disaster from national to local levels Framework and Policy	There is lack of synergy between the existing institutions and lack of effective partnership for communication of messages	National Flagship Programmes offer a huge opportunity for mainstreaming Disaster Risk Reduction (DRR) into development programmes and planning.	At sub-district level, unless effective institutional systems are in place and their capacity is adequately built, allocation of adequate budget for Disaster risk mitigation may be counter- productive as it may not be gainfully utilized.
Various guidelines for hazard management, on minimum standards for relief have been issued or are being formulated.	There is a need for more effective early warning systems, particularly last mile connectivity	With rapid rural and urban development processes underway, development resources of both the government as well as individuals will be wasted if institutions and individuals are not capacitated to protect their development gains	Restricted responses to impending disasters
The Sierra Leone Disaster Management Policy has been established	The mandate provided by Disaster Management Policy at national, district and local level, particularly for disaster risk mitigation needs to be fully exploited	A strong network of civil society organisations working on early warning, disaster management and disaster risk reduction issues in multi-hazard prone areas and communities offer an opportunity to engage them in training and capacity building efforts.	At sub-district level, unless effective institutional systems are in place and their capacity is adequately built, allocation of adequate budget for Disaster risk mitigation may be counter- productive as it may not be gainfully utilized.

Strengths	Weakness	Opportunities	Threats
The government has set up emergency control rooms/ Operation Centres and early warning communication systems in the Office of National Security	Public awareness campaigns for risk-prone communities and local authorities' engagement in reducing disaster risk through public engagement have been generally weak both in terms of outreach and content	Emergence of mobile telephony, social media as a channel for communication, and citizen reporting with prevalence of digital and phone cameras and other information and communication technology (ICT) tools have opened up huge opportunities for fast and instant communication during disaster related emergencies as well	
District Disaster Management committees have been established in all fourteen districts in the country.	The existing institutional approach is primarily government oriented, rather than multi-stakeholder, and there are no proper coordination mechanisms for collaboration with other stakeholders.	The mandate provided by Disaster Management Policy at national, district and local level, particularly for disaster risk mitigation needs to be fully exploited	At sub-district level, unless effective institutional systems are in place and their capacity is adequately built, allocation of adequate budget for Disaster risk mitigation may be counter- productive as it may not be gainfully utilized.
National programmes and initiatives including Disaster Risk Reduction(DDR) have helped create awareness about Disaster Management and DRR issues across various government and non-government organisations and participating communities across the country	Despite the paradigm shift in the disaster management approach from a reactive and response mode to a proactive prevention mitigation and preparedness mode, the major focus of trainings continues to be preparedness for an improved emergency response, rather than long term risk reduction.	Emergence of mobile telephony, social media as a channel for communication, and citizen reporting with prevalence of digital and phone cameras and other information and communication technology (ICT) tools have opened up huge opportunities for fast and instant communication during disaster related emergencies as well.	Delay in adopting a coordinated approach involving media and other stakeholders would be a major negative factor for awareness generation.
Various civil society organisations, often aided by corporate groups, have established a national grid of village knowledge centres, setups, and other such community based knowledge and information infrastructure that is very	Campaigns and awareness programmes by various government agencies and civil society organisations have been in isolation from each other and the value of coordinated	Emergence of mobile telephony, social media as a channel for communication, and citizen reporting with prevalence of digital and phone cameras and other information and communication technology (ICT) tools have opened up huge	Lack of resources reduces ability to deliver early warning messages.

Strengths	Weakness	Opportunities	Threats
valuable for disaster risk management related awareness generation	campaigning has not been tapped. Awareness programmes have largely centered on giving basic knowledge, but behavioral change dimensions such as social referencing, motivational aspects etc. are mostly missing	opportunities for fast and instant communication during disaster related emergencies as well	

Table 5-2: SWOT Analysis – Climate Information

Strengths	Weakness	Opportunities	Threats
SLMD has legal mandate to provide meteorological services for dissemination to the various Stakeholders.	Obsolete and inadequate weather, climate and hydrological monitoring infrastructure.	Through the UNDP CIEWS Project, the SLMD has the potential to be a leading agency for providing Meteorological services and effective dissemination to the various stakeholders.	Limits data collection, analysis and provision of Meteorological data.
Through the UNPD CIEWS Project 8 Automatic weather stations have been installed across the country. Newly installed and operational automatic weather stations.	Limited Knowledge and capacity to generate information and predict future climatic events	Improved weather stations, communication infrastructure and other resources for effective Operations.	Obsolete climate and hydrological monitoring infrastructure due to lack of maintenance of observational infrastructure
Through the UNPD CIEWS Project 8 Automatic weather stations have been installed across the country. Newly installed and operational automatic weather stations	No systematic process for packaging and translating and disseminating weather/climate information and warnings.	Promoting the usefulness of climate Information in ways that decision-makers value most. This will encourage more systematic and evidenced based approaches to decision making under uncertainty.	Different information sources across and within country borders.
	Lack of motivation or incentives to project team members for extra-hours of work done outside the routine working hours.		Acute shortage of technology and skilled human resources.
Climate information available	Poor community level usage of climate information as a result of limited consolidation of effective dissemination Faster communication of weather information has proved to be a major challenge to the SLMD	Fostering economic development via better informed sectors, such as agriculture, forestry, fishing, mining, water resources, energy, transportation, aviation and tourism. In addition, national hydromet services can also supplement their resources by packaging and selling information to the private sector.	Limited trust in warnings received.

Table 5-3: SWOT Analysis – CIDMEWS-SL

Strengths	Weakness	Opportunities	Threats
CIDMEWS-SL is a cost-effective early warning system that encompasses all the hazards that share systems or system components.		Strengthen integration of climate information into planning and policy making processes; and;	
CIDMEWS-SL will enable the ONS-DMD to make sound disaster management decisions – to analyze risks and decide upon appropriate greatly enhanced by the cross-sectoral integration of information within the CIDMEWS-SL		interpretation, packaging and transfer of climate information for relevant user-agencies to minimize risk to life and livelihoods including evacuating vulnerable groups, assisting local communities implement risk reduction, and implementing flood control and re-routing structures	
Improve capacity to analyze and interpret climate data enhancing local, regional, and national data;		packaging of weather and climate data and information for a range of other service providers including applications related to building and management of infrastructure, land and air transport, and the private sector	
Establishing denser networks comprising observation, forecasting, and monitoring infrastructure – including automatic and remote sensing technologies – which can be rapidly deployed, are relatively easy to maintain, and simple to use;			
Building support and awareness among local communities that have a demand for climate information and warnings; and promoting greater collaboration between the providers and users (including user-agencies and local communities) of climate information		lead-times for local communities at risk – of floods and severe storms (hail, thunder, lightning, intense rains and violent winds) – to prepare and undertake risk reduction measures, including moving assets to safer locations and implementing flood resilience measures	

5.1.4 Strategic Approach

The goal of this Communications Strategy in many ways define the approach which is to leverage best practices, innovative methodologies and existing assets to share actionable early warnings and build sustainability for climate information and early warning systems initiatives. This communication strategy proposes seven approaches to address the social norms to empower individuals and communities to respond in a timely and appropriate manner to the hazards in order to reduce the risk of death, injury, property loss and damage. These approaches underlie audience selection, messages and communication activities which are proposed in the implementation matrix. They have been developed in consultation and participatory workshop with implementing partners to ensure their appropriateness to the Sierra Leonean context.

The proposed approaches of this Communication Strategy are as follows:

- Utilizing the official communication procedures by ONS-DMD in relation to Sierra Leone Disaster Management Policy and the Hyogo Framework.
- Collaborate on communication initiatives of stakeholders already working on climate information early warning and disaster management to avoid duplication of resources (human and financial) and time.
- Organize regional, national or stakeholder's events such as workshops, seminars, trainings and meetings to disseminate information on early warning and disaster management and disaster risk reduction.
- Convening briefing sessions with strategic players/targeted audiences (political, senior executive, development partners).
- Utilize social media like Facebook, Twitter, and Blog to publicize climate information and early warning systems and invite stakeholders to join.
- Use SMS text messaging for targeted audiences such as MPs on critical themes of concern.
- Preparing and dissemination of comprehensive reports.

5.2 Methodology for Developing the Strategy

The development of this Strategy involved the following activities:

- Reviewing and scrutinizing relevant literature particularly existing communication strategies on climate change and early warning for example, The Sierra Leone National Disaster Management Preparedness Plan, Hazard Profile, etc.
- Consultations with key stakeholders(ONS-DMD, SLMD,MWR, EPA)

The Strategy consists of three main steps, namely:

- Defining the target groups for the awareness raising;
- Formulating the messages for each target group;
- Appropriate channels and means for communicating those messages

6.1.1 Target Audience

The most important element of communication is remembering your audience. Only by knowing and listening to your target audience can you effectively share messages with them. Each target audience is important in themselves as much as they also reinforce each other. In the rolling out of this Strategy, particular attention will be paid to understanding the audiences' mentality, level of understanding of climate change and early warning, interests, values, and concerns. Accordingly, the message content, and language will be tailored to address their specific information needs, pre-existing knowledge, and concerns.

This Strategy targets the following broad categories of audience at different levels:

- **Communities**: Disaster-prone communities may consist of different social, religious or ethnic groups with varying attitudes and coping mechanisms in disaster situations. Essential is that they actively take part in mitigating and will not see themselves as victims. The local communities must be provided with strong and engaging communications. The success of the work being done in the pilot communities is a determining factor in the success of CIDMEWS-SL. As such, a great deal of effort must be made in communicating and educating this audience. This will include training local village facilitators, who are chosen by their respective communities (e.g., village leader or headmen). As much as possible, awareness raising materials will also be delivered in the local/ethnic language of the communities.
- **Local Governments**: District Development Committees, Municipalities, Village Development Committees (VDC) and District Disaster Relief Committees are responsible to take the lead role in disaster reduction initiatives. Early warning is not a priority in all VDCs/municipalities affected by disasters. In many cases, the VDCs/municipalities do not experience severe flooding and therefore are less enthusiastic for establishing early warning system. However, their cooperation in gathering information is essential for establishing an early warning system.
- **National Government Institutions**: National government institutions and MDAs are responsible for formulating high-level policies and frameworks for early warning and for providing technical support. The government institutions (MWR and EPA-SL) have rainfall recording and river level data collection system, which are instrumental for the early warning systems. The MDAs can provide historical and current data of the flood and rainfall pattern, location of rainfall and river level stations. For early warning system to be effectively implemented, the government needs to be aware of and educated about it. This makes the government the key audience for CIDMEWS-SL messages. This is where the focus of communications should be and this should be reflected in the amount of resources allocated for awareness-raising activities.
- **Non-Governmental Organisations (NGOs):** Several NGOs and civil societies are active in emergency situations. They provide humanitarian assistance to the affected people with relief distribution, establishing shelters and ware houses, rehabilitation and reconstruction. Some NGOs pursue a more development oriented approach and are actively involved in preparedness, prevention and mitigation. Some NGOs have supported establishment of early warning systems through participatory approaches and acted as advocates. NGOs can play a role in raising awareness among individuals, communities and organizations involved in early warning, particularly at a community level. They can also assist with the implementation of early warning systems and in preparing communities for natural disasters.
- **General Public including the media**: Although the general public can be difficult to define, effort needs to be made to raise the awareness of climate information and early warnings among the general public particularly the youth. It's an issue that resonates deeply with young people and they should be involved in conveying the message and interpreting information to reach out to the wider public, mobilizing communities and interest groups to engage in actions that adopts climate friendly practices and behaviour
- **Media**: As it is the media that will convey messages to the general public, it is important that strong and lasting contacts are made across TV, radio, newspapers and magazines to ensure all are better informed about early warnings.
- **Farmers**. This target group is comprised of crop farmers, smallholder farmers, industrialized farmers, pastoralists (livestock herders), fishermen and rural enterprisers. This target group has multiple needs for weather and climate information. It can save lives, contain losses, increase productivity and reduce risk. Reaching rural farmers is a challenge, Internet communication is virtually impossible, literacy is low, and there are regional and village-level cultural and linguistic differences. Primary methodologies for reaching this group include: rural radio, SMS, trainings and informational meetings hosted at the community level, billboards, outreach from schools and health organizations, NGOs, pamphlets and other advocacy methods. They can also be reached through value-added service provides, extension services, cooperatives and innovative last mile approaches.

- **Local Communities.** This group is comprised of community leaders, farm cooperative leaders, village leadership, regional politicians, children, teachers, mums, elders and other community members that do not work in farming, local NGOs, extension services and medium-scale local enterprisers. Reaching this group is a little easier. Villages will often have access to television, radio, and may even have access to the Internet. Primary vehicles to reach them include Public Service Announcements (PSAs), TV, training, radio, policy dialogue (learning routes), print media, social media (growing but still limited), community meetings, school and hospital outreach, SMS and engagement with extension services. Some communities have enabled communications tree within the leadership to ensure messages are disseminated rapidly once generated.
- **Policy Makers**. This group is comprised of national leaders in the SLMD, EPA-SL, ONS, MWR, other GoSL MDAs, media, large private-sector enterprise (telecommunications, banking, mining, etc.), universities, think tanks, and regional cooperation entities (i.e. ECOWAS and African Union). Reaching them will be the easiest of all. They can be reached by email, social media, print, radio, broadcast, and advocacy. However, impacting their opinions and policies is a whole other ball game.
- **Private Sector.** Not only do private sector enterprises benefit from tailored weather information – to protect human and physical resources and make climate-smart business decisions – they can also play a role in disseminating messages. Telecommunications firms can site AWS and serve as go-betweens to send early alerts, mining companies can be tapped to leverage corporate social responsibility money, or pay for tailored weather information, media can be used to share early alerts and PSAs. In order to engage the private sector, a narrative that underscores specific value to the private sector and to their consumers should be created. They need to understand that the SLMD is creating valuable products that they can trust.

6.1.2 Key Themes for the Strategy

The following specific themes provide guidance for the Strategy:

a) General knowledge on climate change;

b) Adaptation;

c) Mitigation

d) Climate change research;

e) Climate change financing; and

f) Gender.

6.1.3 Key Messages

Implementation of the Strategy will be guided by key messages that will build cohesion strengthen outreach and fortify the impact for change. Messages will be tailored to meet individual country and target-audience needs – it is a starting point to begin the hard work of creating those tailored messages and a framework on which to base all communications. The current narrative on climate information, disaster management and early warnings is too technical for the majority of the stakeholders involved, therefore the messages need be short simple and clear; solution oriented and present best information tools and options that are credible and trustworthy.

Warning messages should be prepared for presentation in several different formats – text, graphics, and color-coded categories, audio – and should include specific actions for people to respond to the event. Different formats also make it easier for people with disabilities to receive and act on the warnings. All formats, however, should present the information accurately and consistently. The warnings should also take into consideration information needs and interests of each target audience and the key messages that will be clearly communicated.

6.1.4 Roles and Responsibilities

Defining roles is an essential component of any communications strategy. Not only is it necessary to ensure effective issuance of early warnings, it also plays an important role in how a supportive communications strategy is elaborated. The communication process on climate information, disaster management and early warning involves many stakeholders with diverse interests and roles. However, these interests and roles are not mutually exclusive but cut across the audiences. Audience segmentation is therefore vital for designing stakeholder-focused and channel-specific messages in order for all stakeholders to engage fully in the process. This Communication Strategy has identified nine different groups of stakeholders as stated in the Sierra Leone National Disaster Management Preparedness Plan to implement this Strategy. The group of stakeholders include GoSL MDAs, Local Government Authorities, NGOs, CSOs, CBOs, general public, private sector organizations, development partners, politicians, academia and the media.

6.1.4.1 Central Government

Relevant GoSL MDAs as per the appropriate disaster shall take lead roles and responsibilities in the following: weather and climatic disasters, ecological, pest, man-made disasters, civil strife, population movement, child welfare, drug abuse, collapse building, health / epidemic hazards, mining disasters, security and other disasters that have the potential to cause suffering on the population of the affected community. The enactment of the National Security and Central Intelligence Act 2002 has vested the power for coordinating national emergencies such as natural and man-made disasters on the ONS-DMD, which the focal and implementing institution. This Communication Strategy aims at encouraging MDAs to make relevant information within the central government readily available in order to easily communicate to other key players. The message to MDAs should focus to portray the government as a major partner with an important role of policy formulation, information generation, sharing and implementing participatory processes.

6.1.4.2 Local Government Councils

These local councils should be responsible for coordinating local resources to address the full spectrum of actions to prevent, prepare for, respond to and recover from disasters. In addition, local council authorities provide leadership and play key role in communicating to the public and in helping people, businesses and organizations to cope with the consequences of any disasters within their jurisdiction. They have the ability to quickly reach communities at the grassroots across the country as they also comprise of grass root village governments. Climate information, disaster management and early warning can be addressed at macro level as policy, but the implementation need to be localized at micro level.

6.1.4.3 ONS-Disaster Management Department

The ONS-DMD has the responsibility of coordinating all issues related to both natural and man-made disasters. It brings together stakeholders from the GoSL MDAs, NGOs, World Bank, UN specialized agencies, CBOs, CSOs, academia, the private sector, media, and the local communities on DRR and DRM. It promotes public awareness and advocates for the incorporation of DRR and DRM into development planning. It organizes joint assessment with the involvement of major players in DRR and DRM, and gives strategic directives and guidelines to government to take informed decision on national emergencies. It operates through District and Provincial Disaster Management Committees that are established throughout the country.

6.1.4.4 Relevant Local and International Non-Governmental Organisations

They collaborate with the first responders, government at all levels, local councils and other agencies and organisations providing relief services to sustain life, reduce physical and psychological stress and promote recovery of disaster victims where assistance is not enough or available from other sources. This is done in recognition of their mandates and various institutional contingency plans.

5.3 The Sierra Leone Red Cross Society and Partners

These constitute the first group of volunteers to respond to disasters in various communities. They assist with first aid, disaster preparedness and response, relief, prevention, surveillance, early warning systems, search and rescue, contingency planning, vulnerability and capacity assessment, and water and sanitation. They train personnel and maintain a permanent organisation to alleviate suffering and distress, especially casualties of disasters. When engage in relief work, the Sierra Leone Red Cross Society supplements official service where they exist and in particular are prepared to supply trained auxiliaries for medical services.

5.4 Private Sector

They support the National Disaster Preparedness and Response Plan (NDPRP) by sharing information with the government, identifying risks, performing vulnerability assessment, developing emergency response and business continuity plans, enhancing their overall readiness, implementing appropriate prevention and protection programmes and donating or otherwise providing goods and services through contractual arrangements or government purchases to assist in response to and recover from a disaster. In case of a disaster, private sector organisations are expected to mobilize and employ the available resources necessary in accordance with their plans to address the consequences or impact of disasters of their own facilities or disasters for which they are otherwise responsible.

Private sector organisations (PSO) have access to a large segment of the population such as employees, service users, customers, and investors. Often the PSOs have their own networks and some have set apart social responsibility funds to address social and environmental issues. PSOs require relevant information in order to take part in policy formulation, planning and implementation. This Communication Strategy provides opportunity for PSOs to integrate environment issues in their planning process and in their messages. PSOs should be portrayed as important partners in spearheading the national economy and reducing poverty through their own initiatives as well as public private partnerships (PPP).

5.5 Community Leaders (Grassroots)

They are responsible (with the support of the government and other partners) for coordinating community resources to address the full spectrum of action to prevent, prepare for, respond to and recover from disasters. They can provide (in partnership with the government and other partners) leadership and play a key role in communication to the local community and in helping community People, business and organisations cope with the impact of disasters.

5.6 Civil Society Organisations

Strong partnership with citizen groups and coalitions provides foundation for disaster prevention, preparedness, response, recovery and mitigation. The civil societies constitute a strong pillar for the dissemination of education and training and volunteer services to help make communities safe, strong and better prepared to address threats of disasters. They therefore constitute a strong advocacy group for disaster risk reduction. The civil societies ensure that communities are safe or offer volunteer services opportunities to support first responders, disaster relief activities and community safety.

5.7 United Nations and Development Partners (DPs)

All bodies of the United Nations Country Team or specialized organisations support the central government, local government and communities in disaster preparedness, mitigation, response and recovery. The discharge of these roles is in line with their mandate and the broader objective of the United Nations. Development Partners (DPs) have experience in implementing strategic plans for climate change and early warning. They are well informed on economic and social trends nationally and globally. Given their background, DPs need information on how the policies and programmes in the country are harmonized to achieve the intended goals as well as on implementation progress. These networks have solid connections globally as well as nationally. The Communication Strategy needs to cover good lessons (practices) generated from not only within but also outside the country.

5.8 Media

Whereas different actors or implementers of the Strategy have specific roles, it is expected that different audience segments would provide feedback to each other through various channels to facilitate smooth communication flow in the implementation of the Strategy.

5.9 Communication Tools and Channels

Communication channel is a medium through which a message is transmitted to the intended audiences. These may include a variety of formats (text, graphics, audio) and a wide range of media as available (radio, telephone, Internet, pagers, sirens, visual warnings and even messenger runners for some remote locations). Some of the specific channels include electronic media (television; radio); print media (newspapers, brochures, leaflets, newsletter, billboard, journals, banners, fact sheets); social media (e-mail, Facebook, twitters, my space; blogs);

Warnings should be disseminated over multiple channels to ensure minimum delay in delivery to the end users. Each communication channel is appropriate and effective to a given time, audience and setting. It is therefore important to consider the advantages and disadvantages of a channel when deciding on possible options. The following is the overview of channels that will be used in the Strategy:

5.9.1 Radio

Radio provides broad reach and have so far proven to be effective in increasing awareness of relevant issues amongst specific segments of the population. Radio remains the most popular, viable, accessible and cost-effective means of communication and forms a central pillar in the communication and social mobilization strategy for Sierra Leone with over 85% of respondents preferring to receive information through radio broadcast. Radio broadcasting should be prioritized in behavior change communication efforts and will be done in the different local languages to overcome the barrier of low literacy/education level. Memorandum of Understanding (MOU) should be signed with key radio stations such as the Sierra Leone Broadcasting Corporation (SLBC), Radio Democracy, Capital Radio, Citizen Radio and AVY Radio. A system should also be developed to monitor the media to ensure they are maintaining agreed standards and best practices, especially in the application of specific programme formats, locally developed songs and news reports that may undermine efforts to instill positive responses from the public at large.

5.9.2 Television

Being a visual medium, television should be strategically used to educate the community about CIDMEWS and the importance of early warning. Local communities, individuals and policy makers will be given a visual platform to discuss pertinent issues relating to climate information, disaster management and early warnings. An investment in a variety of short spots should be designed, developed and promoted on SLBC, AYV and Star television station to be played between football programme viewing and African Movie shows, popular throughout the country.

5.9.3 Print Media

Print media are essential channels for communicating climate information, disaster management and early warnings. It includes channels such as newspapers, newsletters, brochures, posters, calendars, T-shirts, billboards, bus/wall displays and diaries. These channels convey information and key conclusions generated through publications. However, they have to be adjusted to specific audiences. Print media has the advantage of making a longer impact on the minds of the reader, with more in-depth reporting and analysis. Research has also shown that the public do like to receive information via leaflets or newsletters. As such they are heavily relied upon as a key promotional tool. They are also relatively inexpensive to produce and provide relatively low cost advertising. The most important, most reliable and most used source of information for Sierra Leoneans is the radio (77%) and about 10% read a newspaper or magazine.

5.9.4 Social Media

Social media (e.g., WhatsApp, Twitter, Facebook, etc.) are very popular channels used for communication and interaction in facilitating exchange of ideas and accessing various publications. MDAs and other stakeholders are expected to use their websites to communicate climate information and early warnings. These social media link audiences to internet resources and possibly a forum for discussion on climate information, disaster management and early warnings.

5.9.5 Mobile Phones

One medium that is consistently on the rise over the last few years is mobile telephony. There are an estimated 2.2 million mobile users in the country, twice the number of radios. There are three main mobile phone service providers in the country – Airtel, SierraTel and Africell. Smart has also recently launched mobile communication services in Freetown and is expanding to other parts of the country. The use of mobile phone technology should be used in reaching mass audiences – especially the younger demographics and urban settings such as Freetown and district headquarter towns (i.e., Bo, Makeni, Kenema and Koidu). Using SMS platform is already planned to reach wider audience as well as with specific target groups.

5.9.6 Meetings and Social Gathering

Meetings and social gatherings are platforms where the public gather with the aim of acquiring knowledge on some issues which affect people’s well-being. The knowledge acquired can be provided in the form of speech or religious teachings. Through these avenues, communication on climate change issues and knowledge sharing can be made. Religious venues such as mosques and churches should be leveraged as critical channels for the dissemination of climate information, disaster management and early warning.

5.9.7 Community Information Centres, Outreach and Fora/Platform

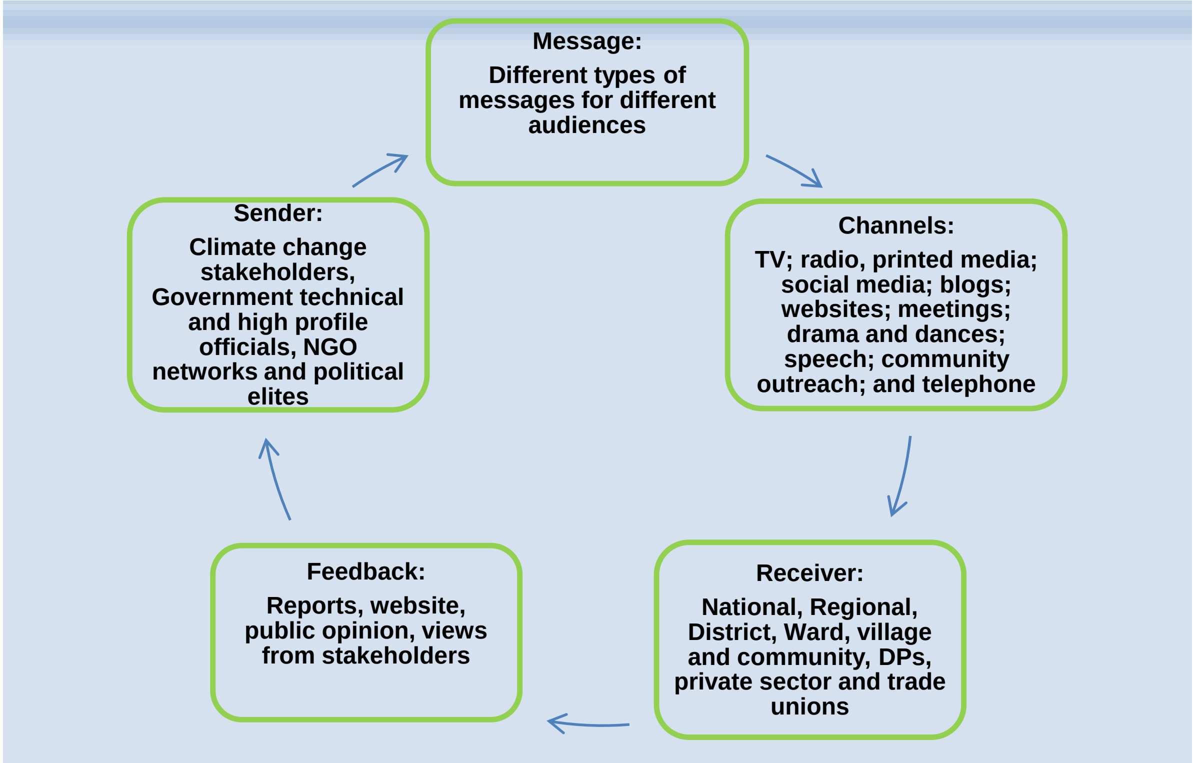
To provide cost-effective information services in places where computers, phone lines or the Internet are not easily accessible, the Communication Strategy looks into the possibility of strengthening community information centres, outreach and fora/platform with up-to-date technology. Assessments can be made of what is already in place, working through for example youth information centres, teacher training centres, women information centres, and district libraries to increase their capacity to provide information on early warning and disaster management.

5.10 Information Generation and Flow

The main source of climate information is the SLMD, where climate and meteorological data and information are generated through monitoring and analysis activities conducted by meteorologists and climate science-related researchers. These climate and weather data and information are becoming an integral part of DRR and DRM and are seen as vital to enhancing people’s capacity to deal with the impacts of climate change.

Climate information is expected to flow from global, national, regional, district and community level and vice versa. It should also flow horizontally among members of a given level. It is therefore important to sustain smooth information flow over time by enhancing the capacity of media practitioners. Equally, there is a need to make use of a trusted, consistent, credible and recognized voice on early warning and disaster management. The role of generating climate information sits within the SLMD and the issuing of warnings rest with the ONS-DMD. The dissemination chain and responsibilities of parties concerned are specified in the National Disaster Risk Response Plan. The ONS should identify and designate appropriate sources of issuing warnings and information from within its structures for different types of risks occurring at different locations. Whereas different actors or implementers of the Strategy have specific roles, it is expected that different audience segments would provide feedback to each other through various channels to facilitate smooth communication flow in the implementation of the Strategy.

Figure 5-1: Information Flow in the Implementation of Communication and Awareness Raising



5.11 Dissemination

Dissemination is delivery of the warning messages, but communication is accomplished only after the information is received and understood. So the foundation of warning communication rests on the format and wording of the warnings, dissemination methods, education and preparedness of stakeholders, and their understanding of the risks they face. Effective warning messages are short, concise, understandable, and actionable, answering the questions of "what?", "where?", "when?", "why?", and "how to respond?". They will also be consistent over time. Alert messages should be tailored to the specific need of intended users. The use of plain language in simple, short sentences or phrases enhances the user’s understanding of the warning. In addition, the most important information in the warning will be presented first, followed by detailed information about the threat with recognizable or localized geographical references.

5.11.1 Weather Forecast

The use of weather forecasting products is key to efficiently and adequately disseminating climate and weather information to a broad spectrum of end users. The weather forecasting service provision institutions and agencies need to use the latest technologies available to disseminate climate, hydrometeorological, and weather information in a variety of formats (gridded, graphical, and text). The weather forecasting strategy must be appropriately streamlined to disseminate a suite of climate information in various formats and media to meet the needs of users/customers in an equitable and open manner.

In setting up weather forecasting products for users, the following objectives should be adhered to:

- Make a wide range of information readily available to a diverse user community;
- Disseminate all weather information nationwide;
- Disseminate broad user community-specific information as a subset of climate and weather information; and
- Deliver critical information to the public, the hazards community, and other users.

To further disseminate and communicate climate information and products, the SLMD has to rely substantially on the contributions of other partners in the public and private sectors.

5.11.2 Advertising

Advertising is a non-personal communication tool with principal aim of creating awareness. Although it does not focus on a specific target audience it can have powerful impact and a wide reach. Traditional awareness raising campaigns rely extensively on advertising using any of or a combination of radio, TV, newspapers, posters, leaflets and direct marketing. Advertising is thought to be a powerful influence on consumers especially when the benefits are aligned with the target audience values and aspirations or the intended action is convenient and tangible. Advertising repetition is important in maintaining awareness. Advertising and awareness raising alone is not strong enough to achieve sustainable behavioural change, particularly for social issues. Advertising also has inherent cost implications.

5.11.3 Direct Engagement

Direct engagement is used to communicate campaign messages directly to the target audience through a number of channels, the most appropriate of which will be derived by the target audience. The success of this methodology will be resource dependent. Direct engagement can also give the opportunity to engage individuals who in turn could act as ambassadors, supporting the campaign message, and educating in more depth either to those who wish to become more involved or focusing on specific target audiences. Community groups comprise a group of people who have shared values or a common interest, and are often highly cohesive and close-knit. The close ties between these people mean that they are more likely to follow through their commitment to activities and that appeal to their beliefs and values. Community based activities can be an effective way of tapping into community spirit and pride.

5.11.4 Stakeholder Engagement

Stakeholder engagement is an effective way of embedding campaign messages and achieving long-term change. Stakeholder engagement allows the creation of active networks through establishing contacts. In short, stakeholders help provide eendorsement for the campaign, extend the campaign reach and maintain momentum; reassurance of the target audience that the scheme is official, reputable and trustworthy; and financial and in-kind contributions enabling cost effective use of resources (time and money). Although anyone can be considered a stakeholder, in this context stakeholders are those influential individuals or groups that have a vested interest in the campaign success. They could be funders, contributors, decision makers or influencers

5.11.5 Advisory Services

Available evidence suggests considerable potential for CIDMEWS services to inform sound decision-making, enabling stakeholders and the general public to better manage risks, take advantage of favorable climate conditions, and adapt to change. However, substantial effort has to be made to ensure that the necessary climate, and weather information are sufficiently available and adequately utilized. This can be done through advisory services – tools/guidelines developed by competent bodies to enable consumers of climate and weather information develop robust and responsible policies and strategies that contributes to development solutions in many areas, encompassing inclusive growth and poverty reduction, climate change mitigation, and environmental sustainability.

5.12 Implementation of the Strategy

The implementation of the Strategy requires commitment and involvement of different stakeholders at all levels. The coordination of planning and implementation of the Strategy at national, provincial and district levels will be the responsibility of the ONS. The ONS has the overall mandate for overseeing the implementation of the Strategy and should, in accordance with the government communication procedure, be responsible for the communication of climate information, early warning and disaster management. It is expected that the communication activities will be integrated into the overall planning frameworks at all these levels and ONS-DMD will ensure synergy between this Strategy and the Sierra Leone Disaster Management Policy as well as other national climate disaster and related plans and programs.

5.13 Strategy Implementation Matrix

Table 5-4: Strategy Implementation Matrix

Theme/ Issue	Key Messages	Target Audience	Means/ Tools/ Channels of Communication	Activities	Expected Outcome
General Knowledge on Climate Change	i) General knowledge on climate change, its causes and impacts, vulnerability, adaptation and mitigation strategies as well as associated opportunities; ii) Linkages of climate change and sustainable development.	General public; religious leaders; journalists; community leaders; schools, politicians and other policy and decision makers	Radio; TV; flyers; posters; newspapers; booklets; social media;	i) Advertising slot or short TV and radio sketch ii) Radio announcements iii) Posters will be put up in places frequented by the target populations. The posters will be setting out: iv) Banners will be made and hung over the main access routes to the targeted sites.	i) Creates awareness, publicity and recognition ii) Can reach large audience. iii) Can focus on target audience
Adaptation	**Agriculture and food security:** i) Impacts of climate change on agricultural production ii) Best agricultural practices (farming systems, storage and	MDAs, LGAs CSOs, private sector, media and farming communities; Politicians; and development partners	Radio; TV; cinema; flyers; posters; newspapers; booklets; community meetings and outreach; drama and songs; websites; social media; farmers exchange visits within and outside the country; local and international exhibitions;	Leaflets, brochures and flyers presenting the various aspects of profiling will also be produced and distributed to local authorities and to the public during awareness raising	

Theme/ Issue	Key Messages	Target Audience	Means/ Tools/ Channels of Communication	Activities	Expected Outcome
	processing); iii) drought tolerant and early maturing crop varieties; iv) crop diversification; v) efficient irrigation technologies such as drip irrigation; vi) crop insurance; vii) early warning system; viii) Traditional/indigenous knowledge; and ix) Change in food consumption behaviour.		demonstration plots; promotional materials; climate change champions and influential leaders.	meetings, political or organisational meetings, and on the way out of religious gatherings, and daily prayer sessions.	
	Livestock i) Impacts of climate change on livestock; ii) Sustainable livestock keeping; iii) Sustainable pasture and range management	MDAs, LGAs, CSOs, private sector, media and livestock keeping communities; Politicians; and development partners	Radio; TV; cinema; flyers; posters; newspapers; booklets; community meetings and outreach; drama and songs; websites; social media; livestock keepers exchange visits within and outside the country; livestock demonstration		

Theme/ Issue	Key Messages	Target Audience	Means/ Tools/ Channels of Communication	Activities	Expected Outcome
	systems; iv) Land use planning; v) Livestock insurance; vi) Sharing of any best practices and lessons learnt e.g. traditional/indigenous knowledge; vii) Impacts on community livelihood; viii) Diseases tolerant Livestock breeds; and ix) Early warning system.		centres; letters; local and international exhibitions; promotional materials; climate change champions and influential leaders.		
	Forestry i) Impacts of climate change on forestry; ii) establishment of seed bank of endangered tree species; iii) Conservation of forest biodiversity and control of	MDAs, LGAs CSOs, private sector, media and communities; Politicians; and development partners	Radio; TV; cinema; flyers; posters; newspapers; booklets; community meetings and outreach; drama and songs; websites; social media; exchange visits within and outside the country; demonstration plots; letters; local and international exhibitions; promotional materials;		

Theme/ Issue	Key Messages	Target Audience	Means/ Tools/ Channels of Communication	Activities	Expected Outcome
	invasive species; iv) Establishment of woodlots; v) Community based forest management best practices; vi) Afforestation and reforestation; vii) Sustainable forest consumption; viii) Sharing of any best practices and lessons learnt e.g. traditional/indigenous knowledge.		climate change champions and influential leaders		
	Water i) Impacts of climate change on water resources; ii) Conservation of water catchments and water sources; iii) Rainwater harvesting technologies; iv) Water use efficient	MDAs, LGAs, CSOs, private sector, media, water user associations and communities; Politicians; and development partners	Radio; TV; cinema; flyers; posters; newspapers; booklets; community meetings and outreach; drama and songs; websites; social media; exchange visits within and outside the country; demonstration of water use efficient technologies; letters; local and international exhibitions; promotional materials; climate change		

Theme/ Issue	Key Messages	Target Audience	Means/ Tools/ Channels of Communication	Activities	Expected Outcome
	technologies; v) Alternative sources of water (such as deep boreholes); vi) Importance and role of Water user associations; vii) Importance of rehabilitation and construction of dams; viii) Conservation of recharge areas for ground water resources; ix) Waste water recycling; x) Importance of water and sanitation; xi) Sharing of any best practices and lessons learnt e.g. traditional/indigenous knowledge; and xii) Early warning system.		champions and influential leaders.		
	Fisheries i) Impacts of climate	MDAs, LGAs, CSOs, private	Radio; TV; cinema; flyers; posters; newspapers;		

Theme/ Issue	Key Messages	Target Audience	Means/ Tools/ Channels of Communication	Activities	Expected Outcome
	change on fisheries; ii) Sustainable fishing practices; iii) Environmentally friendly and adaptation technologies in fish catch, processing and storage; iv) Aquaculture; v) Protection and conservation of aquatic ecosystems vi) Alternative/diversified means of livelihoods for fisheries communities; vii) Sharing of any best practices and lessons learnt e.g. traditional/indigenous knowledge; and viii) Early warning system.	sector, media ; communities ; Politicians; and development partners	booklets; community meetings and outreach; drama and songs; websites; social media; letters; exchange visits within and outside the country; local and international exhibitions; promotional materials; climate change champions and influential leaders.		
	Coastal and Marine	MDAs, LGAs,	Radio; TV; cinema; flyers;		

Theme/ Issue	Key Messages	Target Audience	Means/ Tools/ Channels of Communication	Activities	Expected Outcome
	Environment i) Impacts of climate change on coastal and marine environment; ii) Coastal and beach erosion control systems; iii) Livelihood diversification for coastal communities; iv) Alternative sources and technologies to enhance fresh water availability; v) Sustainable coastal land use planning; vi) Protection and conservation of coastal and marine ecosystems; vii) Restoration of coastal and marine ecosystems (planting of mangroves and coral reefs); viii) Decentralization	CSOs, private sector, media; coastal communities; Politicians; and development partners	posters; newspapers; booklets; community meetings and outreach; drama and songs; websites; social media; letters; exchange visits within and outside the country; local and international exhibitions; demonstration areas; promotional materials; climate change champions and influential leaders.		

Theme/ Issue	Key Messages	Target Audience	Means/ Tools/ Channels of Communication	Activities	Expected Outcome
	of coastal systems management; ix) Sharing of any best practices and lessons learnt e.g. traditional/indigenous knowledge; and x) Early warning system				
	Human Health i) Impacts of climate change on human health; ii) Public health care systems response to climate change-related health risks; iii) Disease surveillance and design of diseases control programmes (e.g. preventive and curative procedures); iv) Early warning system; v) Sharing of any best practices and lessons learnt e.g.	MDAs, LGAs, CSOs, private sector, media; communities; Politicians; and development partners	Radio; TV; cinema; flyers; posters; newspapers; booklets; community meetings and outreach; drama and songs; websites; social media; conferences, seminars, workshop, letters; exchange visits within and outside the country; hospitals and health centres; local and international exhibitions; promotional materials; climate change champions and influential leaders		

Theme/ Issue	Key Messages	Target Audience	Means/ Tools/ Channels of Communication	Activities	Expected Outcome
	traditional/indigenous knowledge on human diseases management and control; vi) Importance of International Health Regulations (IHR); and vii) Early warning system.				
	Wildlife i) Impacts of climate change on wildlife; ii) Protection and conservation of wildlife habitats; iii) Appropriate methods for conservation of climate change threatened species; iv) Community based wildlife management practices e.g. Wildlife Management Areas (WMA);	MDAs, LGAs, CSOs, private sector, media; communities; tourists; Politicians; and development partners	Radio; TV; cinema; flyers; posters; newspapers; booklets; community meetings and outreach; drama and songs; websites; social media; conferences, seminars, workshop, letters; exchange visits within and outside the country; local and international exhibitions; promotional materials; climate change champions and influential leaders.		

Theme/ Issue	Key Messages	Target Audience	Means/ Tools/ Channels of Communication	Activities	Expected Outcome
	v) Wildlife migration vi) Sharing of any best practices and lessons learnt e.g. traditional/indigenous knowledge; and vii) Early warning system.				
	Industry i) Impacts of climate change on industry; ii) Energy efficient technologies; iii) sustainable consumption and production practices; iv) Environmentally friendly fuel switching technologies; v) Sharing of any best practices and lessons learnt.	MDAs, LGAs, CSOs, private sector, CTI; TCCIA; media; communities; Politicians; and development partners	Radio; TV; cinema; flyers; posters; diaries; newspapers; booklets; community meetings and outreach; drama and songs; websites; social media; conferences, seminars, workshop, letters; exchange visits within and outside the country; local and international exhibitions; promotional materials; climate change champions and influential leaders.		MIT; LGAs; TIRDO;
	Energy i) Impacts of climate change on energy; ii) Diversification of	MDAs, LGAs, CSOs, private sector, CTI; TCCIA; media; communities;	Radio; TV; cinema; flyers; posters; diaries; newspapers; booklets; community meetings and outreach; drama and		

Theme/ Issue	Key Messages	Target Audience	Means/ Tools/ Channels of Communication	Activities	Expected Outcome
	energy sources; iii) Alternative energy sources; iv) Energy efficient technologies and practices; v) Co-generation of electricity in industries; vi) Sharing of any best practices and lessons learnt e.g. traditional/indigenous knowledge; and vii) Early warning system	Politicians; and development partners	songs; websites; social media; conferences, seminars, workshop, letters; exchange visits within and outside the country; local and international exhibitions; promotional materials; climate change champions and influential leaders		
	Infrastructure and Human Settlements i) Impacts of climate change on infrastructure and human settlements; ii) Use of building codes and standards adaptive to climate change; iii) Integrated	MDAs, LGAs, CSOs, private sector, NHBRA; media; ERB; CRB; communities; Politicians; and development partners	Radio; TV; cinema; flyers; posters; diaries; newspapers; booklets; community meetings and outreach; drama and songs; websites; social media; conferences, seminars, workshop, letters; exchange visits within and outside the country; local and international exhibitions; promotional materials;		

Theme/ Issue	Key Messages	Target Audience	Means/ Tools/ Channels of Communication	Activities	Expected Outcome
	planning in infrastructure designing, development and use of appropriate technologies; iv) Construction and rehabilitation of infrastructure; v) Land use plans; vi) Acquisition and use of efficient technologies in households and public facilities; vii) Sharing of any best practices and lessons learnt e.g. traditional/indigenous knowledge.		climate change champions and influential leaders		
	Tourism i) Impacts of climate change on tourism; ii) Eco-tourism; iii) Integrated and participatory conservation of	MDAs, LGAs, CSOs, private sector, media; communities; tourists; Politicians; and development partners	Radio; TV; cinema; flyers; posters; diaries; newspapers; booklets; community meetings and outreach; drama and songs; websites; social media; conferences, seminars, workshop, letters; exchange visits within and outside the		

Theme/ Issue	Key Messages	Target Audience	Means/ Tools/ Channels of Communication	Activities	Expected Outcome
	tourist sites; iv) Diversify tourism destinations which are less sensitive to climate change; v) Alternative livelihood to tourism dependent communities; vi) Sharing of any best practices and lessons learnt e.g. traditional/indigenous knowledge.		country; local and international exhibitions; promotional materials; climate change champions and influential leaders		
	Mining i) Cleaner production practices and technologies; ii) Diversification of energy sources and fuel switching technologies iii) Adoption of energy efficient technologies iv) Exploitation of, 'clean coal' v) Sharing of best	MDAs, LGAs, CSOs, private sector, TIC; miners media; communities; politicians; and development partners	Radio; TV; cinema; flyers; posters; diaries; newspapers; booklets; community meetings and outreach; drama and songs; websites; social media; conferences, seminars, workshop, letters; exchange visits within and outside the country; local and international exhibitions; promotional materials; climate change champions and influential leaders		

Theme/ Issue	Key Messages	Target Audience	Means/ Tools/ Channels of Communication	Activities	Expected Outcome
	practices and lessons learnt.				
	Forestry i) Afforestation and reforestation ii) Carbon financing opportunities in the forestry sector iii) Household and institutional woodlots to reduce pressure on natural forests iv) Forest carbon assessment and monitoring v) Reduction of emission from deforestation and forest degradation vi) Sustainable management of forest vii) Conservation of carbon stocks viii) Compliance to forest laws x) Sharing of any	MDAs; LGAs; CSOs; private sector; media; communities; farmers; Politicians; and development partners	Radio; TV; cinema; flyers; posters; diaries; newspapers; booklets; community meetings and outreach; drama and songs; websites; social media; letters; scientific papers, symposium, conferences, seminars, workshop, debates exchange visits within and outside the country; local and international exhibitions; promotional materials; climate change champions and influential leaders		

Theme/ Issue	Key Messages	Target Audience	Means/ Tools/ Channels of Communication	Activities	Expected Outcome
	best practices and lessons learnt e.g. traditional/indigenous knowledge				
	Agriculture i) Contribution of agriculture on emission reduction (Mitigation benefits associated with increased productivity) ii) Best agricultural practices and technology iii) Opportunity associated with climate change mitigation; iv) Sharing of any best practices and lessons learnt e.g. traditional/indigenous knowledge	MDAs, LGAs, CSOs, private sector, Research and Higher Learning Institutions; media; communities; Politicians; and development partners	Radio; TV; cinema; flyers; posters; diaries; newspapers; booklets; community meetings and outreach; drama and songs; websites; social media; letters; scientific papers, symposium, conferences, seminars, workshop, debates exchange visits within and outside the country; local and international exhibitions; promotional materials; climate change champions and influential leaders		
Climate Change	i) Adaptation and mitigation options	MDAs; LGAs; CSOs; Academic and Research	Radio; TV; cinema; flyers; posters; factsheets; newspapers; booklets;		

Theme/ Issue	Key Messages	Target Audience	Means/ Tools/ Channels of Communication	Activities	Expected Outcome
	ii) Sustainable and integrated natural resources management systems. iii) Sustainable management of coastal and marine environment iv) Drought-tolerant, early-maturing and pest-resistant crop varieties and livestock; v) Climate change related diseases and other health risks. vi) Appropriate technologies for adaptation and mitigation. vii) Developing new and make use of available models for predicting the impacts of climate change and estimating adaptation and mitigation cost. viii) Innovations and	Institutions; private sector; media; communities; Politicians; and Development partners	drama and songs; websites; scientific papers; social media; lectures; letters; meetings; symposium; conferences, seminars, workshop, exchange visits within and outside the country; local and international exhibitions; promotional materials; climate change champions and influential leaders		

Theme/ Issue	Key Messages	Target Audience	Means/ Tools/ Channels of Communication	Activities	Expected Outcome
	technologies on eco-friendly energy resources, ix) Climate Change and chemicals management x) Gender and climate change xi) Sharing of any best practices and lessons learnt e.g. traditional/indigenous knowledge.				
Gender and Vulnerable Groups	i) Impacts of climate change on gender and vulnerable groups ii) Participation of women and other vulnerable groups in planning, decision making and implementation of initiatives iii) Gender mainstreaming and empowerment of women and other vulnerable groups	MDAs, LGAs, Disadvantaged groups, CSOs, private sector; media; communities Politicians; and development partners	Radio; TV; cinema; flyers; posters; newspapers; booklets; community meetings and outreach; drama and songs; websites; social media; conferences, seminars, workshop, farmers exchange visits within and outside the country; demonstration plots; local and international exhibitions; promotional materials; climate change champions and influential leaders		

5.14 Monitoring and Evaluation

Monitoring and evaluation is important for measuring performance in various areas of the strategy. The monitoring and evaluation processes will follow government procedures which will be guided by the institutional arrangement provided by ONS. It will do so through evaluation meetings with the various stakeholders, particularly the SLMD, EPA-SL and MWR, MAFFS and reports which will be regularly produced by the various stakeholders. The ONS-DMD under the Office of the President will be the overall coordinator for monitoring and evaluation while sector ministries, departments and agencies will monitor and evaluate the implementation of the strategy at their specific sectors and localities.

The following are output and outcome indicators that will be used for monitoring and evaluation of the Strategy:

5.14.1 Output indicators

1. Number and type of channels used;
2. Number of media institutions involved and the types of messages disseminated;
3. Number and type of audience reached;
4. Number of events/briefings conducted and the No of recipients of the briefings
5. Frequency of communication;
6. Number and type of interventions on climate information and early warning;
7. Number of best practices and lessons learned on adaptation and mitigation;
8. Awareness messages and tools developed;
9. Number of tools identified for this purpose;
10. Feedback and contribution;

5.14.2 Outcome Indicators

1. Level of awareness of the community on climate information, early warnings and disaster management;
2. Resilience of the community to the impacts of disasters;
3. Participation of communities in mitigation activities;
4. Public participation to interactive (radio) programmes; and
5. Benefits of communities through participation in mitigation activities.

5.15 Implementation Budget

Resource mobilization is critical for making this Strategy operational. Financial, human and physical resources should be mobilized from the GoSL, private sector and international funders/donors. However, these financial sources may not yield adequate resources to fully implement the Strategy. The ONS should endeavour to solicit for more financial support to plug the funding gaps, especially for the following costs:

a) Information collection and packaging for public consumption;

b) Website (architectural design, domain name registration and hosting, design and maintenance);

c) Publications (brochures, policy briefs, reports);

d) Promotional materials (posters, banners, etc.) and events (workshops, meetings, trainings); and

e) Airtime (TV talk show and radio talk shows) and advertising space (adverts in the print media).

6 RESPONSE PLAN

An approved national legislative framework that details disaster preparedness, response, and recovery roles, responsibilities, and funding mechanisms is developed or updated, widely disseminated, through appropriate channels, local languages and media, and consistently implemented. There are a number of initiatives to strengthen and develop international laws, principles and guidelines applicable to disasters that GoSL should consider when developing legislative frameworks. The National Disaster Preparedness Plan has clearly defined the institutional "architecture" necessary to implement it. It has also defined a coordination structure, articulating both horizontal (between different sectors) and vertical (between national, sub-national and local entities and authorities) linkages. Although the exact nature of the architecture vary based on the national context, some common elements that has been clearly specified in the institutional arrangements include:

- **Composition:** Entities (including non-governmental bodies) are responsible for disaster preparedness at the local, sub-regional and national levels. These are clearly reflected in their mandates, work-plans and staff job descriptions.
- **Roles and responsibilities:** Entities are responsible for the various tasks and outcomes considered essential to building preparedness capability and different elements expected to relate to each other so that they operate in a cohesive and coordinated manner.
- **Processes, agreements or interagency protocols:** Arrangements are in place to facilitate consistent coordination and communication between different entities with responsibilities for preparedness, and these has been written down and agreed upon by all organizations concerned, including NGOs and CBOs and field staff.
- **Protocols regarding external assistance:** Rules and procedures for requesting and receiving NGO assistance, private donations, international or regional assistance are required and have been agreed and approved in advance.
- **Civil-Military relations:** This system specifies the conditions under which military assets can be deployed at disasters areas.
- **Strengthening capacities:** Arrangements are in place to build and maintain preparedness and response capacity, which cover capacity building at all levels.
- **Decision making on warning dissemination:** This is responsible for issuing warnings of impending threats and they are meant to be done.

In most cases, responsibility for the overall coordination of disaster preparedness activities is assigned to the ONS-DMD. However, it may be necessary to account for specific types of emergencies that may require different agencies assuming authority (e.g. a disease outbreak or a pandemics that may require greater leadership from the Ministry of Health). Linkages between the Government and external factors, including various stakeholders have been clearly articulated in advance. The preparedness system has also specified how the resources of the UN and World Bank systems in the country and from Headquarters might be utilized by all actors, particularly with regards to such areas as Search and Rescue and Disaster and Loss Assessment (DaLA) and Coordination.

6.1 National Disaster Preparedness and Response Framework

The integrated disaster management authorities, policies, procedures and resources of the central and local government, UN Agencies as well as NGOs, private sectors, local communities and international sources constitute the national disaster response framework for assistance delivery following major disasters. The framework makes room for the central government to assist with human and material resources in support of the affected communities in terms of emergencies. Under the NSCIA 2002, the ONS has been mandated to coordinate national emergencies, preparedness planning, management and disaster assistance function.

The ONS-DMD has been delegated the responsibility for establishing national disaster policy. In this stewardship role, the ONS-DMD has the lead role in developing and maintaining the National Disaster Preparedness and Response Plan (NDPRP), which recognizes the fact that certain government institutions have their own emergency response plan describing who will do what, when and with what resources. Also, many voluntary, private and international organizations have their contingency/emergency plans. Much of the NDPRP is directed primarily on operational planning specific to a disaster event. Other forms of planning are crucial to ensuring effective disaster operations. These include contingency planning, action planning and strategic planning.

6.2 Roles and Responsibilities of Institutions

6.2.1 Central Government

Relevant GoSL MDAs, as per the appropriate disaster, shall take lead roles and responsibilities in the following: weather and climatic disasters, ecological, pest, man-made disasters, civil strife, population movement, child welfare, drug abuse, collapse building, health/epidemic hazards, mining disasters, security and other disasters that have the potential to cause suffering on the population of the affected community. The enactment of the NSCIA 2002 has vested the authority for coordinating national emergencies such as natural and man-made disasters on the ONS; of which the DMD is the focal and/or implementing institution and has the responsibility of coordinating all issues related to both natural and man-made disasters. It brings together stakeholders from MDAs, NGOs, UN specialized agencies, Community Based Organizations (CBOs), the private sector, media, and the local communities on disasters. It promotes public awareness and advocates for the incorporation of disaster risk management into development planning.

It organizes joint assessment with the involvement of major players in disaster response. Gives strategic directives and guidelines to government to take informed decision on national emergencies. It operates through District and Provincial Disaster Management Committees (DDMCs and PDMCs) that are established throughout the country.

The Central Government shall be responsible for the following:

- Public works and engineering
- Transportation
- Communication
- Fire fighting
- Housing, mass care and human services
- Resource support
- Search and rescue
- Hazardous material response
- Agriculture and natural resources
- Energy
- Public safety and security
- Long term community recovery and mitigation
- External affairs

6.2.2 Local Government Councils

The local government councils are responsible for coordinating local resources to address the full spectrum of actions to prevent, prepare for, respond to and recover from disasters. In addition, local council authorities provide leadership and play key role in communicating to the public and in helping people, businesses and organizations to cope with the consequences of any disasters within their jurisdiction. The local government councils shall request the central government and, if necessary, other NGOs in situations where the councils' capacities and capabilities have been exhausted.

6.2.3 Relevant Local and International NGOs

The responsibility of the NGOs will be to collaborate with the first responders, government at all levels, local councils and other agencies and organizations providing relief services to sustain life, reduce physical and psychological stress and promote recovery of disaster victims where assistance is not enough or available from other sources. This shall be done in recognition of their mandates and various institutional contingency plans.

6.2.4 The Sierra Leone Red Cross Society and Partners

These shall constitute the first group of volunteers to respond to disasters in various communities. They assist with first aid, disaster preparedness and response, relief, prevention, surveillance, early warning systems, search and rescue, contingency planning, vulnerability and capacity assessment, and water and sanitation. In times of war, civil disobedience, riots, and demonstrations, the Sierra Leone Red Cross Society (SLRCS) shall render assistance to the sick, wounded and the vulnerable groups. This shall be in accordance with the spirit and conditions of applicable conventions. They shall assist in the improvement of health, prevention of diseases and the mitigation of suffering country-wide. They shall train personnel and maintain a permanent organization to alleviate suffering and distress especially casualties of disasters. When engaged in relief work, the SLRCS shall supplement official service where they exist and in particular to be prepared to supply trained auxiliaries for medical services.

In summary, the SLRCS' programs is limited to the provision of the following:

- First aid
- Food supplies
- Non-food items (NFIs)
- Services for the prevention of epidemics including health education
- Social welfare
- Re-union of families and other emergency assistance
- Collaborate with other stakeholders to conduct joint assessments.
- Information sharing and public education

6.2.5 Private Sector

They shall support the NDPRP by sharing information with the government, identifying risks, performing vulnerability assessment, developing emergency response and business continuity plans, enhancing their overall readiness, implementing appropriate prevention and protection programs and donating or otherwise providing goods and services through contractual arrangements or government purchases to assist in response to and recover from a disaster. In case of a disaster, private sector organizations are expected to mobilize and employ the resources necessary available in accordance with their plans to address the consequences or impact of disasters of their own facilities or disasters for which they are otherwise responsible.

6.2.6 Community Leaders (Grassroots)

They are responsible (with the support of the government and other partners) for coordinating community resources to address the full spectrum of action to prevent, prepare for, respond to and recover from disasters. They can provide (in partnership with the government and other partners) leadership and play a key role in communication to the local community and in helping community people; business and organizations cope with the impact of disasters. They shall work with other stakeholder institutions in addressing disaster risk reduction and management of their communities. They shall mobilize community volunteers to serve as first responders to disasters.

6.2.7 Civil Society Movements

Strong partnership with citizen groups and coalition provides foundation for disaster prevention, preparedness, response, recovery and mitigation. The civil societies constitute a strong pillar for the dissemination of education and training and volunteer services to help make communities safe, strong and better prepared to address threats of disasters. They shall therefore constitute a strong advocacy group for disaster risk reduction.

The civil societies shall ensure that communities are safe or offer volunteer services opportunities to support first responders, disaster relief activities and community safety.

6.2.8 Specialize Agencies of the United Nations

All bodies of the UN Country Team or specialized UN organizations shall support the central government, local government and communities in disaster preparedness, mitigation, response and recovery. The discharge of these roles shall be in line with their mandate and the broader objective of the UN.

6.3 Coordination at the Local, Regional and National Levels

A well-functioning disaster coordination mechanism is only said to be in place when it has clear policies and procedures and in which all entities are clear about their roles and responsibilities. Experience has shown that a critical feature of an effective disaster preparedness capability is the extent to which different actors and entities operate in a coordinated and timely manner by avoiding gaps, duplication of effort, and parallel structures. Skillful coordination among the wide range of potential stakeholders that may provide assistance during an emergency (such as the military, NGOs, utility companies and private sector entities) is critical to avoid confusion and to facilitate an effective response.

Ensuring a clear central focal point and location for coordination, such as an Emergency Operations Centre (EOC) is also essential. Different political, cultural, and socio-economic environments necessitate institutional arrangements, including coordination mechanisms, which are appropriate to that particular context. Effective coordination also requires a clear division of labour and clarity as to who does what. It is also important to recognize that even in systems that are decentralized, responsible entities can still provide information and benefit from participation in more centralized coordination mechanisms. Effective preparedness requires close coordination and information exchange among active organizations, including internally (within their own MDAs) and externally (with other stakeholders). It is also important to ensure vertical coordination between the regional, national and local level. An effective coordination system will promote two-way information flow and actual dialogue rather than just information sharing between different components of the system.

It is the responsibility of government to coordinate disaster management initiatives. However, external partners can offer a wide range of support services that may be necessary for comprehensive preparedness initiatives and large response operations. Many focus on specialized technical areas (e.g. meteorological forecasting or pandemic preparedness) that are invaluable to any preparedness capability. Increasingly international organizations are stressing the need for improved coordination both between themselves and the Governments. In many countries Inter-Agency Standing Committee Member organizations, (including UN agencies, many nongovernmental organizations and some international organizations) are increasingly establishing regular sectorial coordination mechanisms through a mechanism called the “Cluster Approach.”

At the regional level, governments should consider coordinating closely with regional organizations working on disaster related issues. There are also a number of global networks and platforms working on disaster risk reduction that can support the GoSL to strengthen preparedness.

6.4 Implementation of Disaster Preparedness and Response Plans

In order to efficiently utilize early warning systems to reduce disaster risk, the ability of the community to respond to natural disasters need to be adequately strengthened. Public education and awareness, stakeholder involvement, warning presentation, and warning communication all contribute to an appropriate response to the warning. This involves implementing strategies for disaster preparedness and response plans, including the development of warnings that meets individual needs of vulnerable communities. Through a holistic analysis process, the following key sectors and players were identified as vital to the implementation of disaster preparedness and response plans both at national and sub-national levels.

6.4.1 Policy Makers

These group comprised of regional and national leaders in the agricultural, emergency services, and similar ministries; locally elected members of the government, regional and national media, large private-sector enterprise (telecommunications, banking, mining, etc.), universities, think tanks, and regional cooperation entities (i.e. African Union). Reaching them should be the easiest of all. They can be reached by email, social media, print, radio, broadcast, telephone, and advocacy. However, impacting their opinions and policies is a whole other ball game.

6.4.2 Private Sector

Not only do private sector enterprises benefit from tailored weather information – to protect human and physical resources and make climate-smart business decisions – they can also play a role in disseminating messages. Telecommunications firms can site AWS and serve as go-betweens to send early alerts; mining companies can be tapped to leverage corporate social responsibility dollars, or pay for tailored weather information; and media can be used to share early alerts. Reaching all these groups means enlisting the support of a wide group of actors. Actors can serve as education providers regarding proper response to different threats and then as messengers in an actual emergency. Actors may include telecoms and electronic media, relevant MDAs, community leaders, first responders, NGOs, CBOs, the education and health sectors, disaster management department, brand ambassadors, country projects, partner agencies, the community of practice, rural radio, etc.

The Legislative and Policy Framework outlined five specific priorities for action in other to achieve disaster preparedness and response plan:

- Making disaster risk reduction a priority,
- Improving risk information and early warning,
- Building a culture of safety and resilience,
- Reducing the risks in key sectors, and
- Strengthening preparedness for response.

The Framework also stressed that disaster risk reduction is not just an issue to be addressed by humanitarians, scientists or environmentalists, but is also critical to sustainable social and economic development processes. Disasters undermine development achievements, impoverishing people and nations. In the absence of concerned efforts to address root causes, disasters represent an increasingly serious obstacle to the achievement of the millennium development goals. In Priority Five; strengthening preparedness for response at all levels, the framework highlighted the essential role that disaster preparedness can play in saving lives and livelihoods particularly when integrated into an overall disaster risk reduction approach. Strengthened preparedness for hazard events is mainly concerned with two objectives: increasing capacity to predict, monitor and be prepared to reduce damage or address potential threats and strengthening preparedness to respond in an emergency and to assist those who have been adversely affected.

The provision of assistance in disasters have been informed by the underlying humanitarian principles of neutrality, humanity and impartiality. In executing this task, the holistic and strategic approach of the Hyogo Framework were leveraged, which is based on a number of further guiding principles that are outlined in detail in the ISDR document.

6.4.3 Agriculturalists

This large, diverse target group consists of (to name just a few members) crop farmers, smallholder farmers, industrialized farmers, pastoralists (livestock herders), fishermen and those involved in the agricultural value chain, ranging from seed salesmen to livestock buyers. This target group has multiple needs for weather and climate information. Such information can save lives, contain losses, increase productivity, and reduce risk. Reaching rural small holders, pastoralists, and fishermen is a challenge, as at best Internet communication is limited, literacy is low, and there are many regional and village-level cultural and linguistic differences. Primary methodologies for reaching this group may include rural radio, megaphone, SMS, training workshops and informational meetings hosted at the community level, outreach from rural schools and health organizations, NGOs specifically targeting one or more of these groups, illustrated pamphlets, and other advocacy methods. They can also be reached through value-added service providers, such as agricultural extension services, cooperatives and innovative last mile approaches.

6.4.4 Local Communities

This group is comprised of community leaders, farm cooperative leaders, village leadership, regional politicians, children, teachers, elders and other community members that don't work in farming but occupy positions of respect, local NGOs, extension services and medium-scale local enterprisers. Primary vehicles to reach them include Public Service Announcements (PSAs), training, radio, policy dialogue (learning routes), print media, social media (growing but still limited), community meetings, school and hospital outreach, SMS and engagement with extension services. Communities have enabled communications trees within the leadership to ensure messages are disseminated rapidly once generated

6.5 Disaster Management

The successful response to any disaster is dependent on the strong relationships with key partners, each having responsibility for elements of overall disaster management activities. Successful disaster management depends on effective integration of planning, prevention, response and recovery at state, regional and local levels. This ensures communities, agencies, NGOs, CBOs and the government operate in an integrated structure that encourages and facilitates the flow of information.

The CIDMEWS-SL integrates multi-hazard disaster management information system (DMIS) that cuts across all levels of government and the private sector to protect life, health, property and the environment through enhancing the ability of the relevant stakeholders and the public to prevent, mitigate, prepare for and respond to hydro-meteorological disasters.

6.5.1 Levels of Disasters

All levels of disasters shall march up with levels one, two and three situation as stipulated in the ONS's National Security Standard Response Guidelines.

- **Level One:** This refers to minor disasters, i.e., any disaster that is likely to be within the response capabilities of the local government, the community and stakeholders working within the affected community and results in only minimal need for national assistance.
- **Level Two:** This refers to major disaster, i.e., any disaster that would likely exceed local capabilities and require a broad range of national assistance.
- **Level Three:** This refers to an extreme disaster, i.e., any disaster that would require massive national assistance including military involvement and support through outside intervention (or international).

Note: The National Security Coordinator will be notified by the Strategic Situation Group (SSG) based upon recommendations from the ONS-DMD before the activation of the different levels can be effected.

6.5.2 Preparedness Planning

Preparedness planning aims to establish a standing capacity to respond to a range of different situations that may affect the country or a region by putting in place a broad set of preparedness measures. This includes, for example early warning systems, ongoing risk and vulnerability assessment, capacity building, the creation and maintenance of stand-by capacities and the stockpiling of humanitarian supplies. Undertaking a contingency planning process has been a key component in developing an analysis of what needs to be done in this process, and has helped in designing, testing and implementing response actions. In order for a plan to be effective, it is essential that all participating actors are meaningfully involved in its development. A process which is built around participation has led to increased ownership by all those involved and has contributed to the smooth implementation of plans during times of disaster. This includes participation at the local, national and international levels. Coordinated participation has helped to work out problems of who is responsible for what when a disaster occurs. It also allows for effective scaling up during disasters; thereby ensuring the required goods and services get to the most affected and vulnerable populations. The CIDMEWS-SL allows for the systematic collection and analysis of information for the purpose of anticipating and identifying emerging, deteriorating, or reoccurring hydro-meteorological disasters. The early warnings and forecasting products generated by the system allows the public and emergency responders to take pre-emptive and protective action to avoid harm to both lives and property.

National institutional arrangements for preparedness clearly designated who can authorize the release of warnings to the public, the organizations have notified, and the procedures to be followed. Standard warning formats and elements should be prepared in advance, and appropriate means or systems for issuing the warning have been determined, based on the nature of the imminent hazard event. These systems should be consistent for all hazards. Early warning systems should be based on thorough hazard/risk assessments, vulnerability and capacity assessments at all levels, including at the community level. Community disaster preparedness and response organizations should be capable of acting on EW messages and mobilizing communities for action. It is imperative that preparedness and warning systems are designed to reach the entire population, including seasonal populations and remote locations.

These communication systems should be two-way and interactive to allow for verification that warnings have been received, and to be able to monitor the impact of an event. Warning alerts and messages should be geographically specific so that warnings are targeted to those at risk only. Dissemination systems should has been tailored to the needs of individual communities (e.g. radio or television for those with access; and sirens, warning flags or messenger runners for remote communities). Warning alerts and messages should has also been tailored to the specific needs of those at particularly high risk (e.g. for diverse cultural, social, gender, linguistic and educational backgrounds). Messages should incorporate the understanding of the values, concerns and interests of those who will need to take action (e.g. instructions for safeguarding livestock and pets).

In order to be effective, existing early warning systems should be tested to make sure that messages are well understood and that systems function effectively. Public education and awareness-raising prior to any hazard or disaster event is also essential. Ideally, on-going public awareness and education activities on disaster preparedness has been built in to school curricula from primary schools to university. Public education and awareness raising activities provide clear information on hazards, vulnerabilities, risks, and how to reduce disaster impacts to vulnerable communities and decision-makers. Community education has also been provided on how warnings have been disseminated and on how to respond to different types of hazards after an early warning message is received. Utilizing mass media and folk or alternative media to improve public awareness has also been effective in this regard. In addition, public awareness and education campaigns have been tailored to the specific needs of each target group (e.g. children, emergency managers, and media). Public awareness strategies and programmes should be reviewed at least once per year (so that they can be updated as required).

6.6 Disaster Response Mechanisms

Most communities with an emergency response plan for disasters include the following categories in the response plan:

- Health services;
- Emergency social services;
- Law and order;
- Urban search and rescue;
- Communications,
- Damage assessment;
- Firefighting/rescue;
- Transportation;
- Engineering and construction human resources;
- Coroner/mortuary;
- Hazardous materials;
- Public information;

- Food and agriculture;
- Finance and insurance and utilities.

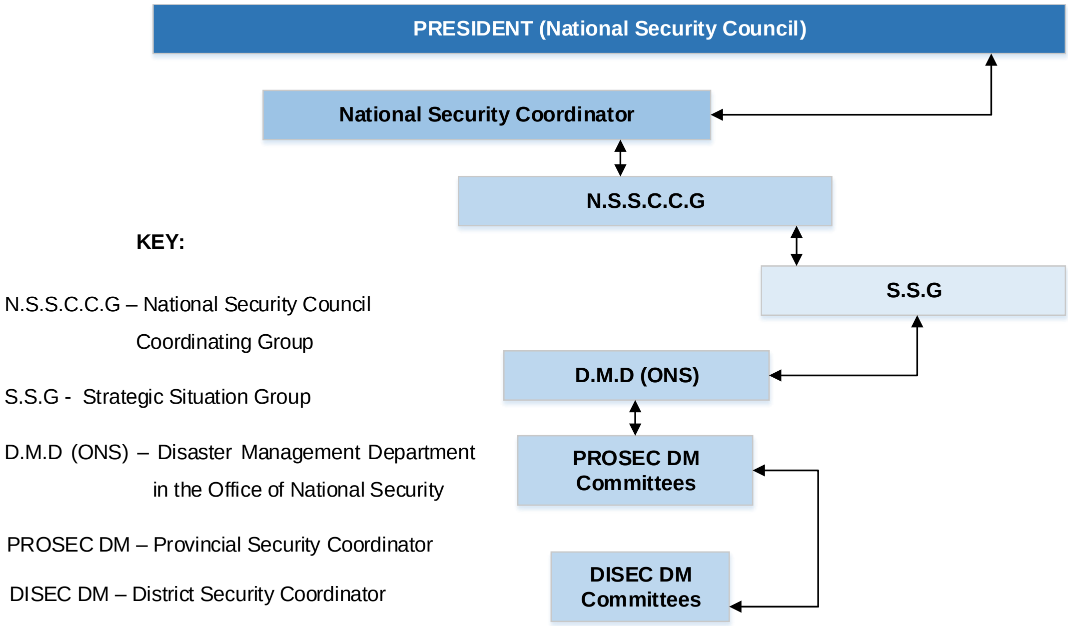
6.7 General Measures for Disaster Response

In accordance with the Sierra Leone National Disaster Management Preparedness Plan, the following under mentioned general measures and approach shall be adopted in response to disasters:

1. Stakeholder emergency meeting
2. Formulation of Sectorial Task Forces (STFs) to execute specific duties
3. Activation of Disaster Management Committee Emergency Operation Centers (DMCEOCs)
    - The Operation Centers(OCs) in each district shall be manned by the District Security Coordinator (DISEC)
    - All OCs at provincial level shall be manned by the Provincial Security Coordinator (PROSEC).
    - At the national level, Emergency Centre (Strategic Situation Room SSG) can be activated and manned by personnel of the ONS, supervised by the Chief of Staff (COS) of the Office of National Security.

The figure below illustrates the flow information from top to bottom and vice versa in times of emergencies. This is applicable to all types of disasters that affect the country.

Figure 6-1: Information flow in an emergency



6.8 Specific Measures

Response to every disaster shall be treated at three levels. These are the national, regional and district levels. There shall be lead institution for each hazard and will be supported by agencies from government departments, United Nations specialised agencies, nongovernmental organizations and private institutions.

6.8.1 National Level

Institutions responsible at the national level include the following:

- Office of National Security
- National Fire Force
- Ministry of Health and Sanitation
- Security Agencies (SLP, RSLAF)
- Ministry of Agriculture, Forestry and Food Security
- Guma Valley Water Company
- Sierra Leone Red Cross Society
- Ministry of Information and Communication
- Sierra Leone Ports Authority
- Sierra Leone Standards Bureau
- Ministry of Lands, Housing and Country Planning
- Relevant Non-Governmental Organizations
- Conservation Society
- SierraTel and other private mobile telecommunications companies
- Media
- National Power Authority

- Freetown City Council
- Specialized Agencies of the United Nations
- NaCSA
- Ministry of Energy and Power
- UNICEF
- Meteorological Department
- State and Private owned telecommunication companies
- World Health Organization
- Non-Governmental Organizations
- Sierra Leone Maritime Administration
- National Power Authority
- Sierra Leone Water Company (SALWACO)
- Volunteer Corps
- Sierra Leone Boat Owners Association
- World Food Programme
- Water Supply Division
- Mobile telecommunication companies
- Ministry of Finance and Economic Planning

6.8.2 Regional Levels

Institutions responsible at regional levels include the following:

- Office of National Security
- Members of the Provincial Disaster Management Committee
- Security Agencies (SLP/RSLAF)
- Regional Medical Officers
- Sierra Leone Red Cross Society
- Regional Office of the Fire Force
- Ministry of Agriculture, Forestry and Food Security
- Private and State owned Media Houses
- Civil Society Movement
- Local Council
- Relevant Non-Governmental Organizations
- specialized Agencies of the United Nations
- Conservation Society
- Traditional Leaders

6.8.3 District Levels

Institutions responsible at district levels include the following:

- Office of the District Security Coordinator
- District Disaster Management Committees
- District Medical Officer
- Security Agencies (SLP/RSLAF)
- District Fire Force
- Volunteer Corps
- Traditional Rulers
- District Councils
- Private and State owned Media Houses
- Sierra Leone Red Cross Society
- Agencies
- Agriculture Extension Workers

6.9 Response Coordination Mechanisms

It is essential to coordinate the reconnaissance of affected areas to ensure that the extent of damage is determined and to establish casualty numbers. The ONS-DMD will ensure initial impact data is collected and communicated to appropriate agencies. It is vital that incoming impact information is managed and communicated effectively to the relevant agencies and governments at all levels.

Much of this support needed for response coordination will involve the administration and cooperation of government and non-governmental assistance. The coordination will be managed by the ONS-DMD, who will primarily be responsible for:

- Co-ordination of the provision of resources required by the DDMCs;
- Allocation of resources and any additional (if required);
- Maintain briefings to the ventral government and the general public on current and predicted operations;
- Incident Action Plan and Situation Report development;
- Safety of Incident Personnel.

6.10 Resource Allocation and Funding

The supply and delivery of emergency relief requires logistical facilities and capacity. A well-organized supply service is crucial for handling the procurement or donation, storage, and dispatch of relief. Having adequate funding and resources available for both planning and operations is fundamental to a well-functioning disaster management system. National legal frameworks should include a national budget allocation and institutionalised funding mechanism for risk management and disaster management. This should not be limited to emergency funds that are accessible during times of disasters but should be permanent and applicable to preparedness, recovery and rehabilitation activities as well.

There are additional means for increasing the availability of funds for use in disaster management, many of which involve agreements that do not necessarily bring in extra funds per se, but rather allow for the freeing up of existing funds. However, all of these need to be developed based on a clear understanding of how they have benefitted affected communities and local economies directly. These include:

- Public-private partnerships that offer affordable insurance services that would spread the burden of disaster risks for individuals or for governments;

- Schemes to cover governments, especially of smaller states, against the massive fiscal impacts of disasters;
- Mechanisms that spread the risk across international reinsurance markets along with the necessary instruments to link world financiers with poor people;
- Government social protection programmes in partnership with private sector financial service providers; and
- Systems for restructuring risk sharing through improved financial intermediation mechanisms.

Including international organizations in the contingency planning process, and integrating DRR into national development processes such as World Bank funded Poverty Reduction Strategies (PRS) enables governments to have dialogue prior to a disaster about the possible availability of international preparedness and response funds. However, many international disaster funds cannot directly fund government relief operations, but instead require that UN agencies or NGOs to undertake the actual work on the ground.

Many UN agencies, the IFRC and some NGOs have emergency response funds that can be used to fund their operations as part of a national response. In addition, the IFRC has an additional Disaster Relief Emergency Fund (DREF) that can be used to fund national society responses in small and medium scale disasters. Complementary to this, the United Nations has recently established the Central Emergency Relief Fund (CERF) that can rapidly disburse funds in larger scale emergencies.

Regardless of preparation, Sierra Leone has experienced shortages of critical resources necessary to respond to disasters. Assumptions regarding necessary resources are described below:

- Teams to support disaster management operations.
- Law enforcement resources for security.
- Vehicles to move first responders, evacuees, and displaced residents.
- Medical health professionals
- Vehicles to move the injured and medically fragile.
- Bedding, food, water, generators, medical supplies, sanitation supplies, qualified staff, and security for shelters.
- Additional shelter space outside of the city.
- Mental health professionals and counsellors.
- Building inspectors.
- Heavy equipment and operators for emergency shoring and debris removal, reduction, transport, and disposal.
- Equipment, staff, and supplies for handling fatalities,
- Water, food, supplies, sanitation facilities, and generators to support emergency operations and to support residents.
- Fuel.
- Qualified emergency managers and other staff to support operations
- Structural and civil engineers.
- Utility restoration teams (power, gas, water, and sewer).
- Communication restoration teams (satellite, cellular, wired, voice/data/video).

6.11 Impact Assessment

Impact assessment must be community focused to ensure the data/information will assist decision making on how to best support impacted communities. Immediately after an emergency incident has affected an area or community there is a need to ascertain what the impact has been particularly in relation to people (casualties, injuries, displacement), property (residences, businesses) and essential community infrastructure (roads, bridges, water, sewage, telecommunications), and to determine whether those damages are sufficient to warrant national emergency assistance. The assessment teams report the information collected to the ONS-DMD for further action. The decision to deploy joint assessment teams shall be done in collaboration with the Disaster Management Committee and the District Council within the affected area. This assessment leads to a better understanding of what needs to occur to ensure the safety of life and property and return the community to normalcy.

6.12 Emergency Relief Services

Emergency relief is the provision of material aid and emergency medical care necessary to save and preserve human lives. It also enables families to meet their basic needs for medical and health care, shelter, clothing, water, and food. Relief supplies or services typically are provided, free of charge, in the days and weeks immediately following a sudden disaster. In an event of a disaster, volunteers and other organized groups such as Republic of Sierra Leone Armed Forces, Sierra Leone Police, National Fire Force, Sierra Leone Red Cross Society, NGOs, MoHS, and Institute of Engineers are mobilized to provide relief services.

Any other co-opted institutions depending on the type, nature and impact of the disaster to perform the following functions:

a) Search and rescue;

b) Evacuation of victims to safe havens;

c) Medical care to the wounded and counselling for the traumatized shall be given simultaneously as search and rescue is conducted;

d) Assessment of emergency supplies;
   - Medical supplies
   - Flood and water
   - Equipment

e) Provision of basic human needs such as water, food, shelter and clothing for victims with special priority given to the most vulnerable groups like:
   - Children
   - Pregnant and lactating mothers
   - Aged
   - Physically disabled

f) Institution of effective follow up mechanisms to ensure proper implementation of relief operation.

g) Assessment of damage to the environment.

h) Maintenance of law and order by the security agencies.

i) Restoration of essential services such as electricity, telecommunications, roads and bridges etc.

j) Appropriate disposal of dead bodies and the chlorination of wells.

6.12.1 Emergency Relief Centers

The ONS-DMD, local disaster management committees, and other relevant emergency response institutions will be notified as soon as information identifying significant damage is available. This will ensure processes are implemented which will provide initial relief for affected persons, whether it is in the form of food, shelter, first aid etc. Providing this information will assist in the smooth transition to recovery activities within affected communities. It should be noted that there are no established Relief centers available. However, ad hoc arrangements are made to utilize some public venues, such as public school buildings and where very large number of people require evacuation - the national stadiums (see Figure 6-2). This almost always pose post disaster challenges in relocating the victims back to their homes.

Figure 6-2: Disaster victims evacuated to the National Stadium

6.12.2 Evacuation

Evacuation involves the relocation of a population from zones at risk of an imminent disaster to a safer location, especially if structures are susceptible to damage. Evacuation of the community or parts thereof is recommended by the ONS-DMD at incident level. It expected that in a large event self-evacuation will occur on a very wide scale, with many people and families moving to areas or locations they consider safer. Initially, self-evacuation will be instinctive and uncontrolled. There will be significant impact on destination communities if there are large numbers of people evacuating. In situations where the disaster has been anticipated evacuation plan will be required as per the usual procedures. Information to the community regarding appropriate locations, routes and methods for evacuation will be disseminated through the appropriate emergency response committees. Should a large scale evacuation of many hundreds or thousands of people be required, as was in the case of the September 2015 flooding in Freetown, evacuation becomes challenging. Therefore, the recommendation would arise from discussions between the ONS-DMD and its relevant partners.

Some of the evacuation DOs and DON'Ts are listed below in case of an emergency:

- If possible wear weather appropriate clothing;
- Leave the building immediately;
- Use stairs, not elevators;
- Assist people with special needs;
- If there is no immediate danger, persons with disability/mobility limitations should shelter in place and call Safety and Security;
- If there is imminent danger and evacuation cannot be delayed, the person with a disability should be carried or helped in the best and fastest manner;
- If you are unable to evacuate, call Safety and Security;
- As you make your way out of the danger zone, encourage those you encounter to exit as well; and

- Follow instructions of identified emergency personnel.

6.12.3 Search and Rescue

Search and rescue (SAR), is the process of identifying the location of disaster victims who may be trapped or isolated and bringing them to safety and medical attention. In the aftermath of disasters, specific MDAs such as, the Ministry of Transport and Communication; National Fire Force (NFF), MLCPE amongst others, are tasked with the responsibility of carrying out search and rescue operations in accordance with the National Disaster Management and Preparedness Plan. These MDAs are being supported by the ONS in coordination with other disaster relief organizations, such as SLRCS, RSLAF, SLP and youth volunteer groups.

Figure 6-3: Response strategies during flooding

6.13 Post Disaster Response Mechanisms

Post disaster response is typically at four) levels.

- **Relief** immediately after the calamity, lasting from the first 24 hours to about two to three months and catering to immediate shelter, food, water and medical assistance.
- **Reconstruction** following relief and extending to a period of approximately two years, aimed at rebuilding the basic physical infrastructure and shelter to enable people to begin afresh.
- **Rehabilitation**, that looks at more long term inputs of reinstating lost livelihoods, introducing new economic opportunities and improving land and water management processes so as to reduce people’s vulnerability and enhance capacities to handle future calamities.
- **Readiness**, a response which should ideally have been a proactive measure, is to enhance preparedness in identified vulnerable regions by introducing mechanisms and methods of construction that mitigate impacts of future disasters.

6.14 Early Recovery

In the rush to plan and execute a relief operation, it is easy to overlook the real needs and resources of the survivors. The assessment must take into account existing social coping mechanisms that negate the need to bring in outside assistance. On the other hand, disaster survivors may have new and special needs for social services to help adjust to the trauma and disruption caused by the disaster. Participation in the disaster response process by individuals to aid community organizations is a key to healthy recovery. Through them, appropriate coping mechanisms will be most successfully utilized.

Humanitarian assistance is vital to reducing loss of life and suffering. However, emergency relief is not designed to address the underlying causes that resulted in the disaster, nor does it automatically stimulate rapid and sustainable recovery. In some situations, post-disaster relief efforts may even exacerbate the underlying causes of vulnerability and increase risk. Previously, reconstruction was often conceptualized and designed to return a disaster-affected community to pre-existing disaster conditions. This often led to rebuilding the conditions of risk that existed before the disaster, thus preparing the ground for future disasters. Recently policy makers and practitioners have begun to look beyond replicating the pre-disaster situation of communities. It is increasingly recognized that closer integration of early recovery activities with lifesaving interventions can lead to more sustainable interventions that will reduce risk while simultaneously accelerating the recovery process.

It is vital that skilled people with experience in early recovery are included during the development of a preparedness capability. Successful early recovering planning will require the participation of a wide range of actors including:

- Relevant Government Ministries, including potentially some additional departments responsible for developmental initiatives;
- Government local authorities in zones of high disaster risk;
- Finance, planning and infrastructure departments;
- Public and private service utilities (electricity, water supply etc.);
- Local NGOs and community based organizations in the identified high risk zones;
- Private businesses located in the high risk zones;
- Associations of professionals such as engineers and architects; and
- Media networks.

Integrating early recovery into contingency planning can help strengthen community resilience to hazard events. This should include measures to reduce immediate risk, for example by locating shelters for displaced populations outside of flood-zones or in areas at lower risk from future hazards. It should also include actions to reduce threats to livelihoods and assets that will strongly impact a community's ability to recover after a disaster.

Discussions should begin well in advance of a hazard event about how quickly 'emergency' projects to provide basic services such as food, healthcare and education will give way to more transitional, or developmental interventions. Having these discussions early on can potentially lead to more sustainable and effective interventions and can minimize the use of temporary emergency supplies. Activities more compatible with longer-term recovery (such as cash for relief projects in the immediate aftermath of a disaster) may also be considered during the response phase to enable populations to retain their assets and livelihoods as far as possible in the wake of a hazard event.

6.14.1 Transition to Recovery

The immediate response to a major disaster will focus on saving lives, providing resources to sustain Sierra Leone residents, and stabilizing the situation. At some point, however, Sierra Leone must transition to a phase in which recovery operations take precedence. Given the level of damage to housing, business, and infrastructure; the direct impact on the population; and the effect on the regional economy, full recovery from a major disaster will take years, if not longer. Nonetheless, rapid initiation of recovery operations is critical to restoring confidence in the community.

Triggers for transition from response to recovery may include the following conditions:

- Widespread fire suppression and Search and Rescue (SAR) operations have concluded.
- Evacuations have ceased.
- Care and shelter operations have stabilized and shelter population is decreasing daily.
- Stabilization of the built environment has minimized the risk to life and property.
- Restoration of utilities and lifelines is underway.

- Local assistance centres are in operation.

6.14.2 Long-Term Recovery Strategy

The NGOs and CBOs have specific responsibility for implementing recovery of their respective operations and proceeding with restoration of their facilities. However, general recovery of services, economy, infrastructure, housing, and communities will require a coordinated effort beyond the specific responsibilities of agencies. Therefore, it is necessary to convene a Recovery Management Task Force, whose main objectives will be to provide a mechanism to coordinate the recovery activities of agencies, identify critical needs and roadblocks to recovery, leverage available resources of the State and governments. The Task Force will convene as short-term recovery efforts proceed and the scope and magnitude of the long-term recovery effort becomes evident.

6.15 Reconstruction and Rehabilitation

The reconstruction of shelter and community infrastructure, in fact, forms an important entry point for the rehabilitation process. A reconstruction program is the first step towards restoring and upgrading local habitat. It introduces improved systems of building, sets up basic building element supply, and builds up the skills and management capacity of families, local agencies in a restricted area and sets up local information and knowledge systems. All these to enable "better building".

Re-establishing people’s lives through rehabilitation efforts involves:

- Moving up the ladder from house to habitat to livelihood;
- Local awareness creation including training for all so that people gain control over the housing process;
- Capacity building and linking to enterprises-livelihood support;
- Devising livelihood interventions in the farm and non-farm sectors based on new economic opportunities to create economic surpluses (that can be directed to responsive housing); and
- Creating a basis for community access to institutional housing finance.

The effectiveness of any reconstruction and rehabilitation is based on detailed planning and careful monitoring of the relevant projects. The ONS and relevant MDAs shall oversee reconstruction and rehabilitation work and ensure that it takes into account the overall development plans for the state. In addition, GoSL will approve reconstruction and rehabilitation projects. Reconstruction & rehabilitation projects are fairly resource intensive. Such funds will be raised by the GoSL, supported by international agencies and other development partners. Government of Sierra Leone shall advocate and enable others to raise funds for disaster mitigation plans.

Emergency management and response systems have been further strengthened through greater collaboration and partnership with and between public, private, non-profit agencies, and the community. However, typical deficiencies still exist in most communities in of Sierra Leone. Most importantly, reliable and timely damage assessment and decision support systems to accelerate and optimize response activities.

7 INFORMATION SHARING TOOLS

7.1 Overview

With the advent of ICT, there has been increased demand for ICT-based disaster management, meteorological, climatic and hydrological data and early warning information system at the national, regional and local platforms. At the national level, several GoSL MDAs, NGOs, CBOs and actors are playing an increasingly crucial role in the overall disaster management, meteorological, climatic and hydrological data and information systems and community-based disaster preparedness activities.

An effective early warning system needs effective communication network systems, which have two main components:

- Communication infrastructure hardware that must be reliable and robust, especially during the disaster; and
- Appropriate and effective interactions among the main actors of the early warning process, such as the scientific community, stakeholders, decision-makers, the public, and the media.

Many communication tools are currently available for disaster management, meteorological, climatic and hydrological data and early warning information dissemination, such as Short Message Service (SMS) (cellular phone text messaging), social media (WhatsApp, Twitter, etc.), and email, radio, TV and web service. Disaster warning/alerting authorities like the SLMD and ONS have long relied on media, such as radio and television to help disseminate public warnings. Television stations like SLBC, AYV and STAR TV insert crawl text with the warning message, and radio stations like SLBC and Radio Democracy insert a recording.

Although some form of early warning systems exists in Sierra Leone, they require assessment, monitoring and review from time to time to keep the systems updated. One way to support effective climate change adaptation planning in Sierra Leone is to comprehensively assess the early warning communications networks to improve climate monitoring and early warning systems through the enhancement of the technical and technology capacities of the relevant mandated institutions – SLMD, ONS-DMD, MWR and the EPA-SL. However, the obstacles in the path include the present limited or non-existence of systematic processes for packaging, translating and disseminating climate information and warnings, lack of technically skilled human resources and poor community level usage of climate information and responses to received warnings. This is because of a number of policies, institutional, financial, technological and informational barriers that exist in national, provincial, district and community levels in Sierra Leone:

- Obsolete and inadequate weather, climate and hydrological monitoring infrastructure, which limits data collection, analysis and provision of meteorological services;
- Limited knowledge and capacity to effectively predict future climate events as a result of an acute shortage of technology and skilled human resources;
- No systematic process for packaging, translating and disseminating weather/climate information and warnings – including different information sources across – and within country borders;
- Lack of maintenance of observational infrastructure and limited technically skilled human resources to operate the systems; and
- Poor community level usage of climate information because of the limited consolidation of effective dissemination channels including physical mechanisms and limited trust in warnings received.

7.2 Purpose of Information Sharing

Natural and manmade hazards do not affect everyone uniformly; in the event of a disaster, the poorest suffer most because they live in fragile topography with structurally poor houses and have limited resources, their capacity for resilience is extremely low. Owing to their weak resilience capacity, every hazard interrupts their livelihoods, pushing them back to the vicious cycle of poverty. Indeed, for the poor, even small hazards occurring in their surrounding weaken their livelihood strategies, savings and assets. The development and implementation of information sharing tools entails the provision of timely and effective information toolkit, through identified institutions, that allows individuals exposed to a hazard to take action to avoid or reduce their risk and prepare for effective response.

7.3 Methodological Approach

The approach to sharing climate and meteorological information incorporates a blend of participatory development approaches and ICT; especially, mobile telephone short messaging services (SMS) (which has proved very effective in disseminating information). This toolkit explores some of the ways in which we collaborate with the local communities to generate and share local information using these tools for:

a) Provision of meteorological advice to those that require it (disaster planners and responders, and other users)
b) Providing outreach services in relation to meteorological issues, to schools, community groups or farmers for example
c) Providing a local point of contact for and providing support and advice to disaster planners and responders
d) Ensuring that severe weather warnings and other products are properly understood.

In addition, these arrangements would raise the SLMD's profile and reach and provide a dedicated local point of contact for those needing meteorological advice

7.3.1 Strengthening Infrastructure and Technical Capacity of Local Community Radios

The goal of early warning systems is to reduce damage inflicted by hazards on people who may be affected. To be effective, warnings must not only have a sound scientific and technical basis, but also a strong focus on the people exposed to risk. In the case of meteorological hazards, the SLMD is an expert and a critical player in the development of risk management plans. The SLMD and ONS should be a credible authority for information on severe weather warnings and have a reputation for accuracy, reliability, and timeliness. It is also increasingly recognised that the SLMD needs to develop a corporate culture of being caring and people-centred, in addition to the more traditional culture of being professional and science-centred. Developing working relationships with partners such as emergency managers and the media and involving stakeholders in the development and review of the warning system is essential.

People-centred early warnings need to be:

- Clearly understood by the people
- Easily and readily accessible to people
- Timely
- Tied to response actions to be taken by the people in advance of, during, and after the event.

The work dedicated to improving the ability of the SLMD and other relevant national institutions to deliver services does not result in real development impacts without reaching the communities and individuals making choices based on their best knowledge about the current and future weather and climate. The dialogue between the SLMD, ONS, EPA-SL and MWR must be continuous and evolving to sustainably serve end user needs.

One main dissemination tool in rural communities is the local radio station. As part of the development and establishment of information sharing tools, the current state of the radio stations and captured information on the operating hours, staffing, radio programs and their content, location and funding sources were assessed.

7.3.2 Information Sharing Tools

In the development of the information sharing tools, the communication networks in early warning systems were extensively explored in several aspects. First, several challenges are identified to deploy the tools, namely, technological, social, and organisational challenges. To adapt to early warnings and emergency circumstances, protocols modifications based on existing protocols are recommended, to avoid violating the existing protocols. In this implementation, several aspects of decentralised rural communication networks were covered that would best disseminate information to these communities. Feasible sharing tools were assessed and implemented, and respective community organisations (Town Criers, Town Runners, Evacuation officers) are strengthened and/or set up to properly utilise these tools.

Keeping in mind the time – sensitivity and volume of data transfer needed for effective and reliable communication to the right stakeholder at the right time. The ONS in collaboration with the relevant stakeholders will make use of cell broadcasting, social media platforms and radio broadcasting throughout the implementation and operational phase. However, for ensuring the EW and forecasting of disasters reach the community in the likely affected area, all the technological options available with public and private ICT operators, including the services of individual members/NGOs are to be pressed into service so that the prime DM objective of eliminating/minimizing the loss of life is achieved.

Communication media, which in general enable early warning dissemination are radio, television, telephone, public address systems of civil defence, email/Internet, cell broadcasting, amateur radio, satellite communications, etc. These are discussed in detail in the following paragraphs.

7.3.2.1 Radio and Television

Considered the most traditional electronic media used for disaster warning, the effectiveness of radio and television media is high because they can be used to spread a warning quickly in an easily understandable format. Local language-based early warning via television to a large population even in an environment where the teledensity is relatively low can be very effective as it would be graphically depictive to the populace. The distribution of warnings by radio and TV requires a device that is switched on and set to the correct frequency.

7.3.2.2 Telephone (Fixed and Mobile)

Telephones can play an important role in sending early warning messages to the communities about the impending danger of a disaster that can save many lives. The effectiveness of telephone calls can be enhanced by a mechanism called 'telephone trees' to warn communities of impending dangers. When an individual receives a warning message (either through phone or by other means), he/she is supposed to make a predetermined number of phone calls (usually four or five) to others in a pre-prepared list. This arrangement not only ensures the timely delivery of the warning message but also ensures the minimum duplication of efforts.

There are, however, two drawbacks to using telephones for disaster warning. Telephone penetration, particularly in rural and coastal areas, is far from satisfactory. The other drawback is the congestion of phone lines that usually occurs immediately before, during and after a disaster, resulting in untimely warnings due to phone calls in that vital period not being materialised through.

7.3.2.3 Short Message Service/Cell Broadcasting

SMS is a service available on most digital mobile phones that permits the sending of short messages between mobile phones, other handheld devices and even landline telephones. Telecommunications companies like Airtel, Smart, SierraTel and Africell will be encouraged to develop a shortcode for cell broadcasting that will be used to communicate warning messages to the citizens especially those in the disaster prone areas. This mode of communication is very effective because it reaches a wider audience almost at instantaneously hence resulting in timely intervention.

Most of today's wireless systems (based on CDMA and GSM technologies) support a feature called cell broadcasting, through which a public warning message in text can be sent to the screens of all mobile devices operating in any group of cells of any size, ranging from one single cell (about 8 kilometres across) to the whole country.

Some of the important advantages of cell broadcasting for emergency purposes are:

- There is no additional cost to implement cell broadcasting. There is no need to build any new towers, lay any cable, write any software or replace handsets.
- It is not affected by traffic load; therefore, it will be of use during a disaster, when load spikes tend to crash networks.
- Cell broadcasting is geo-scalable, so a message can reach hundreds of millions of people across continents within a minute.

7.3.2.4 Internet/Email

The Internet is a global network of networks enabling computers of all kinds to directly and transparently communicate and share services in most of the world. The Internet provides a new, potentially revolutionary, rapid and very cost-effective means of making an intra-national and international disaster warning communications. The Internet, widely available, has no timeline guarantee and is subjected to congestion and disruption. In spite of this drawback, many disaster-related activities are already underway within the Internet community. The role Internet, email and instant messages can play in disaster warning entirely depends on their penetration within a community and the extent of usage by professionals such as first responders, other stakeholders, etc.

7.3.2.5 Other Modes of Information Sharing

Other modes of information sharing include:

- Local devices for communication: word-of-mouth, runners, criers, drums, flags, bells, telephone, radio, television, megaphone, mosque speakers.
- Using a typical dissemination system e.g., mobile phones and SMS texting, social media (e.g., WhatsApp, Twitter, Viber, IMO, etc), post-mail, written and verbal messages.
- Using existing intra as well as inter-linkages between stakeholders to transfer information from national level institutions to community level stakeholders.
- Community level gatherings at mosques and marketplaces by members or NGO activists who work at field level in the locality.
- Local newspapers disseminate daily information during a flood event.

7.3.3 Key Messages

7.3.3.1 Consistency and Standard Messaging

A comparative view shows that just a few of Sierra Leonean languages are partially developed while the majority are not developed at all. Most of these languages are still oral, with no standard orthography and thus do not possess any form of written material. In contrast to language planning, which may start at a level of language development where no written language exists and where no actual linguistic norms exist yet, terminology planning relies on the existence of linguistic norms and a certain grammatical and orthographical stability in the written language (UNESCO 2005). In most cases, if a language is limited to legends and traditions or to the family environment, then such a language will be inadequate to support specialised or professional communication such as warning messages.

Although some of the indigenous languages in Sierra Leone possess fully developed orthographies and some written material, they still lag behind in their terminology for not only early warning systems communication but also other specialised domains like medicine, law, technology, etc. This implies that if there is no immediate intervention, many of the Sierra Leonean indigenous languages will fail to attain their ability to communicate specialised information thus limiting them to general use only.

In addition, most Sierra Leoneans are only orally fluent in their local languages and illiterate in the written language. In such vain, the warning messages were developed on the ground with heavy insight from residents within these rural communities. To best develop oral messages that do take into cognisance their environment and what they relate to, in order to best develop messages for a particular community.

7.3.3.2 Scalability

Scalability refers to the extent to which it is possible to "do more" (one of the cornerstones of *IFRC Strategy 2020*) by rolling out activities to a larger number of people. The aim was for the selected Information Sharing Tools to be scalable to a community level. One of the challenges was whether these could be applied at a sufficiently large scale that the disasters and suffering being faced can be reduced. There are two extreme challenges to scalability, both requiring cost-effective solutions. On the one hand, Sierra Leone is a deeply centralised country, with most of the development occurring in the cities and urban dwellings, mostly neglecting rural communities. Many villages and communities face recurring flood and storm hazards. There is urgent need to reach these populations in economic and political heartlands. On the other hand, the wide geographic spread of rural populations in remote and inaccessible locations poses a different set of challenges in scaling up.

Usually, the most daunting barrier to scaling up is cost. Good programme design should always include strategies for affordable replication because needs multiply at a faster rate than pilot programme solutions can be applied.

The following strategies have been put in place in order to scale up the information sharing tools.

- Partnerships established with NGO's to best develop strategies for continual training within the community as well as the development of new awareness packages over time.
- Partnerships to be established with SLBC, Star TV and Radio, AYV television and radio, Radio Democracy and any other media houses that may be of assistance to get either a discounted and/free space for adverts and broadcasts to help with the awareness packages that would be disseminated to the communities.
- Inclusion of community members in the backbone of the system

7.3.3.3 Sustainability

Sustainability refers to continuing public awareness and public education intervention efforts over a long enough period of time to achieve a shift to a culture of safety. Sustainability is challenged by:

- Rapid population growth, urbanisation and migration
- New technologies that produce greater risks
- Lack of awareness of technologies available to reduce risks
- The long intervals between some natural hazard impacts
- The impacts of climate change
- Loss of collective memory of indigenous knowledge, or inability to adapt it
- Reduced inter-generational transmission of knowledge
- Short-term donor project funding models
- Donor expectations of 'new' rather than 'improved and sustained' approaches
- Lack of financial resources for scaling up
- Volunteer fatigue
- Failure to measure progress.

Sustainability can be enhanced by:

- Identifying activities that can be repeated at regular intervals without being a burden
- Building in opportunities for innovation and creativity
- Making activities part of membership expectations for women and youth, and in turn using these activities to grow volunteer base

- Sharing ownership with government partners to institutionalise efforts
- Ownership is being shared with CBO's and their partners in order to best institutionalise efforts. Ownership is also being shared with education authorities to universalize efforts and have the training and awareness program inculcated into the school curriculum. Regular school drills would be conducted in order to educate the youth on the best practices during a disaster warning. In addition, we'd be sharing ownership with other NGOs like the Red Cross to share the responsibilities for training and awareness programs
- Measuring and advertising successes of the system, thus showing the need for it to be continued and the various strides that are being taken. In addition, awards and recognition should be given to the volunteers, thereby integrating a healthy competitive element to further sustain the Sharing Tools.
- Creation of a training pyramid in order to help sustain the system. The initial trainers would be tasked with training 30 community members each, and those community members, in turn, would be tasked with training another 30 members.
- Monitoring teams would be established to check in on the communities on a monthly or bimonthly basis to best monitor and ascertain the level at which the community is with regards early warning systems.

7.3.4 Awareness-Training Programme

An awareness- training programme is a means used to increase awareness and participation of the community and make development participatory by transferring knowledge, skills and techniques to the people. The people-centred approach to early warning, promoted by the Hyogo Framework for Action, focuses on how communities must understand threats in order to avoid them. Disasters are partly caused by external hazards, but they also stem from vulnerability; people being in the wrong place, at the wrong time, or without adequate protection or resources to respond to a warning. In this regard, communities must at least be active receivers of information, while some may even need to be engaged in monitoring to facilitate their adoption of protective actions.

The training-awareness programme will focus on empowering the local communities in Bumbuna and Dodo, especially women and youth associations. The programme seeks to raise awareness and knowledge thus allowing residents to assess local risk levels and provide early warnings of extreme weather events using local languages.

Disaster risk reduction promotion and early warning education activities rely on a variety of well-designed and effective Training-awareness programme materials to help ensure success and create the desired impact. A hybrid approach consisting of campaigns, participatory learning, informal education, formal school-based interventions and drills is used to ensure hazard awareness and knowledge reaches a wide audience.

This training intends to raise awareness and train local communities to recognise simple hydro-meteorological and geophysical hazard signals, assess local risk levels and act upon them. Awareness within communities will be raised to prepare and respond to disasters, thus reducing damage inflicted by hazards on people who may be affected. Even though there have been other awareness training programmes, experience shows that the impacts of these programmes fade if the community's new knowledge, skills and structures are not put into use. If a community does not experience a natural disaster for many years, much of the training may be wasted. Thus, the aim is to invest in the most vulnerable villages that are most likely to be affected in the near future. Research shows that the Guma Valley, Bumbuna and Dodo dam communities are vulnerable and at risk of experiencing geophysical and hydro-meteorological disasters hazards as a result of their surroundings. This has necessitated the need for a Training Awareness Programme to build their resilience.

7.3.4.1 Media Campaigns

The MDAs, in partnership with local NGO and CBO, undertake flood awareness campaigns to provide uniform and standard messages with the intent of creating a large-scale impact. The campaigns consist of several messages promoting flood awareness that targets audiences in the Bumbuna and Dodo communities. The initial strategy relies heavily on a combination of media formats and tools to spread campaign message to different audiences' via video documentaries, print posters, blogs, audio podcasts, recorded street theatre performances, radio drama or SMS (text message). Humour and compelling testimonies are used to help share the message and resonating with the audience. Humour, to appeal to a young audience, and broadcasting compelling stories of personal experiences, to ensure these are heard by those who have the power to change the situation. The initial duration of the campaign should be short-term (3 months) with the intention of it eventually occurring annually, especially during the build up to the rainy season. The campaign will reach the largest number of people whilst working and building on strengths of all partners and attracting mass media attention.

7.3.4.2 Participatory Learning

Participatory learning aids communities to self-identify threats and vulnerabilities, whilst developing a foundation for risk awareness. Identifying resources and capacities will boost confidence and self-sufficiency all the while building a sense of local and personal ownership. This approach encourages local stakeholders to be a part of the solution and provide an opportunity to integrate disaster reduction with health, water and sanitation, livelihood protection and climate-change adaptation.

Whilst the campaigns run in the background, focus should be on engaging people in discovery and problem solving concerning flood hazard awareness and disaster risk reduction. The relevant MDAs should use local languages (Temme, Loko, Limba, Mandingo, Mende and Creole) to create catchy and enlightening songs, jingles, stories and folklore incorporating/ using traditional characters such as "bra spider", tortoise, monkey, "koni rabbit", snake and frog to strengthen the emerging culture of prevention.

The community engagement should be applied at two levels:

- The organisational level – headquarters, branches, schools, businesses, workplaces, homes; and
- The community level – being scaled up to reach villages and towns;

The tools listed below should target children and marginalised populations:

- Publications such as booklets and illustrated graphics (Posters, leaflets and booklets);
- Participatory activities such as transect walk, risk and asset mapping, seasonal calendar, group discussion, drills, simulations and tabletop exercises; and
- Audio and video materials, including videos, audio clips and songs or other music.

7.3.5 Drills

7.3.5.1 Community Drills

The MDAs should train communities to conduct drills involving all actors (and in particular women and youth associations) of CIDMEWS to test effectiveness and readiness of the communication and information sharing tool with regards:

1. Warning requirements
    - Lead-time, frequency and timing
    - Locally relevant
    - Understandable (content, language)
    - Locally actionable – meets end user needs
2. Dissemination
    - Interpretation
    - Translation
    - Response options
    - Communicating risks

- Lag time

7.3.5.2 School Drills

School drills form a vital part of the school disaster management process and provide an intensive learning experience. Drills should be followed by reflection and assessment by all members of the school community. Lessons learned should be incorporated into the school's disaster management plan, and goals set for improvement next time. Depending on hazards faced, there several major types of drills that can be practised, however, building evacuation and site evacuation will be the priority.

7.3.6 Gender and Youth Mainstreaming

Gender refers to the roles, values and beliefs assigned to men and women by society. Youth, according to the UNDP is defined in Sierra Leone as people aged 15 to 35. Gender mainstreaming is an approach and a means to achieve the goal of gender equality and will be a key dimension of the Information Sharing Tools and Awareness-Training Programme. This involves ensuring that gender perspectives and attention are central to the Project activities and point at gender equality.

Youth mainstreaming is a strategy for integrating youth into every aspect of an organisation or community, including the individual perspectives, shared cultures, and throughout the systems and structures affecting young people every day. Youth mainstreaming is a strategy that engages youth as partners throughout every part of an organisation to promote efficacy, equity and empowerment for everyone involved. It is the active, visible engagement of youth throughout the entirety of a defined institution. Melding the best strategies from across the youth-serving sector, Youth mainstreaming empowers youth voice through youth involvement to infuse youth throughout society.

In establishing and developing the Information Sharing Tools and Awareness-Training Programme, it is understood that different groups have different vulnerabilities according to culture, gender, age or other characteristics that influence their capacity to effectively prepare for, prevent and respond to disasters. In the context of Information Sharing Tools and Awareness-Training women and youth are important because different tasks and responsibilities culturally assigned to men, women and youth impact how they are affected by disasters. Women and youth often have less access to and control over resources and less involvement in decision-making. This makes them more vulnerable to disasters. Meanwhile, women and youth bear much of the responsibility for the safety and health of family members, in particular children, and are primarily responsible for the provision of food, water, for hygiene practices and sometimes for organising temporary shelter. It is thus important to ensure the full and active participation of women, youth, elderly, disabled and socio- economically disadvantaged (as well as men) in all Awareness-Training programme activities. All information, instructional arrangements and warning communication systems should be tailored to meet the needs of every group in every vulnerable community.

Furthermore, the implementation of the Information Sharing Tools and Awareness-Training Programme will be carried out in alignment with the WMO Policy on Gender Mainstreaming and with consideration for the following critical principles:

- Active involvement of women and men in designing services for users, to ensure the appropriate consideration of the specific needs of women and men, specifically in the disaster risk management, water and the agriculture sectors;
- Attention to gender equality when selecting participants for training and workshops; and
- In addition, weather and climate information can yield multiple indirect benefits for the public and private sectors in the longer term by generating reliable data that can support economic activities in sectors such as agriculture, energy and transportation.

In the process of achieving enhanced disaster, preparedness through Information Sharing Tools and Awareness-Training, community members and community-based organisations should be enabled to improve their communication and outreach activities and engage with the CIDMEWS in important relay functions. This should contribute to broader economic and social development benefits for local communities in the area.

7.4 Knowledge Sharing Forums

7.4.1 Radio and Television

Radio and television provide a broad reach and have so far proven to be effective in increasing awareness of relevant issues amongst specific segments of the population. These mass media channels provide an easy, accessible and cheap means of communicating information to the end user and soliciting feedback. Radio remains the most popular, viable, accessible and cost-effective means of communication for urban and rural people in Sierra Leone. It overcomes barriers of distance, illiteracy and language diversity better than any other media. There shall be frequent weather updates given by the radio station on an hourly basis, with the presenters and staff having been properly trained on how to read these messages to the public.

During any disasters, messages should be broadcasted to the public in all major languages and dialects of that community, informing them of the current situation as well as the precautionary steps to be taken and the relevant emergency numbers to contact for help.

7.4.2 Telephones (Fixed and Mobile Phones, Social Media)

Telephones can play an important role in sending an early warning to the communities about the impending danger of a disaster that can save many lives. The effectiveness of telephone call can be enhanced by a mechanism called ‘telephone trees’ to warn communities of impending dangers. When an individual receives a warning message (either through phone or by other means), he/she is supposed to make a predetermined number of phone calls (usually four or five) to others in a pre-prepared list. This arrangement not only ensures the timely delivery of the warning message but also ensures the minimum duplication of efforts.

Short message service (SMS) is a service available on most digital mobile phones that permits the sending of short messages between mobile phones, other handheld devices and even landline telephones. There could be instances when many residents of affected disaster areas are unable to make contact with relatives and friends using traditional landline phones, but could easily communicate with each other through SMS as long as the network is functional. This is because SMS works on a different channel and can be sent or received even when phone lines are congested. SMS also has another advantage over voice calls is that one message can be sent to a group simultaneously.

Most of today’s wireless systems (based on CDMA and GSM technologies) support a feature called cell broadcasting, through which a public warning message in text can be sent to the screens of all mobile devices operating in any group of cells of any size, ranging from one single cell (about 8 kilometres across) to the whole country.

Some of the important advantages of cell broadcasting for emergency purposes are:

- There is no additional cost to implement cell broadcasting. There is no need to build any new towers, lay any cable, write any software or replace handsets;
- It is not affected by traffic load; therefore, it will be of use during a disaster, when load spikes tend to crash networks; and
- Cell broadcasting is geo-scalable, so a message can reach hundreds of millions of people across continents within a minute.

7.4.3 Megaphones & Mosque Speakers

To further aid the dissemination process, megaphones are used to disseminate warning messages in a time of disaster. A megaphone is a handheld public address system that amplifies the human voice using electric power. It consists of a microphone to convert sound waves into an electrical audio signal, an amplifier powered by a battery to increase the power of the audio signal, and a loudspeaker to convert the audio signal to sound waves again. Although slightly heavier than acoustic megaphones, electric megaphones can amplify the audio to a higher level, to over 90 dBs.

Groups have been set up to be in charge of various key locations around the community. They will play a siren followed by a pre-recorded message denoting the evacuation procedure that is supposed to be followed. In addition to the megaphones, the CBEWS will make use of speakers as well to best cover the community.

7.4.4 Runners and Criers

Town Crier [19] groups can be set up to disperse information to the locale during times of imminent danger. They are normally used to spread information within a town/community as opposed to town runners. Runners have been used to convey information between two or more towns. The concept is similar to the Town Crier, with the notable difference being that runners normally report to one person or body in a town that they convey information to, whereas town criers relay information to a whole community. Town runner and crier groups have been set up making use of the youth in the community. Each of the runners and town criers has been properly orientated on the importance of early warning dissemination within the community. They can be split up into groups with each of the groups responsible for dissemination within a certain area in the community as well as in-between communities for town criers and runners respectively. They can be equipped with portable loudspeakers that will play pre-recorded messages in the main languages and dialects of that community. One way of improving the speed of dissemination would be to provide them with a suitable means of transportation.

7.4.5 Bells and Drums

Bells and drums have been used in rural communities for a long period to inform the community members of impendent danger. Certain sequences were played to signify the type of danger they were faced with and the precautionary measure that should be taken. Using this same baseline principle, bell and drum sequences were developed which would be played prior to the occurrence of a hydro-meteorological and/or geophysical risk to warn residents of what they were likely to be faced with and the type of action that should be taken. The bells and drums would be rung and played by a dissemination group comprised of youth that would be tasked with supplementing the efforts of the town criers and runners to mitigate against possible disaster.

7.4.6 Flags

A colour coding system has been implemented, and different sequences of flags will be raised during a time of disaster. The sequences will best inform the user on the type of disaster that is imminent and what step should be taken.

Yellow - Weather Alert - Be Aware

The concept behind YELLOW level weather alerts is to notify those who are at risk because of their location and/or activity and to allow them to take preventative action. It is implicit that YELLOW level weather alerts are for weather conditions that do not pose an immediate threat to the general population, but only to those exposed to risk by nature of their location and/or activity.

Orange - Weather Warning - Be Prepared

This category of ORANGE level weather warnings is for weather conditions that have the capacity to impact significantly on people in the affected areas. The issue of an Orange level weather warning implies that all recipients in the affected areas should prepare themselves in an appropriate way for the anticipated conditions.

Red - Severe Weather Warning - Take Action

[19] The term "Town Crier" has its first origin in Medieval Times between the years of 1595-1605. It was established as a means of passing on information from the court and/or King to the common people. It had its ascendancy in Africa during the colonial era when colonial masters used this method to dispatch messages to the community.

The issue of RED level severe weather warnings should be a comparatively rare event and implies that recipients take action to protect themselves and/or their properties; this could be by moving their families out of the danger zone temporarily; by staying indoors; or by other specific actions aimed at mitigating the effects of the weather conditions. This level of warning assumes a high confidence of the event occurring. Any false warnings could lead to unnecessary panic and loss of credibility.

7.5 Implementation of Training and Awareness Programme

Disaster risk within Sierra Leone has its roots in development decisions that do not adequately address disaster concerns, and the resulting disasters are coming at the cost of development and poverty reduction. By not considering disaster risk in development planning, new risks could be unintentionally created or existing ones exacerbated through investments in infrastructure and public services, and through improper planning and regulation. Thus, it is essential that the process of development planning identifies and analyses the underlying causes of risk, and factors in measures for risk reduction. By mainstreaming disaster risk reduction into national development processes, disaster risk considerations can be made an integral part of development processes, especially in priority sectors such as agriculture, education, health, housing and roads.

The Training and Awareness Programme should be developed to enhance the capacity of government officials, development partners and stakeholders involved in development planning to mainstream disaster risk reduction into development activities and practices. The Programme is aimed at helping participants and their respective organisations to design and implement early warning systems. The Programme will help participants develop early warning systems and risk management plans tailored to the needs of their respective organisations.

The Programme introduces participants to various aspects of early warning and disaster management, which should be designed to increase the audience's awareness of the process of early warning system, leading to better performance in disaster preparedness and response. The major objective of this Programme is to increase awareness about early warning mechanisms for different hazards, their potential benefits, challenges in taking decisions during such early warning, and capacity building in interpreting and taking suggested protective measures. The content, in general, follows the ISDR early warning system principles, procedures, and terminology.

The Programme was intended for audiences, end-users and the SLMD, ONS, EPA-SL and MWR staff. Upon completion of the course, participants will:

- Understand operational mechanisms and procedures of the warning products.
- Examine the warning products that have been developed to integrate information into forms most useful for them to make decisions at various levels, and establish appropriate contingency plan or options to guide members of their organisation against various hazards of different timescales.
- Prepare & communicate tailor made early warning information products to elicit response from at-risk communities.
- Apply emerging new generation climate prediction technologies for anticipating and managing disaster risks associated with climate change & variability

7.6 Implementation Challenges

Driven by factors such as economics, communities usually design and deploy IT and communication infrastructures for expected usage scenarios and not necessarily for extreme situations. During a crisis, the very infrastructure that we expect to serve as an enabling technology for an effective and timely response might itself be prone to failures and vulnerable to malicious attacks. Dependence on IT might thus introduce new additional vulnerabilities to an already fragile process. For example, if emergency organizations start depending solely on technologies such as reverse calls, (a communication solution that combines databases and GIS mapping to deliver outbound notifications to targeted geographical areas via voice and text messages) to communicate alerts and evacuation plans with the public. Telephony's failure under extreme loads could have devastating consequences.

7.6.1 Radio and Television

The Sierra Leone 2015 Census data was used to understand the households that had access to/owned radios in the three Districts/Areas, where the research study was conducted..

Table 7-1: 2015 Ownership of durable goods by District (Radio)

District Name	Kenema	Tonkolili	Western Area Rural
Total Households	111,734	86,840	91,284
Households with Radios	77,297	45,458	69,937

From the above table, it is evident that radios can be a good means of information dissemination. Also taking into consideration that some villages might not have a radio at all, this means of information dissemination would need to be supplemented by other local devices.

One disadvantage to using televisions as a means of disseminating information to rural communities is their access to regular electricity. If at the time of a disaster, an early warning message were broadcasted via television at a time when there is no electricity, that message would not be received by people in that locale. Another disadvantage is television ownership, which is shown in the table below. The penetration of televisions in these rural areas is very low, and also taking into consideration their ready access to electricity using televisions to disseminate information is not an effective means in rural communities.

Table 7-2: 2015 Ownership of durable goods by District (Television)

District Name	Kenema	Tonkolili	Western Area Rural
Total Households	111,734	86,840	91,284
Households with Televisions	14,586	3,392	24,288

7.6.2 Telephones (Fixed and Mobile Phones, Social Media)

There are two drawbacks to using telephones for disaster warning. Telephone penetration, particularly in rural and coastal areas, is far from satisfactory. The other drawback is the congestion of phone lines that usually occurs immediately before and during a disaster, resulting in many phone calls in that vital period not being materialised through.

Using any form of Social Media to broadcast information in these communities may be counter-intuitive due to the lack of use, literacy or technical expertise as well as a limited, and in certain cases, the absence of an Internet connection in certain areas within these communicates.

Since each of the communities that were visited was situated in different districts, we made use of the Sierra Leone 2015 Census data to understand the households that had access to/owned mobile phones.

Table 7-3: 2015 Ownership of durable goods by District (Mobile Phone)

District Name	Kenema	Tonkolili	Western Area Rural
Total Households	111,734	86,840	91,284
Households with Mobile Phones	68,173	38,089	76,765

From the table above, it can be deduced that early warning dissemination within the rural communities in these districts would only be effective to a certain extent due to the ownership/access to mobile phones. Also taking into consideration cell phone coverage and access to a reliable power source, it should be ensured that the warning system was not heavily dependent on mobile phones.

7.6.3 Megaphones & Mosque speakers

Megaphones and mosque speakers are only useful within the distance they can be heard and exclude members of the community with hearing impairment. Maintenance of systems may also prove difficult.

7.6.4 Runners and Criers

The dissemination of correct and timely information is of the essence in early warning systems. Runners and Criers may be liable to misinform the populace on a hazard based on their comprehension of the initial warning message. Ensuring and maintaining the consistency of standard messages is near impossible. Timeliness of spreading messages becomes a major concern when using Runners and Criers

7.6.5 Bells and Drums

Bells and drums are only useful within the distance they can be heard and exclude members of the community with hearing impairment.

8 CIDMEWS-SL

The CIDMEWS-SL integrates GIS and MIS systems and mobile data collection technology to provide a family of sophisticated tools and Web services for collecting, managing, visualizing, mapping, analysing, monitoring, evaluating and reporting on various aspects of climatological, hydro-meteorological, disaster management and early warning information in Sierra Leone. The ability of the ONS-DMD and various stakeholders to make sound disaster management decisions – to analyze risks and decide upon appropriate counter-measures - can be greatly enhanced by the cross-sectoral integration of information within the CIDMEWS-SL.

The ONS-DMD provides a coordinating role in establishing and implementing early warning programmes through development of a robust early warning system and capacity building of its staffs. This allows the ONS-DMD to partner with the SLMD, EPA-SL, MWR and various stakeholders involved in the end to end early warning system from community to national levels, sectoral MDAs, the PROSEC, DISEC, community committees and humanitarian agencies as well as the Sierra Leone Red Cross Society. The development of the CIDMEWS-SL took into consideration previous problems associated with insufficient warning information and potential future problems associated with social vulnerability, capacity, and disaster event variability in terms of increased frequency, severity, unpredictability, and spread to areas that were previously relatively unaffected.

The ability of the ONS-DMD to make sound disaster management decisions – to analyze risks and decide upon appropriate counter-measures - can be greatly enhanced by the cross-sectoral integration of information within the CIDMEWS-SL. For example, to understand the full short- and long-term implications of floods and to plan accordingly requires the analysis of combined data on meteorology, topography, soil characteristics, vegetation, hydrology, settlements, infrastructure, transportation, population, socio-economics and material resources. This information comes from many different sources and at present it is difficult in the ONS-DMD to bring it all together.

The usage of the CIDMEWS-SL is three-fold:

- Preparedness planning
- Mitigation
- Response & recovery

The hazard and vulnerability assessments and mapping components of the CIDMEWS-SL are the cornerstone of preparedness planning as well as planning and implementation of mitigation programmes. All CIDMEWS-SL data and information are of critical use in the preparedness plan as well as in the actual response operations. The CIDMEWS-SL has been built bottom up from the lowest administrative unit (Administrative Section) to the level (national) of the disaster preparedness plan. The Administrative Section and Chiefdom databases feed into the District and Provincial databases and then into the National database.

This multi-layered approach to hazard and disaster management benefits from:

- More stable levels of dialogue on early warning and climate information activity throughout the year: during the off-season when one hazard is dormant another hazard may require monitoring. When two hazards are off-season (e.g., flood in the dry season), vulnerability (or resilience) may still be monitored.
- Greater efficiency of limited human and financial resources: centralizing CIDMEWS-SL at any level minimizes system maintenance and number of required staff/volunteers.
- More clarity: a one-stop-shop that has been given authority will result in less confusion for users on where to seek early warning information.

Key components of the CIDMEWS-SL databases are:

- Hazard and vulnerability assessment mapping
- Socio-demographic distribution

- Infrastructure, lifelines and critical facilities
- Logistics and transportation routes
- Human and material response resources
- Communication facilities
- Environmental, natural resources
- Meteorological
- Hydrological, topographical and geological

8.1 Development of the CIDMEWS-SL

The CIDMEWS-SL was developed to standardize, interoperate, integrate and centralize information, responses and early warnings, about all disaster management, meteorological, climatological, environmental and hydrological hazards that are pertinent to a given level/entity with careful attention to resilience and vulnerability. The CIDMEWS-SL can be used to disseminate weather and forecasting products, climate information and early warnings to the GoSL, MDAs; international and national NGOs; CBOs; Development Partners; private sector organisations; academia and the general public to enable early preparation against disasters such as floods and other severe weather stresses.

8.1.1 Design and Development of the CIDMEWS-SL

The technical approach to the design, development and deployment of the CIDMEWS-SL was to:

- Build a robust, scalable, flexible and interoperable CIDMEWS-SL with an integrated browser-based [20] MIS and high-quality production ready databases (on hired dedicated servers in the Cloud [21]), including preconfigured mobile data capture applications, for collecting, managing, visualizing, mapping, analysing and monitoring climatological, hydro-meteorological, disaster management and early warning information in Sierra Leone.
- Build a network-enabled CIDMEWS-SL that can be accessed over the Internet, local Intranet, as well as a locally installed system using the latest ICT so that all Project stakeholders can access accurate, timely, secured and reliable CIDMEWS-SL resources from any device (desktops, smartphones/tablets and the Web), from any place, and at any time. The deployment alternatives will be: offline deployment; online deployment; and hybrid deployment.
- Build interactive and user-friendly browser based interfaces, including dashboards and maps, using the latest MIS, GIS, mobile, server, network and Web technologies so that all stakeholders can access accurate, timely, secured and reliable CIDMEWS-SL data and information right from any device (desktops, smartphones/tablets and the Web), from any place (both online and offline), and at any time.
- Build an integrated GIS and MIS System using a combination (i.e., hybrid approach) of commercial (proprietary) and FOSS and web services. This hybrid approach will help reduce risk and add value in several ways: avoiding single software vendor lock-in; reducing costs associated with licensing; and promoting interoperability with existing software and architecture.
- Build an integrated CIDMEWS-SL, GIS and MIS System that is platform independent and thus runs on any platform (e.g., Windows, Linux, Mac OS X) with a Java Runtime Environment (JRE 7 or higher) installed. Can be used in many different contexts depending on the exact requirements of the operating system to be used.

[20] The only real requirement to interact with the System is with a web browser on any desktop or mobile device.
[21] Takes away the worry and hassle of buying and setting up expensive server hardware, software and accessories.

During the design of the CIDMEWS-SL, the Development Team considered and examined how various communities can use social media to improve their resilience to both man-made and natural disasters. Specifically, the Development Team:

- Examined how social media can be used to crowdsource information during a crisis situation and how this information can help reduce response and recovery times and raise awareness about the risk of future disasters.
- Examined how community representatives and those involved in emergency management can use social media to create early-warning systems that can be activated during such events.
- Identified examples of good practice for information dissemination to the public during crises. These will be used to develop widgets for emergency services and incident managers that will raise public awareness about the risks associated with disaster events.
- Explored how members of the public can be empowered to provide accurate and timely information during disaster events that decrease response and recovery times.

8.1.2 Key Features of the CIDMEWS-SL

The key features of the CIDMEWS-SL are as follows:

- Provides a comprehensive data management solution based on data warehousing principles and a modular structure which can easily be customised to the different requirements of the Project's management information system, supporting analysis at different levels of the Project's organisational hierarchy (national, district, chiefdom, section, town).
- Customisation and local adaptation through the user interface. No programming required to start using the CIDMEWS-SL in a new setting within or outside the SLMD, ONS, EPA-SL and MWR.
- Serves as a data collection, recording and compilation tool, and all data (be it in numbers or text form) can be entered into it. Data entry can be done in lists of data elements or in customised user defined forms which will be developed to mimic paper based forms in order to ease the process of data entry. Provides data quality checks that help to improve the quality of the data being collected or entered.
- Provides easy to use one-click reports with charts and tables for selected indicators or summary reports using the design of the data collection tools. Allow for integration with popular external report design tools to add more custom or advanced reports.
- Flexible and dynamic (on-the-fly) data analysis in the analytics modules (i.e. GIS, PivotTables, Data Visualizer, Event reports, etc.). Dashboards to provide quick access to different analytical objects (maps, charts, reports, tables, etc.) to an individual user.
- Integrated GIS module to easily display temporal and spatial data on maps, both on polygons (e.g., districts, chiefdoms, sections) and as points, and either as data elements or indicators.
- Temporal data and periodicity are organised according to a set of fixed period types: daily, weekly, monthly, bimonthly, quarterly, six-monthly, yearly, etc. This becomes an important factor when analysing CIDMEWS-SL data over time e.g. when looking at cumulative data, when creating quarterly or annual aggregated reports.
- All data, including meta-data, reports, maps and charts, can be retrieved in most of the popular representation formats of the Web of today, such as XML, JSON, PDF and PNG.
- A user-specific dashboard for quick access to the relevant tools, including indicator charts and links to favourite reports, maps and other key resources in the climate and hydrometeorological System.

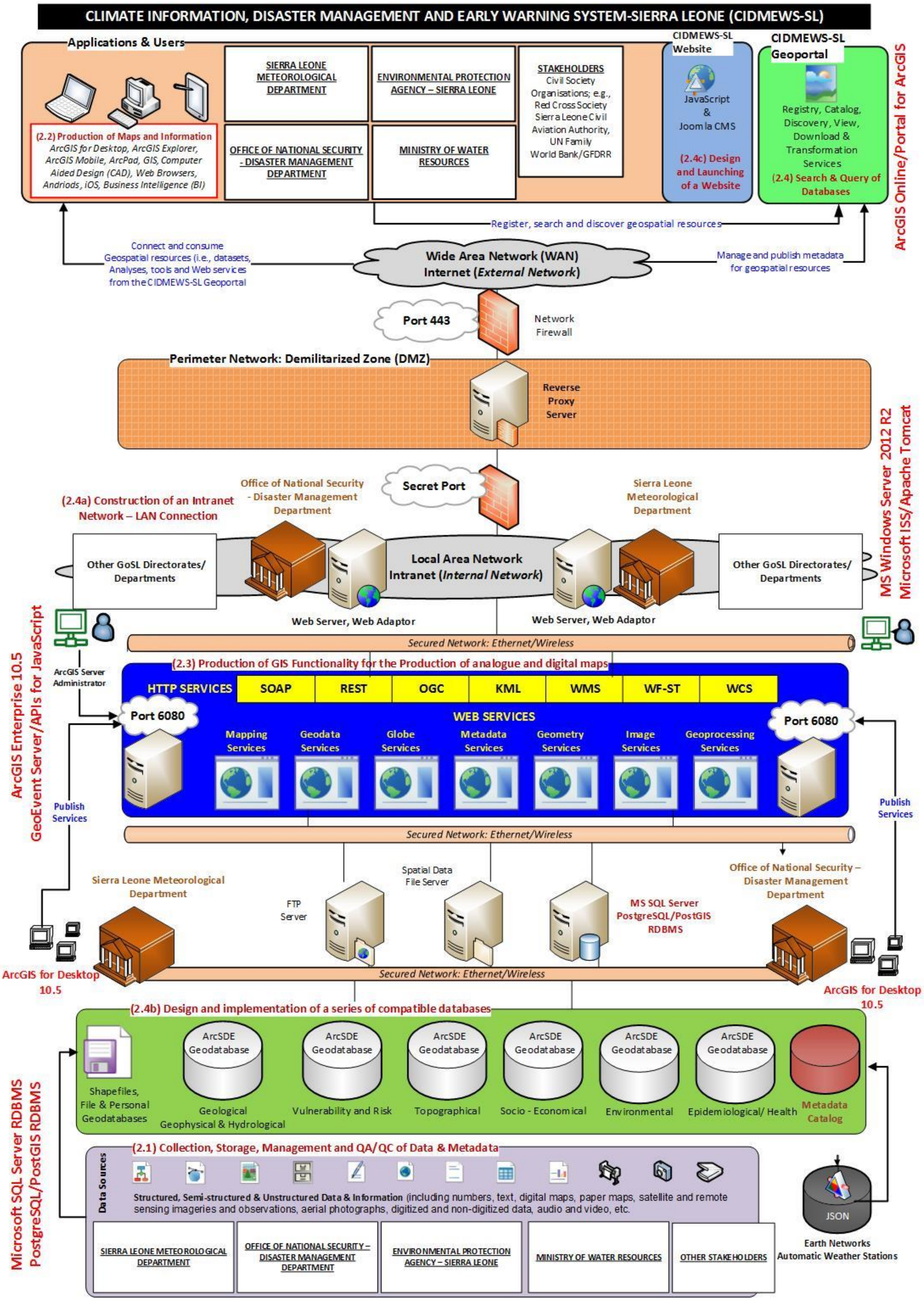
- Easy to use user-interfaces for metadata management.
- User management module for passwords, security, and fine-grained access control (user roles). CIDMEWS-SL allows for multiple users to access the system simultaneously, each with a defined set of permissions, which can be finely tuned so that certain users can only enter data, while others may generate reports. Multiple user roles can be created, each with their own set of permissions, and then assigned to users which grant them certain privileges within the system.
- Messages can be sent to users for feedback and notifications. Messages can also be delivered to email and SMS.
- Users can share and discuss their data in charts and reports using Interpretations, enabling an active information-driven user community.
- Functionalities of export-import of data and metadata, supporting synchronisation of offline installations as well as interoperability with other applications.
- Using the Web-API, allows for integration with external software and extension of the core platform through the use of custom apps.
- Further modules can be developed and integrated as per user needs, either as part of the user interface or a more loosely-coupled external application interacting through the Web-API.
- The CIDMEWS-SL can be deployed: offline; online; and hybrid. The GPRS/3G mobile module provides a mechanism for remote clients using mobile phones to enter data directly into the CIDMEWS-SL.

8.1.3 GIS-enabled and Web-based

GIS-enabled and Web-based early warning and decision support system like the CIDMEWS-SL enables timely insights and better communication, thus making the information rapidly available for better preparedness and action. Early warning and preparedness heavily depends on inputs like reliable, accurate real/near real data on the hazard causing parameters, forecasting, data analyses, alert recognition and dissemination of alerts. The CIDMEWS-SL comprises geospatial databases for decision making and management in an event of natural hazards, envisages a system to capture the data in a near real-time manner and automates the generation of reports, alerts and early warnings to various stakeholders and end user communities by:

- Generating auto-mode customised alerts, early warnings, advisories based on the high density and high resolution near real-time data collected from telemetric systems and semi-auto mode.
- Issuing timely auto alerts, early warnings and advisories related to natural disasters to government bodies and communities via SMS, help desk, email, social media and web portals.
- Ensuring data integrity for delayed/no response and build an interactive system to conveniently manage SLMD stations, perform analysis, search, compare current and forecasted data
- Viewing weather information (temperature, humidity, wind speed and direction, etc.) and forecast data for weather and rainfall for periodical reports, e.g. actual rainfall vs. weighted average rainfall information and sending alerts if advised.
- Integrating historical data with data from installed meteorological and weather stations.

Figure 8-1: Overview of the CIDMEWS-SL Architecture



8.1.4 Integration of Automatic Weather Stations

The CIDMEWS-SL is used as an early warning system that is based on networks of real-time AWS installed on existing mobile telecommunication towers and equipped with total lightning sensors. In-situ observation data from the AWS system is integrated into cloud-based data repositories as well as nowcasting and numerical weather prediction (NWP) systems. This solution provides easy access for the SLMD to surface observation and forecast data for historical analysis as well as for real-time, current weather conditions.

If all the stations are operating with uninterrupted electrical power and Internet communications, the AWS network can provide a cloud-to-ground lightning detection efficiency of over 95 percent for the high resolution area. It also provides intra-cloud detection efficiency of over 60 to 70 percent in the region, which enables key information on storm development and behaviour. When working at maximum capacity, the system provides detailed total lightning data for storm cell identification and tracking in the region and serves as a tool for the monitoring of storm intensity, positioning and movement. Lightning location accuracy is 200 to 300 metres within the region.

This information is then processed through the cloud computing infrastructure to create an integrated early warning solution. All the data points and layers are visually presented in a specialized display environment, which is utilized by the NHMS to aid in the issuance of early warnings. Select SLMD staff have received trainings from Earth Networks on applying the new technology, and the Project aims to continue training to ensure both meteorologists and field technicians are functionally prepared to use the information generated by the system. This modality has introduced and aims to sustain total situational awareness across this broad region with real-time tracking and automatic alerting of impending hazards. It means that timely, localized decisions on the issuance of early warnings can be made now, without the need to install expensive, hard-to-maintain weather radar systems across the region.

8.1.5 Mobile Technology

The role of mobile technology and mobile phones in improving early warning and emergency response has greatly expanded due to adoption of 3G, social networking, video, voice over internet protocol (VoIP) which has led to massive growth in communication and improved channels of communication. The expansion of bandwidth, especially 3G and Wifi networks across various parts of Sierra Leone has provided users of mobile phones and mobile devices with value added services.

Use of smartphones has greatly improved due to reduced cost impacted by android technology which has allowed such devices to have improved capability in providing location using GPS, quick internet access and in some mobile devices pre-disaster warning. The users of mobile devices have the ability to receive updates about the early warning or disaster in question and are likely to spread the information to their neighbours, relatives and friends through messages on various platforms. Through Wi-Fi and Web 2.0, various users can connect in public places which can be useful in getting updates about issue. This can be feasible by installing mobile wireless masts at public centres.

The current advancement in computation technology has led to proliferation of mobile smart phones, tablets, laptops and androids which are used for communication. Such devices are valuable in disseminating information about unfolding events about a given disaster suitable for disaster communication because of the following:

- Small size allows portability and can be used in the field without any weight burden on the user due to their light weight.
- Mobile devices are chargeable which makes them suitable for use in areas without power supply for several hours.
- Multifunctional capability of mobile phones allows delivering multiple types of information such as messages, emails, data and calls to other remote users.
- Customized web applications on mobile platforms make it easier to enter information on mobile devices on various application shortcuts such as Facebook, twitter, without necessary launching various browsers.

The current mobile devices have geo-tagging and geocoding capabilities. Therefore, information gathered from mobile devices is very rich because audio, video, pictorial from mobile devices can be transmitted with geo-location codes. The open access communication in disaster management promotes inflow of information from the general public and other private entities on unfolding important updates. Recent development in technologies has shown that mobile technologies can be used to deliver disaster management information and hydro-meteorological forecasts and warnings, and climate information to customers, partners, and the public in graphic and digital formats. When there are no warnings, the consequences of unfolding disaster can very tragic and costly. Warnings are very effective in predictable disasters like flooding. However, unpredictable disasters like wildfires, and manmade disasters, will only benefit from effective disaster reporting through mobile technology to get information from survivors.

The CIDMEWS-SL comprises tools to allow users to report information about unfolding disaster using mobile devices and Internet/Web based enabled devices. It makes it easier to plot disaster location on Web map without necessarily having mapping skills. The reported information becomes readily available to both survivors and disaster management personnel so that they can make well informed decisions about unfolding events of a given disaster that is being reported. The CIDMEWS-SL platform also allows collection of data through crowdsourcing with the use of mobile and Internet/Web enabled device applications. This information gathering and sharing can be effectively achieved through voluntary data collection by use of mobile devices and social media which currently dominate the revolution of Web 2.0 and growth in Internet use.

8.1.6 Crowdsourcing

Crowdsourcing is seen a major breakthrough in information sharing and data collection through techniques known as voluntary geographic information. The CIDMEWS-SL allows interactive information sharing through three major information blocks i.e. submit reports, get alerts and view reports. The CIDMEWS-SL platform creates a new era of disaster communication through use of mobile technologies. The role of the user of the CIDMEWS-SL platform is reduced to interaction with the interface; since no computation knowledge or mapping skills are required. Instead, a customized interface with clear instruction on how to report information is provided. Summarization algorithms for crowdsourced climatological, hydro-meteorological, disaster management and early warning information and data has been incorporated with spatial and geo-analytical statistical summaries.

In the design and development of the CIDMEWS-SL, attention was paid to climatological, hydro-meteorological and disaster reporting, especially information dissemination with geo-location on Web maps through the developed application to report disasters without GPS-enabled phones (provided they have internet). The users of CIDMEWS-SL are able to only zoom to the location of the disaster, mark it and report it with possibility of uploading video and picture of the type of disaster which unfolds. This approach is elaborated to exclude the role of phone operators or service providers in negotiation for information retrieval which can be frustrating to access in most cases, since the users have to wait for long before they talk to operator. The primary role of service provider is to ensure the victims have access to network or restoring damaged communication masts and probably a request can be made to service providers to allow victims to have free GPRS/3G data.

The role of social media has been fully integrated in the CIDMEWS-SL and it allows users of CIDMEWS-SL to share information about a given disaster on their social network, which helps circulate information to a wider audience within a protracted period of time. The information can also be verified easily at no cost as people post their comments about disasters reports on the social network. Integration of the role of mobile technologies with social media in disseminating disaster information is fully incorporated into the CIDMEWS-SL paradigm and approach to disaster reporting and information dissemination. During disaster management, timely delivery of the right information to the right group of people is the primary goal. The CIDMEWS-SL provides seamless delivery of such information at no cost. This approach creates a good platform for information sharing without being limited to technological knowhow of geospatial skills.

8.1.7 Service-Oriented Architecture (SOA)

CIDMEWS-SL involves the integration of a broad spectrum of free and open source software (FOSS) and proprietary software and hardware technologies, including database servers, Web servers, map servers, desktop and server GIS software, Web services, storage area networks, etc. - all connected by Local Area Network (LAN)/Wide Area Network (WAN) communications that integrate with existing and legacy applications to support a balanced MIS/GIS environment. Thus, a Service-Oriented Architecture (SOA)[22] technical approach has been successfully employed in delivering the CIDMEWS-SL. Building a CIDMEWS-SL that leverages SOA to author, publish and serve intelligent data and maps empowers the SLMD to utilize best-of-breed components in delivering the right data, information and services to the right beneficiaries at the right time in the right place in a robust, scalable and efficient manner. The SOA approach improves business interoperability and integration - CIDMEWS-SL has been integrated at a service level reducing requirements for data level integration and enabling agility. Furthermore, the CIDMEWS-SL has been increasingly delivered as a composition of reused services allowing faster adaptation to new business requirements.

The SOA approach includes multiple access layers connecting the SLMD, ONS, EPA-SL and MWR with various stakeholders, based on client/software technology and service communication tiers. With desktop (ArcGIS for Desktop) and enterprise server-based GIS (ArcGIS Enterprise) and database management solutions (PostgreSQL and MS SQL Server), the SLMD and partners can now integrate mapping into their existing workflows and solve the challenges of providing Web and mobile access to MIS/GIS-based data and information and mapping services.

The CIDMEWS-SL is based on the integration of both open-source and proprietary software - ESRI ArcGIS Enterprise 10.5 (ArcGIS Server, Portal for ArcGIS and GeoEvent Server), ESRI ArcGIS for Desktop 10.5, and PostgreSQL/PostGIS 9.5 and Microsoft SQL Server 2014 Database Management Systems (DBMS), Joomla 3.3 Content Management System (CMS) and/or Microsoft Internet Information Services (IIS)/Apache Tomcat, employing a multi-tier server configuration. The backbone of the CIDMEWS-SL is a cabled and wireless LAN/WAN interconnected via the Transmission Control Protocol (TCP)/Internet Protocol (IP). The foundation of the CIDMEWS-SL's physical infrastructure and data storage architecture is a Cloud-based dedicated server (Windows Server 2012 R2) and storage device that has the capacity to store nine terabytes of data, utilize a RAID system and intelligent backup mechanisms.

In addition, various interactive maps and data are available from the CIDMEWS-SL Website through various web browsers (e.g., IE, Safari, Chrome, FireFox, etc.). Compressed files of data, maps, and metadata are available by direct download from data catalogue and atlas/map gallery pages on the CIDMEWS-SL Website, which also provides a gateway to interactive map services built with ESRI ArcGIS API for JavaScript, HTML, and CSS. Basic and advance map and geo-processing services allow visualization of pre-packaged sets of data layers (vector and raster) and metadata. Users are able to zoom and pan maps, turn on and off layers, and query the attribute tables associated with the data and metadata. The CIDMEWS-SL Website also provides feature-streaming capabilities, in which data will be downloaded and/or streamed to the client machine to allow advanced GIS and MIS functionality, including data import/export capabilities, direct download of public-access data and maps, and interactive visualization of related spatial, non-spatial data, data management and hydrometeorological data and information.

8.1.8 Infrastructure as a Service (IaaS) - Dedicated Cloud Server

The Project procured (on a 3-years per-use basis) Infrastructure as a Service (IaaS) - Dedicated Server, from a reliable UK-based Internet Service Provider (ISP) that securely hosts the CIDMEWS-SL hardware, software, servers, storage and other infrastructure components. This pay-as-you-go model eliminates the capital expense of deploying in-house hardware and software at the SLMD premises.

The IaaS is hosted in the Cloud by a UK-based ISP, Fasthosts UK (www.fasthost.co.uk) - a provider of Internet access and Web hosting services that provides all the hardware and peripherals needed to reliably run the CIDMEWS-SL 24/7. Extensive environmental controls are employed by the ISP to make sure the IaaS works to its full potential and delivers high performance day-in, day-out. The ISP ensures

[22] Services-oriented architecture (SOA) is an approach for building distributed computing systems, based on encapsulating business functions as services which can be easily accessed in a loosely coupled fashion. The core components supporting a service-oriented architecture (SOA) are: Service Providers - developers provide component services available for consumption over the web; Service Consumers - Web applications are developed from the available component services; and Service Directory - connects web applications with available component services. Common web protocols and network connectivity are essential to support this type of architecture.

the very highest levels of uptime and security, with the power to cope with surges in demand, plus unexpected power or network outages.

The IaaS model also offers highly scalable resources that can be adjusted on-demand, making the IaaS model well-suited for the CIDMEWS-SL workloads that are high, varied and demanding. The ISP also hosts the CIDMEWS-SL' applications and handle tasks, including system maintenance, backup and resiliency planning, automation of administrative tasks, dynamic scaling and policy-based services. In addition to offering powerful, easy-to-use analytical tools for the CIDMEWS-SL, the ISP fully supports the operation of the applications, data and associated resources on a Dedicated Server in the IaaS. This includes managing the hardware, software, infrastructure and technical staff required to support a sophisticated interactive CIDMEWS-SL Website and pertinent Web-based GIS and DBMS systems on a 24/7 basis.

8.1.9 Software as a Service (SaaS) - Hybrid Approach

The Project also procured Software as a Service (SaaS) through which the CIDMEWS-SL applications is hosted by the ISP and made available to the stakeholders over a network, typically the Internet. SaaS supports the CIDMEWS-SL' Web services and service-oriented architecture (SOA) and also hosts both free-open source software (FOSS) and proprietary software (using a hybrid approach); i.e., ArcGIS Enterprise (ArcGIS Server, Portal for ArcGIS and GeoEvent Server, ArcGIS Online and Google Cloud Services) over the Web.

Benefits of the SaaS model include: easier administration; automatic updates and patch management; all users will have the same version of software; easier collaboration, for the same reason; and global accessibility.

8.1.10 Cloud-based Solution for the CIDMEWS-SL

8.1.10.1 Secure, Scalable & Compliant Hosting of CIDMEWS-SL in the Cloud

INTEGEMS offers the perfect CIDMEWS-SL environment, providing hosting, support, consulting and development to the SLMD, ONS-DMD, EPA-SL and MWR. INTEGEMS provides lots of additional services that improves ease of management, stability, security and performance of the CIDMEWS-SL. In addition, INTEGEMS uses state of the art ISP providers for hosting of the managed CIDMEWS-SL instances and uses dedicated servers that are most suitable for achieving great performance and stability with CIDMEWS-SL - that means a lot of memory, multiple CPUs and fast solid-state drives.

8.1.10.2 Focus on CIDMEWS-SL, not Servers

INTEGEMS takes care of all the aspects of hosting the CIDMEWS-SL, like system upgrades, reliable backups, automatic scaling and minimal down-time. This allows the SLMD, ONS-DMD, EPA-SL and MWR to focus on what's important: disaster management, meteorological, climatic and hydrological data and information. From time to time the SLMD, ONS-DMD, EPA-SL and MWR might get stuck with technical issues. Then it's reassuring to know that they can turn to INTEGEMS support, provided by people with deep knowledge of CIDMEWS-SL. INTEGEMS helps the SLMD, ONS-DMD, EPA-SL and MWR with anything from technical problems to how to upgrade the CIDMEWS-SL.

8.1.10.3 Managed CIDMEWS-SL Hosting

INTEGEMS provide turn-key solutions leveraging Cloud computing to provide managed services for a variety of data and information software. It makes sure that disaster management, meteorological, climatic and hydrological data and information systems are reliable and that the SLMD, ONS-DMD, EPA-SL and MWR can focus on their core businesses. With critical systems the SLMD, ONS-DMD, EPA-SL and MWR might want to have complete control over their networking environment, including the possibility to set up their own IP ranges, keep databases in a private-facing subnet and connect to their server over a Virtual Private Network (VPN).

INTEGEMS delivers CIDMEWS-SL as a service which lets the Project start small and cheap and scale up when they need it - they pay only for what they need. It keeps data and information resources safe and secure through measures such as intrusion detection and encryption, giving them one less thing to worry about.

8.1.10.4 Software and App Development

INTEGEMS has software developers with deep insight and core development experience in CIDMEWS-SL and other climate and hydrometeorological information software. It builds customized extensions and apps in order to support the SLMD, ONS-DMD, EPA-SL and MWR specialized information requirements and needs. INTEGEMS experienced software developers aso develop custom apps for special requirements based on client-side technologies such as Javascript, CSS and HTML5, including mobile-first Apps which scale well down to smartphones and tablets.

8.1.10.5 System Design and Data Modelling

Implementing a large information system like the CIDMEWS-SL is a challenging and complex perspective, as it involves planning, infrastructure, software customization, system configuration, training and more. INTEGEMS has worked on numerous large system implementations and know what it takes to make it a success. It helps the SLMD, ONS-DMD, EPA-SL and MWR with all aspects of the implementation, from advisory to hands-on, on-site work and with design of routine, aggregate systems to projects involving case-based data collected with mobile phones.

8.1.10.6 System Integration and Interoperability

Making new information systems play well with auxiliary and legacy systems is often critical. INTEGEMS also assists the SLMD, ONS-DMD, EPA-SL and MWR with systems integration in terms of data modelling and mapping, transformation and loading.

8.1.10.7 Reliable Backup of Database and Application and Uptime and Support

INTEGEMS hosting plans come with 24/7 monitoring and support, meaning that if CIDMEWS-SL instance goes down or there is a problem, it is there to help. Its backup service makes sure that data is always backed up in a secure place - both on the SLMD, ONS-DMD, EPA-SL and MWR client’s server for easy access as well as on a server located physically somewhere else in case something goes wrong.

8.1.10.8 SSL (Encryption) Setup

In today's Internet environment setting up SSL (as in HTTPS and encryption) is an absolute must for applications like CIDMEWS-SL which requires users to log in with a username and password. The SSL service provides the SLMD, ONS-DMD, EPA-SL and MWR client’s server with a trusted SSL certificate which will keep the private information of users secure.

8.1.10.9 Email Configuration

CIDMEWS-SL features its own messaging functionality where all messages can be delivered to the user's email inbox, too. The email service gives users access to CIDMEWS-SL’ email servers, and INTEGEMS will set up and configure email settings for the SLMD, ONS-DMD, EPA-SL and MWR client’s CIDMEWS-SL instances.

8.1.10.10 Application and Resource Monitoring

Monitoring resource utilization, application performance and operational health is essential for keeping CIDMEWS-SL system running smoothly. The monitoring feature delivers a highly detailed and reliable monitoring solution.

8.1.10.11 Real-time Data Aggregation

CIDMEWS-SL performs data aggregation once every day. The real-time data aggregation service makes data available for reports only minutes after data arrives in the system.

8.1.10.12 Replication for High Availability

INTEGEMS set up CIDMEWS-SL instance with web-server replication, meaning that if one server goes down, the SLMD, ONS-DMD, EPA-SL and MWR client’s instance is still available. It also means that it can add new servers to increase capacity during periods where demand is high.

8.1.10.13 Training

INTEGEMS will equip the SLMD, ONS-DMD, EPA-SL and MWR trainees with an understanding of the various data visualization techniques, analysis concepts, and dashboard creations in CIDMEWS-SL.

8.1.10.14 Help Desk

When operating a sophisticated software like CIDMEWS-SL it is comforting to know clients can rely on INTEGEMS to help them if they get stuck. The help desk service provides assistance on technical matters related to server and CIDMEWS-SL instance.

8.1.11 ESRI ArcGIS Technology for CIDMEWS-SL

The use of ESRI ArcGIS technology, specifically ArcGIS Enterprise/ArcGIS Online for Organisations and ArcGIS for Desktop, is key as the GIS foundation for the CIDMEWS-SL since it is designed as a system to work within an integrated SOA environment, which works together to cost-effectively satisfy the requirements of the CIDMEWS-SL.

8.1.11.1 ESRI's ArcGIS Online

ESRI's ArcGIS Online for Organisations is a Cloud-based GIS Solution that provides a robust platform for sharing CIDMEWS-SL data and information with users both inside and outside of the SLMD. ArcGIS Online allows the SLMD, ONS-DMD, EPA-SL and MWR to share data, maps, tools and applications via the Web using ArcGIS Online hosted solutions.

8.1.11.2 ArcGIS for Enterprise

The Project procured an ArcGIS Enterprise 10.5 Licence (Advanced Enterprise), which is a comprehensive Web-based GIS that can provide out-of-the-box end user applications and services for mapping, analysis, data collection/editing, distribution and management of CIDMEWS-SL data and spatial information. It provides a standards-based platform upon which the SLMD and partners can easily publish and serve their data, information and knowledge to a broader audience and stakeholders. ArcGIS Enterprise also provides a map-centric content management system that helps access, search, and discover GIS assets, including project resources. It includes an integrated map viewer, mapmaking tools, and application templates to quickly and easily create and deploy Web applications.

ArcGIS Enterprise and its extensions expose the complete range of ArcGIS functionality to the rest of the partners, who can create and manage Web services for mapping, geocoding, GIS analysis, Web editing, network analysis, database access and climate and hydrometeorological data management. ArcGIS Enterprise works with spatial data stored in multiuser relational database management systems such as PostgreSQL/PostGIS. ArcGIS Enterprise fits the CIDMEWS-SL infrastructure and security requirements and has been deployed in the Cloud and ArcGIS Online has been added to the deployment. ArcGIS Enterprise includes a range of client apps that do everything from providing a dashboard summarizing critical business information to bringing maps into mainstream business intelligence software and helping field crews collect data. Client apps include Operations Dashboard for ArcGIS; ESRI Maps for Office; Collector for ArcGIS and Explorer for ArcGIS.

8.1.11.3 ESRI GeoEvent Server

ArcGIS GeoEvent Server is a capability of ArcGIS Enterprise. It extends the capabilities of ArcGIS for Server, enabling real-time event-based data (weather, early warning, etc.) streams to be integrated as data sources in enterprise GIS. Event data such as the automatic weather information are filtered, processed, and sent to multiple destinations, allowing the SLMD and partners to connect with virtually any type of streaming data and automatically alert personnel when specified conditions occur, all in real-time. The GeoEvent Server consumes weather data from multiple real-time data streams. Filters and processors enable CIDMEWS-SL to discover and focus on the most interesting events, locations, and thresholds for their operations.

With the GeoEvent Server, CIDMEWS-SL:

- Streams (push) CIDMEWS-SL event data to client applications via WebSockets.

- Directs CIDMEWS-SL event data into feature services hosted on ArcGIS Online, Portal for ArcGIS, or ArcGIS for Server so that maps created represent the most up-to-date information occurring in the real world.
- Views the latest feature status using any ArcGIS Viewer (for example, Operations Dashboard for ArcGIS).
- Filters GeoEvents using spatial or attribute conditions to focus on the most interesting event data.
- GeoFences areas of interest using existing feature data to detect the spatial proximity of events.
- Archives CIDMEWS-SL event data within feature services or tables.
- Enriches incoming events with data from a secondary feature service or system file.

8.1.11.4 ArcGIS for Desktop

The Project procured ArcGIS for Desktop licences (Advanced, Single User/Concurrent), which is used with climate and hydrometeorological data and geographic information of all kinds to display or manipulate tiles and features from almost any source across a variety of devices, including mobile.

- Overlays multiple standards-compliant map layers into a single application.
- Displays tiles and features from a variety of sources, including OGC tile standards, Google Maps, Bing Maps, OpenStreetMap, ArcGIS Server, and more.
- Supports vector feature for OGC WFS, KML, GeoJSON, GML, and more.
- Allows Web-based editing, including feature snapping and splitting, via OGC WFS-Transactional.
- Provides support for many cartographic projections and client-side map reprojection.

ArcGIS for Desktop and ArcGIS Enterprise deliver fully integrated sets of GIS functionality and provide technology for publishing GIS services that can be consumed by ArcGIS for Desktop, mobile GIS and standard Web browsers. Both ArcGIS Enterprise and ArcGIS Online offer application programming interfaces (API) for Web application development on JavaScript, Adobe Flex and Microsoft Silverlight platforms, including Web applications using Simple Object Access Protocol (SOAP), Representational State Transfer (REST) and Open Geospatial Consortium (OGC) Web service APIs.

The Project gains numerous advantages from adopting an ESRI-centric SOA approach to the development and implementation of the CIDMEWS-SL, including the following:

- Uses distributed geodatabase management tools and services to support remote user access to centrally managed CIDMEWS-SL resources and provide better protection and sharing of data.
- Migrates standalone hydrometeorological data from “silo” and file-based environments, especially Microsoft Excel, to a common central geodatabase (i.e., PostgreSQL/PostGIS), allowing the SLMD to support the efficient management of data backups, operating system upgrades and so forth.
- Allows CIDMEWS-SL users (within and outside the SLMD) to enjoy mobile and Web browser access to published CIEW data and services over the Intranet/Internet. Expand SLMD operations to incorporate mobile users as an integral part of its workflow with improved availability and capacity of wireless technology to support field staff.
- Uses Web technology to introduce innovative ways to share CIEW data and services, along with interoperability standards that provide open and adaptive solutions.

8.1.12 CIDMEWS-SL Data Management

The following CIDMEWS-SL datasets are managed in various spatially-enabled databases:

- Hazard assessment mapping
- Vulnerability assessment
- Socio-demographic distribution
- Infrastructure, lifelines and critical facilities
- Logistics and transportation routes
- Human and material response resources
- Communication facilities
- Environmental, natural resources
- Meteorological
- Hydrological, topographical and geological

8.1.12.1 PostgreSQL/PostGIS

PostgreSQL/PostGIS is an open source database management system (DBMS) software that stores and queries for information about location and mapping and provides spatial objects. It also adds functions, operators, and index enhancements to these spatial types that augment the power of the core PostgreSQL DBMS, making it a fast, feature-rich, and robust spatial database management system. PostgreSQL/PostGIS is used for creating and sharing the CIDMEWS-SL' spatial and non-spatial data and information. Powerful features, broad platform support, and an easy-to-use interface make PostgreSQL/PostGIS indispensable for the CIDMEWS-SL, especially for effortlessly managing CIEW data and information on mobile devices and the Web. A benefit of storing CIEW data in PostgreSQL/PostGIS is sharing the data with other users on a network, or import or export data from another file. In addition, the CIDMEWS-SL users can employ ODBC (Open Database Connectivity) and JDBC (Java Database Connectivity) to share files with ODBC- and JDBC-compliant applications, or the CIDMEW files can be accessed from external data sources.

8.1.12.2 ESRI ArcSDE Geodatabase

An ESRI ArcSDE Geodatabase (implemented in PostgreSQL/PostGIS) that utilizes a multitier architecture was adopted to store, manage, access and distribute CIDMEWS-SL data, information and maps and services and to make use of advanced GIS logic and behaviour in the application tier (e.g., ArcGIS for Server). The responsibility for managing CIEW data in the multiuser geodatabase is shared between ArcGIS Enterprise and PostgreSQL/PostGIS (running an ESRI ArcSDE service). CIDMEWS-SL data management solutions is provided to support data file, geodatabase, and Extensible Markup Language (XML) and JSON/GeoJSON based formats. ArcSDE Geodatabase is leveraged to make full use of the capabilities of ArcGIS for Desktop and ArcGIS Enterprise to allow the storage of disaster management, meteorological, climatic and hydrological data and early warning information in a central location for easy access and management.

Implementing ArcSDE geodatabases (in PostgreSQL/PostGIS RDBMS) brings the following benefits to CIDMEWS-SL data and information management:

- Flexibility to store CIDMEWS-SL data in a supported RDBMS like PostgreSQL/PostGIS.
- Ability to apply existing IT knowledge and experience to manage the environment through common DBMS practices.
- Spatial types to enhance data storage and interoperability.
- Provide a central, scalable data storage and management system.
- Utilize additional functionality that is not available in single-user geodatabases.

- Provide better data security (such as access permission control for individual datasets) and maintain data integrity with features such as data backup, recovery, rollback and failover.
- Provide a spatial index that supports spatial queries, functions, and predicates. Is a seamless component of data and information.
- Provide the flexibility to issue SQL-level spatial queries that support spatial types.

8.1.12.3 Google Drive

Google Drive, a file storage and synchronization service is also used to store CIDMEWS-SL data and information in the Cloud, share files and edit documents and spreadsheets with CIDMEWS-SL users.

8.1.13 CIDMEWS-SL Web Hosting and Management

An ISP provides Managed Services for deploying the CIDMEWS-SL Website, which includes providing external HTTP/HTTPS access to the CIDMEWS-SL Website, operational hosting and monitoring, and troubleshooting technical support incidents through Hosted Environment Support. The ISP has set up the base components comprising the underlying Hosting Environment infrastructure, including the relevant hardware, power, facilities and network infrastructure to enable external HTTP/HTTP access to the CIDMEWS-SL Website.

To facilitate unified public access to the CIDMEWS-SL data and data services, a combination of Joomla Content Management System (CMS) and Rich Internet Web Application (using ArcGIS API for JavaScript) technologies was developed and deployed within the IaaS (Dedicated Server). The interactive CIDMEWS-SL Website allows the SLMD/ONS to expose meteorological data and geospatial services from the server and stream the results to remote clients through a single consumer access point. The CIDMEWS-SL Website expedites the discovery, transfer, and utilization of CIDMEWS-SL data and information by the SLMD/ONS and various stakeholders.

8.2 CIDMEWS-SL Mapping Application

The **CIDMEWS-SL Mapping Application** (accessed via **https://cidmews-sl.solutions**) is a Geographic Information Systems (GIS) Web mapping application that provides easy and convenient ways to collect, map, explore, query, analyze and freely share available climate information, disaster management and early warning data and information resources from any device, anywhere, at any time.

Figure 8-2: User Interface of the CIDMEWS-SL Mapping Application on a Desktop

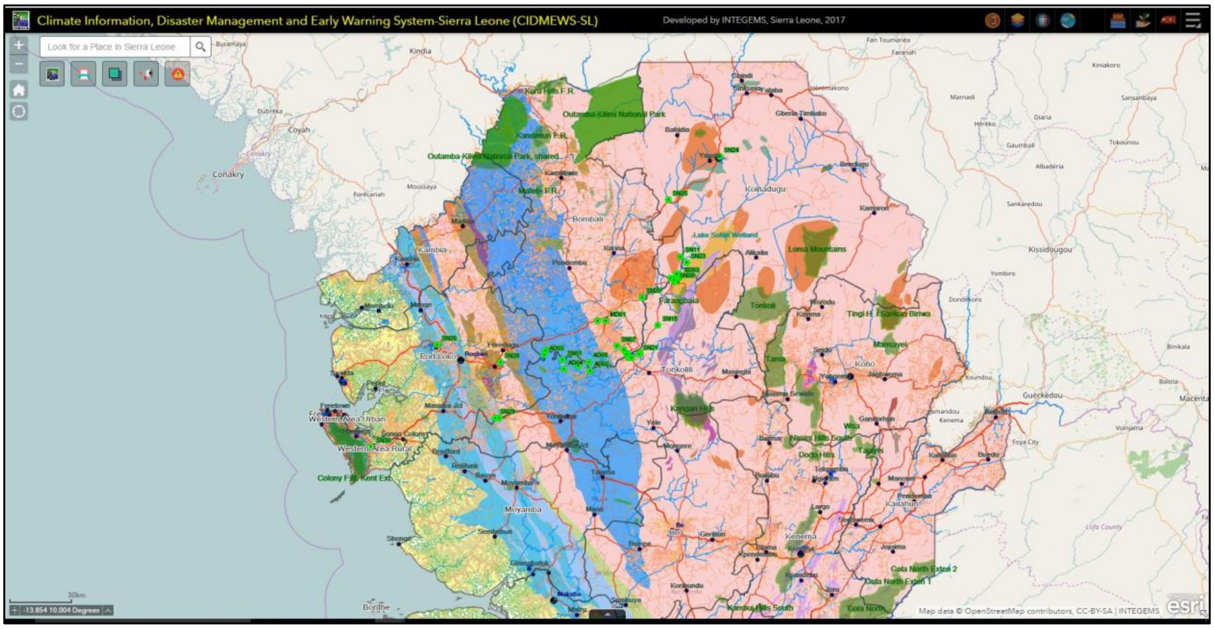


Figure 8-3: User Interface of the CIDMEWS-SL Mapping Application on an iPad

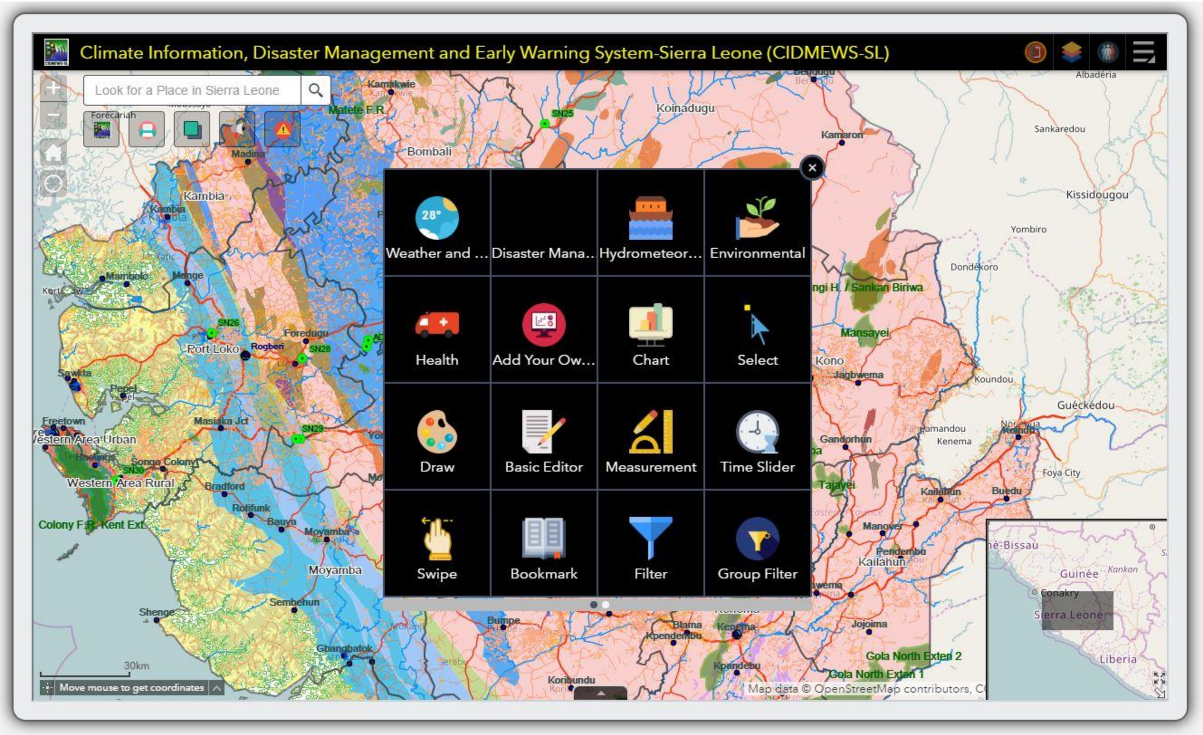


Figure 8-4: User Interface of the CIDMEWS-SL Mapping Application on a Samsung Galaxy Phone

A primary goal of the CIDMEWS-SL is to allow people who are not GIS professionals to do self-service mapping on any device (i.e., desktop, tablets and smartphones using Internet browsers) and expand the creative use and sharing of climate information, disaster management and early warning data and information resources about Sierra Leone.

It is hoped that by using the CIDMEWS-SL from any device, anywhere and at any time will encourage collaboration and information sharing, and promote efficiency and effectiveness in providing individuals and organisations with timely and accurate climate information, disaster management and early warning data and information resources for better and more informed decision making in preparedness and planning, mitigation, response and recovery.

The CIDMEWS' easy-to-use widgets and tools can be interactively used to easily accomplish various spatial analysis and mapping tasks using relevant socio-demographic datasets (Sierra Leone Housing and Population Census 2015) and the following geospatial data layers for Sierra Leone:

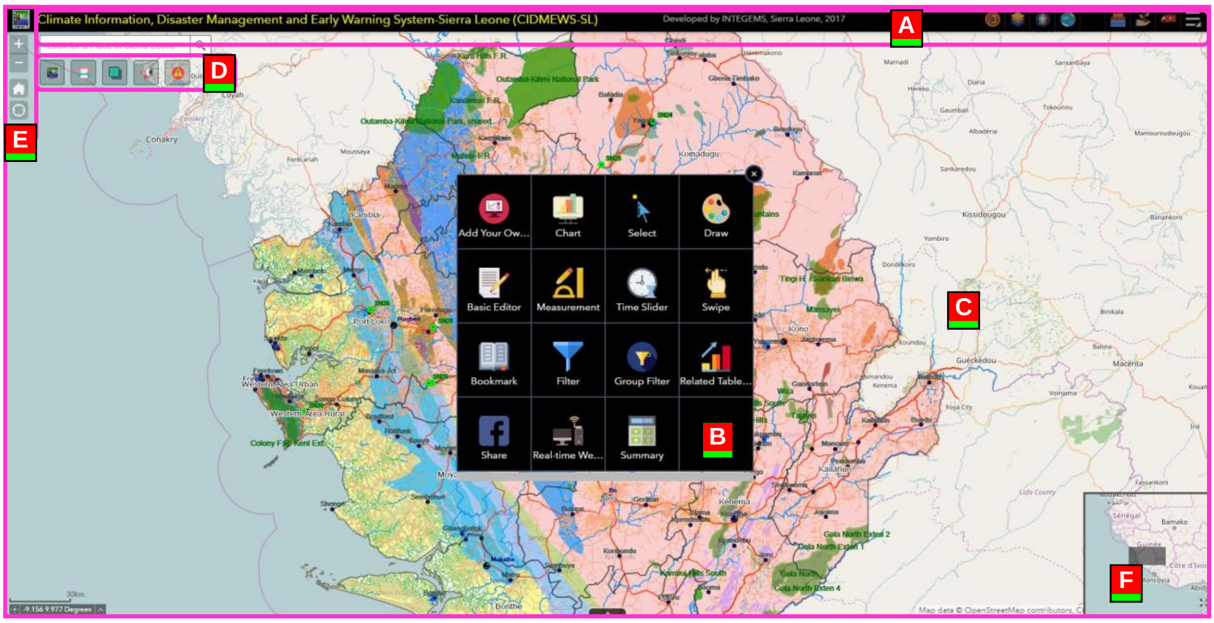
CIDMEWS' easy-to-use widgets and tools can be interactively used to accomplish various meaningful queries, spatial analysis and mapping tasks using relevant socio-demographic data and the following geospatial data layers for Sierra Leone:

- **Sierra Leone Housing and Population Census 2015** – Districts and Chiefdom level demographics (Source: Statistics Sierra Leone, 2016)
- **Health facilities** - clinics, hospitals and health centres (Source: MoHS, 2015)
- **Educational facilities** – primary, secondary and tertiary institutions (Source: UNICEF, 2014)
- **Police stations,** police schools and prisons (Source: UNMEER, 2015)
- **Road networks** – Tertiary, primary and secondary roads, including residential streets in urban areas (Source: OSM, 2016)
- **Hydrology** – major rivers and tributaries and streams (Source: OSM, 2016)
- **Sierra Leone Water Security Project** - borehole water monitoring in the Rokel-Seli River Basin (Source: MWR, 2016)
- **Provinces** – First-tier administrative boundaries in Sierra Leone (Source: Statistics Sierra Leone, 2015; OSM 2015)
- **Districts** - Second-tier administrative boundaries in Sierra Leone (Source: Statistics Sierra Leone, 2015; OSM 2015)
- **Chiefdoms** - Third-tier administrative boundaries in Sierra Leone (Source: Statistics Sierra Leone, 2015; OSM 2015)
- **Sections** - Fourth-tier administrative boundaries in Sierra Leone (Source: Statistics Sierra Leone, 2015; OSM 2015)
- **Local Council Wards** - local administrative boundaries in Sierra Leone (Source: Statistics Sierra Leone, 2016)
- **Settlements** – cities, towns and villages in Sierra Leone (Source: OSM 2016)
- **Places of worship** – churches and mosques (Source: UNICEF, 2014)
- **Soils** - soils type and spatial distribution in Sierra Leone (Source: FAO, 2004)
- **Geology** - geological formations and distribution in Sierra Leone (Source: National Minerals Agency, Sierra Leone, 2014)
- **Environmental Management** - Mangroves, protected areas and wetlands/swamps (Source: Ministry of Lands, Country Planning and Environment, 2012)
- **Building footprints** - detailed building footprints of structures (Source: OSM, 2016)
- **Topographic contours (10m and 20m)** - detailed topolines from ASTER GDEM (Source: INTEGEMS, 2014)

- **Bumbuna Watershed** – Dam, Reservoir, Settlements (Source: INTEGEMS/BWMA, 2016)
- **Guma Valley and Dodo Dam** – Catchment and settlements (Source: INTEGEMS/BWMA, 2016)
- **Earth Networks Automatic Weather Stations** – real-time meteorological information from 8 weather stations (Source: Earth Networks, 2016)
- **Disaster Prone Areas (Western Area)** - Disaster prone areas and locations within the Western Area (Source: ONS-DMD and INTEGEMS, 2017)

8.2.1 CIDMEWS-SL Mapping Application User Interface

Figure 8-5: User Interface of the CIDMEWS-SL Mapping Application with Key Tools and Widgets



Top Bar (A) - The top bar includes preconfigured set of widgets (**B**) that give CIDMEWS-SL functionality, such as Layer List, Legend, Demographics and Socio-economics, Climate Information and Meteorological, Disaster Management, Hydrological, Environmental and Add Your Own Data.

Map Display (C) - The map display shows the current map. The Search, About CIDMEWS, Print, Basemap, Incident Analysis and Situation Awareness widgets (**D**) are located immediately below the top bar in the upper left corner of the map display. The map display changes as the user navigates around the map, displays additional layers, and shows the results of various widget/tools requests.

Navigation Buttons and Zoom Slider Bar (E) - The map display also includes several navigation tools along its left hand side, including a Home, Current Location and Zoom In and Zoom buttons.

Overview Map (F) - widget adds an overview map to the application. It shows the current spatial extent of the map display as a grey rectangle relative to the entire spatial extent of the base map service. This widget is located in the lower right corner of the application. It can be easily maximized or minimized by clicking the expand arrow.

Figure 8-6: CIDMEWS-SL User Interface Showing the Incident Analysis Widget

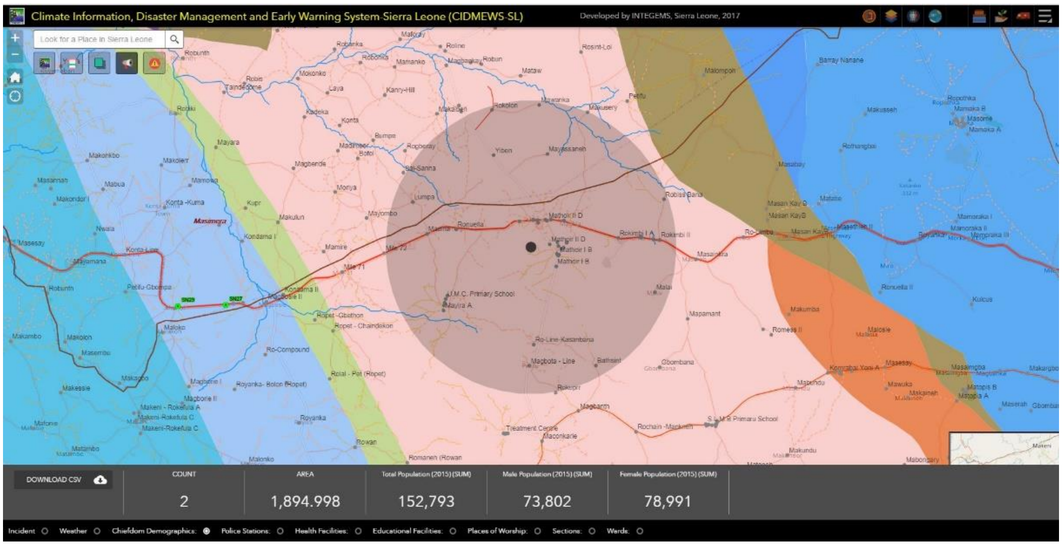


Figure 8-7: CIDMEWS-SL Mapping Application Showing Widgets and Tools

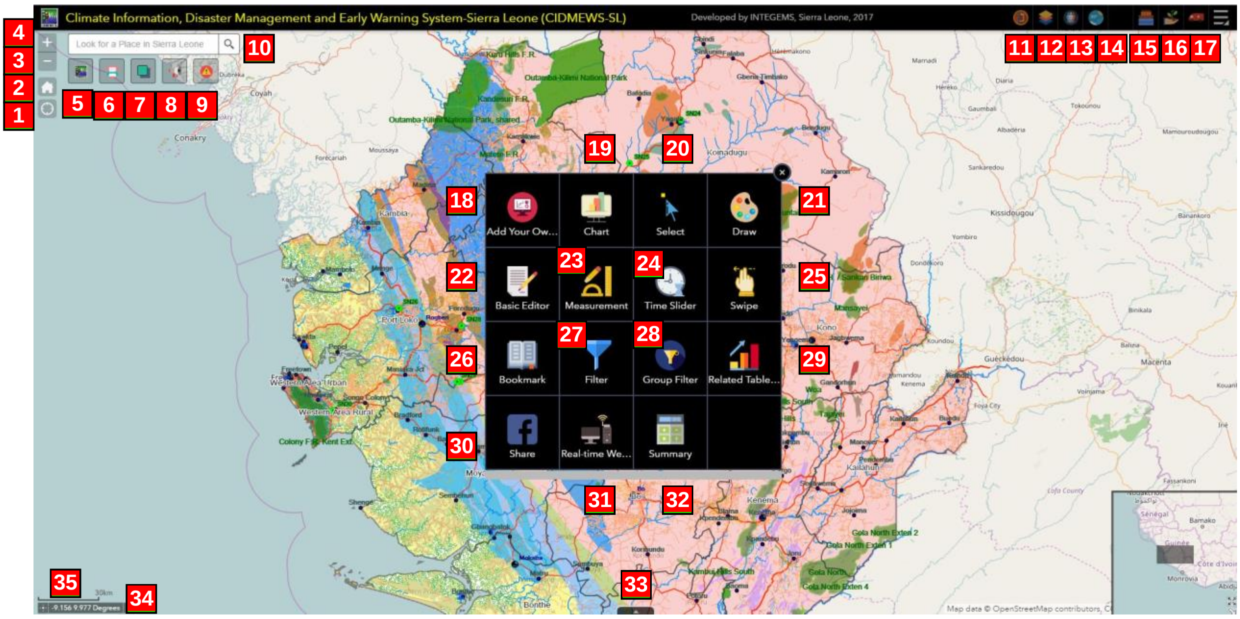


Table 8:1 List of CIDMEWS-SL Functionality Widgets

ID	CIDMEWS-SL Functionality Widget	ID	CIDMEWS-SL Functionality Widget
1	My Location	19	Chart
2	Home Button	20	Select
3	Zoom Out Button	21	Draw
4	Zoom In Button	22	Basic Editor
5	CIDMEWS-SL Disclaimer	23	Measurement
6	Print a Map Yourself	24	Time Slider
7	Basemap Gallery	25	Swipe
8	Incident Analysis	26	Bookmark

ID	CIDMEWS-SL Functionality Widget	ID	CIDMEWS-SL Functionality Widget
9	Situation Awareness	27	Filter
10	Search	28	Group Filter
11	Map Layer List	29	Related Table Charts
12	Map Legend	30	Share
13	Socio-Demographics	31	Real-time Weather
14	Weather and Climate	32	Summary
15	Hydrometeorology	33	Attribute Table
16	Environmental	34	Coordinate
17	Health	35	Scale Bar
18	Add Your Own Data		

1.1.2 Overview of the CIDMEWS-SL Widgets

1.1.2.1 My Location

The **My Location** widget (1) allows the network to detect a user's physical location and zooms the map to it. The location can be highlighted if necessary. The widget takes advantage of HTML geo-location. When the app runs on desktops, it uses the browser on the network to detect the location. When the app runs on mobile devices, by default, it uses GPS on the device to determine a location.

1.1.2.2 Home Button

The **Home Button** widget (2) zooms the map to the initial map extent. Clicking it resets the map extent to the map initial extent.

1.1.2.3 Zoom Out

The **Zoom Out** widget (3) zooms out on the map, using the centre as its focus. The Minus (-) zooms out.

1.1.2.4 Zoom In

The **Zoom In** widget (4) zooms in on the map, using the centre as its focus. The Plus (+) zooms in.

1.1.2.5 CIDMEWS-SL Disclaimer

The Disclaimer (4) provides the terms and conditions of use of the CIDMEWS-SL data and information resources.

1.1.2.6 Print A Map Yourself

The Print A Map Yourself widget (6) connects the CIDMEWS-SL web application with a printing service to allow the current map to print. The Map scale/extent section defines the method that the print service should use to calculate the printed extent of the map.

1.1.2.7 Basemap Gallery

The Basemap Gallery widget (7) presents a gallery of basemaps and allows users to select one from the gallery as the CIDMEWS-SL basemap.

1.1.2.8 Incident Analysis

The Incident Analysis widget (8) allows you to locate an incident on the map and analyze information from different feature layers within a specified distance of the incident.

1.1.2.9 Situation Awareness

The Situation Awareness widget (**9**) allows you to locate an incident on the map and analyze information from different feature layers within a specified incident area.

1.1.2.10 Search

The Search widget (**10**) enables end users to find locations or search features on the map.

1.1.2.11 Map Layer List

The Layer List widget (**11**) provides a list of operational layers and their symbols, and allows users to turn individual layers on and off. Each layer in the list has a check box that allows users to easily control its visibility. Layers having expansion arrows indicate that they contain sub-layers or subtypes. The order in which layers appear in this widget corresponds to the layer order in the map. This widget provides functionality allowing you to change the order of layers in the map.

1.1.2.12 Map Legend

The Map Legend widget (**12**) displays labels and symbols for layers in the map. It supports dynamic, tiled, image, feature, KML layer types, and WMS layers with an associated legend URL. The Legend widget can be set to automatically update when the visibility of a layer or sublayer changes. When no operational layers are rendered in the map, the Legend widget is blank.

1.1.2.13 Socio-Demographics

The Socio-Demographics widget (**13**) allows users to retrieve information on the 2015 Census from source data by executing a predefined socio-demographic query such as Chiefdom total population, female population, male population and locate settlements.

1.1.2.14 Weather and Climate

The Weather and Climate widget (**14**) allows users to retrieve weather information from the automatic weather stations by executing a predefined query.

1.1.2.15 Hydrometeorology

The Hydrometeorology widget (**15**) allows users to retrieve information on the Salone Water Security Project/Ministry of Water Resources from data by executing a predefined query.

1.1.2.16 Environmental

The Environmental widget allows (**16**) users to retrieve information on protected-areas, rivers and water bodies and protected wetlands from source data by executing a predefined query.

1.1.2.17 Health

The Health widget (**17**) allows users to retrieve information on health focusing on the EVD from source data by executing a predefined query. Data sources can be one of the following

1.1.2.18 Add Your Own Data

The Add Your Own Data widget (**18**) enables end users to add data to the map by searching for layers in ArcGIS Online or Portal for ArcGIS content, entering URLs, or uploading local files, including shapefiles, CSV, GPX, and GeoJSON. In this way, end users can temporarily add layers to the map and remove them from the map. However, they cannot save them to the map.

1.1.2.19 Chart

The Chart widget (**19**) displays quantitative attributes from an operational layer as a graphical representation of data. It makes it easier for end users to observe possible patterns and trends out of raw data.

1.1.2.20 Select Widget

The Select widget (**20**) enables users to interactively select features on the map and take actions on the selected features. The selected features can be passed on to other widgets as input, such as the Geoprocessing widget, Attribute Table widget, Directions widget, and so on.

1.1.2.21 Draw Widget

The Draw widget allows (**21**) users to create graphics that display on the map. It optionally adds line distance or polygon area to the feature as text. It enables users to draw basic graphics and text onto the map. It provides basic sketching and redlining functionality for the web application. It also displays some measurements for drawn features, such as lengths for lines, and areas and/or perimeters for polygons. When the widget initially activates, a dialog box shows containing 11 feature creation tools.

1.1.2.22 Basic Editor Widget

The Basic Editor widget (**22**) provides editing capabilities using an editable layer in a feature service. It displays a gallery of templates from one or more feature layers.

1.1.2.23 Measurement Widget

The Measurement widget (**23**) allows the user to measure the area of a polygon, length of a line, or find the coordinates of a point.

1.1.2.24 Time Slider Widget

The Time Slider widget (**24**) enables users to view temporal layers in a map, and play the map to see how the data changes over time. Using this widget, users can control the animation of the data with buttons to play/pause, go to previous time period, and go to next time period.

1.1.2.25 Swipe Widget

The Swipe widget (**25**) enables users to easily compare the content of different layers in a map. It provides horizontal, vertical and spyglass view modes. Users can slide the swipe tool or move mouse around to reveal the content of another layer.

1.1.2.26 Bookmark Widget

The Bookmark widget (**26**) stores a collection of map view extents (that is, spatial bookmarks) displayed in the app. It also allows users to create and add spatial bookmarks through configuration or at run time after the app starts. In addition, if there are any existing bookmarks defined for the web map used in the app, they are used automatically.

1.1.2.27 Filter Widget

The Filter widget (**27**) allows users to limit the visibility of features in a layer. Only the features that meet the expression criteria will be visible in the map.

1.1.2.28 Group Filter Widget

The Group Filter widget (**28**) allows users to apply a filter on the map based on one or more layers in the map. A set of layers are grouped into a logical filter set. Each set can have a predefined value to facilitate user interaction. This widget has two modes: normal mode, which allows building complex filters during runtime, and simple mode, which only allows one filter criteria to be applied.

1.1.2.29 Related Table Charts Widget

The Related Table Charts (**29**) widget allows users to chart (bar, pie or polar chart) values from a related table of a feature layer. The structure of the layers requires a relationship between a feature layer and a table and must be a one-to-many geodatabase relationship.

1.1.2.30 Share Widget

The Share widget (**30**) allows users to share an app by posting it to a social media account, sending an email with a link, or embedding it in a website or blog. It also provides an easy way to define URL parameters for the app.

1.1.2.31 Real-time Weather Widget

The Real-time Weather (**31**) widget allows users to visualize and control real-time data feeds from Earth Networks automatic weather stations streaming feature layers. Since certain attributes of real-time weather layers are dynamically updated, the attribute table only displays the attributes with a snapshot of stream layers when it opens.

1.1.2.32 Summary

The Summary widget (**32**) allows users to summarize numeric attributes from a feature layer in the current map that fall within the visible map extent. The Summary widget supports feature layers.

1.1.2.33 Attribute Table Widget

The Attribute Table widget (**33**) displays a tabular view of operational layers' attributes. It displays at the bottom of the CIDMEWS-SL web application and can be opened, resized, or closed. When more than one layer's attributes display, multiple tabs automatically generate in the attribute panel allowing users to switch among the attribute tables.

1.1.2.34 Coordinate Widget

The Coordinate widget (**34**) displays x and y coordinate values on the map. With the default coordinate system of the CIDMEWS-SL web map, the coordinate values change dynamically when the mouse pointer moves to different locations on the map.

1.1.2.35 Scale Bar Widget

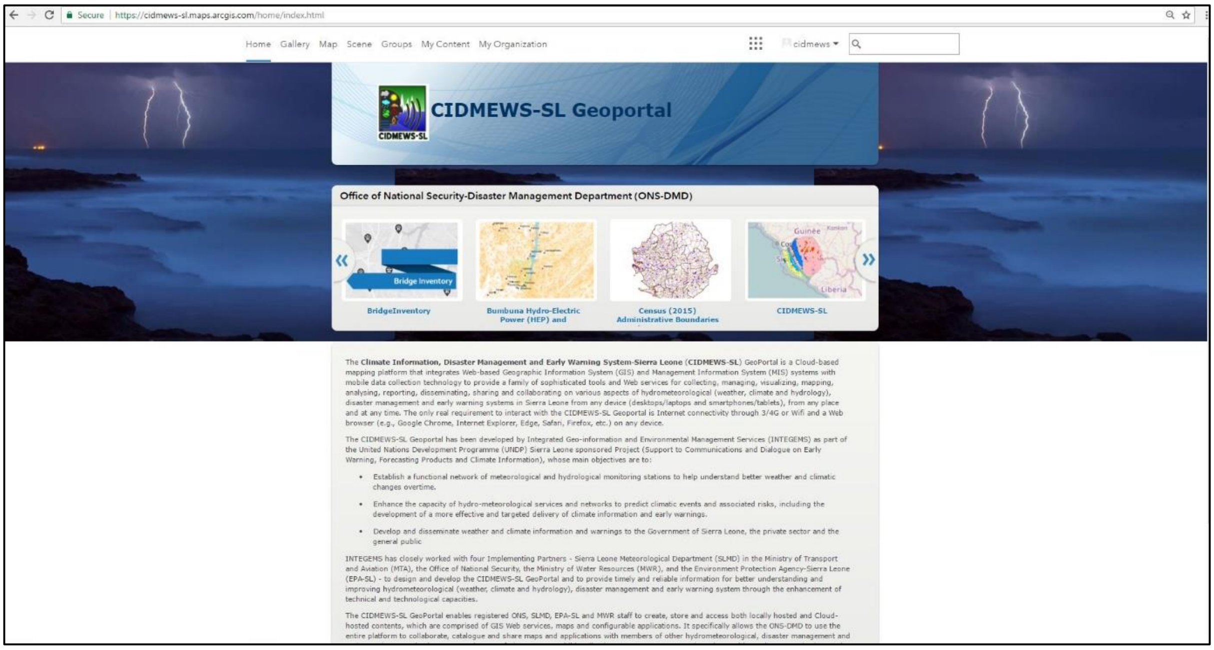
The Scalebar widget (**35**) displays a scale bar on the map. When working with Web Mercator or geographic coordinate systems, the scalebar takes into account projections and dynamically adjusts.

8.3 The CIDMEWS-SL Geoportal

Efforts to modernize the status of hydro-meteorological services in Sierra Leone in the past decades had been pathetic at best, or, in many areas, were absent. Consequently, despite many interventions by various donors and development partners, including the UNDP, the Sierra Leone Meteorological department is still not a dependable, reliable, timely, usable, useful, credible, authentic or responsive source of weather, water and climate information for most businesses and individuals (with limited exceptions, such as in aviation, due to legal requirements). Addressing the aforementioned challenges requires dedicated interventions capable of developing bespoke technological solutions that are platform agnostic and can work sinuously to integrate new systems into the varied patchwork of information technologies and hydro-meteorological monitoring systems currently in place. This need for careful systems integration is one of the key technical objectives of the **Climate Information, Disaster Management and Early Warning System-Sierra Leone (CIDMEWS-SL) GeoPortal**.

The CIDMEWS-SL GeoPortal (**https://cidmews-sl.maps.arcgis.com**) is a Cloud-based mapping platform that integrates Web-based Geographic Information System (GIS) and Management Information System (MIS) systems with mobile data collection technology to provide a family of sophisticated tools and Web services for collecting, managing, visualizing, mapping, analysing, reporting, disseminating, sharing and collaborating on various aspects of hydrometeorological (weather, climate and hydrology), disaster management and early warning systems in Sierra Leone from any device (desktops/laptops and smartphones/tablets), from any place and at any time. The only real requirement to interact with the CIDMEWS-SL Geoportal is Internet connectivity through 3/4G or Wi-Fi and a Web browser (e.g., Google Chrome, Internet Explorer, Edge, Safari, Firefox, etc.) on any device.

Figure 8-8: User Interface of the CIDMEWS-SL GeoPortal



The CIDMEWS-SL Geoportal has been developed by Integrated Geo-information and Environmental Management Services (INTEGEMS) as part of the United Nations Development Programme (UNDP) Sierra Leone sponsored Project (Support to Communications and Dialogue on Early Warning, Forecasting Products and Climate Information), whose main objectives are to:

- Establish a functional network of meteorological and hydrological monitoring stations to help understand better weather and climatic changes overtime.
- Enhance the capacity of hydro-meteorological services and networks to predict climatic events and associated risks, including the development of a more effective and targeted delivery of climate information and early warnings.
- Develop and disseminate weather and climate information and warnings to the Government of Sierra Leone, the private sector and the general public.

INTEGEMS has closely worked with four Implementing Partners - Sierra Leone Meteorological Department (SLMD) in the Ministry of Transport and Aviation (MTA), the Office of National Security, the Ministry of Water Resources (MWR), and the Environment Protection Agency-Sierra Leone (EPA-SL) - to design and develop the CIDMEWS-SL GeoPortal and to provide timely and reliable information for better understanding and improving hydrometeorological (weather, climate and hydrology), disaster management and early warning system through the enhancement of technical and technological capacities.

The CIDMEWS-SL GeoPortal enables registered ONS, SLMD, EPA-SL and MWR staff to create, store and access both locally hosted and Cloud-hosted contents, which are comprised of GIS Web services, maps and configurable applications. It specifically allows the ONS-DMD to use the entire platform to collaborate, catalogue and share maps and applications with members of other hydrometeorological, disaster management and early warning organisations or constituents of Sierra Leone. Additionally, the CIDMEWS-SL GeoPortal can be used by various organisations to lay the foundation for creating a collaboration pattern across disaster and emergency management organisations, establish a pattern for each disaster and emergency management organisation to use the platform and fosters sharing and collaboration across each pattern.

The Implementing Partners (i.e., ONS, SLMD, EPA-SL and MWR) have been fully subscribed to the CIDMEWS-SL GeoPortal and can use it to manage, create, store, and access hosted services, maps and applications. Other GoSL MDAs, Development Partners, NGOs and INGOs, CBO and other organisations can subscribe to the platform through the ONS and use it to access various hosted services, maps and applications.

The CIDMEWS-SL Geoportal can contribute to the following:

- lead-times for local communities at risk – of floods and severe storms (hail, thunder, lightning, intense rains and violent winds) – to prepare and undertake risk reduction measures, including moving assets to safer locations and implementing flood resilience measures;
- interpretation, packaging and transfer of climate information for relevant user-agencies to minimize risk to life and livelihoods including evacuating vulnerable groups, assisting local communities implement risk reduction, and implementing flood control and re-routing structures;
- agro- and hydro-meteorological information for informing integrated farm management and water resources management;
- integration of climate information into planning and policy making processes; and;
- packaging of weather and climate data and information for a range of other service providers including applications related to building and management of infrastructure, land and air transport, and the private sector.

8.3.1 CIDMEWS-SL Geoportal Applications

The CIDMEWS-SL Geoportal includes the following Applications:

Preparedness: Empowers the relevant MDAs to map and model potential plans, communicate with citizens regarding resources within their communities, analyze hazards and critical vulnerabilities, and plan for special events.

1. The **Situational Awareness Viewer** can be used by emergency management staff to identify the impact of an incident on public infrastructure and human populations. It helps officers analyze and understand potential impacts to the community while planning for an impending incident.
2. **My Hazard Information** helps residents discover hazards that exist in their community and obtain information about evacuation routes and government facilities provided by government agencies. This application provides access to the ONS 24 hours a day, seven days a week, and typically supplements customer service phone numbers staffed by the ONS-DMD. My Hazard Information can be deployed by MDAs and emergency responders for delivering hazard and facility information to the general public from their desktop computers, smartphones, and tablet devices.
3. The **Incident Briefing** application can be used by ONS management staff to provide map-based briefings and reports during an incident. Incident Briefing can be deployed and used by response personnel on desktop computers, smartphones, and tablet devices.
4. **Evacuation Zones** can be used by ONS staff to notify the public when evacuations are required. Evacuation zones are typically referenced when people and property must be removed from a neighbourhood or community because of safety concerns.
5. **Emergency Assistance** can be used by the general public to register for emergency assistance. Emergency assistance is typically provided by public safety or emergency management personnel to vulnerable populations whose needs are not fully addressed by traditional service providers. During an emergency, response personnel may enter the residents of those enrolled in an emergency assistance programme to assure the safety and welfare of an individual.

Mitigation: Assess and analyze risk and vulnerabilities, evaluate potential impacts, engage organizations in mitigation efforts, understand the status of mitigation projects, and communicate the status of mitigation plans.

Response: Deliver situational awareness, assess impacts to the community post-event, communicate state of infrastructure with the public, and understand the impact of an event using focused applications and common tools.

1. **Shelter Locator** can be used by the ONS-DMD and emergency management agencies responsible for providing citizens a safe place when they are displaced from their residence during a natural or man-made incident. Emergency shelter status and shelter-specific information (capacity, current occupancy, special needs, etc.) is provided and managed by the ONS-DMD and partners. Shelter Locator allows citizens to locate emergency shelters in their community from a smartphone, tablet, and desktop computer.
2. The **Situational Awareness Viewer** can be used by emergency management staff to identify the impact of an incident on public infrastructure and human populations. It helps officers analyze and understand potential impacts to the community while planning for an impending incident. The
3. The **Public Information** application is configured to utilize authoritative event based information in conjunction with social media feeds to present both organizational content, and content being contributed by the public. The application enables the ONS to quickly deploy an application that is accessible to the various stakeholders across an impacted area.
4. **Photo Survey** can be used by the ONS and other emergency response organisations to publish aerial and street-level photo collections and conduct surveys that identify damaged areas and structures within the images. Photo Survey expedites damage assessments by leveraging photos produced by many commercially available cameras. It combines these photos with a series of questions in the form of an online survey and associates the answers to points or administrative units on the ground. The simple to use application will enable ONS staff, and optionally the general public, to review time sensitive images after a disaster, thus allowing emergency response organisations to quickly estimate damage costs and determine potential financial impacts of an event.
5. The **Operations Response** application can be used by the ONS staff to understand the current status of emergency facilities and response teams. It can be deployed by emergency management organisations and used by response personnel on desktop computers, smartphones, and tablet devices.
6. The **Impact Summary Map** can be used by emergency management organizations to quickly communicate impact of an event to interested parties. It utilizes enriched content to facilitate quick summary information for the affected population. The application enables you to quickly configure, deploy and communicate impact using the application.
7. The **Logistics Planning** application can be used by ONS staff to plan logistical operations and manage resource requests during an incident. It can be used by response personnel on desktop computers, smartphones, and tablet devices.
8. The **Incident Status Dashboard** can be used by ONS management staff to monitor response activities and measure progress toward the incident objectives. It can be deployed by emergency management organisations and used by response personnel on desktop computers and tablet devices.
9. The **Incident Briefing** application can be used by the ONS staff to provide map-based briefings and reports during an incident. It can be deployed by other emergency management organisations and used by response personnel on desktop computers, smartphones, and tablet devices.
10. **Debris Reporting** can support the ONS and the EPA-SL in collecting and monitoring debris. The solution facilitates the collection of debris type and its location in order to assess and report back where debris clean-up is needed.
11. The **Damage Assessment** solution can be configured by the ONS to conduct detailed damage assessments in the field. It can also be used to monitor field assessments

and determine whether damage costs exceed ONS declaration thresholds. Damage Assessment supports the collection of structural damage to residential and commercial structures; and damage to public facilities during emergency response activities.

12. **Citizen Reports** can be used by citizens to report non-emergency incidents. Citizen Reports is used by the public as a means to provide non-emergency reports and observations throughout the community. This information will be immediately available to public safety personnel.
13. **Health and Safety Reports** allows the general public and public safety personnel to file reports important to the health and safety of a community. The ONS and EPA-SL personnel can monitor, verify and assign those reports to responsible agencies for resolution. If appropriate, health and safety reports can also be incorporated into an incident management system for further action. Health and Safety Reports can be used by the ONS and other emergency management organisations during severe weather, power outages, and other events to collect information vital to response and recovery efforts.

Recovery: Provide applications for the public to report information about the community, and deploy tools within the organization to collect and communicate status regarding debris and damage.

1. **Community Mitigation** enables the ONS and relevant organisations to submit, manage and track the status of mitigation projects and local mitigation plans. It also facilitates the management of mitigation projects, funding status and enables the ONS and relevant organisations to submit projects around localities where vulnerabilities have been identified.
2. **Hazard Vulnerability Analysis** can used by ONS-DMD staff to map infrastructure, community and government owned assets. This can then be enhanced with demographic, social vulnerability and hazard data, allowing a broad assessment of vulnerability and exposure across jurisdictions. This solution delivers a set of tasks to walk disaster management staff through the process of sourcing authoritative content, analyzing potential vulnerabilities, and sharing the results of the work with various stakeholders.
3. **Hazard Assessment and Analysis** can used by ONS-DMD management staff to map and analyze hazards and their potential impacts. The solution delivers a set of tasks to walk emergency management staff through the process of sourcing authoritative content, analyzing historic hazard events, assessing the likelihood of future events and sharing the results of the work. It provides a way of comparing different jurisdictional areas (for instance tribal areas, tracts or counties).

8.4 CIDMEWS-SL Website

The CIDMEWS-SL Content Management System (CMS) Website (https://www.cidmews-sl.solutions) takes full advantage of the flexibility of features offered by Joomla CMS with array functions and modules that can be easily added to over time without costly redesigns to interfaces and templates. Designed with end users in mind, the CIDMEWS-SL Website's responsive web design (RWD) and multi-device design technologies uses the gantry framework to ensure the site is highly mobile-accessible and viewable on all screen sizes (from desktops to smartphones).

Visitors to the site can access relevant CIDMEWS-SL information in a timely and consistent manner. Climate, disaster management, hydrometeorological and early warning systems information are presented in a non-technical and visually appealing manner incorporating a well thought out site-flow and information architecture. Information is organised clearly to facilitate access to relevant information and content easily searchable. All pages feature similar and consistent navigation controls with a minimum number of clicks required for navigation. Clear and intuitive labels, controls are grouped into logical units.

An integrated and interactive CIDMEWS-SL Web Mapping Application has been embedded in the CIDMEWS-SL CMS Website's Home Page and menu to allow users to interactively and effectively create, edit, publish, review, and collaborate on climate information, disaster management and early warning mapping, updating and managing development project locations and attributes through a robust, easy-to-use Web browser. The CIDMEWS-SL Web mapping application exposes SLMD meteorological data and geospatial services from the server and streams the results, expediting the discovery, transfer and utilisation of climate information, disaster management and early warning data and information by the ONS-DMD and SLMD to various stakeholders.

The CIDMEWS-SL Website promotes the SLMD, ONS-DMD, EPA-SL and MWR to all stakeholders using media (picture, audio, and video) to highlight climate, disaster management, hydrometeorological and early warning systems events at SLMD, ONS-DMD, EPA-SL and MWR. Acting as a discussion forum on on-going climate, disaster management, hydrometeorological and early warning systems projects, CIDMEWS-SL CMS informs and connects to a larger audience by integrating social media (Twitter, Facebook).

Figure 8-9: User Interface of the CIDEWS-SL Website

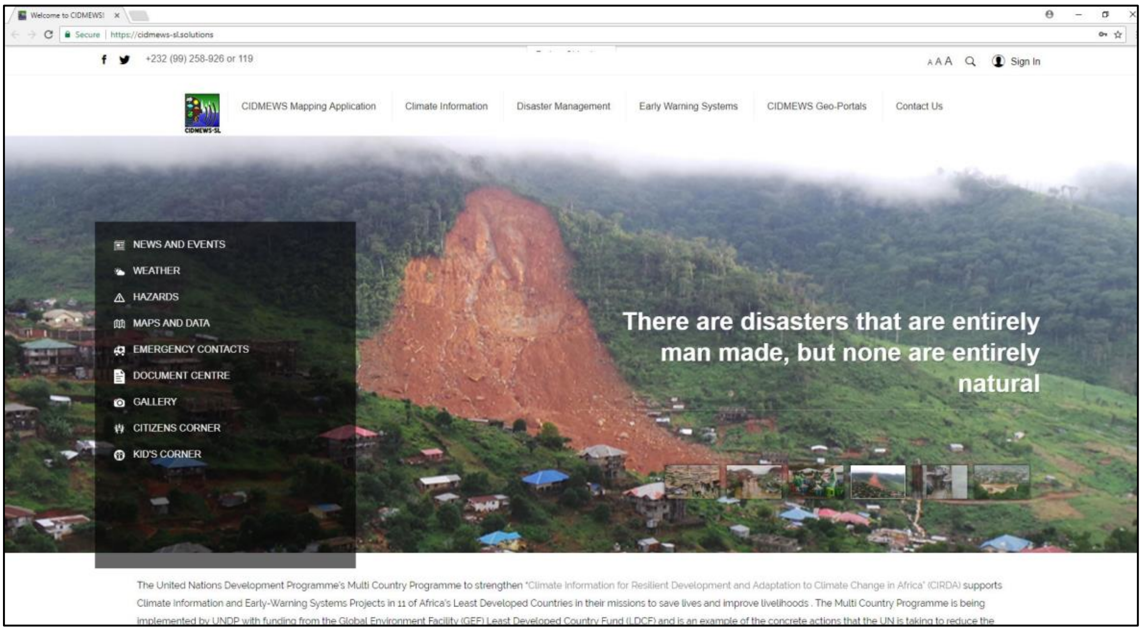
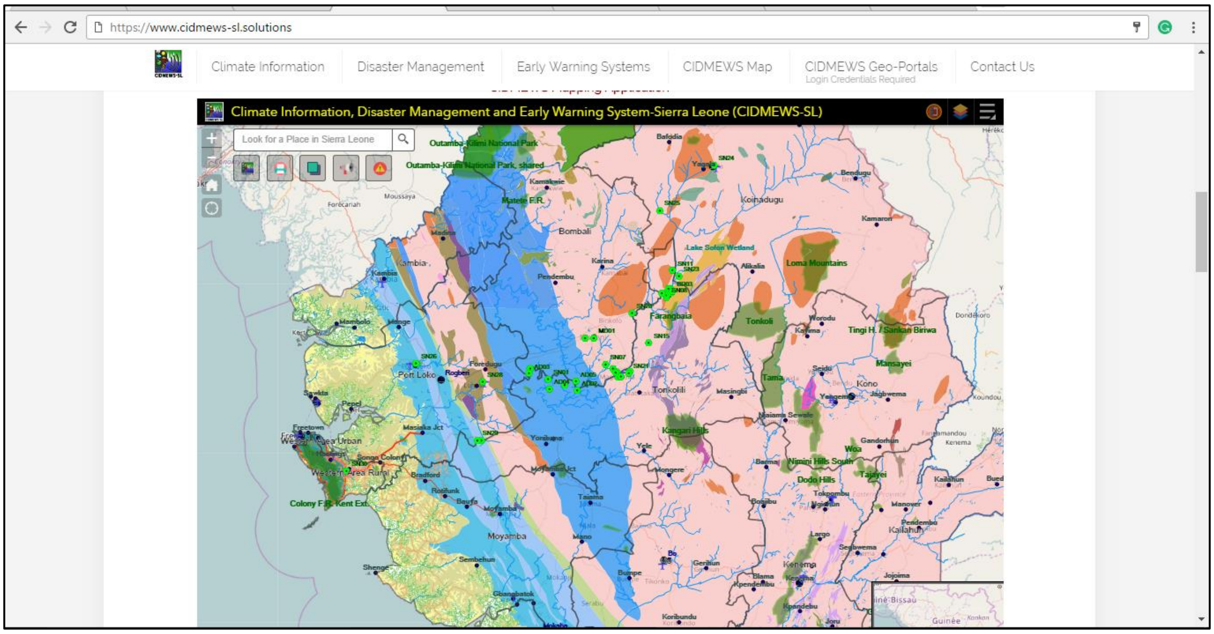


Figure 8-10: User Interface of the CIDEWS-SL Mapping Application in the CIDMEWS-SL Website



The CIDMEWS-SL CMS Website also includes the following features and functionality:

- FAQ functionality
- A Contact form module plus a dynamic form for sending enquiry emails
- Online print facility
- Website data content backup
- Unlimited email addresses
- Widgets and web parts for multimedia capabilities
- Monitoring tool for periodic reporting on web statistics
- Firefox, Safari, Chrome, Opera, IE8+ Compatible
- User Login for non-public information sharing
- Control-Panel backup of database
- High availability web server to guaranty little to no downtime
- A Search button to help quickly locate texts and sections of the site
- Contact Us page with CAPTCHA enabled contact form to prevent automated spam mail submissions.

Figure 8-11: User Interface of a Web Page of the CIDEWS-SL Website

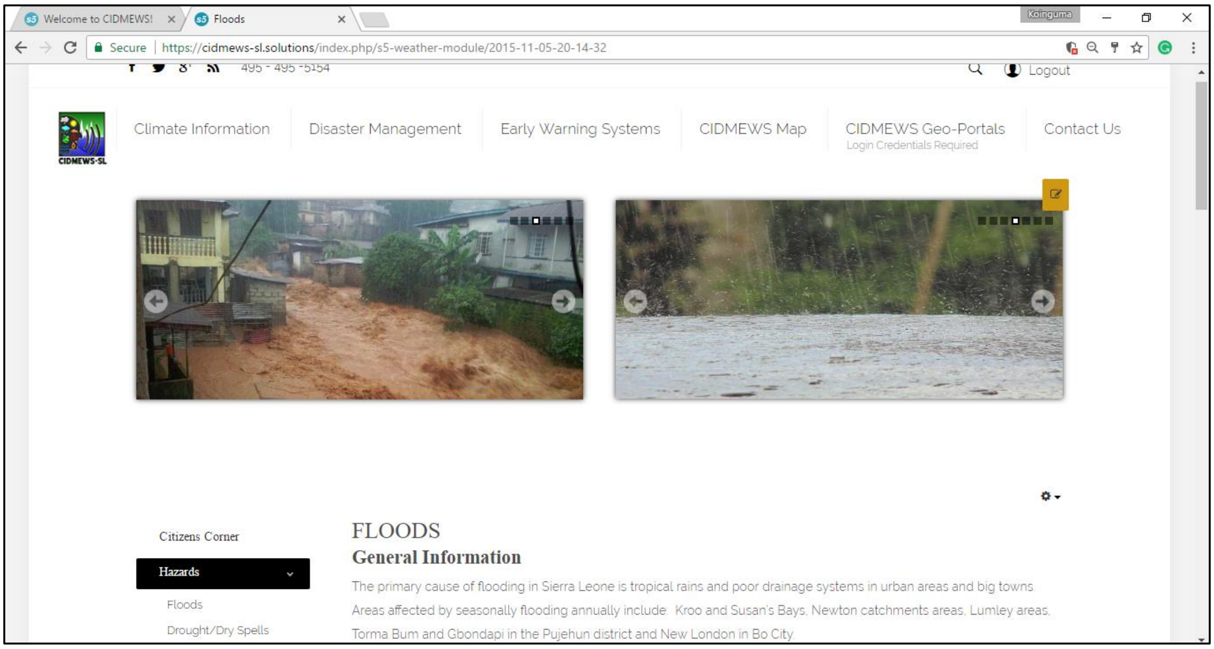
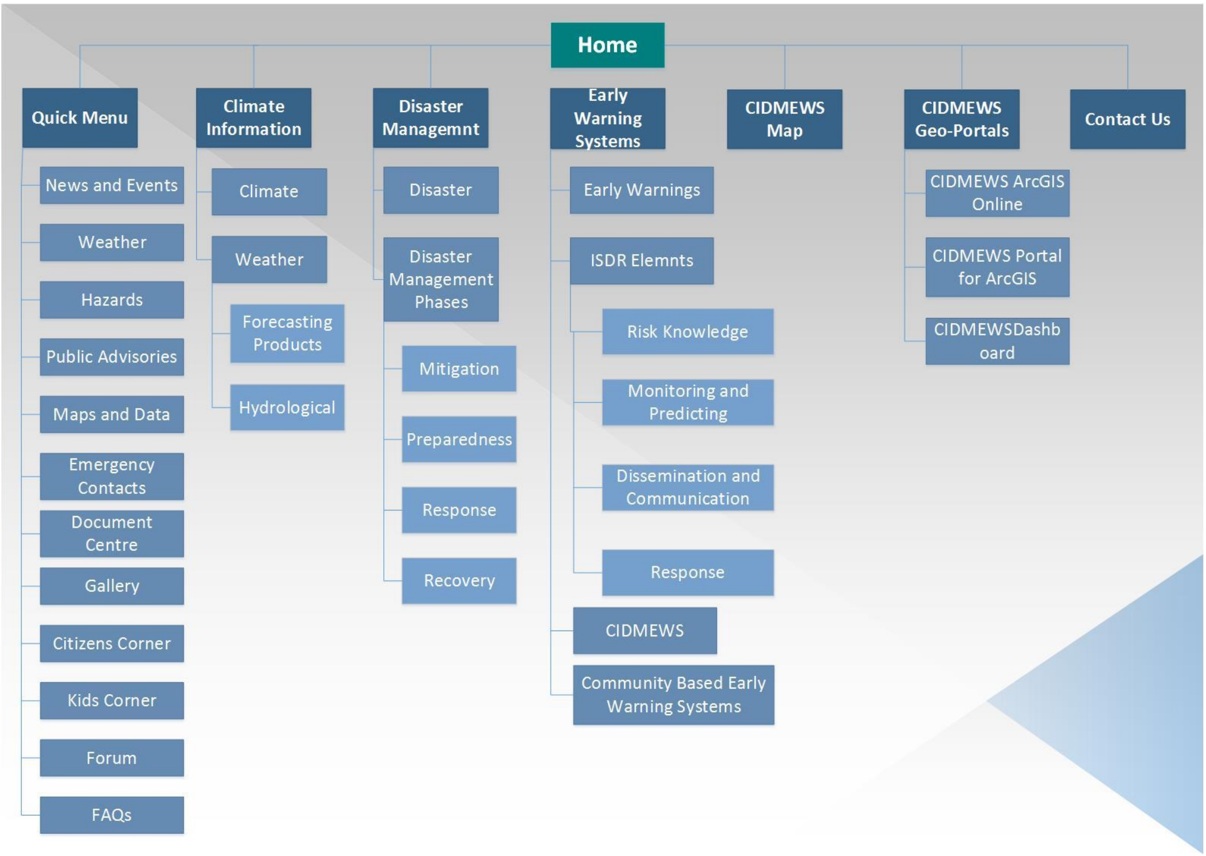


Figure 8-12: Site Map of the CIDEWS-SL Website



8.5 Sierra Leone Meteorological Services Website

The Sierra Leone Meteorological Services Website (https://www.slms.website) is the Sierra Leone Meteorological Department's website that captures a look-and-feel that reflects the brand of the SLMD. The SLMD website takes full advantage of the flexibility of features offered by Joomla CMS with array functions and modules that can be easily added to over time without costly redesigns to interfaces and templates. Designed with end users in mind, the websites responsive web design (RWD) and multi-device design technologies using the gantry framework ensure the site is highly mobile-accessible and viewable on all screen sizes (from desktops to smartphones).

Figure 8-13: User Interface of the SLMS Website

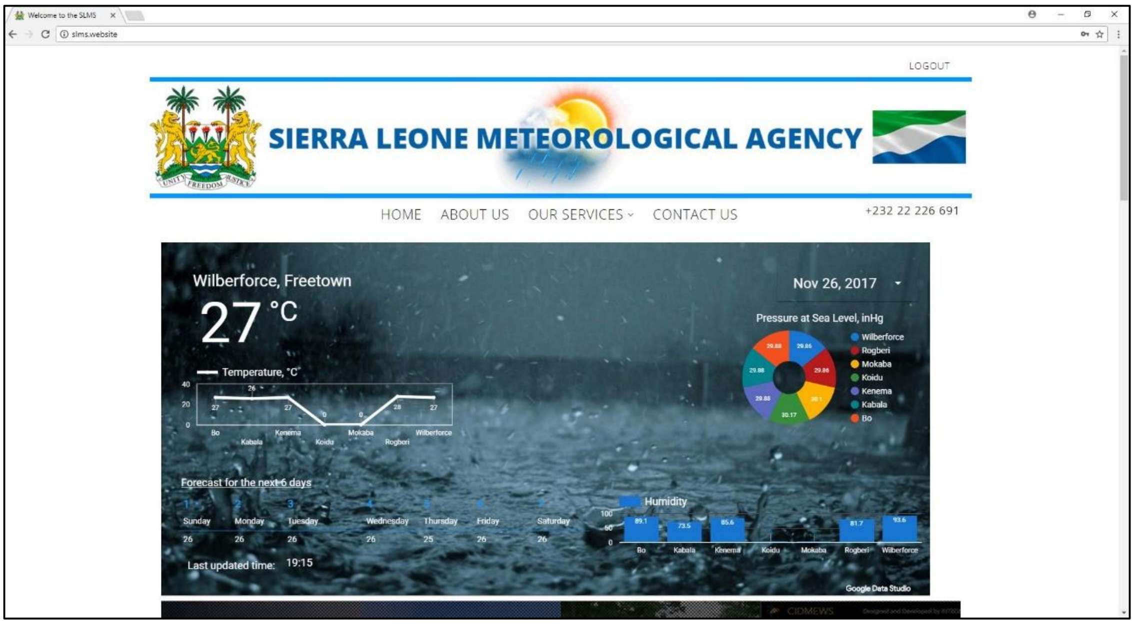
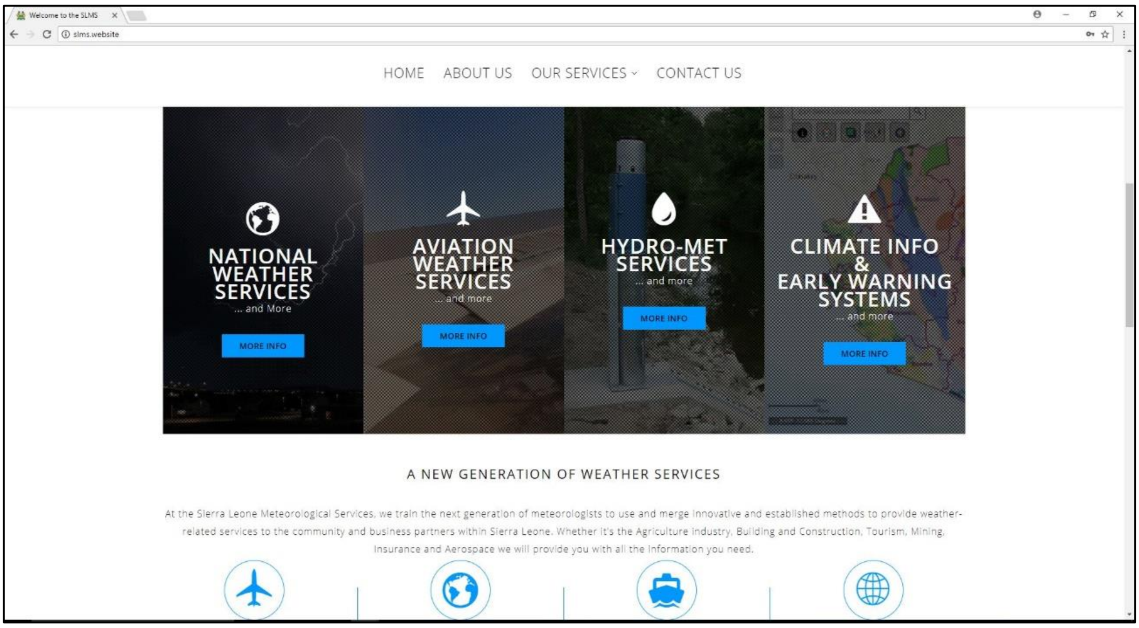


Figure 8-14: User Interface of the SLMS Website's Home Page



Visitors to the site can access relevant climate and weather information in a timely and consistent manner. National, aviation, hydrometeorological and climate information early warning systems information are presented in a non-technical and visually appealing manner. All pages feature similar and consistent navigation controls with a minimum number of clicks required for navigation. Clear and intuitive labels, controls are grouped into logical units.

8.6 Conclusion

The Project recognises the commercial need for customized meteorological services as well as the importance of not only to collect weather data, but also to ensure that it is communicated effectively. Thus, there is need for the SLMD to partner with existing commercial telecommunications providers to build more effective methods to provide real-time meteorological information and early warnings to various end users, including weather conditions from any mobile device anytime, anywhere, free of charge.

Providing vulnerable communities with improved hydrometeorological services has the potential to increase farm production and lower risk. With better information on extreme weather events, improved crop forecasts and more actionable information on what to do when bad weather hits, farmers can protect property and human lives, access risk-management mechanisms like index-based insurance, and create long-term plans for a future that will be highly dependent on rainfall patterns, droughts, floods and other natural disasters.

CIDMEWS-SL provides new ways of collecting, analysing, mapping and communicating weather, water, disasters and climate information. It also provides opportunities to enhance the capacity of the SLMD, ONS-DMD, MWR and the EPA-SL to issue early warnings of fast-acting storms and extreme weather events and to prepare for climate change, and to achieve other economic, environmental and social goals simultaneously. CIDMEWS-SL can be used to disseminate authoritative weather information and warnings to the public, media and disaster management authorities.

CIDMEWS-SL provides the SLMD, ONS, EPA-SL, MWR and other relevant organisations with the ability to anticipate the onset of severe weather later in the day, then monitor it in real time and deliver effective warnings for the imminent arrival of hazardous events such as severe thunderstorms and flash flooding. Accomplishing this task requires a well-synchronized forecast centre able to blend real-time observations with radar or lightning-locating data, hydrologic data, and satellite imagery to identify the onset of hazardous weather, monitor the developments and movements that are indicative of severe weather, carry out continuous nowcasting of the future path of the hazard, and communicate warnings to the regions in the path of the storms.

By leveraging the installed automatic weather stations (AWS) and weather forecasting and meteorological information data, information and services, the MDAs, especially the SLMD, with the help of the CIDMEWS-SL, could use various bespoke Apps and solutions and benefit from the following:

8.7 Climate Information and Forecasting Products

The seamless integration of weather and climate information in government, non-government and private sector decision making can help mitigate against the risks of disasters, weather and climate variability, climate extremes and other related events that threaten vulnerable communities in Sierra Leone and around the world. Climate information is generated through monitoring and analysis activities conducted by meteorologists and climate science-related researchers. This information is becoming an integral part of risk management and resilience programming and is seen as vital to enhancing people's capacity to deal with the impacts of climate change.

Equally, the production of climate information for decision-making is increasingly being seen as an entry point for joining up work on climate change adaptation, disaster risk reduction and development in climate-sensitive places. Extreme events are already putting lives, livelihoods and assets at greater risk and these events are becoming more common in some places in Sierra Leone. Building resilience to the shocks that can be anticipated as well as those that cannot relies on our ability to manage extreme events today and adapt to future changes. This involves decision-making on the basis of short-, medium-, and long-term scenarios, foreseeing the problems and opportunities associated with these – and the uncertainties. There are many starting points, but an obvious one is to improve the availability, quality and use of climate information.

For climate information products to be interpreted and applied in decision-making, they need to be developed through strong partnerships between information providers (or source agencies) and government (e.g. line agencies, departments and local governments), private sector and research entities and directly affected users. What is referred to now as the 'climate services approach' also calls for improvements in the weather and climate information itself to link it to information on impacts and make it more relevant for decision making in particular context. Improving capacities to take appropriate action in light of expected climate change trends and uncertainties will help equip communities to deal with climate changes. To do this, we need reliable, relevant, accessible, useable, credible and understandable climate information.

Climate information and forecasts can cover varying timescales, such as short-range (e.g. up to a few days), medium-range (e.g. from weeks up to a month) and long-range (e.g. greater than one month, including seasonal time scale). Climate information also includes projections and scenarios (e.g. decadal and longer). While the term ‘weather’ is the state of the atmosphere at a given time and place with respect to variables such as temperature, moisture, wind and barometric pressure, the term ‘climate’ is typically defined as the average weather over a long period of time.

End-users of climate and weather information produced by national, regional and international agencies face various challenges when it comes to applying the information they receive to decision-making. Some of these challenges are related to factors such as quality of the information products, not having information at appropriate scales and difficulties in communicating and interpreting the information produced.

8.8 All-in- One Automatic Weather Stations

SLMD has installed 8 new sufficiently sophisticated automatic weather stations (AWS) that now play the central role in the SLMD’s observing network. These AWS have been installed and maintained by Earth Networks through an approach being promoted in the UNDP’s Programme on CIRDA, which exploits the capabilities of the latest generation of smart, integrated, all-in-one (AIO) AWS, supplemented where necessary by even more powerful stand-alone data loggers, to provide sustainable observing networks for the 11 sub-Saharan African countries partnered with the support programme.

Earth Networks, under a contract with the UNDP, has installed a baseline network of integrated compact automated weather and lightning sensors on mobile communications towers in eight secured locations across Sierra Leone. For more than 20 years Earth Networks has operated the world’s largest and most comprehensive weather observation, lightning detection, and climate networks.

In these all-in-one systems, the majority of the sensors and the related electronics are housed in one package. This significantly reduces the workload during deployment and subsequent field maintenance. These AWS exploit the cell-phone network to link the AWS to a central data collection facility. These cell-phone networks are subsequently used as a means to deliver hydromet services and information - another key component of this new vision.

In these installed modern AWS, a specialized on-board computer or ‘data logger’ handles the collecting and initial processing of sensor readings. This has eliminated the need for human observers, handwritten observing forms, and calling or mailing in the recorded observations to a central office. Within a few seconds of being made, observations from AWS spread across a wide region can be collected at a central location, quality-checked using a consistent set of rules, archived, and made available for use by forecasters, climatologists and other users.

The SLMD’s AWS are now ‘smart’, incorporating an on-board computer that autonomously provides for the generation and transmission of formatted meteorological reports, changing sampling rates and/ or special observations when preset environmental thresholds are crossed, and providing alert messages when preset thresholds in key variables are exceeded.

Following guidance from the Earth Network central data-collection facility, the distributed network of individual station computers manage all the necessary communications protocols. Individual stations have some storage capability, so that when communications to the central collection point are interrupted, data continues to be collected. They are then forwarded to the central collection point when communications are restored. This not only means that one is comparing apples to apples for long-term climate monitoring, in an ideal world, this could also mean automated storm, lightning and flood alerts for local communities.

The last decade has seen rapid advances in both sensor design and packaging technologies that has led to the recent emergence of a generation of 'integrated, all-in-one' automatic weather stations (AIO AWS). Typical AIO AWS contain sensors for measuring air temperature, relative humidity, precipitation intensity, precipitation type, precipitation quantity, air pressure, and/or wind direction and speed, all contained in a single package. Most moving parts have been eliminated, with wind speed and direction sensed by ultrasonic anemometers. Overall, AIO AWS prices are quite reasonable, particularly when long-term maintenance savings are considered. Most importantly, accumulating experience suggests that properly designed AIO AWS do quite well in difficult environments.

8.8.1 Integrated Observation Suite

A baseline network of integrated compact automated weather and lightning sensors on mobile communications towers:

- Mobile communication towers provide optimal security, power, and communications
- Leveraging Earth Networks regional and global networks
- This critical infrastructure provides foundation for:
    - Real-time nowcasting and advance storm warnings
    - Precipitation monitoring and accumulation estimates
    - Forecasting on a variety of timescales

8.8.1.1 Earth Networks Total Lightning Sensor

- Total lightning detection (in-cloud and cloud-to-ground)
- Wideband electrical field recorder (1 Hz to 12 MHz)
- Records and transmits lightning flash waveforms
- Real-time data transmission
- Compatible with mounting on mobile telecom towers

8.8.1.2 Automatic Weather Station (AWS)

- Integrated AWS with no moving parts or maintenance
- Measures all weather parameters with high precision
- Real-time data transmission with hours of data storage
- Integrated with total lightning sensor for storm tracking

8.8.1.3 Earth Networks Network Appliance (ENNA)

- ENNA is a microprocessor-controlled computer
- Provides key connectivity, diagnostic, calibration and data archival functionality
- Ensures high quality data is transmitted from weather stations and lightning detection networks

8.8.2 Analysis and Alerting Services

8.8.2.1 Dangerous Thunderstorm Alerts (DTAs)

Dangerous Thunderstorm Alerts (DTAs) by Earth Networks provide advanced notification of the increased threat of severe weather moving into an identified area. A DTA alert is issued when there is a high frequency of lightning detected by the Earth Networks Total Lightning Network™ (ENTLN) indicating the increased potential for: lightning strikes, heavy rain rates, high winds and hail activity. The alert is updated every 15 minutes until the dangerous weather activity is no longer a threat and the alert expires. The advanced technology used within ENTLN enables the detection of both in-cloud and cloud-to ground lightning (otherwise known as total lightning). High rates of total lightning activity serve as precursory indicators of the potential for severe weather activity.

Earth Networks issues a Dangerous Thunderstorm Alert when the lightning detection rate exceeds high levels. These alerts are available through a data API that will return the alert information in CAP format. The alert CAP feed includes a polygon encompassing the area at risk, direction and speed of the severe lightning activity, cities in the route of the storm and current observations from weather stations near or in the affected area. A ready to use weather bulletin text is also provided within the CAP feed.

- Severe storms identified by monitoring lightning flash rates and rate changes
- DTA is 45 minute threat zone based on storm vector; re-analyzed every 15 minutes
- Early warning for: severe thunderstorms, high winds, hail storms, tornadoes, and cloud-to-ground lightning

8.8.2.2 PulseRadSM Rainfall Monitoring and Estimating

- Radar imagery (dBz) using solely lightning activity data
- Visually identify and track severe weather and rainfall
- Monitor aggregate rainfall in real-time and monthly/annual for flood and drought warning
- Inexpensive (many times less!) alternative to radar with comparable imagery

8.8.2.3 ENcast Hourly Forecasts

The Earth Networks ENcast 15-Day Hourly Sensor Forecast Feed provides the MDAs and various stakeholders with a variety of hourly forecast variables up to 15 days in the future that will help organization make informed decisions. The ENcast 15-Day Hourly Sensor Forecast is available through Representational State Transfer (REST). This is an efficient and guaranteed delivery method utilizing web service (HTTP) explicitly where stakeholders can choose a file type, structure, and data variables from a menu of options. The forecast data, which is available through REST in JavaScript Object Notification (JSON) format is streamed into CIDMEWS-SL via the GeoEvent Server's streaming and feature services functionality:

- Forecasts for two weeks out: updated hourly based on latest forecast model runs
- Hyper-Local: uses data from existing and new stations
- Fastest Updates: use of real-time AWS data or tuned to latitude/longitudes where no station data exists
- Lowest Forecast Error: accuracy and nowcast advantage
- Data hosting and delivery system ensures data quality control checks and sensor operability to deliver highest quality data at lowest maintenance cost
- Streaming total lightning detection (in-cloud and cloud-to-ground) data, recorded observations, and calculated weather data: 27 different variables
- Total lightning data is used instead of costly radar for storm cell identification, tracking, and alerting as well as real-time rainfall monitoring and estimating
- Hourly forecasts using ensemble of top global models (ECMWF, GFS, GEM, etc.) and weather and total lightning data to localize and enhance performance

Web-based display allows the CIDMEWS-SL user to view forecast information for specific locations (Bo, Kenema, Koidu, Mokaba, Rogberi, Kabala, Makeni and Wilberforce), timescales, and variables:

- Temperature
- 24hr High Temperature
- 24hr Low Temperature
- Wind Direction
- Wind Speed

- Dew Point
- Cloud Cover
- Thunderstorm Probability
- 1hr Precipitation Probability
- 1hr Accumulated Precipitation
- Fog Probability
- Visibility
- Rain Probability
- Surface Pressure
- Surface Insolation

8.9 Hydrometeological Services

CIDMEWS-SL and related information products have the potential to provide a wide range of hydromet information that, if properly applied, can be of great benefit to the people, economies and government of Sierra Leone. Realizing these benefits requires collecting, processing and analyzing weather, water and climate data to create and deliver specific, consistent and credible hydromet information immediately applicable to users' decision-making processes. The broad range of potential users points to the many opportunities for positive impacts created by the availability of quality hydromet information.

Sierra Leone is prone to disruptive events—severe storms, landslides, floods—so one driver for improving hydromet services has been the provision for early warnings so that government agencies, the private sector and individuals can respond proactively. Further, in Sierra Leone a high percentage of the population works the land in smallholder agriculture. Daily, seasonal and annual hydromet information tailored to the needs of these farmers reduces risks and increases production. Modern national hydromet systems, with end-to-end systems for monitoring, analyzing, and skilfully predicting weather, water and climate events, can support these needs (and many others), saving lives and reducing the costs of disaster relief and reconstruction on the one hand, while improving the daily lives of a large portion of the population and a nation's economic vitality on the other.

Reducing the impacts of natural disasters is a powerful argument for early warnings of extreme hydromet events. The broader economic benefits of public investment in good hydromet services have not been as well documented but are also sizable, and offer the potential for different sources of political support. Properly addressing these challenges requires solutions tailored to the SLMD. These meteorological observing systems can be combined with hydrological monitoring to create a complete hydrometeorological observation, with hydrological measurements including the following:

These various observations and measurements provide the foundation for modern hydromet information services. In the CIDMEWS-SL, the data streams from the various observing networks are merged with other spatial data such as terrain/elevation, soil type and vegetative cover, as well as the output of Numerical Weather Prediction (NWP) models, to produce weather, water and climate information. This information is then used by the SLMD and others to produce a host of products and services with a wide range of applications. These services can be as diverse as a warning based on a short-term forecast, or 'nowcast' of the projected path of an evolving, moving thunderstorm, an estimate of the amount of water likely to be entering a reservoir in the next 24 to 36 hours, the updating of the seasonal precipitation climatology for a region, or the prediction of temperatures and precipitation likely to be experienced in a coming growing season.

Unfortunately, it has proven to be very difficult for the SLMD to establish and sustain hydromet observing networks. All too quickly, networks installed with the best of intentions—and at significant cost—have failed to provide the desired data due to a variety of adverse factors, leading to discouragement on the part of SLMD staff, and a lack of credibility with other government agencies, the nation's business community and citizens.

The most frequently cited are the coupled challenges of limited budgets; poor initial design, improper implementation, lack of tailored end-to-end systems that run from sensors in the field to products and services delivered (or not) to users; and lack of technical expertise and supporting infrastructure. As a consequence, the SLMD is unable to deliver in a timely, reliable fashion the many hydromet monitoring, alerting and forecasting services needed by the people it is supposed to serve. The SLMD thus loses credibility with the citizens and the government of which it is a part, receives even less support, and has the potential to enter into a non-virtuous cycle as a government agency.

For hydrological services, one of the main challenges is the lack of end-to-end solutions. Traditionally, hydrological services have mainly focused on the collection of accurate time series of surface and groundwater levels, and less on integrated water resources management. The advent of new observation technologies and innovative connectivity solutions have made it possible to replace manual observation systems with automatic systems to gain real-time information on water levels and river discharge. These systems have, at least theoretically, also given the hydrological services the possibility to expand their services to the provision of real-time flood warnings, drought monitoring, water resources planning and abstraction licenses, to name a few. Furthermore, the maintenance of dams and waterways can be carried out in a much more timely and efficient manner. However, without adequate integrated water resources management software solutions, which integrate hydrological and meteorological data, the possibilities offered by the new Earth Networks automatic observation infrastructure (combined with the ease of digital data exchange) cannot be fully exploited. Despite the new systems, the focus of the hydrological services remains on data, rather than information products.

Given the essential nature of observations, the SLMD has become tightly focused on deploying observing systems. However, while observations are necessary, they are only one input to the end-to-end system that is necessary to providing hydromet monitoring, forecasting and alerting services. The SLMS lacks the in-house programme management, engineering and technical staff required to independently procure integrated, innovative early warning and climate information systems that are sustainable, increase SLMD capabilities and build organizational capacity. For similar reasons, the SLMD is unable to properly evaluate, critique and offer viable alternatives to proposed system solutions.

All too frequently, attempts to meet the hydromet observing needs of Sierra Leone is by deploying observing equipment and by following procedures commonly used in developed mid-latitude countries have resulted in networks that perform poorly and quickly prove to be unsustainable. This unfortunate outcome is often due to poor design—of the network, the stations, and/or the selected equipment—and to the lack of supporting technical expertise and infrastructure.

Building hydromet observing and sustaining hydromet observing networks in Sierra Leone requires that these factors be addressed holistically. Proactive approaches to addressing these challenges can provide the SLMD with opportunities to procure, deploy and sustain observing networks as the first element in the end-to-end systems they need to properly serve Sierra Leone. The proactive approaches include tailoring solutions and providing supporting technical capacity; taking advantage of a convergence of new technologies in the meteorology, hydrology, climatology and cell-phone industries; designing model end-to-end systems that provide monitoring, forecasting and alerting services; and appropriately constructing public-private partnerships so as to contribute to long-term sustainability.

A crucial part of the hydrologic monitoring infrastructure is the integrated water resources management system. Without this system, the different observing systems would merely send data to a server or cloud-based data management system, resulting in a (number of) large database(s), and not much more. Although hydrological time series are extremely important for a number of applications and users, much more information can be generated from the available hydrometeorological data streams. Automatic systems provide the basis on which integrated water resources management can be built. Flood early warnings can gain in lead time when meteorological data and hydrological data are combined, river flow can be modelled, and a better understanding of the interactions between rainfall, surface-water resources and groundwater can be had. Agricultural and hydrologic droughts can be observed and forecasted, giving policymakers more time to respond, adapt and mitigate. Water resources planning and allocation strategies can be developed, to work towards fair and sustainably managed water resources management systems.

8.10 Multi-hazard Early Warning System

Despite the urgency, the conventional ways of doing things at the SLMD and the ONS has yet to deliver critical climate information and early warning services to key stakeholders—including farmers, vulnerable communities and policymakers—to enable them to understand and manage their hydrometeorological risks. The Support to Communication and Dialogue on Early Warning and Forecasting Products & Climate Information Project is already changing conventional ways of doing things, creating custom-built solutions, ensuring the long-term sustainability of investments, incapacitating an existing lack of trust between the public and private sectors, and creating different ways of operating that focus on going beyond the procurement of technologies to an end-to-end systematic approach.

The Support to Communication and Dialogue on Early Warning and Forecasting Products & Climate Information Project has propelled the challenging work of modernizing the SLMD's hydrometeorological services forward over both the short and long term. Through the Project, INTEGEMS took stock of existing assets, identified obstacles and looked critically at the past in rehabilitating the SLMD's hydrometeorological monitoring and forecasting infrastructure, and creating sustainable solutions that leverage better hydrometeorological information to improve the livelihoods of Sierra Leone's poorest, most vulnerable communities. INTEGEMS is currently working with the SLMD and ONS-DMD to pioneer and scale up outreach initiatives that will bring weather information to end-users and provide weather updates to citizens in collaboration with Mobile Telecoms Companies and share weather alerts via SMS message.

Through the Support to Communication and Dialogue on Early Warning and Forecasting Products & Climate Information Project, INTEGEMS has also worked with the UNDP to put in place software and hardware at the SLMD to ensure quality data, ongoing power, security and communications for the eight Automatic Weather Stations (installed by Earth Networks in 2016) to beef up our weather monitoring and forecasting systems. INTEGEMS has also put in place an integrated MIS and GIS systems with real-time and near real-time data capture functionality to ensure weather monitoring and forecasting data are processed quickly and effectively. This will allow for better data and enable the SLMD to build trust and provide effective and timely weather alerts, like storm and flood watches, advisories and warnings.

INTEGEMS is also providing training and building the capacity of SLMD staff to share these weather warnings and package information to meet various end user needs as the project moves from procurement and installation of new equipment to another phase that focuses on the application of weather monitoring and forecasting data and information in the field. In addition, the technical capacity of the SLMD to monitor and forecast extreme weather, hydrology and climate change is being enhanced through training and capacity building programmes in partnership with the UNDP Programme on Climate Information for Resilient Development in Africa to ensure long-term sustainability and maintenance of the hydro-meteorological monitoring system.

8.11 Dissemination of Early Warning Information

StreamerRT Web-Based Display System (StreamerRT) is a real-time weather decision system that provides a fully interactive mapping platform with a comprehensive collection of weather data. CIDMEWS-SL users have the ability to monitor real-time station observation data from the WeatherBug network and overlay numerous enhanced data sets to stay up-to-date with significant weather events before and after they develop.

MDAs and other stakeholders can use StreamerRT to create the customized Views that are important to them and then monitor the weather through easy access to Views, Slideshows of Views and animations. StreamerRT has a comprehensive and user-friendly tool for visualization of live and forecast weather conditions and real-time situational awareness at local, regional, national and international levels for critical decision-making.

StreamerRT has a Mobile Phone Weather Content and Alerting functionality for:

- Location based warning for feature / smart phones

- All mobile platforms like iOS, Android, Win 8, etc.
- Push notification
- Hazard proximity alerts
- Current weather conditions
- Detailed forecast content

On-line Communications Portal Setup

- Regular blog postings of important weather information and alerts
- Communication vehicle for technology transfer
- Intergovernmental exchange of best practices

Automated and manual content delivery to decision-makers and the general public using unique early warning system data that is collected locally and analyzed in real-time. Automated alert types can include: current weather observations, lightning strikes, flooding, DTAs and severe weather alerting, hourly forecast information. The early warning system technology enables the SLMD and other MDAs and stakeholders to deliver alerting via multiple optional channels:

- GIS display systems for NMHS and 3rd parties (including APIs)
- SMS, text, email as well as mobile applications
- TV, radio, internet, and bulletin broadcast
- Specialized outdoor alerting devices
- In combination with other information (agriculture, health, energy)

8.11.1 Adaptive Capacity and Sustainability Support

- EWS installation, hosting, and program management
  - Utilizing private/national investments made into mobile telecom infrastructure
  - Engaging NMHS technicians for instrument installation, maintenance, and operations
  - Program management: national design, implementation, regional coordination and support.
- Training and capacity building component
  - Gradual technology transfer taking place alongside country-specific training
  - Initial and continuing observation network field engineering training
  - Initial and continuing early warning system platform user training
- Sustainability planning and business development
  - Development of sustainability plan based on products and services for the private sector using EWS information
  - Transferred technology and expertise drive applications for industries, private sector partners, government agencies, and NGOs
- Protection of life and property – support the overall key mission of NMHS organization
- Climate change adaptation – warnings for increasing incidence of climate hazards
- Disaster risk reduction – ability to automatically alert at the local level in real-time
- Food Security – early warning of severe weather damage to agricultural production
- Flood and drought warning – long term rainfall totals in areas with no radar

- Water resource management – monitoring impact of thunderstorms on water levels
- Energy security – electrical grid stability, power outage management, demand response
- Hydropower – operation of power plants, localized real-time rainfall totals w/o radar
- Aviation – flight safety, air traffic control, ground crew safety at airports
- Development of infrastructure – inclusion of localized storm and rainfall statistics in planning
- SLMD sustainable operation – revenue from provision of information to stakeholders.

8.11.2 Applications of the AWS and CIDMEWS-SL

The SLMD and relevant partners can leverage the benefits of the AWS and CIDMEWS-SL for the following:

- **Specialized Weather Information Packaging** - SLMD is now producing raw data. But with limited budgets, and limited experience, it possess the capacity to package and tailor raw data for consumers. The SLMD should aggregate weather data and produce a value-added product to resell it to end consumers (like financial services firms, mobile-phone operators or mining companies) but this poses both opportunities and challenges for SLMD. It may be able to tap new markets and share in the profits, but they may be limiting its potential long-term value—and overall value propositions—by focusing mainly on raw data collection.
- **Aviation** - The best example of where the SLMD are packaging and gaining some revenues comes from aviation. The SLMD has existing relations with the aviation sector, and in some cases already receive some nominal funding for the information and services they provide. Creating better tailored products for this sector—and placing well-thought-out monetary valuation on the services provided—is a strong opportunity for the SLMD.
- **Mining** - Mines and other resource extraction enterprises often use customized weather reports for localized early warnings. Lightning forecasts and local weather monitoring are used to manage the use of roads and other infrastructure. In some cases, mines already have local monitoring systems set up, or turn to private weather monitoring companies to provide local monitoring.
- **Agriculture** - Agriculture accounts for a dominant share of GDP in Sierra Leone so the agriculture sector has an opportunity to use monitoring variables like soil moisture, humidity, the number of sunny days and night-time temperatures to improve production. With support from seed companies and other businesses that sell to farmers, mobile-phone companies can provide free seasonal weather information as a dial-up service. Local monitoring systems could be integrated into the monitoring systems of the SLMD to improve overall climatological monitoring. The SLMD can also work with both large producers and MAFFS to create customized crop reports. In some cases these reports already exist, but lack the granular level necessary to create significant impacts, especially for smallholder farmers.
- **Banking and Insurance** - Packaged weather and climate information can be used to mitigate risk, create pay-out thresholds and foster climate-smart investments. Banks can use tailored data to predict market cycles, offer consulting services, protect data centres affected by severe weather, and produce better analytics.
- **Health** - Weather and climate information can be key in predicting the spread of mosquito-borne diseases. The health industry can benefit in other unexpected ways. For instance, early weather warnings and consistent forecasts can prevent damage to costly equipment, minimize false alarms, or help predict fluctuations in patient admissions to hospitals.

Engagement with cell-phone companies is one of the strongest opportunities for the SLMD and the CIDMEWS-SL. Not only can they provide secure locations to site AWS, but they can also aid in the distribution of valuable life-saving messages to a wide, diverse audience. From the perspective of the SLMD, this can occur in a variety of ways:

- Directly, carried out by the SLMD, who pays the cell-phone company to do so, or if the material to be disseminated is critical but infrequent, such as storm warnings, the cell company may disseminate the warnings without charge as a public service.
- Indirectly, carried out by the telephone company, who develops a business in which a package of routine weather information, say a daily morning agricultural forecast, is provided for a (very) small fee to the user, in this case a farmer or herdsman. While the fee for each user could be small, there are many potential users, so the revenue could become sufficient to justify the service.
- Through a third party that serves as an intermediary between the SLMD and the phone company. This might be a for-profit branch of the SLMD that could add value to the meteorological information through additional analysis, tailoring and personalization before passing it on through the phone system to a paying customer base.

Mobile-phone companies should be encouraged to work with the SLMD because providing even basic weather information products to customers, as part of a wider suite of desirable content, pays back over time. For the operator the addition of reliable weather information—currently mostly derived from satellite data and other free services—catalyzes the value-added uses of other mobile services that are profitable, such as mobile banking. It also serves to reduce customer churn and attract new customers. However, the mobile-phone companies and various stakeholders ultimately require a carefully tailored and expertly packaged climate information, disaster management and early warning system like the CIDMEWS-SL (not just the raw weather data from AWS).

9 CAPACITY BUILDING

Community capacity building focuses on enabling all members of the community, including the poorest and the most disadvantaged or vulnerable, to develop skills and competencies so as to take greater control of their own lives and also contributes to inclusive local development. Not only can communities be more cohesive but they can also be more resilient and better placed to confront climate change challenges. Meaningful and effective community capacity building can be stimulated and fostered by national and local governments, and by the capacity which communities have already developed, so that power becomes increasingly embedded within them.

Climate forecast applications for early warning systems, training and capacity development programmes, innovation of multi-hazard early warning systems and a focus on needs of end users should help improve meteorological and hydrological forecasting in Sierra Leone. However, current weather and climate information products from the SLMD are either lacking or not effectively communicated and not well understood owing to a lack of communication and familiarisation. Traditional climate information products are not sufficiently user-friendly and the same information is often given to all users without advice on thresholds for action. Users are unable to interpret the risk information correctly or take appropriate action in response. This is regarded as a gap in early warning and forecast systems. Regular two-way communication between providers of information and decision makers (at all levels) is needed to enable the co-production of information relevant to decisions that need to be taken. Useful forecasts are those that meet recipients’ needs in terms of attributes such as timing, climate parameters, spatial and temporal resolution and accuracy.

Improvements in public weather services, by creating awareness and education programmes, campaigns, targeted initiatives and media outreach will help effectively communicate SLMD’s forecast products and climate information. This document also provides an overview of the results from the research survey and capacity building training conducted in requirements for the development of a flood warning and mitigation system in three flood-prone areas of Guma Valley Watershed in Freetown, Bumbuna Watershed in Tonkolili and Dodo dam in Kenema. The specific focus is to enhance local communities’ capacity to design and implement strategies to build, rebuild and sustain community capacity – especially in the disaster prone areas. To this end, this reports highlights the current approaches to Community Capacity Building (CCB), the challenges to designing effective CCB strategies, together with the drivers to more effective empowerment at the local level. Emphasis is also put on the skills and institutions needed in these communities to actively build or rebuild local social and economic life. Recommendations and examples of good practices (‘learning models’) are also provided.

A sound and robust early warning system should include the expertise of the local communities ensuring their capacity are enhanced with the support of the government and other Civil Society Organisations (CSO) to effectively produce the guidance, know-how and products that could be channelled to the grassroots. This support at the regional level should include access to weather forecast; on-demand human operational guidance in case of high-impact events; on-the-job training in all aspects of the operation.

9.1 Need for Capacity Building

Sierra Leone is particularly vulnerable to the increasing frequency and severity of droughts, floods and severe storms (hail, thunder, lightning and violent winds), and their impacts on sectors such as agriculture, fisheries, as well as infrastructure and hydroelectric power production. Such climate-related hazards are having increasingly adverse effects on the country and future climate change is likely to further exacerbate the situation. A large proportion of the Sierra Leone population has a low capacity to adapt to climate change. Climate change impacts are likely to be particularly negative in Sierra Leone’s rural population because of their high dependence on rain-fed agriculture and natural resource-based livelihoods. Sierra Leone’s capacity to adapt to climate-related hazards should, therefore, be developed to limit the negative impacts of climate change and address the country’s socio-economic and developmental challenges effectively.

One way to support effective adaptation planning – in particular for an increase in intensity and frequency of droughts, floods and severe storms – is to improve climate monitoring and early warning systems. For Sierra Leone to improve the management of these climate-related hazards it is necessary to:

- Enhance the capacity of hydro-meteorological services and networks to predict climatic events and associated risks;
- Develop a more effective and targeted delivery of climate information including early warnings; and
- Support improved and timely responses to forecasted climate-related risks

Barriers that need to be overcome to establish an effective early warning system (EWS) in Sierra Leone include the following:

- Limited knowledge and capacity to effectively predict future climate events;
- Weak capacity for issuing warnings and dissemination;
- Absence of a national framework and environmental databases to assess and integrate climate change risks into sectoral and development policies; and
- The absence of Long-term sustainability plan for observational infrastructure and technically skilled human resources.

Other stumbling blocks in the path include obsolete and inadequate weather and climate monitoring infrastructure, which limits data collection, analysis and provision of meteorological services; limited knowledge and capacity to effectively predict future climate events, non-existence of systematic processes for packaging, translating and disseminating climate information and warnings, uncertainty in the long-term sustainability of observational infrastructure and technically skilled human resources and lastly the poor community level usage of climate information and responses to received warnings.

9.2 Capacity Building Objectives

Community participation helps people to understand better how to manage projects and has increased and improved recognition of beneficiaries' needs, priorities, roles, and responsibilities in community development. It is essential that communities understand their risks: respect the warning service and know how to react. Education and preparedness programmes play a key role. It is also essential that disaster management plans are in place, well-practiced and tested and the community should be well informed on options for safe behaviour, available escape routes, and how best to avoid damage and loss to property.

The overall objective was to build the capacity of the local communities in targeted communities of Guma Valley Watershed, Bumbuna Watershed and the Dodo dam on practical applications of climate information and early warning services for improved decision-making and better management of natural disasters especially flood.

Specifically, the capacity building exercise was carried out with the following objectives:

- Engage community-focused organisations to undertake stakeholder consultations and capacity building exercises to analyse responses to previous early warning advisories and warnings and incorporate lessons learnt into future capacity building strategies.
- Assess community ability to respond effectively to early warning advisories and warnings.
- Ensure visited communities are trained to recognise simple hydro-meteorological and geophysical hazard signals to allow an immediate response.
- Ensure public awareness and education campaigns are tailored to the specific need of each audience (e.g. children, emergency managers, media, etc.) and mass media and folk or alternative media are utilised to improve public awareness of early warning advisories and warnings.

9.3 Capacity Building Methodology

The research design was based on a disaster risk reduction framework consisting of four key elements of an early warning system. The study comprised a literature review, field case study (focus group discussions and key informant interviews), and data analysis. Data were collected from both primary and secondary sources. Criteria were developed for site selection for the case study and guiding questions and checklists formulated for the focus group discussions and key informant interviews.

The study entailed reviewing target community response measures applied amidst changing climate/seasons. There was a deliberate assessment of indigenous knowledge of communities concerning climate change impacts, vulnerability and adaptation. This entailed analysis of community perceptions, attitudes on the adaptation and mitigation measures.

9.3.1 Stakeholder Consultations

A stakeholder analysis (including capacity gap analysis) of key institutions and/or players in the DRM and humanitarian sectors in Sierra Leone was carried out. The overarching objective of the stakeholder analysis was to create and facilitate the enabling environment for a multi-hazard, multi-sector, multi-agency partnership oriented disaster management programme, using risk knowledge as the base, in line with global conventions and frameworks.

The Project and its intended results involve a lot of stakeholders; hence, a comprehensive stakeholder identification and analysis were imperative. Stakeholders included the public, other national government agencies, emergency management agencies, local authorities, NGOs, the media, social scientists, national and regional infrastructure authorities, academia, etc. Involving stakeholders very early on in the Project has many benefits, such as:

- Improved presentation, structure, and wording of early warnings themselves;
- More effective communication of the risks and actions to take in response to severe weather;
- Better understanding of how, and how often, stakeholders want to receive warnings; and
- Increased sense of ownership, and therefore, credibility in the warning system.

INTEGEMS professionally engaged stakeholders and sectors consuming disaster management, risk assessment, meteorological, climatic and hydrological information to determine, among others, how best to communicate targeted information to users and how to build and strengthen local ownership of climate/hydro-meteorological information and services.

A Stakeholder Consultative Workshop was convened in Freetown, in collaboration with the UNDP, SLMD, ONS, EPA-SL and MWR. The workshop was facilitated by INTEGEMS with technical presentations and workgroup sessions. At the Workshop, various Subject Matter Experts directly or indirectly involved in the Project were encouraged to share their experience and expertise with others through presentations.

The purpose of the Stakeholder Consultative Workshop was to:

- Introduce the Project, review stakeholders' roles and responsibilities in the Project; and formalise a mandate that details what their contributions should be to the Project.
- Present the Project and proposed work plans to a wider audience and discuss the roles, functions, and responsibilities within the Project's decision-making structures, including reporting and communication lines, and conflict resolution mechanisms.
- Obtain support and commitment at the senior decision-making level from the SLMD, ONS, EPA-SL and MWR.
- Agree on key issues to be addressed during the Project
- Explore for availability of data and technical know-how available to the Project
- Identify data gaps and causes and clarify and resolve areas of overlaps or duplications of efforts
- Consult various stakeholders and present the stakeholder analysis and their role in achieving the project results.

Additionally, field visits were organised and community-focused organisations engaged with the main objective of undertaking stakeholder consultations and capacity building exercises to analyse responses to previous early warning advisories and warnings and incorporate lessons learnt into future capacity building strategies.

Specifically, stakeholder consultations at all levels were conducted to assess how users of early warning advisories and warnings understand climate-related issues, through:

- Assessment of the communities' ability to respond effectively to early warning advisories and warnings.
- Ensure visited communities are trained to recognise simple hydro-meteorological and geophysical hazard signals to allow an immediate response.
- Ensure public awareness and education campaigns are tailored to the specific need of each audience (e.g. children, emergency managers, media, etc.) and mass media and folk or alternative media are utilised to improve public awareness of early warning advisories and warnings.

9.4 Capacity Building Training Sessions

The training will provide a framework for managing increased climate change risks in Sierra Leone, which affect national institutions, local governments, and all actors in natural resources due to climate change impacts leveraging the initial needs assessments and prioritisation identified as climate change risks. Context

It aims to help local government departments:

- Specify risks related to climate change impacts
- Prioritise risks that require further attention
- Establish a process for ensuring that these higher priority risks are managed in time and effectively.

Needs assessment of the climate risks had been undertaken by trained technical personnel who have gained sound professional knowledge of all the environment and natural resource components; and their relevant interactions with institutions, together with a general understanding of the directions and magnitudes of climate change risks.

9.4.1 Training Objectives

The capacity building training were conducted with the main objective that by the end of the training each participant was able to understand and/ or be capacitated to perform the following tasks:

- Recognise simple hydro-meteorological and geophysical hazard signals
- Assess local risk levels
- Provide early warnings on extreme weather events
- Conduct regular drills.

9.4.2 Training Content

Disaster prone areas (i.e. flooding) in Tonkolili (BWMA) and Kenema (Dodo Dam) were visited and effective training and sensitization about disaster management were undertaken. Some of the important questions asked during the training and sensitization were;

- What is Disaster Management?
- The threats disaster presents to communities and livelihoods
- What individuals and communities can do in their local context to reduce their vulnerability to disaster and withstand its impacts?
- The opportunities presented by disaster and national adaptation strategies

This provides guidance on:

- How to prepare for and respond to climate-related disasters
- How to ensure that new and existing community disaster preparedness and response activities take disaster management into account
- How to ensure that community development programmes take disaster management into account

The two (2) most important training methodologies used were;

- Presentations
- Workshops

9.4.3 Training Programme

INTEGEMS' training comprised theoretical and practical components that were interactive and straightforward to ensure the messages were not lost upon the people. The training was broken down into five (5) topics, which are outlined below:

Topic 1: Recognising simple hydro-meteorological and geophysical hazard signals

Topic 2: Understanding how disasters affect our community

Topic 3: Assessing local risks

Topic 4: Deciding how to prepare for hydro-meteorological and geophysical hazards

Topic 5: Drills

9.5 Capacity Building Exercises

Capacity building exercises were conducted to analyse responses to previous early warning advisories. Lessons learnt from this exercise is intended to be incorporated into future capacity building strategies. The objective was achieved through public awareness, practical demonstrations and plenary discussions.

9.5.1 Public Awareness

Public awareness was used to increase awareness and participation of the community and make development participatory by transferring knowledge, skills and techniques to the people. The people-centred approach to early warning, promoted by the Hyogo Framework for Action, focuses on how communities must understand threats in order to avoid them. Disasters are partly caused by external hazards, but they also stem from vulnerability; people being in the wrong place, at the wrong time, or without adequate protection or resources to respond to a warning. The public awareness focused on empowering the local communities in Bumbuna, Dodo and Guma Valley Watershed especially women and youth associations by raising awareness and knowledge thus allowing residents to assess local risk levels and provide early warnings of extreme weather events using local languages.

9.5.2 Media Campaigns

Local NGOs and CBOs undertook flood awareness campaigns to provided uniform, standard messages with the intent of creating a large-scale impact. The campaign consisted of several messages promoting flood awareness that will target audiences in the Bumbuna and Dodo communities. The initial strategy relied heavily on a combination of media formats and tools to spread our campaign message to different audiences' via video documentaries, print posters, blogs, audio podcasts, recorded street theatre performances, radio drama or SMS (text message). We used humour and compelling testimonies to help share the message and resonating with the audience. Humour, to appeal to a young audience, and broadcasting compelling stories of personal experiences, to ensure these are heard by those who have the power to change the situation.

The initial duration of the campaign was short-term (3 months) and was intended to occur annually especially during the build up to the rainy season. The campaign reached the largest number of people whilst working and building on strengths of all partners and attracting mass media attention.

9.5.3 Participatory Learning

Participatory learning aided communities to self-identify threats and vulnerabilities, whilst developing a foundation for risk awareness. Identifying resources and capacities boost confidence and self-sufficiency while building a sense of local and personal ownership. This approach encouraged local stakeholders to be a part of the solution and provide an opportunity to integrate disaster reduction with health, water and sanitation, livelihood protection and climate-change adaptation.

Whilst the campaigns run in the background, our focus was to engage people in discovery and problem solving concerning flood hazard awareness and disaster risk reduction. We used local languages (Temme, Loko, Limba, Mandingo, Mende and Creole) to create catchy and enlightening songs, jingles, stories and folklore incorporating/ using traditional characters such as "bra spider", tortoise, monkey, "koni rabbit", snake and frog to strengthen the emerging culture of prevention.

The community engagement was applied at two levels:

- The organisational level – headquarters, branches, schools, businesses, workplaces, homes
- The community level – being scaled up to reach villages and towns

The tools listed below targeted children and marginalised populations:

- Publications such as booklets and illustrated graphics (Posters, leaflets and booklets)
- Participatory activities such as transect walk, risk and asset mapping, seasonal calendar, group discussion, drills, simulations and tabletop exercises
- Audio and video materials, including videos, audio clips and songs or other music

Our approach encouraged communities to own their own data and plans enabling the ONS and NGOs to work with people rather than for them, thus building organisational capacity and improving relationships among all partners.

9.5.4 Informal Education

The focus of informal education took advantage of brief moments and encounter to stimulate thinking and engage people in the discovery of actions and behaviours to increase safety and resilience. Informal education in communities and schools is the most flexible of all approaches with respect to setting, audience and timeframe. Specific tools used for informal education include:

- Publications – posters, guidelines, flyers, brochures, booklets, activity books, paper models, comic books, story books, colouring books, assembly kits and teacher resources
- Curricula, modules and presentations – teacher briefings and community training
- E-learning – self-study curricula
- Performing and cultural arts – plays, dances, poems, songs, street theatre, puppet theatre

- Games and competitions – card games, board games, cooperative, activities role play, drawing competitions, writing competitions, tournaments, radio quizzes
- Audio and video materials – short videos, radio programmes, television programmes
- Web pages and activities – web sites, online games, online quizzes
- Social media and telecommunications – SMS, early warning.

Informal education involved disseminating standard messaging but with the flexibility to accommodate the needs and concerns of specific local audiences. This is particularly effective because peer information, social proof and social support are vital to shifting human behaviour. Volunteers are leaders and role models that offer powerful examples as they engage the wider public. Tools focused on stimulating discovery and problem solving allow scope for endless creative activities and materials to appeal to various target audience segments. These include:

- Presentations
- Brainstorming
- Guided Discussion
- Small Group Discussion
- Demonstration, Visual Aids
- Question Box
- Role Play
- Dramatization
- Storytelling
- Simulation
- Case Studies

They involved communicating and building relationships and organising, sensitising and mobilising communities. Peer-to-peer activities work equally well with adults, youth and children. Much of the best informal education has cross-generational appeal. Often the energy, enthusiasm and curiosity of children and youth are the hooks for adult involvement. One of the strengths of school-based informal education is that the school can act as a hub to attract the wider community, through special programmes, by showcasing student work and by sending messages home with students. Just like other strategies, the potential benefits of informal education will be reached through scaling up, consistent messaging and a focus on behaviour change.

The focus of formal school-based interventions covers two areas: school disaster management and disaster risk reduction in school curricula. These are considered to be formal because accountability and responsibility for school safety and curricula belong exclusively to education authorities, so they require support for long-term planning and capacity building. Whether there is one such authority, many, or seemingly none, the same issues of caution remain.

Unless efforts are being officially and systematically piloted or tested, inconsistency may undermine rather than support the goal. No matter how schools are organised, where possible a proper approach should begin with a group of interested NGOs and intergovernmental organisations that approach school authorities in a spirit of collaboration, in order to offer support and identify a single focal point within the system. Expecting schools to contend separately, with multiple uncoordinated projects and programmes, places a burden on school authorities and is ultimately unproductive. The goal is not to run a parallel system, but to support and help develop capacity within existing public education systems. The team should also approach and involve national disaster management authorities.

The primary goals of school disaster management are to ensure the safety of students and staff, and for education to continue. Sustained school disaster management requires the familiar participatory and ongoing process of identification of hazards and risks, mitigation and reduction of risks, and developing response capacity. In order to be effective, these need to be led by school staff and supported by consistent policies throughout the jurisdiction.

A school disaster management plan, developed at the school level, should be the living document that expresses this. Standard operating procedures in response to various hazards should be consistent. Training in response skills is vital. The following elements are essential:

- An incident command
- Community-based first aid type of system to organise
- Mass casualty triage the local responder
- Light search and rescue
- Fire suppression
- Communications
- Psychosocial support
- Shelter
- Sanitation
- Nutrition
- Evacuation
- Student–family reunification procedures.

9.5.5 Plenary Sessions

There was an imperative need to improve the transfer of knowledge, technology and expertise and the sharing of best practices and lessons that may help to enhance capacity building for sustainable risk reduction and improved disaster management. Several plenary sessions were undertaken with relevant stakeholders and disaster prone communities.

Emphasis was laid on what kind of research, education and training was needed, in order to respond efficiently to risks and disasters in the future, as well as how new technologies can enhance the processes of learning about reducing risks and managing disasters. Interactive discussions were highlighted on how to build capacity in order to analyse, map and forecast hazard, risk, vulnerability and impact. The session addressed how to raise awareness in all sectors of society, and how to make sure that relevant information is disseminated effectively to policy-makers, the general public and communities at risk. In order to reduce vulnerabilities and increase resilience, information must be integrated into decision-making processes.

9.5.6 Practical Demonstrations

Practical Actions work with communities to reduce the impacts of disasters and to alleviate poverty. The existing capacities of the community, such as the livelihoods and assets, are the basis to enhance their ability to improve economic status and increase resilience by improving capacities of community and stakeholders to reduce hazard stresses, sensitivity and better preparedness such as an early warning to reduce disaster risk.

9.6 Challenges

The survey and training exercises provided a lot of information on the key challenges faced by these communities from the lack of requisite tools and equipment to information technology infrastructure, and professional staff capacity, as well as prepare for hazards beyond tropical cyclone.

9.7 Recommendations and Way Forward

Recommendations have been made in line with findings on targeted components of the project that include water, energy, agriculture, land management and environment.

The findings and recommendations of this study are expected to be useful to policymakers and implementers in strengthening new EWS by integrating gender into their design and implementation. The following recommendations are made to ensure that flood early warning systems are gender sensitive, gender responsive, and effective.

- **Involve women in all aspects of EWS**: Ensure that disaster management activities are gender sensitive at all stages of the disaster cycle, by involving both women and men in the design, administration, and implementation of EWS.
- **Link organizations in EWS with those working for gender equality**: Link policies and organizations for disaster management and EWS with those for gender equality and social justice (such as the National Commission for Women and Children, the Gross National Happiness Commission, and INGO/NGOs working on gender and social issues) to help achieve gender integration in EWS.
- **Amend policies and laws to be gender sensitive:** Amend policies and laws to make it mandatory to consider the differential experiences, needs, and roles of women and men in disaster management.
- **Bring about a gender balance in the staffing of EWS implementing agencies**: Bring about a gender balance in the staffing of agencies implementing disaster management and EWS to improve the gender sensitivity and responsiveness of EWS. For this, affirmative action in recruitment and incentive structures for women should be considered to facilitate the promotion of women to higher positions
- **Strengthen the capacity of communities for EWS:** Continuously strengthen the capacity of communities for EWS, with particular attention to the involvement of women in risk knowledge, monitoring and warning, dissemination and communication, and response capacity, to ensure the sustainability of the EWS. Affirmative action should be used to ensure women's involvement in capacity building activities, such as training and exposure visits, to enhance their capacity to respond to floods. Women should also be involved in infrastructure management teams for local early warning systems to enhance women's leadership in EWS.
- **Use gender responsive materials in capacity building and EWS technology: Ensure** that the materials used in capacity building activities and technology for EWS are responsive to the needs of all community members. For example, illustrative communication materials are more effective for illiterate community members, among whom women constitute the majority. Similarly, the preference for mobile phones as a tool for receiving flood warnings (over sirens) is higher among women; hence, consider integrating both sirens and mobile phones as part of the alert system. The sound of a siren for flood warning also needs to be differentiated from other warnings, such as those for ambulances.
- **Increase community ownership of EWS for greater sustainability and effectiveness**: Consult stakeholders while planning, designing, and implementing EWS to avoid any mismatch between the needs of different social groups, including women, and to install ownership of the system in local communities.
- **Conduct further research on gender issues:** Conduct further research on gender issues in disasters to inform policies and programmes. There is a need for the increased documentation of successful gender strategies used by communities living in disaster-prone areas. There is also a need to focus on gender-based vulnerabilities and capacities, rather than physical exposure to technological and environmental hazards.

9.8 Conclusion

In this context, this study reviewed disaster risk reduction and management and EWS-related policies, organisations, and practices at the community level in Bumbuna and Dodo communities from a gender perspective to understand the gaps and challenges in establishing an effective and inclusive EWS. What is missing from these policies is the integration of gender into the four elements of EWS (risk knowledge, monitoring and warning, communication and dissemination, and response capacity) to ensure the receipt of equal benefits of EWS implementation by men and women and to minimize the unequal impact of flood disasters on men and women. The review of the 23 organisations involved in disaster risk reduction and EWS highlighted the need for coordination and linkages among institutions to strengthen early warning practices. The study found that coordination and collaboration among the various organisations involved in ‘risk knowledge’ and ‘information dissemination’ could minimise the loss of life and property in a flood event.

More efforts are needed to ensure that EWS information on hydro-meteorological hazards and risks reach all end users, including women, vulnerable groups and specific social groups, especially those who are illiterate. The study also found that the methods used to disseminate warnings need to consider the needs of different members of the community. Some of the women who participated in the survey preferred receiving warnings by mobile phone, rather than siren (which are only sounded in public places); hence, an integrated warning system consisting of both mobile alerts and sirens should be considered in EWS design.

10 BIBLIOGRAPHY

Blinker, L., 2006. Coutry Environment Profile (CEP) Sierra Leone

Bomah & A.K. S.S. Sama, 1990. Deforestation and Soil Degradation in Sierra Leone. International Journal of Ecology and Environmental Sciences, pp. pg 16, 97 – 105.

Centre for International Studies and Cooperation, Norwegian Geotechnical Institute (NGI) & Asian Disaster Preparedness Centre (ADPC), 2010. Nepal Hazard and Risk Assessment

Church, J. A., White & N.J., 2011. Sea-Level Rise. Surveys in Geophysics, Volume 32(Issue 4-5), pp. pp 585-602.

CIty, N. Y., 2014. Hazard Mitigation Plan (Draft), New York

Cole. N., 2007. Climate Change Impacts, Adaptation and Vulnerability, Sierra Leone: Njala University College Press.

Cunha Forte, J., 2016. Liquid Waste Management Strategy, Bo City: Bo City Council and WeltHungerHilfe.

Department, D. M., June 2011. Sierra Leone National Platform for Disaster Risk Reduction and Climate Change Adaptation – Draft Working Document

Diara, M.A & Koroma S.D., 1995. Population Projections and Policy Implications of the 1985 Population Census, Freetown Sierra Leone: National Population Commission.

Disaster Management Center (DMC), 2012. Hazard Profiles of Sri Lanka

DM, 2012. Disaster risk reduction and risk management, Sierra Leone

EM-DAT, 2011. The OFDA/CRED International Disaster Database. [Online] Available at: www.em-dat.net [Accessed 12 September 2017].

Environment Protection Agency-Sierra Leone (EPA-SL, 2015. Sierra Leone State of the Marine Environment Report, Freetown

Facility, G. E., 2001. A Guide for Self- Assessment of Country Capacity Needs for Global Environmental Management, Washington D.C. U.S.A: International Geosphere-Biopshere Programme (GBP).

Fileccia, . A. T., 2017. Hydrogeology of Sierra Leone, Freetown: Ministry of Water Resources.

Gordon, O., Kater, A. G. & Schwaar. , . D., 1979. Vegetation and Landuse in Sierra Leone, UNDP/FAO.

Government of Sierra Leone Ministry of Transport a, 2007. Sierra Leone National Adaptation Programme of Action

Government of Sierra Leone, 1989. The Forestry Regulations

Government of Sierra Leone, 1991. The constitution of Sierra Leone

Government of Sierra Leone, 1994. National Environmental Action Plan, Volume 1

Government of Sierra Leone, 1994. The National Environmental Policy

Government of Sierra Leone, 1998. National Forestry Act

Government of Sierra Leone, 2000. National Environment Protection Act

Government of Sierra Leone, 2000. The Sierra Leone Maritime Administration Act, Freetown

Government of Sierra Leone, 2002. National Security and Intelligence Act, Freetown

Government of Sierra Leone, 2003. Road Transport Authority Act

Government of Sierra Leone, 2003. Sierra Leone National Recovery Strategy Assessment, Final Report. Freetown

Government of Sierra Leone, 2004. The Local Government Act

Government of Sierra Leone, 2006. Initial Communication (INC) on Climate Change

Government of Sierra Leone, 2008. Poverty Reduction Strategy Paper 1

Government of Sierra Leone, 2013. The Agenda for Prosperity

Group), E. (. a. S. C., 1988. The Study of Watershed Degradation in Sierra Leone

Hɛn Mpoano, 2013. Coastal Resources Center: Coastal Hazards and Flooding Risk, Ghana's Western Region: Our Coast, Our Future.

Institute of Marine Biology and Oceanography, 2002. Management Plan for Sand Extraction in Sierra Leone

Jesus, C., 2010). Capacity Assessment of the Disaster Management Department, s.l.: Office of National Security.

Johnson, M. J., 2003. An Investigation into How to Rationalize and Institutionalize EIA in Sierra Leone, Freetown

Karim, A. B. & Reynold, G., 1996. Assessment of Damages caused to the Environment and Biodiversity, Mining and Agriculture, Karim A.B. ; Eds. A.B. Karim, Reynold G

Karim, A. B. et al., 2004. National Hazard Assessment Profile, Freetown: Office of National Security.

Karimu, M., 1992. Community Perception of Environmental Problems: An Opinion Survey in Bo and its Complementary Regions. Njala University College.

Keyser & Mansaray, 2013. Geologic Map of Sierra Leone: (1:250,000), s.l.: Sierra Leone National Mineral Agency (Sierra Leone Geological Survey).

Koroma, A. P., 2004. Causes of Forest Loss and Degradation and Issues of unsustainable Forestry in Sierra Leone

McSseeney, C., New, M. & Lizcano, G., 2012. UNDP climate change country profile, UNDP.

Ministry of Energy and Water Resources, 2008. National Water and Sanitation Policy, Freetown

Ministry of Fisheries and Marine Resources, 2016. Summary of Revenue Generation, Freetown

Ministry of Health and Sanitation, 2004. Medical Statistics, Environmental Health Unit.

Ministry of Health and Sanitation, 1995. National Environmental Action Plan Vol. 1, Freetown

Ministry of Lands, Country Planning, 2001. Case Studies of the Impact of Natural Resources and the Environment, Freetown

Ministry of Transport and Aviation, 2007, December. Sierra Leone National Adaptation Programme of Action (NAPA) – Final Report, Freetown: Government of Sierra Leone.

Ministry of Water Resources, 2015. Data and hydrological understanding generated in the Water Security project Vol. 3, Freetown

Ministry of Water Resources, 2015. Strategy for Water Security Planning Vol. 1, Freetown

Ministry of Water Resources, 2015. Water resources monitoring in Sierra Leone Vol. 2, Freetown

Morel, S. W., 1979. The geology and mineral resources of Sierra Leone, S. W.: Sierra Leone Diamond Company Limited.

NACEF, 2006. Report on Working Visit to Eastern Province (Kono and Kenema Districts)

National Climatic Data Centre, 2006. Climate of 2006, s.l.: U.S. Standardized Precipitation Index

National Drought Mitigation Centre, 2009. Monitoring Drought. [Online] Available at: http://drought.unl.edu/ [Accessed 25 September 2017].

Nations, U., 1992. United Nations Framework Convention on Climate Change, New York: United Nations.

New York City, 2014. New York City Hazard Mitigation Plan (Final Draft), New York

OECD, 2000. Shaping the Urban Environment in the 21st Century: From Understanding to Action, a Development Assistance Committee Reference Manual on Urban Environmental Policy

ONS-DMD Sierra Leone, 2010. National progress report on the implementation of the Hyogo Framework for Action (2009-2011) – interim

ONS-DMD Sierra Leone, 2004. National Hazard Assessment Profile, Freetown: FBC-USL.

ONS-DMD Sierra Leone, 2011. Joint Assessment Report on Floods and Fire Disasters in Kenema, Kambia and Freetown for year 2011

S, A., 2010. Solid waste management. Solid waste management.

Saaty, T. L., 2008. Decision Making with the Analytical Hierarchy Process

Sankoh, S. K., 2001. Report of the Scientific Investigation on the Environmental Effects of Sewage Discharge and Solid Waste Dumping into the Sierra Leone Estuary

Sierra Leone Meteorological Services, 2011. Sierra Leone Energy Policy and Strategic Plan 2009

Statisitics Sierra Leone, 2015. Population and Housing Census, Freetown: Statisitics SL.

Statistics Sierra Leone, 2004. National Census Report.

Statistics Sierra Leone, 2005. Provisional results of the Population and Household Census, Freetown

Stuart, S. N. & Adams, R. J., 1990. Biodiversity in sub-Saharan Africa and Its Islands Conservation, Management and Sustainable Use

Tappan, G. G., 2016. West Africa: Land Use and Land Cover Dynamics. [Online]

Available at: https://eros.usgs.gov/westafrica/data-downloads [Accessed 15 September 2017].

Tarawalli, P., 2012. Diagnostics Analysis of Climate Change and Disaster Management in Relation to the PRSP III in Sierra Leone, Freetown: UNDP - SL.

UNDP, 1994. United Nations Convention to Combat Desertification, New York: United Nations.

UNDP, 2011. Human Development Report

UNDP, 2011. Sierra Leone Disaster & Risk Management Report, Freetown

UNDP, UNEP, FAO & UNHABITAT, November 2005. Report on the Joint United Mission on the proposed National Commission on Environment and Forestry in Sierra Leone

UNEP, 2010. Sierra Leone: Environment, Conflict and Peace Building Assessment – Technical Report

UNEP, U. N. E., 2002. Global Environment Outlook Programme

UNISDR, 2009. Terminology on Disaster Risk Reduction

World Meteorological Organisation, 1992. International Meteorological Vocabulary, Geneva: WMO.

World Meteorological Organisation, August 2005. Meteoworld (weather. Climate. Water), WMO.

11 APPENDIX A – STAKEHOLDER CONSULTATIVE WORKSHOP

11.1 Stakeholder Identification, Consultations and Workshop

11.1.1 Identification

INTEGEMS identified and professionally engaged stakeholders and sectors consuming disaster management, meteorological, climatic and hydrological information to determine, among others, how best to communicate targeted information to users and how to build and strengthen local ownership of climate/hydro-meteorological information and services.

The process of a technology needs assessment is strongly participatory as it requires stakeholders' input at each stage; hence, a comprehensive stakeholder identification was imperative for:

- improved presentation, structure, and wording of early warnings themselves;
- more effective communication of the risks and actions to take in response to severe weather;
- better understanding of how, and how often, stakeholders want to receive warnings; and
- increased sense of ownership, and therefore, credibility in the early warning system.

Stakeholders include the public, other national government agencies, emergency management agencies, local authorities, NGOs, the media, social scientists, national and regional infrastructure authorities, academia:

- **Government**: Given their mandate, governments at all levels are the quintessential partners of the Project. Local and district governments, often have the first legal responsibility for disaster risk reduction/management, and will be the first partners a community should look to when developing early warning systems. INTEGEMS will promote local government much more in the Project, as they are the closest governmental institutions to communities, usually have many regulatory powers relevant to disaster risk reduction, and can be an accountable channel for the GoSL resources for early warning systems.
- **NGOs and the Red Cross/Red Crescent:** There is a growing cohort of grassroots organizations that are making interesting advances in the field of bottom-up and genuine community-driven early warning systems, in support of national and local authorities wherever possible. There is little reason for the International Red Cross Red Crescent Movement or any NGO to start early warning systems all alone. Although partnerships may slow down the process (gaining wide ownership and consensus takes time), they will greatly strengthen the impact and sustainability by partnering with projects like the CIDMEWS.
- **Media**: National and local media channels have a stake in the Project. Their business is communication: getting the word out to the largest possible group of listeners or readers. The media also have the responsibility to relay accurate and timely information to those in need. All Project efforts, and especially training sessions, include media representatives, not just to be informed and publicize the effort but also to participate and contribute as another active member of the Project community. INTEGEMS capitalized on the strengths of the media to better explore communication channels for remote communities, help package warning messages into consumable actionable chunks and lobby for free or subsidized air-time or print-space to assist in issuing disaster management information and hydro-meteorological forecasts and warnings to customers, partners and the public.
- **Private sector:** Even at the community level, and definitely higher, private sector enterprises have resources that could be put to good use to strengthen CIDMEWS. Not only will warning messages directly benefit the private entities by helping to keep their supplies safe and sound, but they will also be encouraged (or demanded by the GoSL) to demonstrate corporate social responsibility (CSR). Giving back to the community by donating a communication device or building a shelter demonstrates recognition that they are part of the community. The private sector entity that will be

prioritized in Phase 2 for link with the CIDMEWs is the telecommunications industry (warning dissemination).

- **Military and Police**: The Republic of Sierra Leone Armed Forces (RSLAF) and Sierra Leone Police (SLP) have strengths and capacities that can be tapped to deliver warning messages to at-risk communities. They may have human resources or communication channels that they would consider lending to a warning effort, if authorized by the GoSL that manages them. They may benefit from partnerships and assessing the CIDMEWS, including training sessions that are organized.
- **Academia and youth:** Still closely entwined with the community, it is important to creatively explore how to use universities, institutes, schools and groups of youth to compile risk knowledge, monitor hazards, build response capability and communicate early warnings. We will engage students in the act of monitoring river levels and rainfall to provide the perfect teachable moment for a lesson on disaster risk science, while developing an archive of data that could serve both community needs and science.

11.1.1.1 Key Consultative Meetings with Relevant MDAs

The summary represents the results of the initial consultations with the relevant key stakeholders, primarily the SLMD, ONS, UNDP, EPA-SL and MWR

11.1.1.1.1 Sierra Leone Meteorological Department (SLMD)

Department	Sierra Leone Meteorological Department
Dates	17- 18 October 2016
Participants	Alpha Bockarie (SLMD), Sinneh Kamara (SLMD), Gabriel Kpaka (SLMD), Julius Mattai (INTEGEMS), Koinguma Baimba (INTEGEMS) and Samuel Nonie (INTEGEMS)
Summary The consultation covered a review of the SLMD's management framework in place, departmental practices and procedures and discussions relating to the CIEWS project in terms of significant problem areas to better understand the dynamics of the Project and how to build and strengthen local ownership of climate/hydro-meteorological information and services. In summary, the following were discussed: **Technical Capacities:** The SLMD lacks the requisite technical capacities in all areas, including infrastructure, equipment and human resources**.** **Management Process:** The need for necessary processes to be in place was discussed as the current management requires work standards for proper coordination. It was recognized that management is anxious to this issues as the restructuring phase is ongoing with the appointment of the new Director of the SLMD. **The Project**: The Projects methodology was briefly explained describing the scope of work and deliverables and the manner in which the output of the contract, such as work documents, progress reports will be submitted. INTEGEMS staff were given a tour of the building and ICT infrastructure.	

11.1.1.1.2 Office of National Security (ONS)

Department	Office of National Security
Dates	28 September 2016 and 19 October 2016
Participants	Julius Mattai (INTEGEMS), Koinguma Baimba (INTEGEMS), Samuella Faulkner (INTEGEMS and 12 Directors and Managers of ONS

Summary

The initial consultation with the ONS entailed a PowerPoint presentation of the Project by Mr Mattai and a tour of the ONS relevant departments, especially the ICT facilities and the Situation Room. The presentation was centred on the Project's objectives, scope and methodology. Discussions that ensued after the presentations highlighted the importance of disaster management, early warning systems, national security and the Project, the timeliness of the Project and the necessary support (both administrative and technological) needed for the successful implementation of the Project.

Subsequent consultations were conducted on 19 October 2016 to discuss the technical aspects of the Project in terms of ICT. A demonstration of the technical solution for the Project was displayed with schematics of the CIDMEWS architecture, system components and work flow process and CIDMEWS infrastructure and system components. The findings from the consultation revealed that the both the ICT and DM departments lack some of the necessary CIDMEWS technical capabilities and this will be supported with the implementation of the Project.

11.1.1.1.3 United Nations Development Programme (UNDP)

Department	United Nations Development Programme
Date	3 October 2016
Participants	Julius Mattai (INTEGEMS), Samuella Faulkner (INTEGEMS), Koinguma Baimba (INTEGEMS), Sylvester Tucker (INTEGEMS), Joseph Kaindaneh (UNDP) and Georgie George (UNDP)

Summary

INTEGEMS staff met with Georgie George (Technical Advisor: Alternative Technologies Programme on Climate Information for Resilient Development in Africa (CIRDA)) and Mr Joseph Kaindaneh (Project Manager, UNDP CIEWS) to give a comprehensive presentation on the Project. The presentation gave an overview of the Project objectives and scope touching on INTEGEMS proposed methodology, work plan and project deliverables. The meeting was also set up to ensure both INTEGEMS and the UNDP were on the same page and identified synergies and overlaps in the proposed work plan and work done by other consultants. During the meeting, the UNDP Project Management Team highlighted an overlap concerning the subcontracting of Task 2.4 to Meteo France International (MFI) and work already done by Earth Networks, who were already contracted by UNDP to install automatic weather stations nation-wide, including a demonstration of the Earth Networks portal and data/information. Mr George demonstrated the lightning network system that was installed by Earth Networks in Sierra Leone.

11.1.1.1.4 Environmental Protection Agency- Sierra Leone (EPA-SL)

Department	Environmental Protection Agency- Sierra Leone
Date	18 October 2016
Participants	Julius Mattai (INTEGEMS), Koinguma Baimba (INTEGEMS), Samuel Kamara (EPA-SL), Paul Lamin (EPA-SL), and eight (8) other EPA-SL staff
Summary INTEGEMS met 10 members of EPA-SL staff consisting of Directors, Heads of Departments and Officers. During the meeting, INTEGEMS staff gave an overview of the project, objectives and scope and highlighted the role the EPA-SL would play in the Project, especially in GIS and climate change. During the meeting a misunderstanding in the scope of work for the Project was brought to light, EPA-SL staff believed they should have been the implementing partner instead of INTEGEMS. INTEGEMS also asked EPA-SL for permission and co-operation during the needs assessments. At the end of the meeting, Mr George commended the progress made by INTEGEMS and promised to share project related documentation with INTEGEMS.	

11.1.1.1.5 Ministry of Water Resources (MWR)

Department	Ministry of Water Resources
Date	18 October 2016
Participants	Julius Mattai, Koinguma Baimba, Samuella Faulkner, Sylvester Tucker, Leticia Gbondo, Hafisatu Sillah, Joseph Tucker (All INTEGEMS) and Mohamed Juana (MWR) and St. John Day (Adam Smith International)
Summary INTEGEMS team met with Mr Juana and a Representative from Adam Smith International. The meeting allowed INTEGEMS to give an overview of the Project and its objectives and scope, proposed methodology, work plan and project deliverables, highlight synergies/overlaps and the role the MWR would play in the Project. INTEGEMS commended the work that the MWR, in collaboration with Adam Smith International, was doing with regards hydrological monitoring. The Adam Smith representative gave an overview of the Sierra Leone Water Security Project and the pilot hydrological monitoring network in the Rokel-Seli River Basin and raised his concerns about CIDMEWS complexity and sustainability. Mr Juana praised INTEGEMS and assured the MWR's commitment and co-operation.	

11.1.2 Facilitation of the Stakeholder Consultative Workshop

A **Stakeholder Consultative Workshop** was convened in Freetown on Thursday 13 October 2016 at the INTEGEMS Geo-Innovations Centre, Freetown, Sierra Leone, in collaboration with the UNDP, SLMD, ONS, EPA-SL and MWR. The SLMD and UNDP were responsible for organising (i.e., publicity and invitation of stakeholders, Workshop venue hire, catering/hospitality, etc.) the Workshop, while INTEGEMS was responsible for the facilitation of the Workshop, including technical presentations and workgroup sessions. At the Workshop, presentations were made by various Subject Matter Experts directly or indirectly involved in the Project and were encouraged to share their experience and expertise with others.

11.1.2.1 Purpose of Workshop

The purpose of the Stakeholder Consultative Workshop was to:

- Introduce the Project, review stakeholders' roles and responsibilities in the Project; and formalize a mandate that details what their contributions should be to the Project.
- Present the Project and proposed work plans to a wider audience and discuss the roles, functions, and responsibilities within the Project's decision-making structures, including reporting and communication lines, and conflict resolution mechanisms. The Terms of Reference for the Project was discussed as needed.
- Obtain support and commitment at the senior decision-making level from the SLMD, ONS, EPA-SL and MWR.
- Agree on key issues to be addressed during the Project.
- Explore the availability of ICT, data and technical know-how available to the Project
- Identify data gaps and causes and clarify and resolve areas of overlaps or duplications of efforts
- Consult various stakeholders and present the stakeholder analysis and their role in achieving the project results.

11.1.2.2 Statements by the Workshop Participants

11.1.2.2.1 Statement by the Representative of the UNDP Deputy Country Director

The UNDP Sierra Leone Deputy Country Director was represented by Mr Joseph Kaindaneh, Project Manager, UNDP Climate Information and Early Warning Systems (CIEWS) Project. In his statement, Mr Kaindaneh outlined the various facets of the overall Climate Change programme for Sierra Leone. He expressed UNDP's support and firm commitment to the overall implementation of the Project and highlighted the various initiatives UNDP is supporting in Sierra Leone. He stated that the current Support to Communication and Dialogue on Early Warning and Forecasting Products & Climate Information Project is very crucial to the overall Climate Change project as it has to do with communication and dialogue between the various stakeholders. He stated that this Project symbolises the continued progress that Sierra Leone is making towards becoming more resilient to the impacts of global climate change.

He stated that the Project is part of a regional initiative on Strengthening Climate Information and Early Warning Systems for Climate Resilient Development and Adaptation to Climate Change, in which ten (10) other African countries are undertaking, which is supported by the Global Environment Facility (GEF), with support from the UNDP and implemented by the Ministry of Transport & Aviation (MTA) in partnership with the ONS, the EPA-SL, the MWR and other partners. He highlighted the progress that has been made including the installation of eight new automatic weather stations, the setting up of communications servers, the development of standard operating procedures and early warning products, and the training of hydrological and meteorological experts in order to ensure that Sierra Leoneans are able to benefit from daily weather forecasts through various channels by the end of 2016. This he said will mark the beginning of a new chapter in communicating real-time and reliable climate and early warning information for the country. Furthermore he expressed optimism, that the outcomes of this Project is expected to strengthen Sierra Leone's capacity to communicate climate and early warning information, adapt to climate change impacts, and also in greater resilience of the country from expected climate related shocks.

The Workshop, he indicated, is a unique opportunity for stakeholders to identify and agree on workable communication systems, and strategies that would equip Sierra Leone to monitor and predict weather patterns and extreme events, as well as prepare for and respond effectively to natural hazards. This will be crucial in protecting vulnerable population groups, in helping vulnerable sectors plan ahead, and in enabling the country as a whole to prepare for, and adapt to the impacts of climate change.

In conclusion, he commended the Ministry of Transport and Aviation, and its Meteorological Department, the Office of National Security, the Sierra Leone Environment Protection Agency and the Ministry of Water Resources for their continued efforts in contributing to making Sierra Leone and its people more resilient to the local impacts of global climate change

11.1.2.2.2 Statement by the Director of Sierra Leone Meteorological Department

Mr Alpha Bockarie, Director of Sierra Leone Meteorological Department, in his speech outlined the various activities of his Department, the strides they are making and the support underway from various development partners, including UNDP.

He expressed his gratitude to the UNDP and all implementing partners for the Support to Communication and Dialogue on Early Warning and Forecasting Products & Climate Information Project and stated that the Project came about as a result of the shortcomings faced by the SLMD, especially at a time when the Country is confronted with critical climatic threats. He mentioned that this Project is been implemented in ten other African countries as part of the Strengthening Climate Information and Early Warning Systems in Africa for climate resilient development and adaptation to climate change.

He identified the challenges that propelled the need for the Project to be implemented and key of these challenges were limited knowledge and capacity to effectively monitor climate events; weak capacity for issuing warnings and lack of observational infrastructure and technically skilled human resources. He stated that the Project started earlier in 2014 before the Ebola crisis; thus, it is far behind schedule, but he assured that the Project will be successfully delivered in 2016.

Mr Bockarie catalogue the types of support required by the SLMD, including human capacity building for the SLMD. In conclusion, he expressed hope that the Workshop will lead to practical and viable steps towards addressing climate challenges and emphasized the need for all stakeholders to give their input and collaborative efforts to ensure successful delivery and implementation of the Project to help shape adaptation policies and prepare for future uncertainties.

11.1.2.2.3 Statement by the Director of Disaster Management Directorate (DMD), ONS

Mr John Vandy Rogers, Director of ONS-DMD, in his statement spoke about progress the ONS has made in putting together a framework for responding to disasters in general and climate change related hazards and disaster particularly. Mr Rogers stated that global interest in early warning has been heightened since the Indian Ocean Tsunami of 26 December 2004.

He stated that the Workshop is very timely as it comes at a period when the nation is being faced with critical climatic threats and one of the aims of the Project is to strengthen community resilience and local adaptive capacity to climatic change. Outlining the climatic changes affecting the nation, Mr Rogers discussed the present and future impacts of changes in weather patterns and explained the particular vulnerability of the nation to climate change. He stressed the importance of early warning, citing the flood incident that happened in Freetown in September 2015 that impacted the lives of people and the nation. He said that if there was a structured early warning systems in place such a flood disaster would have been averted by informing the people to move away for those disaster prone areas in time.

He went on further to say that for an early warning system to be effective, communities at risk must be involved as this will help strengthen community resilience and local adaptive capacity to climatic change. Furthermore he emphasized the need for participation and community involvement in identifying, analyzing, reducing and monitoring and evaluating disaster risks by integrating mobile communication networks into early warning programme and leveraging the perverse use of mobile communications technology in the country. This he said will help end users to have early and timely information on hazards as in most instances the community are the first to respond.

He further highlighted the importance of early warning system, stating that it goes beyond just a warning system to the public but also the provision of real time early warning alerts in advance of the impact of disasters and hazards such as, lightning storms, tsunami, floods, wild fires and earthquakes. Early warnings will also be given for industrial, chemical, and biological accidents, as well as intentional terrorist actions. Most potential threats to human life and property will be included in the system.

In conclusion, he recognised the need to foster closer relations with disaster mitigation agencies and support a multi-sectoral approach which will be utilized in addressing the challenges of climate change. He also encouraged all stakeholders to work with INTEGEMS and give the necessary support needed to mobilize action from all sections of society, from grassroots level through to governmental and international organisations for greater collaborative efforts and action to help shape adaptation policies and prepare for future uncertainties for the safety and security of the nation.

11.1.2.2.4 Statement by the Representative of EPA-SL

Mr Samuel Kamara, Assistant Deputy Director of Natural Resources Management and GIS at EPA-SL, expressed his delight for the opportunity given to the EPA-SL to be part of the Workshop not just because the EPA-SL is responsible for environment management and protection but also that the deliberations and the outcome will enhance good governance, sustainable development, climate change adaptation and mitigation. He outlined the policies framework and the operation aspect of EPA-SL that will ensure the Sierra Leone environment is managed in such a way and manner that climate change effect is considered adequately.

He also acknowledge that effective early warning is an essential component in a disaster management systems especially for climate change. Mr Kamara stated that Sierra Leone is one of the three most vulnerable countries due to climate change with potential for socio-economic implications from impacts of variability, drought and flooding as cited in the Fifth Assessment Report of the Inter-Governmental Panel on Climate change (AR5).

He reaffirmed the EPA’s commitment and highlighted the strides his institution is making on climate change, including the establishment of National Climate Change Secretariat (NCCS); a GIS unit to support with geospatial information and data on climate change and critical environmental issues; and the engagement with ECOWAS Coastal and Marine Resources Management Centre for early warnings and earth observation data analysis systems. He said the EPA-SL works in close collaboration with the ONS and other MDAs on climate change related matters.

Mr Kamara concluded by thanking the UNDP and INTEGEMS for the Project, especially with the progress made so far and encouraged all to participate meaningfully for a successful deliberation in the spirit of national development.

11.1.2.2.5 Statement by the Representative of the Ministry of Water Resources

Mr Alhaji Sesay expressed delight for the invitation and informed the participants about the just concluded training of five staff on Hydrological Monitoring/Integrated Water Resources Development and Management at AGRHYMET Regional Centre in Niamey (Niger). He went on further to say that MWR is on the verge of installing thirteen (13) automatic stations to monitor instantaneous water levels and subsequent discharge measurement of the major rivers of Sierra Leone. This intention is to ensure that adequate measures are put in place to adapt as a result of changes in the water resources within the country. Mr Sesay reaffirmed the MWR’s commitment in working with other line MDAs in preparing the country for adaptation to climate change and its impact.

11.1.2.2.6 Official Opening Statement by the Honorable Deputy Minister of Transport & Aviation

Hon Abu Bakarr Jalloh, Deputy Minister of Transport & Aviation welcomed the participants to the Workshop and expressed his satisfaction of the initiative of the SLMD to embark on the Project, which he said has demonstrated Sierra Leone’s preparedness to effectively respond to climate change. He reiterated the objectives of the Project and underscored the need for effective participation of all key stakeholders in the process as that is the basis for conducting the consultative Workshop.

He recognised the strides and improvement of the SLMD through the support and contribution of development partners such as UNDP and GEF and expressed his delight for the potential advancement and efficiency of SLMD in serving the nation with much needed information. He thanked UNDP and GEF for funding personnel at the SLMD and the MWR for postgraduate education in the UK and Niger, respectively, and also the installation of the 8 new automatic weather stations around the country. He went on to outline the major challenges that the SLDM is facing and assured INTEGEMS of the Ministry's unflinching support throughout the Project lifespan and requested other stakeholders to equally provide the needed support for successful implementation of the Project.

11.1.2.3 Workshop Presentations

11.1.2.3.1 Presentation 1: SLMD

Mr Alpha Bockarie (Director SLMD) introduced to the participants the roles and responsibilities of the SLMD within the Ministry of Transport and Aviation. In order to understand the nature of the projects he gave an introduction on the the implementation of the meteorological component of the Project, which he stated that the Climate Information and Early Warning System (CIEWS) Project is a regional project that is being implemented in 10 other African Least Developed Countries (LDCs) and is one of the priority projects that was identified during the country's National Adaption Programme of Action (NAPA) assessment that followed Sierra Leone's Initial (First National) Communication (FNC) with the United Nations Framework Convention on Climate Change (UNFCCC).

He said the main aim of the Project is to institute an early warning and information system that will inform end-users in good time on climate /weather related extreme events and also to build the capacity of the meteorological and hydrological services of the SLMD and the MWR, respectively. This he said is done in collaboration with the EPA-SL, ONS'-DMD, MAFFS, and Sierra Leone Red Cross Society as key partners among others.

In terms of implementation he underscored that following:

- Two Meteorologist have just been trained in Reading, UK, and are now fully engaged in the activities of the Project and the SLMD.
- SLMD in collaboration with ONS and other partners has facilitated four pilot activities of the early warning system during the stimulation drill exercise at the Bumbuna Hydro downstream communities.
- The contractual arrangement for the local training of serving SLMD personnel is almost concluded and this will be addressing the internal (in-service) training needs of the SLMD.
- Six personnel have been accepted for WMO Class II forecasting training in Nigeria and Kenya
- Eight Automatic Weather Stations (AWS) have already been installed at almost even locations throughout the country
- The SLMD has built partnership with AFRICEL Mobile Company for both hosting its AWS on their masts/towers (which has removed the theft factor of the AWS accessory solar panel) and the transmission of data from the AWS to the server at the SLMD Forecast Office and Headquarter in Freetown.
- SLMD actively participated in the ONS activity for the development of Standard Operation Procedure (SOPs) and for the dissemination of the early warning information in real time for informed decision making
- Just barely two weeks ago, SLMD implemented the engagement of policy makers for their in-depth understanding of the issues of climate change, SLMD operations in the CIEWS and their role and support for the necessary legislation on the SLMD transformation to an Agency, the report of which is attached.

- SLMD is presently working with INTEGEMS for the information packaging and best option of tailor-made meteorological products for various end users
- The UNDP has awarded the SLMD a vehicle for the CIEWS and this has helped to partly address the transportation need of the SLMD.

In conclusion, Mr Bockarie emphasized the need for proper understanding of the Project document by all partners so that they can channel issues correctly. He also expressed his satisfaction with the achievements done so far despite all the setbacks. He said he is highly impressed with the Project Coordinator and the UNDP as a whole.

11.1.2.3.2 Presentation 2: ONS-DMD

Mr Vandy Rogers (Director ONS-DMD) delivered his presentation on the National Disaster Management Plans, Response and Communication of Early Warning. He explain the core elements that constitute the Sierra Leone Disaster Management Plans, response mechanism and communication of early warning system on hazards at both local and national levels.

In his presentation, he highlighted the common hazards that are experienced in Sierra Leone - categorized into climatic hazards that include floods, water shortage, extreme heat, thunder, wind storm and lightening; geological hazards that include landslide, mudslides, rock falls, and erosion; social hazards that include demonstration, strikes, conflict and poverty; epidemic hazard that include Ebola, cholera, measles, HIV/AIDS, tuberculosis; and human induced hazards that include accidents, deforestation, waste management, depletion of catchment areas, collapse buildings, etc.

Included in his presentation was the National Disaster Management Architecture, ONS Disaster Management organisational chart, and the Sierra Leone Disaster Management Strategy, which sets the direction, providing agreement on the overarching end goal of the DMD, and includes six components, all of which need to be achieved to reach its goal.

He further went on to elaborate on the disaster management preparedness and response mechanism, citing the key focus areas which include national disaster management policy, the district disaster management committee(DDMC), national plans, National Strategic Situation Group (NSSG), National Situation Room, coordination mechanism, national vehicle pool for effective response, training, assessment at all levels and awareness raising.

11.1.2.3.3 Presentation 3: MWR

Miss Olaimatu Sadia Karim, Hydrologist at the MWR, delivered the presentation on the Hydrological Monitoring, Water Resources and Flood Forecasting in Sierra Leone**.** The presentation focused on four key areas:

Water Resources Potential: The country is endowed with vast water resources consisting of both surface and groundwater resources with annual renewable water resources of 160,000 million cubic metres. The quality of groundwater and surface water is generally good; however, the country water resources faces numerous threat on account of population growth, economic and industrial development, and water management that is not informed by sound data. The consequences of the various challenges and threat to Sierra Leone's water resources is hard to predict in detail. Therefore it is imperative that water resources are monitored in order to understand fully the trends in rainfall, groundwater levels, abstraction and land use and all key factors that affect water balance.

Government Reform: She stated that the GoSL in recent years has embarked on a process of fundamental reforms in the water sector, which have substantially changed the context for managing water resources. The development of a National Water and Sanitation Policy (2012), the separation of the Ministry of Water Resources from the then Ministry of Energy and Water Resources, the decentralization of responsibilities for rural water supply services, and the proposed establishment of the national water resources management agency for the management of water resources were the key reforms highlighted**.**

Data Collection Platform (DCP): She outlined the data collection process, stating that the platform is designed for terrestrial or ground use, by ships, buoys, balloons and aircraft. Illustrating with diagrams she briefly explained the use of tools and equipment used in data collection platform which includes bubbler pressure sensors, rain gauges and staff gauges**.** The automatic stations are mostly equiped with a rain gauge and the sensor is used to measure the quantity of rainfall or the volume of rain water that falls at any given time interval.

She further explained the steps and functionalities of the key components in the reception of real time raw data: **DCP**: for logging, recording, rearranging the data of the sensor, and transmission of data to the satellites; Satellites: transfer the received data of the DCP to the ground receiving stations or direct to the users Ground receiving stations: used to transfer data received are transfer to the processing centres ; Processing Centres: Transmit results from the processing centres to the users via different communication channels.

Opportunities: In terms of opportunities she mentioned the UNDP/GEFCIEWS project that re-established 13 hydrological network stations and 16 groundwater monitoring stations; RWSSP-AfDB-component of re-establishment of hydrological network and capacity building; IUCN-bridge project on transboundary water resources management- Moa-Makona River Basin and Mano River Basin and the WRCC/MRU Mano River Basin Authority.

11.1.2.3.4 Presentation 4: EPA-SL

Mr Samuel Kamara, Assistant Deputy Director of Natural Resources Management & GIS, EPA-SL, underscored five focus areas in the presentation: Conceptual Framework; Climate Change and Integrated Environmental Management Information Systems; Environmental Management, Data Collection, Modelling and Analysis; Strategies for achievements and key Issues/challenges**.**

Conceptual Framework: The framework is developed on six main environmental management building blocks which include strong leadership and governance, robust environmental information systems, strong environmental workforce, efficient service delivery, solid environmental financing and quality equipment and environmental products and services. All of this is enabled by supporting environment management policies, equitable access, improved quality and full scale community engagement and community level care, improved coordination communication and improved accountability.

Climate Change and Integrated Environmental Management Information Systems: This is a system developed for systematically obtaining processing and dissemination of relevant environmental information. 89 core sets of indicators has been identified and differentiated into key thematic areas.

Environmental Management, Data Collection, Modelling and Analysis: He highlighted the challenges in collection quality data in Sierra Leone and listed the various aspects for which data is been collected. This include air, water, land and agriculture, waste chemicals, biodiversity, climate change, energy, noise, Environmental Impact Assessment (EIA) ,Environmental Social Health Impact Assessment(ESHIA), disaster and utilities. He outlined the process of data collection from literature review to producing thematic maps. Models have are developed within the integrated environmental management systems focusing on four key areas for analysis; environmental sensitive areas, susceptible pollution, land use possible of contributing to pollution and pollution effect.

Strategies for achievements: For sustainable environmental management and achievement, the EPA is working with various government ministries to encourage sustainable use of land and environmental resources; support integrated development planning; building alliance to benefit Sierra Leone and adaptation to climate change. In collaboration with the ONS, the EPA-SL has developed a methodology to collect early warning data in terms of flood, all of this will be done by developing a web-based GIS application

Key Issues/challenges: The key issues he pointed out here were: waste management problems, Uncontrolled and unregulated sand mining, infrastructure and climate change; flooding and fire accidents and coastal mangrove deforestation. Displaying pictures of huge volume of waste discharge in drainages, he expressed the need for proper waste management to reduce the impacts of flood and other climate change disasters.

11.1.2.3.5 Presentation 5: INTEGEMS

Mr Julius Mattai, Principal Consultant, INTEGEMS, provided a succinct introduction and overview of INTEGEMS as a consultancy firm, including a synopsis of its main services. He also provided a narrative to the background of the Project and emphasized that the Project's main objective is to establish a functional network of meteorological and hydrological monitoring stations to help understand better the weather and climatic changes overtime and provide timely information to avert any weather and climate change related disasters in Sierra Leone. He added that the Project will also develop and disseminate weather and climate information and warnings to the GoSL MDAs and institution, private sector and the general public to enable early preparation against various natural and man-made disasters. He intimated that at the successful completion of the Project, most GoSL MDA and institutions will be expected to integrate weather, hydrological and climate information into national policy plans and local government development plans.

Mr Mattai stressed that the key Project partners are the SLMD, ONS-DMD, EPA-SL and the MWR but a plethora of stakeholders will be directly and/or indirectly involved with the Project; hence he went on to shed some light on their specific roles and responsibilities in the Project**.**

From the onset of his presentation, Mr Mattai clarified the scope of work for the Project, stressing that the duration of the Project was very challenging considering the technical nature of the Project and the need to work across four MDAs and the three Project pilot communities across the country. He outlined the scope of work as outlined below and went on to brief explain the Project approach and technical methodology:

- Carry out needs assessment of early warning communication network;
- Develop communication channels between SLMD and ONS-DMD for dissemination of forecasting products;
- Establish institutional mechanisms for collection of feedback from the community end-users on the usefulness of warning messages;
- Develop a communication and awareness raising strategy, pilot application and implementation of local level responses;
- SLMD, MWR, EPA and ONS-DMD in partnership with local NGO's and CBO´s to communicate and disseminate response plans; and
- Field visits and stakeholder consultations undertaken to understand how users of early warning advisories and warnings.

Mr Mattai pointed out that the stumbling blocks in the path of CIDMEWS include the present limited or non-existence of systematic processes for packaging, translating and disseminating climate information and warnings, lack of technically skilled human resources and poor community level usage of climate information and responses to received warnings. He explained that this is as a result of a number of policies, institutional, financial, technological and informational barriers that exist in the country, including:

- Limited knowledge and capacity to effectively predict future climate events as a result of an acute shortage of technology and skilled human resources;
- Obsolete and inadequate weather, climate and hydrological monitoring infrastructure, which limits data collection, analysis and provision of meteorological services;
- Lack of maintenance of observational infrastructure and limited technically skilled human resources to operate the systems; and
- Poor community level usage of climate information as a result of limited consolidation of effective dissemination channels including physical mechanisms and limited trust in warnings received.

He warned that the current state of climate information and early warning systems in Sierra Leone, if not improved, will significantly undermine socio-economic development under a changing climate.

Mr Mattai went on to graphically present and explain the technical methodology for the Project, empathizing that in the submission of its Technical Proposal, INTEGEMS proposed the design, development and implementation of an integrated Climate Information, Disaster Management and Early Warning Systems (CIDMEWS) for disaster management, meteorological, climatological, hydrological and early warning information. He pointed out that the CIDMEWS will integrate GIS and Management Information System (MIS) systems and mobile data collection technology to provide a family of sophisticated tools and Web services for collecting, managing, visualizing, mapping, analysing, monitoring, evaluating and reporting on various aspects of climatological, hydro-meteorological, disaster management and early warning information in Sierra Leone.

He explained that the key components of the CIDMEWS will be, but not limited to, databases of:

- Hazard and vulnerability assessment mapping
- Socio-demographic distribution
- Infrastructure, lifelines and critical facilities, including logistics and transportation routes
- Disaster management, human and material response resources
- Environmental, natural resources
- Meteorological, hydrological, topographical and geological data and information

Mr explained that the successful implementation and delivery of the Project will avail Sierra Leone the opportunity to better manage climate hazards, food security and agricultural production, scarce and dwindling water resources and make its socio-economic development process less vulnerable to climate-related risks; enhance the capacity of hydro-meteorological services and networks to monitor and predict weather and climate events and associated risks e.g. floods, droughts and severe storms; develop effective and efficient ways of packaging weather and climate information, including contextualising with other environmental and socio-economic data to produce early warnings/alerts and advisories; and support improved and timely preparedness and response to weather and climate information and early warnings, including efficient delivery mechanisms using radio and telecommunications networks.

The demonstration portion of his presentation included a quick StreamerRT Web-Based Display System (StreamerRT) technology primer to assist participants unfamiliar with the technology to think more constructively and creatively about its capabilities and applications. Mr Mattai demonstrated and explained that StreamerRT Web-Based Display System (StreamerRT) is a real-time weather decision system that provides a fully interactive mapping platform with a comprehensive collection of weather data. He pointed out that users have the ability to monitor real-time station observation data from the WeatherBug network and overlay numerous enhanced data sets to stay up-to-date with significant weather events before and after they develop.

MDAs and other stakeholders can use StreamerRT to create customized views that are important to them and then monitor the weather through easy access to views, slideshows of views and animations. StreamerRT has a ccomprehensive and user-friendly tool for visualization of live and forecast weather conditions and real-time situational awareness at local, regional, national and international levels for critical decision-making. He demonstrated that the StreamerRT has a mobile phone weather content and alerting functionality for:

- Location based warning for feature/smart phones
- All mobile platforms like iOS, Android, Win 8, etc.
- Push notification
- Hazard proximity alerts
- Current weather conditions
- Detailed forecast content

Mr Mattai specifically pointed out that the EWS technology will enables the SLMD and other MDAs and stakeholders to deliver alerting via multiple optional channels:

- GIS display systems for NMHS and 3rd parties (including APIs)
- SMS, text, email as well as mobile applications
- TV, radio, internet, and bulletin broadcast
- Specialized outdoor alerting devices
- In combination with other information (agriculture, health, energy)

11.1.2.4 Workshop Thematic Group Sessions

In other to achieve this relevant stakeholder need to discussion and give feedback. This was done through group discussions. The groups were formed on the basic of participants' institutional affiliation or area of operations/interest in connection with the said Project. To that effect, three groups were formed.

11.1.2.4.1 Thematic Working Group 1

***Topic**: Understanding weather and climatic changes overtime and provision of timely information to avert any weather and climate change related disasters, including the identification of key vulnerable populations, areas at risk, forecasting products, and innovative communication channels.*

Name	Institution
Foray Faena	AMR Gold
Ibrahim .S. Kamara	Sierra Leone Metrology Department (SLMD)
David .J. Allied	Health For All Coalition
Hawa Kandeh	Bumbuna Watershed Management Authority (BWMA)
David .A Korma	Bumbuna Watershed Management Authority (BWMA)
Audrey Juana Amanda	Sierra Leone Red Cross (SLRC)
Maj**.** F S D Kamara	HQ Joint Force Command/Joint Communications Unit (JFC, JCU)
Mary Mya Kamara	Office of National Security (ONS)
Sylvester Tucker	INTEGEMS Facilitator
Amilia Conteh	INTEGEMS Facilitator
Samuel Nonie	INTEGEMS Facilitator

Having gone through the technical methodology presentation and the guidelines, it was prudent to give the participants a platform to discuss and comment on the findings and recommendations from the assessment communication network, including recommendation to address identified gaps and the specifications of the required equipment to address the production and consumption of early warning information.

In addressing these challenges a number of strategies were highlighted and the groups were given guidelines as a basis for discussion and presentation.

- Understanding weather and climatic changes over time
- What is the difference between weather and climate?
- Provision of information in an efficient and timely manner.
- Understanding disaster
- Understanding risk and vulnerability

- Forecasting product and communication channels

David A Korma gave a brief definition of weather and climate. He said weather is the state of atmosphere to the degree that is hot or cold wet or dry most weather phenomena occur in the troposphere just below the stratosphere, in a short period of time and while climate is the weather condition prevailing in an area in general over a long period of time usually 35 years. He also stated that the difference is, weather is a condition of an area over a short period of time whilst climate the average weather condition of a place over a long period of time.

Mary Mye Kamara elaborated on the provision of information in a timely manner. She first spoke about the provision of information, which is getting forecast information through the SLMD and/or the Ministry of Water Resources. The ONS should be updated regularly on an hourly or daily basis so that the communities at risk could be duly noted. Her main point was disseminating information in local communities where there is no radio, SMS facility or TV, is by town criers, village horns and drumming (Tabula). In order to raise awareness about impending disasters, the ONS is responsible for dissemination of information via SMS, Radio, TV and other suitable innovative means using the right partners. This will help rapid response to avert disaster or to ensure that mitigation measures are enacted.

David J Allieu explained what his understanding of disaster was, and he stated that; a disaster is a serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources" He went further on stating that the Project would enable us to avert disasters through the provision of early warnings to communities at risk, thus starting evacuation and mitigation measures.

Audrey Juana Kamanda spoke about risk and vulnerability. She started by explaining the terms vulnerable people and vulnerable communities. She named few communities that are prone to disaster like coastal areas (Kroo Bay, Banana Island), those residing downstream of the Bumbuna Dam (Yealiboya and Conakredee), and people living on steep slopes (IMATT, Regent, Mount Aureol). She said vulnerable people are those that might be affected when disaster occurs. She added that vulnerability does not depend on your financial status, and added that the rich people building on steep slopes are also vulnerable people as there is a risk of mudslides, rockslides and landslides. Her advice was that the Government should find a way to move people out of the aforementioned areas to avert any and all disasters that they would be exposing themselves to.

Ibrahim S Kamara of the SLMD gave his own understanding about forecasting product and communication. He said forecasting product is the tools used to collect weather or climatic conditions. He further stated that upon receipt of such information, the right bodies should be contacted using the right communication channels in a very short period of time to avert disasters and provide suitable time for evacuation. He suggested that coordination between key stakeholders should be paramount, and that all key stakeholder should be willing to work together, citing the involvement of NGOs, CBOs and communities in dissemination of information on time so that there will be a timely response in order to save lives and properties.

In conclusion all members of Group 1 accepted that all the points brought up by members of the Group were good and we should act as one in our own communities or offices to make this Project a success. By properly understanding weather and forecasting, the right information could be extracted from it and proper communication measures be taken to avert disasters and save lives and property.

11.1.2.4.2 Thematic Working Group 2

Topic: *Development and dissemination of weather and climate information and warnings to the government, private sector and the general public (communities) to enable early preparation against manmade disaster such as floods and other severe weather and agricultural stresses.*

Name	Organization	Designation	Telephone	Email
Emmanuel Lansana	NMA	NMA Manager	+23278061166	elansana@nma.gov.sl
Yusuf D. Suma	NMA	NMA Manager	+23279252449	ydsuma@nma.gov.sl
Samuel M. Koroma	EPA-SL	M. Dpt. Director	+23278817515	Samrata001@yahoo.co.uk
Francis L. Keili	DWS	Director	+23276418194	fikeilie@yahoo.com
Stephen S.J. Jusu	NMA	EHS Manager	+23276127511	sjusu@nma.gov.sl
Mohamed Deen	BWMA	Agro-forestry Officer	+23276691401	mbordeen@yahoo.com
Gabriel E. Kpaka	MET	Meteorologist	+23279667742	gabrielkpaka@gmail.com
Prince Tucker	WFP	Logs Officer	+23279829850	Prince.tuckerwfp.org
Doe Karidaniel	UNDP	Project Consultant	+23278906312	doekandaniel@gmail.com
Musu Ansumana	ONS	R.O.	+23276346242	mansumana@ons.gov.sl
Joseph Tucker	INTEGEMS	Consultant	+23278396582	j.tucker@integems.com
Malal Jalloh	INTEGEMS	Consultant	+23279881882	m.jalloh@integems.com
Prince Kemoi	INTEGEMS	Consultant	+23278607355	p.kemoi@integems.com

After the presentation has been done by technical and non-technical expert on different subject component in the Project. Participants were able to raise their concerns on some of the key issues that were highlighted during the Workshop. A brief summary of the project background was analyzed to all the representatives to have a better understanding of the Project so they can be able to make meaningful contribution through their comments, suggestions, questions and recommendations.

INTEGEMS is closely working with the four relevant MDAs to build their institutional capacity to be able to adequately respond to climate information and early warning system by putting mechanisms in place to address some of the gaps, challenges and constrains. This will help the above four MDAs to efficiently enable early preparation against natural disaster like flooding, storm, drought, landslide in real time with the right equipment and expertise.

According to a representative from the SLMD, Gabriel Kpaka, a monitoring system is in place though it is not that robust. Over the years the SLMD has been supported by International Fund for Agricultural Development (IFAD) to support some farmers in their various zones they operate which is Kenema, Kailahun, Kabala and Kono. He also mentioned that whatever forecast they have on climate issue they communicate it to them for early warning. Because of the challenges faced with the SLMD, they cannot pay the SLBC for their service to disseminate their forecasts. With the support from IFAD the SLMD is still working towards progress even though their focus is on agriculture.

The Group discussion was held to allow every participant to have the opportunity to make an input into the discussion. This Group was to brainstorm and point out the key issues on each of these MDAs according to the topic in the above heading.

SLMD currently have eight new weather station system in place to collect data as forecasting product for end users.

Forecasting Product	End Users	Medium of Dissemination
Wind	General public telecommunication/farmers/NGOs	Text messaging
Rainfall	Aviation/farmers/telecommunication/security/mining companies	Television station
Temperature	Aviation/Mining Companies/farmers	Agriculture Extension workers
Visibility	MOHs/security/marine Administration	Web base information
Windfall	NGOs/General public/Researchers	Electronic/print media
Humidity	Farmers	Sign post, Town Crier
Wind speed and wind direction	Telecommunication companies	Electronic and print media
Thunder and lighting	Aviation	Web base information
Soil temperature	Farmers	Sign post, town crier

The EPA-SL is only concentrating on the collection of environmental data which are:

- Air quality
- Noise Monitoring
- Rain fall
- Land use
- Water quality
- Environmental Impact Assessment

The MWR only collect hydrological data which are:

- Rainfall data such as duration and intensity.
- Water level monitoring

The ONS is responsible for disaster management and one of their key activities is the response plans to hazard or disaster.

Francis Kellie said the ONS has three (3) response plans policies which are: Natural Response Plan; National Disaster Response Plan; and National Disaster Policy.

11.1.2.4.3 Thematic Working Group 3

***Topic**: Integration of weather, hydrological and climate information into national policy plans and the local government development plans. Hydro-meteorological and technical requirements and EWS for disaster management and long term planning.*

Name	Institution
Patrick Musa	Sierra Leone Metrology Department (SLMD)
Momodu J Bundu	Statistics Sierra Leone (SSL)
Mohamed Turay	Ministry of Agriculture Forestry and Food Security(MAFFS)
Alhaji Sesay	Ministry of Water Resources (MWR)
Joseph S Bangura	Ministry of Agriculture Forestry and Food Security(MAFFS)
Ibrahim Kemba	National Fire Force
Samuella Faulkner	INTEGEMS Facilitator
Koinguma Baimba	INTEGEMS Facilitator
Donald Gbassa	INTEGEMS Facilitator

The following key components were deliberated upon:

Institutional policies: Pertinent topics related to planning and legislation, institutional coordination and operational aspects, emergency preparedness as well as activation of emergency plans based on warning levels were discussed. The importance of consistency in policies, legislation and planning at different levels of government and the need for clarity in authority and mandates were also highlighted. A few of these policies/plans highlighted were; The National Adaptation Plan of Action (NAPA), National Water and Sanitation Policy under the Water Resource Management Agency for hydrological monitoring; meteorological forecasting for climate prediction; and water catchment area development policy.

Furthermore, it was discussed that development of effective EWS for weather, hydrological and climatic disaster would require a multi-dimensional, multi-sectoral and multi-agency approach at national to local levels. Flood and drought were highlighted as key national issues relating to hydro-meteorological related disasters and that implementation of flood, drought risk management and warning systems would require regional cooperation in a number of areas. The need to institutionalize the relationship between ONS-DMD and the SLMD from national to local levels through the documentation of plans, protocols and standard operating procedures was also a key area of focus during the discussion.

Challenges/gaps: The key issues discussed here were the absence or lack of institutional capacity of the ONS-DMD; lack of technical expertise and good practices; lack of maintenance and associated training for monitoring networks; poor coordination and feedback mechanisms amongst the institutions; and poor data management system.

Long-term planning/sustainability/strategies to improve: In this regard, a number of approaches utilized in different good practices were discussed, such as strengthening the coordination mechanisms across various institutions to benefit from improved hydro-meteorological forecasts and warning information. Improved service delivery at the national level in supporting national to local emergency contingency planning and response operations.

Comments/suggestions: Awareness campaigns should be conducted for national decision-makers on hazards, their possible impacts and ways these impacts could be reduced through prevention, preparedness measures and EWS. The discussion also recognized the need to incorporate risk information, including potential

Impacts (e.g., potential loss of life, property and infrastructure destruction, crop losses) as well as behavioural advice, in warnings in a way that is understandable to all. A combination of channels (modern and traditional systems such as SMS, regular TV programs, and volunteers) for dissemination of public information and warnings was recommended. Joint training programs targeted at the relevant key stakeholders should be conducted to ensure enhanced cooperation and communication across them and public education and awareness campaign should be developed to train the population and the media on meaning and appropriate reactions to warning messages

The discussions concluded that the inclusion of the local communities and in the EWS is the foundation for development of national to local emergency preparedness and response. In this respect, the discussion highlighted the critical need both national and local to monitor, archive and share hazard, vulnerability and exposure data as well as develop communities capacities for response.

11.1.3 Needs Assessment of Information Systems and Networks

Generally, the following were undertaken:

a) Assessed the SLMD's current capacity to meet ICAO new guidelines and standards for aeronautical forecasting and observing, the implementation of an audited Quality Management System and training of staff to agreed standards.

b) Assessed the MWR's infrastructures (monitoring network, data handling systems, workstations and modelling capacity) to produce flood forecast or warnings, including operational hydro-meteorological network to allow the monitoring of river flow and contribute to flood forecast

c) Assessed both the weather and hydrological sectors' personnel in terms of their capability and capacity to maintain a monitoring network and handle data to support the necessary forecast operations.

d) Assessed the SLMD's and recommend Radio Detection and Ranging (RADAR) Device or Upper Air Sounding system to support the forecasting operations and to accurately forecast the dynamics of thundery storms.

e) Assess the SLMD's contractual issues regarding the receipt of data from the EUMETSAT-Satellite imagery (PUMA follow-up) via African Monitoring of the Environment for Sustainable Development (AMESD) e-station to support meteorologists in producing daily forecast.

11.1.4 Assessment of ICT Networks and Tools

A comprehensive Needs Assessment was undertaken to document existing ICT networks and tools and then identified desired improvements in close collaboration with the SLMD, ONS-DMD, EPA-SL and MWR. Operational data acquisition, archival processes, quality assurance procedures, compilation, and technological capacity were also documented to recommend innovative ICT enabled tools (inclusive of equipment; database, mobile and GIS/geo-referenced applications) to engage citizens and stakeholders in the production and consumption of disaster management, meteorological, climatic and hydrological data and information. INTEGEMS also took stock and assessed the communication network capability for climate/hydro-meteorological and disaster forecasting between the relevant mandated MDAs, taking into consideration the following technical features of the CIDMEWS:

- A robust, scalable, flexible and interoperable CIDMEWS with an integrated browser-based[23] MIS and high-quality production ready databases (on hired dedicated servers in the Cloud[24]), including preconfigured mobile data capture applications, for collecting, managing, visualizing, mapping, analysing and monitoring climatological, hydro-meteorological, disaster management and early warning information in Sierra Leone.

- A network-enabled CIDMEWS that can be accessed over the Internet, local Intranet, as well as a locally installed system using the latest Information & Communication Technology (ICT) so that all Project stakeholders can access accurate, timely, secured and reliable CIDMEWS resources from any device (desktops, smartphones/tablets and the Web), from any place, and at any time. The deployment alternatives will be: offline deployment; online deployment; and hybrid deployment.

- Interactive and user-friendly browser based interfaces, including dashboards and maps, using the latest MIS, GIS, mobile, server, network and Web technologies so

[23] The only real requirement to interact with the System is with a web browser on any desktop or mobile device.
[24] Takes away the worry and hassle of buying and setting up expensive server hardware, software and accessories.

that all stakeholders can access accurate, timely, secured and reliable CIDMEWS data and information right from any device (desktops, smartphones/tablets and the Web), from any place (both online and offline), and at any time.

- An integrated GIS and MIS System using a combination (i.e., hybrid approach) of commercial (proprietary) and free open source software (FOSS) and web services. This hybrid approach will help reduce risk and add value in several ways: avoiding single software vendor lock-in; reducing costs associated with licensing; and promoting interoperability with existing software and architecture.
- An integrated CIDMEWS, GIS and MIS System that is platform independent and thus runs on any platform (e.g., Windows, Linux, Mac OS X, etc.) with a Java Runtime Environment (JRE 7 or higher) installed. Can be used in many different contexts depending on the exact requirements of the operating system to be used.

A systematic process involving an assessment of a baseline or desired future state, analysing the current condition, evaluating what the difference between the desired and current state (i.e. the gap), outlining the possible causes of the gap, and ultimately what remedial action were undertaken to address the gap. This process were undertaken for each of the partner organisations based on the data that are gathered from the Stakeholder Workshop and e-survey.

Gaps were evaluated in each organisation for the three major areas: **data management and gathering; data sharing, analysis and reporting; and ICT and human resource capacity**. A Needs Assessment Matrix was designed to outline the current status, desired future state, gaps, reasons for gaps, and the proposed remedial actions for a series of issues that was determined to be priorities. The current state was assessed for each organisation by examining the survey responses. This was then compared against a desired future state. If there are shortcomings between the current state and the desired state, this was then articulated as a 'gap'.

11.2 Workshop Agenda

Time	Programme	Action
09:30-10:00	Arrival participants	
10:00 – 10: 50	Official Opening (Introduction of Chairperson/Chairman's opening statement)	Chairman
	Statements i. UNDP Deputy Country Director - Programmes ii. Director, Meteorological Directorate iii. Director, Disaster Management Directorate (ONS) iv. Representative, Environment Protection Agency- Sierra Leone (EPA-SL) v. Representative, Ministry of Water Resources **Official Opening Statement** The Hon Minister, Ministry of Transport & Aviation	
10:50 – 11:20	**Tea Break**	
Session 1 – Project background and ongoing activities		
11:20 – 11:35	Introduction to the Climate Information and Early Warning System (CIEWS) Project, status of implementation, challenges/gaps, and future direction	UNDP EERNM,
11:35-11:50	**Presentation 1** on current state of meteorological observational infrastructure, forecasting and early warning systems (EWS) operations in Sierra Leone.	Meteorological Directorate
11:50 – 12:15	**Presentation 2** on current disaster management plans, response and communication of early warnings in Sierra Leone	Disaster management Department (ONS)
12:15-12:30	**Presentation 3** on the current state of hydrological monitoring, water resources and flood forecasting in Sierra Leone	Ministry of Water Resources
12:30 -12:45	**Presentation 4** on managing the environment, climate change and related issues, including environmental information management in Sierra Leone	EPA-SL

12:45- 1:00	**Presentation 5** on Overview of the Support to Communication and Dialogue on Early Warning and Forecasting Products & Climate Information in Sierra Leone	Project Lead/INTEGEMS Consultant
1:00-2:15	**Lunch**	
Session 2 – Project Methodology and Technical Working Group Sessions		
2:15-3:00	Project methodology and work plan - the technical approach and potential benefits	INTEGEMS Consultancy
3:00 – 4:00	Three Thematic Working Groups Sessions: **Group 1:** Understanding weather and climatic changes overtime and provision of timely information to avert any weather and climate change related disasters, including the identification of key vulnerable populations, areas at risk, forecasting products, and innovative communication channels. **Group 2:** Development and dissemination of weather and climate information and warnings to the government, private sector and the general public (communities) to enable early preparation against manmade and natural disasters such as floods and other severe weather and agricultural stresses. **Group 3:** Integration of weather, hydrological and climate information into national policy plans and the local government development plans. Hydro-meteorological and technical requirements and EWS for disaster management and long term planning.	Participants and INTEGEMS Consultants
	Tea Break	
4:00 – 5:00	Technical Working Groups Presentations and Conclusions/Recommendations	Group 1, 2 and 3 Leads and INTEGEMS
5:00 – 5:30	Close of workshop	UNDP Focal & Consultants

11.3 Workshop Participants

No	Full Name	Organisation/Institution	Designation
1	Major Foday S D Kamara	Ministry of Defense HQJFC	Commanding Officer
2	Alhaji Bangura	Africell-SL	Admin Supervisor
3	Musa Ansumana	Office of National Security (ONS)	Regional Officer (RO)
4	Hawa Kandeh	Bumbuna Watershed Management Authority (BWMA)	Consultant
5	Alpha Bockarie	Meteorological Department	Director
6	Prince Tucker	World Food Program	Logistic Officer
7	Joe Kaindaneh	UNDP	Project Consultant CIEWS Project
8	David A Koroma	EAU- Bumbuna	Team Leader
9	Nabeela Tunis	WONES	Gender Consultant
10	Ella Margai	Save the Children SCI	Gender in Emergency Coordinator
11	John V Rogers	Office of National Security (ONS)	Director
12	Hon. M A Jalloh	Ministry of Transport and Aviation (MTA)	Deputy MTA
13	Joseph E W Jackson	National Mineral Agency (NMA)	GAMRTO
14	Samuel M Kamara	EPA-SL	Assistant. Deputy Director
15	A B Carew	Ministry of Transport and Aviation (MTA)	Permanent Secretary
16	Francis L Keili	D W S	Director
17	Mary Mye-Kamara	Office of National Security (ONS)	Director Human Resource
18	Ibrahim Kemba	National Fire Force (NFF)	Sergeant
19	Momodu J Bundu	Statistics Sierra Leone	Senior Statistician
20	Ibrahim S Kamara	Meteorological Department	Meteorologist
21	Patrick Musa	Meteorological Department	Forecaster/Officer-in-charge
22	Mohamed B Deen	Bumbuna Water Management Authority	Agro-forestry Officer
23	E B A Lansana	National Mineral Agency (NMA)	Geological Data & Information Manager

No	Full Name	Organisation/Institution	Designation
24	Yusuf Dauda Suma	National Mineral Agency (NMA)	Large Scale Mining & Compliance Manager
25	Stephen A S Jusu	National Mineral Agency (NMA)	EHS Manager
26	Audrey Juana-Kamanda	Sierra Leone Red Cross Society	Disaster Management Officer
27	Gabriel E Kpaka	Meteorological Department	Chartered Meteorologist
28	Tommy Garnett	Environmental Foundation for Africa(EFA)	Director
29	Daniel D Siaffa	SLANGO/CADA-SL	Board Chairman
30	Bobic L Kanu	Sierra Leone Broadcasting Corporation	Cameraman
31	Joseph S Bangura	MAFFS	Asst. Director
32	Mohamed Turay	MAFFS	M & E Officer
33	Steve Sesay	World Health Organisation (WHO)	GIS Analyst / Data Management
34	Olaimatu S Karim	Ministry of Water Resource (MWR)	Hydrologist
35	Alhaji Sesay	Ministry of Water Resource (MWR)	WASH Mopping Officer
36	Ronald Moore	Sierra Leone Maritime Administration (SLMA)	Environment Director
37	David J Allieu	Health For ALL Coalition	Advocacy
38	Mariama D Kanu	Sierra Leone Broadcasting Corporation (SLBC)	Reporter
39	Foday M Fofana	AMR-Gold	Project Geologist

11.4 Workshop Photo Plates

Photo Plate 1-1: A cross section of the Workshop's participants

Photo Plate 1-2: Participant registering for the Workshop at the Reception

Photo Plate 1-3: High table 1 (L to R): Mr Bockarie (Director, SLMD); Mr Abu Bakarr Jalloh (Deputy Minister, MTA); and Mr X ()

Photo Plate 1-4: High table 2 (L to R): S Kamara (Representative, EPA-SL); L Keili (Workshop Chairman and Director of Planning, ONS) and J Rogers (Director of DMD, ONS)

Photo Plate 1-5: Participants during the Workshop

Photo Plate 1-6: Participants during the Workshop

Photo Plate 1-7: Alpha Bockarie, Director of SLMD, delivering his statement

Photo Plate 1-8: Hon Jalloh, Deputy Minister of Transport and Aviation, delivering his keynote speech

Photo Plate 1-9: Representatives from the MDAs, UNDP and Consultants presenting at the Workshop

Langumba Keili (Chairman & Director ONS); Joseph Kaindaneh (UNDP CIEWS Project Manager); John Rogers (Director ONS-DMD); Samuel Kamara (Deputy Director NRM & GIS, EPA-SL); Oliamata Karim (Hydrologist, MWR); Julius Mattai (Managing Director, INTEGEMS); Samuella Faulkner (Senior Consultant, INTEGEMS) and Koinguma Baimba (Consultant, INTEGEMS)

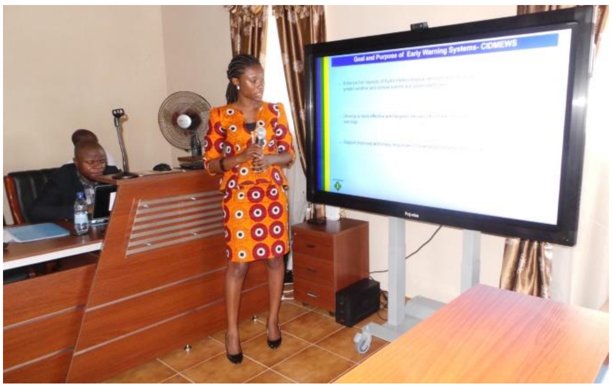


Photo Plate 1-10: Workgroup Session 1: Participants discussing the Project's activities and scope

Photo Plate 1-11: Workgroup Session 2: Participants discussing the Project's activities and scope

12 APPENDIX C: NEEDS ASSESSMENTS RESULTS

12.1 Needs Assessment Summary Tables

12.1.1 Sierra Leone Meteorological Department (SLMD)

Issues	Current State	Desired Future State	Gaps	Reasons for Gaps	Proposed Remedial Action
Category 1: Meteorological and Hydrological Data and Projections					
Precipitation and General Meteorological Monitoring	Currently no system in place.	The SLMD hopes to have a well-developed meteorological system after the implementation of the Support to Communication and Dialogue on Early Warning and Forecasting Product and Climate Information	There are gaps with equipment, funding, and technically skilled staff	Availability of financial resources from the GoSL leading to poor infrastructure and human resource	The proposed remedial action is to establish stationary sites for forecasting weather-related hazards
Climate Modelling and Forecasting	Currently no system in place	There should be adequate coverage of the landscape and proper maintenance to ensure continuity of supply according to the ICAO. processed models	There is very little functioning meteorological equipment. Lack of funding and technically skilled staff.	Availability of financial resources from the GoSL leading to poor infrastructure and human resource	The SLMD's infrastructure would need to be looked at and developed. Also, their Human resource capacity must be increased with regards to that area.

Issues	Current State	Desired Future State	Gaps	Reasons for Gaps	Proposed Remedial Action
		and forecast outputs should be easily accessible online.			
Hydrological Monitoring	Currently no system in place. The MWR provides hydrological data and information to the SLMD, where necessary and available.	There should be adequate coverage of the water resources and proper maintenance and upkeep to ensure continuity in the supply of data. Attribute data e.g. rivers width, depth, water volume; watershed information should be attached to the hydrology datasets. Processed outputs should be easily accessible online	There is a lack of common standards and methods by which data is acquired and processed. Need for improvement in the hydrological infrastructure and equipment.	The hydrology sector in Sierra Leone is still embryonic, lacking all the necessary infrastructures (monitoring network, data handling systems, workstations and modelling capacity) to produce flood forecast or warning. A large amount of stations owned by the MWR are manual stations, which have to be read by someone in the field. Heavy rains and storms wash many stations away. However as part of this project some Automatic weather stations are being set up and will be handed over in due time.	To provide Automatic Weather Stations to support meteorologist in providing daily forecasts. With regards the manual weather stations, mobile data collection should be implemented in order to update CIDMEWS with real time/near real time data.

Issues	Current State	Desired Future State	Gaps	Reasons for Gaps	Proposed Remedial Action
Category 2: Hazards and Risks					
Drought Risk Monitoring	Currently no system in place	There should be adequate coverage of drought monitoring. The forecast outputs should be easily accessible online.	There is no capacity built to package information or to adequately produce tailored forecast for end users in sectors such as mining, tourism, planning and agriculture and marine	The accuracy and detail of forecasts are not satisfactory due to lack of enough data from the workstations and the communication system with capacity for accessing regional forecasting product through telecommunication system to allow the downscale operation.	There should be a significant investment in communication, computers and workstations as well as specialised training to all forecaster.
Flood Risk Assessment	Currently no system in place	All forecasted product should be accessible online	The rapid rise in rivers are not identified as a precursor to flooding in flood prone areas	Lack of access to monitoring stations in key locations of the country with regards flood risk assessment.	To establish an appropriate communication channel with the different stakeholders; ONS, EPA-SL and the general public.
Storm Surge Impact Analysis	Currently no system in place	For the public to access the storm surge forecasts online	The SLMD does not have any radio detection and ranging device- RADAR	This is reflected in the poor performance of the service and inability of providing sector tailored forecast	The SLMD development process will build storm surge

Issues	Current State	Desired Future State	Gaps	Reasons for Gaps	Proposed Remedial Action
			system to support air sounding the forecasting operation. This restricts the capacity of SLMD to accurately forecast the dynamics of storms. They also do not have a website to display those findings.	and warnings. The most likely cause of this is a lack of integrated data sets and monitoring infrastructure to supply these reports.	risk into its functional requirements. This will include mapping vulnerable infrastructure.
Category 10: Critical and Emergency Infrastructure					
Disaster Response	The SLMD currently does not supply any stakeholders with necessary information to properly mitigate and respond to disasters	To establish an up-to-date disaster response dataset for the country easily accessible online.	Lack of funding and trained personnel who are able to maintain a monitoring network and handle data to support the necessary forecast operations	Poor infrastructure and human resource due to lack of funding	Consultation with stakeholders will be required in order to identify entities managing disaster response information. Following this, an assessment of the data format of the data, methods of data collection, transfer and analysis, accessibility of datasets and

Issues	Current State	Desired Future State	Gaps	Reasons for Gaps	Proposed Remedial Action
					maintenance protocols. Based on this evaluation, an operational plan can be generated, which will provide a framework for the creation of the complete disaster response dataset. INTEGEMS, on behalf of the SLMD/MTA applied to the Registrar for a www.slms.gov.sl domain registration with Afcom.
Maintenance and Security of Critical Infrastructure	There is a rapid decline in infrastructure dedicated to meteorological monitoring	To install new infrastructure for meteorological monitoring	The SLMD is severely understaffed with only two available meteorologists, approx. 15 observing staff and met technicians, with only one maintenance and repair technician	The SLMD is under budgeted and financial resources obtained through government are not sufficient to undertake training and capacity development to raise the number of technical staff to keep a credible record of weather and climate data.	The critical civic features data from various organisations (ONS, EPA-SL, SLMD and MWR) should be evaluated for consistency, the format of the data, methods of data collection, transfer and analysis, accessibility of datasets and maintenance

Issues	Current State	Desired Future State	Gaps	Reasons for Gaps	Proposed Remedial Action
					protocols. Based on this evaluation, an operational plan can be generated.
Gaps in Data Analysis and Reporting for Environmental Change					
Agency collaboration	No standardised agency collaboration. Loosely planned	To establish a communication network between the stakeholders	Poor inter-sectorial coordination at a departmental and ministerial level results in the available climate, agriculture, and environmental data, and information not been adequately combined or translated for key messages to be easily understood by users	The limited amount of information generated by SLMD is still not shared with end-users in a timely manner. Thus, preventing the necessary response action to be put in place.	The system will need to be well-organized and versatile using a variety of communication media, and partners including the media, and NGOs active at the local community level in recognition of their capacity for public sensitization and education.
Data storage and systems backup	Currently, there is no such system in place both the climatology server and the DSL server that were donated to the department are non-functional.	Rationalisation and coordination of equipment and processes.	No IT staff in the SLMD. Inadequate data storage capacity and systems backup. Additionally,	Lack of human resource as well as infrastructure due to financial resources	Discuss whether data backup/ storage may be incorporated as part of data sharing guidelines and specifically as part of a central repository.

Issues	Current State	Desired Future State	Gaps	Reasons for Gaps	Proposed Remedial Action
			general workflow within organisations is adversely affected by power outages experienced at regular intervals.		Make recommendations for in-organization and national mechanisms for systems backup.
Software	Only software in place is the MS Office 2007 Suite.	To develop software packages that are capable of working with the standards of the ICAO	Insufficient software and licenses to execute the necessary tasks.	Lack of funding	Ascertain from consultation with stakeholders the software that needs to be used and to prioritise these in terms of required licenses. Compare these software packages and determine if there is consistency across Sierra Leone and or the sub-region and make recommendations for standardised software usage and possibly open source options. This may be included in data management standards.

Issues	Current State	Desired Future State	Gaps	Reasons for Gaps	Proposed Remedial Action
					Recommended the deployment of GIS (ArcGIS for Desktop and ArcGIS for Server) and Meteorological Information System (MIS) application software for the CIDMEWS, including the Earth Network Forecasting products and services (e.g., WeatherBug, PulsaRAD API and StreamerRT, etc)
Internet connectivity	Africel provides the network for the transmission of data from the weather stations to the head office, but at the moment it is currently non-existent. In the head office, there is often little or no internet connectivity. Provided via a DSL internet connection to AFcom	To ensure sufficient connection that provides a continuous and relatively high volume of data transfer (for large data sets that need to be uploaded or downloaded from servers).	Lack of equipment, technically skilled staff, and resources.	Lack of funding	To ensure sufficient connection that provides a continuous and relatively high volume of data transfer (for large data sets that need to be uploaded or downloaded from servers). To also ensure that data is received and processed by the servers.

Issues	Current State	Desired Future State	Gaps	Reasons for Gaps	Proposed Remedial Action
					INTEGEMS, on behalf of the SLMD/MTA has applied to the ECO-WAN Project to provide a 10Mbits/5Mbits upload/download bandwidth for Internet connectivity in the SLMD
Roles	The SLMD has a very low human capacity and lacks IT and GIS personnel. The SLMD contributes to the open data initiative readily sharing information with other departments and organisations; never for commercial gain. They meet the Freedom of Information request. The SLMD currently lacks publication schemes on climate information and disaster management With regards to early warnings the SLMD on issue fishers early warnings on weather events	At a minimum, the SLMD should have people that provide IT support to GIS technicians.	No training for enhanced application of statistical rigour to data. No dedicated ICT staff to the SLMD.	No funding in place	A policy that speaks to the minimum of staff and support that allows us to stay in touch with technological advances.

Issues	Current State	Desired Future State	Gaps	Reasons for Gaps	Proposed Remedial Action
GIS capability	There is no GIS capability whatsoever	The SLMD should become familiar with simple geospatial tools.	Lack of GIS-skilled set and software	No human resources and financial resources are a likely cause.	Provision of the necessary software as well as in-depth to improve the human resource capabilities. ArcGIS for Desktop and ArcGIS for Server software are being procured for the SLMD.
ICT Capability	The staff have Wired and wireless network connections throughout the building. They near to zero ICT capability	The organisation should have set data handling and security compliance procedures with regular training of new staff employed by the SLMD. They should also have sufficient ICT human resources to handle the ICT needs of the SLMD.	The Gap is the lack of the right tools, operating procedures and human resources.	Lack of human resources and equipment due to lack of financial resources.	Provision of necessary equipment. Training of new and existing staff to properly handle data. Creation of Data Security manuals and Standard Operating Procedures for the staff to follow. Hiring of ICT sufficient and competent staff to properly hand the ICT component of the SLMD

12.1.2 Office of National Security (ONS)

Issue	Current State	Desired Future State	Gap	Responsible Factors for Gap	Proposed Remedial Action
Category 1: Meteorological and Hydrological Data and Projections					
Climate Modelling and Forecasting	Not actively involved in climate modelling and forecasting				
Category 2: Hazard and Risk					
Drought Risk Assessment	No activity on risk assessment	Analyse risk assessment and make decision			
Flood Risk Assessment	N/A	Assessing flood risk and put mitigation measures in place			
Storm Surge Impact Analysis					
Diseases and pest risk and distribution					
Category 3 Geographical and Biophysical Environment					

Issue	Current State	Desired Future State	Gap	Responsible Factors for Gap	Proposed Remedial Action
Air quality	The ONS work with EPA-SL to help facilitate some of these issues, some emissions are regulated under the Environment Protection Act 2008/ 2010	To establish a coverage of similar automatic air quality stations across the entire country. In addition, air quality measurements to include toxic gases in the atmosphere. Processed outputs should be easily accessible online.	Non-stations existing for monitoring air quality in sierra Leone	Lack of resources to set up air quality stations Restriction, Similarly, there is an instrument to measure toxic gases.	Based on this evaluation, a decision will need to be made whether to set up the monitoring toxic gases stations in the ONS-DMD.
Category 10: Critical and Emergency Infrastructure					
Disaster Response	The ONS is responsible for disaster response. There are three (3) disaster response policies in place. They themselves do not gather data but collaborate with the front-line agencies that collect this data. Further discussion with ONS will be required to determine exactly which data sets they use.	Data related to vulnerable areas as well as disaster impact management needs to be readily accessible and available to response teams. This implies that the data should be electronic, centrally stored, and easily deployed to relevant groups.	There are currently no hazard, vulnerability and risk maps within the institution	There has not been the investment and integration of data required to produce these data products.	
Maintenance and Security about Critical Infrastructure	The maintenance and security of critical infrastructure are handled by multiple institution, Further discussion with ONS will be required to determine exactly which data sets they use.	Critical infrastructure should be identified and data relating to its status should be monitored so as to ensure that it continues to function.	The critical infrastructure to be monitored was not identified		

Issue	Current State	Desired Future State	Gap	Responsible Factors for Gap	Proposed Remedial Action
Agency Collaboration	There is some form of between the ONS and some key stakeholders	Standardised and continuous collaboration amongst government, private, NGO, academic and other aligned agencies.	standardisation and protocol for sharing of information	Many collaborative partners have little to no standards for sharing data or the proper infrastructure.	
Data storage and systems backup	The ONS has 6 Servers running on Microsoft windows server 2008 R2 Standard the servers have used 60GB of storage and 1.94 TB of free space. Roughly 100 Desktop and 29 Laptops System backs up are done and stored on External Hard Drives within the organisation The ONS backs up its Data on External Hard Drives. Backups are stored within the organisation.				
Software	The ONS has 2 applications on its servers and 24 Machines with QGIS mapping software				
Internet Connectivity	The ONS has 10 internet access points with an average download				

Issue	Current State	Desired Future State	Gap	Responsible Factors for Gap	Proposed Remedial Action
	speed of 4 Mbps and an upload speed of 2 Mbps. The institution has 1 fibre optic internet link				
Roles	The ONS has a small but capable team of 5 IT personal, 4 able to perform computer and network maintenance, and 1 network security and database administrator. The ONS contributes to the open data initiative readily sharing information with other departments and organisations; never for commercial gain. They meet the Freedom of Information request. The ONS has publication schemes on climate information, early warning, and disaster management.				
GIS capability	15 members of staff have shown interest in learning GIS however the institution's GIS capacity is very low the ONS currently cannot spatially represent threats, risk and hazards. The institution is currently using open source software for GIS				

Issue	Current State	Desired Future State	Gap	Responsible Factors for Gap	Proposed Remedial Action
ICT capability	The ONS has a good ICT backbone that is barely being used to its fullest potential. The ONS implements correct access controls for digital information, Its measures to ensure no sensitive information could be released in error a largely enforced. The organisation largely understands data handling and security compliance but understand staff require further security training. The ONS has largely included all formats in information management initiatives but standards are yet to be put in place. Most information is stored in corporate spaces however some members of staff still pass out information using public information or chat applications. At the ONS there is an identified owner of each information asset, the institution documents how each information asset will be used over time and has identified and assessed the risks to its information asset. The staff have wired and wireless networks within the office that can be readily accessed.				

12.1.3 Environmental Protection Agency-Sierra Leone (EPA-SL)

Issues	Current State	Desired future state	Gap	Responsible factors for Gap	Proposed remedial actions
Category 1: Hazards and Risk					
Drought Risk assessment	There is fairly comprehensive hydrological and meteorological data being gathered by the SLMD, MWR and ONS-DMD. It is not clear what drought indices are being processed at this point. There is a lack of integration between the data sets and this may inhibit a true perspective on drought assessment. For similar reasons, the absence of hydro-meteorological monitoring network means that drought conditions (for example rainfall and atmospheric demand) are not being efficiently monitored for agricultural lands and selected crops cultivated in the IVS of four districts in Eastern Sierra Leone (Kono, Koinadugu, Kailahun and Kenema).	The desired future state would be to have high spatial resolution analysis that can address drought risk assessment. Relevant data sets should be integrated where appropriate.	The gap appears to be a lack of integration of meteorological and hydrological data that would have allowed drought indices to be calculated. There is enough equipment at EPA-SL to carry out this assessment but a lack of human resource is impeding this assessment.	The causal factors appear to be the unintegrated parallel development of different monitoring systems by different agencies.	Although there is a lack of integration, there are programs and projects in place to improve this. CIDMEWS should work in parallel with these projects and the Drought risk assessment. The key will be to bring added value through integration with other regional data sets and to not replicate efforts of the projects running Sierra Leone.

Issues	Current State	Desired future state	Gap	Responsible factors for Gap	Proposed remedial actions
Flood Risk assessment	There is no information and data available for the hydro-meteorological services to produce accurate forecast that can protect population and assets, e.g. intense rainfall is not monitored in areas such as Kambia (Mambolo Chiefdom) and Kailahun (Jawie and Nyaluahun chiefdoms) Districts are prone to floods and rapid rises in rivers are not identified as a precursor to flooding .Sierra Leone is essential for flood risk mapping. With the integrated monitoring systems and models that are being developed through SLMD, ONS-DMD, MWR and EPA-SL. Flood risk analysis should be feasible.	High-resolution flood warning data is required. Hydrological data that allows for reporting effectively on floods is necessary. This may require more sophisticated source data than is currently being gathered (stream levels).	One thing that is lacking is good topographical data. Therefore, many potentially threatening flood hazards are not forewarned because of the absence of monitoring stations in key locations of the country's watershed.	The causal factors appear to be the unintegrated parallel development of different monitoring systems by different agencies and the corresponding need for integration.	The flood risk analysis can be built into CIDMEWS using data from the automatic weather stations to properly tabulate the occurrence and severity of the rain. The development of this functionality can happen in parallel with complementary projects that are happening in Sierra Leone.
Storm surge impact analysis		Organisation seeks to minimise the impacts and disruptions caused by storms. In order to do this, each country needs to have an understanding of the critical infrastructure and populations that are at risk and then have adaptive	The data is currently not being processed properly nor disseminated to the various communities that would be at risk from such hurricanes and storms. Infrastructure and topographical data	The casual factors appear to be a lack of integration between storm surge warnings and infrastructural data – this could be due to a lack of	Connecting topographical and coastal zone data (GIS – based) with storm surge data. This will be explored in the determination of functional requirements for CIDMEWS

Issues	Current State	Desired future state	Gap	Responsible factors for Gap	Proposed remedial actions
		mechanisms to achieve this. Storm tracking data must be of an adequate resolution to connect with other relevant social and economic data to produce risk products. The storm path and surge data should be in a format that can be integrated with these other data sets. Additionally, each country needs to be able to identify what other data is relevant for risk reduction in their territory.	need to be connected with storm surge hydrological data in order to assess risks. This is currently not happening.	resources and/or technology to do so.	
Category 2: Coastal zone and ocean					
Coastal zone monitoring - Beach profile/ coastal change	EPA-SL manually measures beach profiles at locations across Sierra Leone. Results are recorded on paper and then inputted into a spreadsheet. GIS maps the geology and physical features of coastlines, measures beach profiles, collects bathymetry of the Sierra Leonean shelf, and undertakes time series analysis of coastal changes using satellite imagery and aerial photography.	Adequate coverage of coastal locations (according to experts input) to include beaches as well as other important coastal areas of Sierra Leone. Standardised mechanisms to monitor change and proper maintenance and to ensure continuity in the supply of data. Outputs should be easily accessible.	EPA- SL has a few beach profile monitoring locations across the country, but there is an urgent need for additional locations. There is a lack of country-wide coastal zone data and this suggests the need for data for areas other than beaches. However no indication of the locations was given.	There is currently a lack of human resource as well as infrastructure for proper coastline monitoring to take place. This is mainly due to a lack of financial resources in that area.	The current network of coastal change monitoring undertaken by EPA-SL (and any other Stakeholders) should first be closely evaluated for the following; 1. Consistency in data supply 2. The format of the data 3. Methods of data collection 4. Transfer and analysis 5. Maintenance protocols. Based on this evaluation,

Issues	Current State	Desired future state	Gap	Responsible factors for Gap	Proposed remedial actions
					an expert assessment on the number of stations as well as the type of coastal zone data to be acquired, an operational plan can be generated with an increase in locations, if warranted. It is also necessary to conduct further research in order to determine which other entities collect coastal zone data and ascertain how this data may be combined with that from EPA-SL and ONS-DMD in order to build a comprehensive repository of coastal zone data. Indeed, collaborations amongst organisations and data standards are important and must be addressed in the operational plan.
Ocean monitoring sea temperature	EPA-SL manages automatic stations at which sea temperature is recorded.	Adequate coverage of the coastal waters surrounding Sierra Leone (according to experts input) and proper maintenance and upkeep to ensure continuity in the supply of data. Processed outputs should be easily accessible online.	The EPA-SL currently has no instruments of their own to carry out this analysis, and instead rely on data from neighbouring and regional partners, although in most cases this data would be inadequate.	If problems with data do exist, then difficulties with maintenance, data gathering (due to human resource, infrastructure and finances), and transmission may be a likely reason.	The current network of sea temperature monitoring must be assessed in terms of data consistency, format, methods of data transfer, and maintenance protocols. Based on this evaluation, and an expert assessment of the number of stations, an operational

Issues	Current State	Desired future state	Gap	Responsible factors for Gap	Proposed remedial actions
					plan can be generated and also a possible increase in stations, if warranted.
Category 3: Land Cover and Land Use					
Land Cover and Land Use	The EPA-SL does collect data related to land cover types and different land uses, as well as the. The specific nature of this data (metadata for GIS) is unclear.	Land cover and land use data should be extensive, covering national and regional priorities as well as key socio-economic and biophysical phenomenon relevant to each national stakeholder. Climate change and environmental impacts should be addressed in the data sets.	There is no current data that properly depicts the recent land cover and land use based on any and all migrational patterns of the residents in certain areas. Also, a proper database has not been set up to hold the existing data with regards land cover and land use.	Financial Constraints and no proper monitoring of People movement.	Specific questions should be asked of the Ministry of Lands and Country Planning, as well as the Ministry of Agriculture and Forestry in regards to the specific types of land cover and land use data they collect. If it is GIS data, the complete specification will be required (projection, resolution, etc). This can be done in the review of functional requirements for CIDMEWS in the design phase.
Protected Areas and Parks	EPA-SL does collect data related to protected areas and parks – both terrestrial and marine. The National Protected Area Authority also collects data on these areas.	Data for protected areas boundaries and health should be electronically accessible and stored. Impacts on these systems due to environmental change and climate change should be addressed.	There is currently limited data specifying the size of these protected areas, as well as the updating of new areas and the increase or decrease in the size of existing areas.	Financial constraints and little proper monitoring of protected areas.	Specific question about the format of the data they store on protected areas and parks in need to be resolved. This can occur in the design phase of the project.
Category 4: Agriculture and Food Security					

Issues	Current State	Desired future state	Gap	Responsible factors for Gap	Proposed remedial actions
Agricultural Productivity	MAFFS collects data related to agricultural productivity based on weather (bimonthly) and for agriculture (monthly). They pass on this data to the EPA-SL. They are in the process of implementing a GIS-based system.	Data related to agricultural productivity should be regularly gathered in a consistent and quality assured ways. It is particularly important for this data to be suitable for assessing impacts of regional climate and environmental change on agriculture.	There was not sufficient enough detail provided by the EPA-SL to determine where there were gaps. One area that would need attention is the gathering and analysis of data related to weather and climatic change and its impacts on agriculture.	Due to a lack of infrastructure, there hasn't been any integrated analysis for climate change impacts on agriculture.	Specific detail about the nature of agricultural data that the Ministry of Agriculture and Forestry needs to be clarified in the design process of Consultation with the ministry in the establishment of functional requirements will be necessary
Soil quality	The EPA-SL currently does not have a soil quality database highlighting the area of coverage, type and consistency of soil covering the whole of Sierra Leone.	Soil quality data needs to be comprehensive enough to indicate the type, productivity, and status of different regions. Spatial resolution may vary depending on the heterogeneity of the landscapes. Data should be made available to organisations concerned with food security and planning and other relevant stakeholders like the EPA-SL	It appears that accurate and available soil type data is not currently available.	Lack of human resources as well as financial resources to conduct soil analysis surveys.	The provision for soil data management can be provided in CIDMEWS. The GIS interface will be particularly useful for soil mapping. Populating the database will have to be done by the Ministry of Agriculture and Forestry, as well as the EPA-SL
Category 5: Critical and Emergency Infrastructure					
Disaster Mitigation	The EPA-SL carries out sensitization in disaster prone areas, although it is not as frequent nor does it reach everyone.	Data related to vulnerable areas as well as disaster impact management needs to be readily accessible and available to response	The Gap lies in the amount of personnel available to disseminate this information on a regular (monthly) basis	Human resource factor due to financial limitations	The appropriate organisations for emergency response should be identified in the design phase of the

Issues	Current State	Desired future state	Gap	Responsible factors for Gap	Proposed remedial actions
		teams. This implies that the data should be electronic, centrally stored, and easily deployed to relevant groups.	within these communities by passing out leaflets.		CIDMEWS system. The exact format and types of data required to produce emergency response products can then be clarified.
Maintenance and Security of Critical Infrastructure	The EPA-SL provides data that the ONS and other relevant stakeholders could use in times of disaster.	Critical infrastructure should be identified and data relating to its status should be monitored so as to ensure that it continues to function.	The Gap lies in the amount of expertise available to handle certain security and critical infrastructure.	Human resource factor due to financial limitations. Needs a larger ICT department	As part of the implementation of the CIDMEWS system, a proper ICT department would need to be set up with the EPA-SL with a secure server room. Also, the amount of staff available across all of the regional offices needs to be improved
Agency Collaboration	The survey respondents indicated that they engage in some form of research collaboration. The institutions that collaborate together are SLMD, ONS, MWS and Media and Print houses. In terms of collaborative sharing of data, organisations indicated that they were ready and willing to collaborate and share data.	Standardised and continuous collaboration amongst government, private, NGO, academic and other aligned agencies.	Whereas collaboration is existent, in most cases it is done via the wrong channel or using inefficient means and different naming conventions.	Lack of standard operating procedures with regards agency collaboration.	Sharing of data and inter-agency collaboration will have to be examined within the context of the specific problems that need to be solved. These details will need to be sorted out in Phase 2 when the protocols for the system inputs and outputs are determined.

Issues	Current State	Desired future state	Gap	Responsible factors for Gap	Proposed remedial actions
Data Storage and System Backup	The EPA-SL has 7 servers but currently uses 2 running on Microsoft windows server 2012 Standard. The File server specifications: 64- Bit system type, hard drive capacity of 2 TB and 1.93TB free space 168 GB usable Ram and 2 Intel(R) Xenon(R) processors with speeds of 2.20GHz The second server houses the EIA database (which has crashed) specifications: 64- Bit system type, 8 GB Ram and Intel(R) Xenon(R) processor with a processor speed of 2.20GHz The 4 Servers not used have 36 TB of space Backups are stored within the institution on external hard-drives.	Rationalisation and coordination of equipment and process. Computational power to use a web-based application that draws upon different data sources (CIDMEWS)	Backup resources are limited and proponents use fairly basic software packages.	The EPA-SL have limited resources and this is likely the main factor that contributes to this.	The backup requirement will need to be assessed for the EPA-SL depending on their role in contributing data. The storage of critical data for CIDMEWS will need to be evaluated. It is likely that there will be a central repository of data at the most secure location.

Issues	Current State	Desired future state	Gap	Responsible factors for Gap	Proposed remedial actions
Software	Computers are outfitted with various versions of windows. The EPA-SL are In possession of 26 ArcGIS Desktop Licenses (12 standard, 4 basic, 12 student) and 2 ArcGIS Server licenses.	Software packages and OS that are compatible with the platform chosen for CIDMEWS.	No apparent gap as of yet.		The design process for CIDMEWS will need to address software requirements for the stakeholder groups. The software choice should be accessible and preferably have a low entry cost (nothing in terms of PHP/MySQL and GeoNode).
Internet Connectivity	The EPA-SL have a 15Mbps ADSL internet connection from Sierratel with 4 internet access points within the building. Regional offices, however, rely heavily on Wi-Fi dongles.	Sufficient connection that provides a continuous and relatively high volume of data transfer for large data sets that need to be uploaded to or downloaded from the CIDMEWS servers.	There are some respondents that indicated that they have a very slow internet connection. This may prove to be a problem for functions that require the transfer of a large amount of data. For those working in the provinces, they have little or no internet connection and would normally have to send in vital and time sensitive information via courier to the head office.	Lack of finances to set up DSL internet connections in all of their regional offices	The design process will need to recognise any bandwidth limitations in Sierra Leone, as well as look for ways to improve the bandwidth the EPA-SL. Each of the Provincial offices would also need a DSL connection so that they could readily update the CIDMEWS site with the relevant data. Also, there would need to be proper monitoring of the network use and potential blocking of non-work related sites.

Issues	Current State	Desired future state	Gap	Responsible factors for Gap	Proposed remedial actions
Roles	The EPA-SL has two IT experts, of which one is conversant in computer maintenance and database administration. They have only 2 GIS specialists.	Each organisation should have persons who can provide IT support to GIS technicians. Also to enable better coordinate for environmental activities and to create, and enforce a strict regulatory framework for environmental regulation in Sierra Leone. The EPA contributes to the open data initiative readily sharing information with other departments and organisations; never for commercial gain. They meet the Freedom of Information request The EPA lacks publication schemes on climate information, early warning, and disaster management.	No training for enhanced application of statistical rigour to Data.	Limited experts and financial resources are a likely cause.	A policy that speaks to the minimum of staff and support that allows the EPA-SL to stay in touch with technological advances. The requirements for programming personnel will need to be examined in the sustainability and outreach component of the CIDMEWS project.
GIS Capacity	The GIS capacity of the EPA-SL is currently inadequate as they are understaffed in that regard. They are equipment rich but human resource poor. The EPA has 3 machines with GIS mapping	To boost the technical capacity of Sierra Leone EPA-SL through training, to systematically streamline digital information (e.g. using GIS platform to generate vulnerability and risk maps)	The EPA-SL only has one GIS expert and one trainee do to all of their required mapping and data collection across the whole country.	Limited experts and financial resources are a likely cause.	Ascertain from consultation with stakeholders, the level of GIS competence at each organisation, based on this evaluation, an operational plan that speaks to minimum training requirements can be generated. Long intensive

Issues	Current State	Desired future state	Gap	Responsible factors for Gap	Proposed remedial actions
	applications. The UNDP donated 16 ESRI ArcGIS Licenses to the EPA within the 16 licenses there are 2 standard licenses, 4 basic license and 12 student licenses. A further 10 ArcGIS 10.4 Standard licenses have been donated by the UNDP and 2 enterprise ArcGIS Server 10.4.1 licenses. They also have 15 Trimble GPS's, 1 large format printer, 1 map plotter, 1 large format scanner and 5 Samsung galaxy tablets with ArcPad	to support decision making in sector planning such as mining, tourism and land planning			training exercises can be laid out for new and existing employees of the EPA-SL in accordance the CIDMEWS implementation and sustainability plan. Each regional office would furthermore need at least in-house GIS experts and ICT staff to support them.
ICT Capacity	The EPA lacks correct access controls for digital information, measures to ensure no sensitive information could be released in error are not enforced. The organisation partially understands data handling and security compliance it understood that there is an indifferent attitude within the institution towards following data security procedures storing information in	The organisation should have set data handling and security compliance procedures with regular training of new staff employed by the EPA. They should also have sufficient ICT human resources to handle the ICT needs of the EPA.			

Issues	Current State	Desired future state	Gap	Responsible factors for Gap	Proposed remedial actions
	personal spaces rather than corporate. The EPA documents how each information asset will be used over time but does not have an identified owner of each information asset and has not assessed of identified the risks to its information asset. The staff have wired and wireless networks within the office that can be readily accessed.				

12.1.4 Ministry of Water Resources (MWR)

Issue	Current Issue	Desired future state	Gaps	Responsible factor for gaps	Responsible remedial actions
Category 1: Meteorological and Hydrological Data and Projections					
Precipitation and general meteorological monitoring	Data collect from simple and manual rain guages				
Hydrological monitoring	A pilot hydrological monitoring network has been established in the Rokel-Seli river basin consisting of a network of 33 monitoring sites (24 set up by this project, 9 from other organisations).	To have adequate coverage of hydrological monitoring across all regions. Proper maintenance and upkeep to ensure continuity in the supply of data. Attribute data e.g. rivers- width, depth, water volume; watershed information should be attached to the hydrology datasets. Processed outputs should be easily accessible online.	There is no established framework for nationwide hydrological monitoring in the Country. There is also no operation technical personnel although a number of water technicians are expected to be trained under a parallel GEF programme "*Building Adaptive Capacity to Catalyze Active Public and Private Sector Participation to manage the Exposure and Sensitivity of Water Supply Services to Climate Change*". Outdated legislation and enact a new National Water Resources Law.	Sierra Leone's hydrological monitoring infrastructure was largely destroyed during the decade-long Civil War. The MWR has also suffered from a lack of investment in infrastructure and human resources.	The current network of hydrological monitoring should first be assessed for spatial coverage, consistency in data supply, the format of the data, methods of data transfer, and maintenance Protocols. Based on this evaluation, and an expert assessment of the quantity of stations and laboratory infrastructure, an operational plan can be generated, inclusive of standards. Given that hydrological monitoring is undertaken by multiple organisations, collaboration and

Issue	Current Issue	Desired future state	Gaps	Responsible factor for gaps	Responsible remedial actions
	Monitoring has focused on establishing measurements of rainfall, groundwater level and surface water flows. Using equipment and resources which were relatively inexpensive, portable and capable of being deployed and operated locally by trained Government of Sierra Leone staff working alongside local communities. There are currently no resources in place to adequately manage the data collected from monitoring programmes.	Integrated Water Resource Management, Accurate flood and drought risk data should be available to organisations that need it.	No national monitoring networks for precipitation, surface water and groundwater. No website and repository for collating hydrometeorological data		standardisation of processes are extremely important here. It would also be ideal for all stations to be loggers in order to allow for continuous data collection and thereby improved temporal resolution and data quality
Category 2: Hazards and Risks					
Category 4: Coastal Zone and Ocean					
Coastal zone monitoring – beach profile/ coastal change	MWR monitors water availability in the Coastal Zone.	Coastal zone data should be accessible and usable by relevant stakeholders. Due to the integrated nature	Coastal zone data aside from water quality data was very sparse.	Further investigation is required with MWR and EPA-SL to determine the	The aforementioned agencies will be contacted in the process of

Issue	Current Issue	Desired future state	Gaps	Responsible factor for gaps	Responsible remedial actions
		of coastal zone management, a variety of data sets that come from different agencies may be required: biodiversity, inundation, tourism, etc.		extent of coastal zone data they gather.	determining functional requirements.
Category 7: Water: Availability, Quality and Use					
Water availability	MWR is responsible for the monitoring, availability and sustainable management of freshwater resources of the country.	Data for water availability should be regularly collected and made available electronically to relevant stakeholders. Impacts of climate or environmental change should be reflected in this data.	Numerous rivers of interest, in the country, are not monitored thus there is a poor spatial resolution. There are also temporal and spatial data gaps owing to data not being recorded manually by responsible persons.	A significant amount of stations owned by the MWR are manual stations, which have to be read by someone in the field.	There are several different aspects of Water availability that could be addressed but the most pressing are having a good understanding of the impacts that environmental and climate change have on water resources.
Water quality	The Ministry currently monitors water quality in the Rokel-Seli river basin	Water quality measured nationally. Data should cover all key parameters such as nitrates,	Not enough monitoring stations. However, further investigation of the monitoring system is required before citing this as a distinct gap in data.	The reason cited by stakeholders for this gap in monitoring is a lack of funding for monitoring stations. other	The current network of water quality monitoring should first be closely evaluated for the consistency in data supply, the format of the data, methods of data transfer,

Issue	Current Issue	Desired future state	Gaps	Responsible factor for gaps	Responsible remedial actions
		phosphates, coliform, BOD, and others. The data should be made available to relevant stakeholders and electronically stored.		data is compiled related to process - policies, laws, institutions etc.	and maintenance protocols.
Water use	Water use is monitored by MWR. However, different stakeholders collect water use data; the protocols for collecting this data vary between stakeholders.	Central management and integration of this data can help with getting a cohesive understanding of national water use.	N/A	N/A	
Category 10: Critical and Emergency Infrastructure					
Data storage and systems backup					

Issue	Current Issue	Desired future state	Gaps	Responsible factor for gaps	Responsible remedial actions
Software					
Internet Connectivity					
Roles					

Issue	Current Issue	Desired future state	Gaps	Responsible factor for gaps	Responsible remedial actions
GIS capability					
ICT capability					

12.2 Assessment of Communication Network Capability

The assessment of communication network capability is a forward-looking, organisational and technological inventory and review that assessed the ability of the SLMD, ONS-DMD, EPA-SL and MWR and the local communities to meet future objectives and challenges in climate, hydro-meteorological and disaster forecasting communications. The assessment focused on political, environmental, social, legal, technical, leadership, strategy and delivery capabilities in providing a range of available technologies and technological products to improve communication of climate, hydro-meteorological, early warning and disaster forecasting information between the relevant mandated MDAs and the local communities and identify equipment specification to improve communication.

The communication network capability assessment was designed to be relatively short and take a high-level view of the strategic operations of the SLMD, ONS-DMD, EPA-SL and MWR, especially in accelerating the wireless mobile networking capability. It was primarily informed by interviews with directors, senior leaders and external stakeholders. It also considered the views of staff who attended a series of disaster management, meteorological, climatic and hydrological data and early warning workshops and round-table discussions.

Specifically, the communication network capability assessment focused on the following:

- The formality of and level of participation in interagency partnerships, forums, or governing bodies established to address common interoperability interests in disaster management, meteorological, climatic and hydrological data and early warnings.
- The level of adequacy, participation in developing, and consistency of formalized standard operating procedures (SOPs) to address common interoperability interests in disaster management, meteorological, climatic and hydrological data and early warnings.
- The technology standards and equipment that are being utilized to effectively provide interagency communications in disaster management, meteorological, climatic and hydrological data and early warning.
- The availability and regularity of training and exercise programs for communications interoperability
- Ease and regularity of using interagency communications technologies and procedures within the area and across all types of events, including day-to-day, task force, and mutual aid operations.
- Network service functions to satisfy user needs; network performance capability to meet service demands; security of service; quality of Service (QoS); and dependability of service.

12.3 Assessment Using the UN-ISDR Framework

Climate information and early warning is a major element of disaster risk reduction as it prevents loss of life and reduces the economic and material impact of disasters. Although it must be based on good science, prediction and technology, effective early warning systems need a people-centred approach tailored to local conditions to be successful. Best practice systems have strong linkages and effective communication channels between all elements and need to actively involve communities at risk, facilitate public education and awareness of risks, effectively disseminate messages and warnings and ensure that there is a constant state of preparedness.

Given this, the framework for analysis of the existing arrangements and for design of the CIDMEWS was been based around the guidance produced by the UN International Strategy for Disaster Reduction for Promotion of Early Warning Systems (UN-ISDR, 2006), suitably adapted for Sierra Leone’s situation and focussing on meteorological hazards. The UN-ISDR framework sets out four key interrelated elements and four cross cutting issues as outlined below:

- **Risk Knowledge:** To establish a systematic, standardised process to collect, analyse and share data, maps and trends on hazards and vulnerabilities.
- **Monitoring and Warning Service:** To establish an effective hazard monitoring and warning service with a sound scientific and technological basis.
- **Dissemination and Communication:** To develop communication and dissemination systems to ensure people and communities are warned in advance of impending natural hazard events and facilitate national and regional coordination and information exchange.
- **Response Capability:** To strengthen the ability of communities to respond to natural disasters through enhanced education of natural hazard risks, community participation and disaster preparedness.
- **Cross Cutting Issues:** To Develop institutional, legislative and policy frameworks that support the implementation and maintenance of effective multi-hazard early warning systems which involve local communities and take due consideration of gender and cultural diversity.

12.3.1 Key Element 1: Risk Knowledge

Aim: To establish a systematic, standardized process to collect, assess and share data, maps and trends on hazards and vulnerabilities

Table 12:1 UN-ISDR Framework –Risk Knowledge Assessment

	Summary Of Existing Situation(SL)	**Contribution Made by Project**
Organisational Arrangements Established		
Key national government agencies involved in hazard and vulnerability assessments identified and roles clarified.	The key national agencies involved in hazard and vulnerabilities assessment are Office of National Security (**ONS**) Disaster Management Department (**DMD**), Environmental Protection Agency (**EPA**), Ministry of Water Resources (**MWR**) and Sierra Leone Meteorological Department (**SLMD**). The **ONS(DMD**) is the leading institution on vulnerability assessment	No direct contribution but the use of existing hazard and vulnerability data from a number of sources will be required to develop some basic that the project will support to develop
Responsibility for coordinating hazard identification, vulnerability and risk assessment assigned to one national organisation.	The National Security and Central Intelligence Act in 2002 through which the ONS was established mandate The Office of National Security to be 'the Government of Sierra Leone's primary Coordinator for the management of national emergencies such as disasters both natural and man-made. Thus the ONS is responsible for coordinating hazard identification, vulnerability and risk assessment.	This Project provides benefits for long term planning and help the SLMD and other institutions (e.g., ONS, EPA-SL, MWR) build capacity to service other needs for example by providing long-term datasets for monitoring and trend detection
Legislation or government policy mandating the preparation of hazard and vulnerability maps for all communities in place.	The National Disaster Management Policy and Disaster Management Plan have been developed in collaboration with key partners and this has in its mandate to prepare district hazard and vulnerability maps	N/a – outside scope of the Project

	Summary Of Existing Situation(SL)	Contribution Made by Project
National standards for the systematic collection, sharing and assessment of hazard and vulnerability data developed, and standardized with neighbouring or regional countries, where appropriate.	The Government through the support of the UNDP has developed a National Hazard Profile which set the foundation for the development of an effective national disaster management programme However, Sub regional meetings are held on a regular basis to develop standardized sub-regional hazard/vulnerability/risk assessments with sub-regional response plans	N/a – outside scope of the Project
Process for scientific and technical experts to assess and review the accuracy of risk data and information developed.	Periodically experts from the UNSIDR office reviews and analyse the risk data and information developed.	N/a – outside scope of the Project
Strategy to actively engage communities in local hazard and vulnerability analyses developed.	With the decentralization process in its optimal stage, District Disaster Management Committees(DDMC) have been established to ensure the participation and cooperation of district and local communities in every aspect of disaster risk reduction;	Research surveys will be undertaken to get feedback from community end-users on the usefulness of warning messages and on how communities understand their risks; respect the warning service and know how to react. Capacity building, community and volunteer education and training programmes will be develop and implement to educate communities on how warnings will be disseminated and which sources are reliable and how to respond to different types of hazards after an early warning message is received
Process to review and update risk data each year, and include information on any new or emerging vulnerabilities and hazards established	Hazard profile is continually being reviewed to include new vulnerabilities based on the changing times and circumstances Most recently thunder and lightning assessment has been added to the risk data.	N/a – outside scope of the Project

	Summary Of Existing Situation(SL)	Contribution Made by Project
Key Natural Hazards Identified		
Characteristics of key natural hazards analysed and historical data evaluated	The Government through the support of the UNDP has developed a National Hazard Profile which set the foundation for the development of an effective national disaster management programme.	The project will undertake an assessment of the key natural hazards (eg frequency of flood and landslide events) in the pilot areas of Guma Valley Watershed, Bumbuna Watershed and drought prone eastern districts of Kenema. It will attempt to correlate these with historical records to establish preliminary thresholds for the proposed severe rainfall warning products.
Hazard maps developed to identify the geographical areas and communities that could be affected by natural hazards	The government through ONS has conducted vulnerability and capacity assessment in the districts in the country. This includes risks assessments, hazard-mapping and risks monitoring programmes right across the country	Geographic Information Systems (GIS) mapping will be done for vulnerable areas, meteorological information on flooding, droughts and severe storms, and community-based and/or traditional early warning systems. It would provide indicators for monitoring the impacts of climate change and facilitate climate hazard preparedness and adaptation planning.
An integrated hazard map developed (where possible) to assess the integration of multiple natural hazards.	There are no integrated maps developed .	The Disaster Management Information System (DMIS) will be developed as part of the CIDMEWS project and , once in place will allow better integrated hazard mapping
Community Vulnerability Assessed		
Community vulnerability assessments conducted for all the relevant natural hazards.	The DMD of ONS was funded by United Nations Development Programme through Red Cross to conduct a vulnerability capacity assessment in three	The project aims to assess community ability to respond effectively to early warning advisories and warnings undertake

	Summary Of Existing Situation(SL)	Contribution Made by Project
	District in the country; Western Area Urban, Western Rural and Tonkolili.	incorporate lessons learnt into future capacity building strategies
Historical data sources and potential future hazard events considered in vulnerability assessments.	The historical data available at the DMD is the data generated from the 2014 UN-ISDR Assessment. Data beyond that period cannot be accessed as a result of poor data management. The recently DesInventar database developed aims to store all risk and vulnerability data going forward. The SLMD also have historical data from 1923 up to date, though there are some lapse between the time periods because of the poor record system.	The project will Integrate historical risk and vulnerability data with data from installed meteorological and weather stations using the CIDMEWS MIS that will be established
Factors such as gender, disability, access to infrastructure, economic diversity and environmental sensitivities considered. .	A gender perspective has been integrated into the Sierra Leone Disaster Management Policy and other sectoral policies to ensure that the different needs of men, women, boys & girls are considered and addressed.	The project will consider socio-economic determinants (gender, disability, economic diversity and environmental sensitivities considered,) of all possible environmental, ecological and social impacts, both positive and negative, that are likely to bring about changes in the baseline environmental and social conditions as a result of the proposed interventions and establishing a mechanism for intersectoral dialogue and collaboration for a harmonized plan for recovery and rebuilding.
Risks Assessed		
Integration of hazards and vulnerabilities assessed to determine the risks faced by each region of community.	The ONS-DMD have conducted risk assessment and develop hazard profile and other climate hazards report.The vulnerability and capacity assessments also inform policy and decision making at strategic levels	The CIDMEWS will focus on monitoring and warning of hazards and vulnerability by assessing the risks faced by each pilot region of community

	Summary Of Existing Situation(SL)	**Contribution Made by Project**
Community and industry consultation conducted to ensure risk information is comprehensive and includes historical and indigenous knowledge, and local information and national level data.	The DMD has conducted community and industry consultations for various communities within the country to ensure the participation of the community in all prevention and mitigation activities. This shall be under the overall supervision of the DDMCs	The project will engage community-focused organisations to undertake consultations and capacity building exercises to analyse responses to previous early warning advisories and warnings and incorporate lessons learnt into future capacity building strategies.
Activities that increase risks identified and evaluated.	A comprehensive national assessment has not been conducted by the EPA and ONS (DMD) and Met Department have identify activities that are disaster risk activities like coal burning wide fire, deforestation, stone and sand mining in disaster prone specific areas in the country	This will form part of the risk mapping component of the Project.
Results of risk assessment integrated into local risk management plans and warning messages.	District risk management plans incorporate local analysis of hazards and rrecovery efforts are generally carried out with a view to reducing the risks and vulnerabilities	Existing information on risks will input into the development of CIDMEWS for early warning messages
Information Stored and Accessible		
Central library of GIS database established to store all disaster and natural hazard risk information.	The DMD at the moment has no GIS database or capacities established	The Project will integrate GIS and Management Information System (MIS) systems and mobile data collection technology to provide a well sophisticated tools and Web services for collecting, managing, visualizing, mapping, analysing,

	Summary Of Existing Situation(SL)	Contribution Made by Project
		monitoring, evaluating and reporting on various aspects of climatological, hydro-meteorological, disaster management and early warning information in Sierra Leone.
Hazard and vulnerability data available to government, the public and the international community (where appropriate).	It is understood that information that is held on the Disaster Management Information System is made available to government, the public and the international community.	The project will help to establish institutional mechanisms within the SLMD, ONS-DMD, MWR and EPA-SL to collect information about early warning systems aimed at empowering individuals and communities to act in sufficient time and in an appropriate manner
Maintenance plan developed to keep data current and updated	No maintenance plan developed yet.	This will be part of the Disaster Management Information System the projects aims to deliver.

12.3.2 Key Element 2: Monitoring and Warning Service

Aim: To establish an effective hazard monitoring and warning service with a sound scientific and technological basis

Table 12:2 UN-ISDR Framework – Monitoring and Warning Services Assessment

	Summary Of Existing Situation(SL)	**Contribution Made by Project**
Institutional Mechanisms Established		
Standardized process, and roles and responsibilities of all organisations generating and issuing warnings established and mandated by law.	It is the responsibility of the SLMD to establish warnings, develop early warning systems and build and formalize institutional partnerships between agencies and organisations. WMO advice sets out that the SLMD should be the lead authoritative voice on weather warnings and for multi-hazard warnings and related services. In Sierra Leone, the responsibility for issuing weather warnings (including impact based warnings) rests with SLMD, whilst responsibility to plan and coordinate the appropriate responses, based on the information supplied rests with ONS (in line with the institutional arrangements set out in the disaster management policy). This means that production of any warning that includes advice on response will require agreement with ONS and SLMD	The Project will assist to formalize the process, roles and responsibilities for the issuing of severe weather warnings amongst agencies and organisations.

Agreements and interagency protocols established to ensure consistency of warning language and communication channels where different hazards are handled by different agencies.	No formal agreements or interagency protocols established but there is a general consensus around the wording and issuing of warnings so that they are both consistent, timely and contain relevant information for responders and the public	The CIDMEWS will identify and assess existing communication and awareness raising documents and dissemination systems and also identify the mechanism and medium for communication and dissemination based on the information and level of risk
An all-hazard plan to obtain mutual efficiencies and effectiveness among different warning systems established.	The DMD policy set out the adoption of multi-hazard approach to disaster risks reduction as part of its strategic objective.	The CIDMEWS will standardize, interoperate, integrate and centralize information, responses and warnings, about all disaster management, meteorological, climatological, environmental and hydrological hazards that are pertinent to a given level/entity with careful attention to resilience and vulnerability.
Warning system partners, including local authorities aware of which organisations are responsible for warnings.	The national policies including the flood response plan sets out roles and responsibilities of all key stakeholders agencies and institutions in disaster preparedness, mitigation and response.	The CIDMEWS project will include activities to raise awareness of the new warning service, once it is in place. Preparedness measures set out in the Flood Response Plan provides a framework to achieve this.
Communication arrangements with international and regional organisations agreed and operational.	Sierra Leone is part of the Mano-River and the ECOWAS (sub-regional and regional bodies) that have strong cooperation in terms of risk assessments and reduction activities Sub regional meetings are also held on a regular basis to develop sub-regional hazard/vulnerability/risk assessments with sub-regional response plans. These resources, both human and material are designed in such a way that they could be requested for a very short notice by any member country as and when the need arises.	N/a outside scope of the Project.

Regional agreements, coordination mechanisms and specialized centres in place for regional concerns such as tropical cyclones, floods in shared basins, data exchange, and technical capacity building.	Sierra Leone is part of the Mano-River and the ECOWAS (sub-regional and regional bodies) that have strong cooperation in terms of risk assessments and reduction activities Sub regional meetings are also held on a regular basis to develop sub-regional hazard/vulnerability/risk assessments with sub-regional response plans. These resources, both human and material are designed in such a way that they could be requested for at a very short notice by any member country as and when the need arises.	N/a outside scope of project.
Warning system subjected to a system-wide tests and exercises at least once each year.	The Disaster management policy mandates the DMD to set up regular simulation exercises to test the disaster management systems. At the local level, DDMCs have a number of responsibilities to keep disaster management arrangements up to date.	The CIDMEWS project includes for testing of the system before it becomes fully operational. Once established, the warning system will become part of routine testing undertaken by DMD. The nature of testing that will be appropriate, given existing capacity will need to be further discussed with DMS and the Met Department.
National all hazards committee on technical warning systems in place and linked to National Disaster Management and Reduction authorities, including the National Platform for Disaster Risk Reduction.	National Disaster Management Executive Committee, National Disaster Management Technical Committee and a National Platform for Disaster Risk Reduction are in place.	N/a outside scope of the Project
System established to verify that warnings have reached the intended recipients.	The DDMCs conducts regular monitoring and reporting for their areas of responsibilities (AOR) to the department.	This will also be developed as part of the testing of the CIDMEWS system.

Warning systems staffed at all times (24 hours per day, seven days per week).	It is vital that the EWS is a 24/7 service with no breaks in provision of service or monitoring. systems are not equipped enough for 24/7 monitoring, although the airport forecast office operates on a 24/7 basis Staffing levels have dropped significantly from even post conflict	N/a outside scope of the Project
Monitoring (observations) Systems Developed		
Measurement parameters and specifications documented for each relevant hazard.	The parameter that is used to measure rain, flooding are been documented. It can also be detected by the high intensity of rain fall that there is every likely hood that there will be flooding. Establishing thresholds relating meteorological parameters (mainly rainfall) with impacts reported across the country will be a key part of developing the EWS and improving rainfall intensity forecast data	The CIDMEWS project will support development of preliminary rainfall thresholds, based on existing data, for the pilot districts across the country, especially related to rainfall induced landslides and flooding.
Plans and documents for monitoring networks available and agreed with experts and relevant authorities.	The SLMD has an inventory of the existing observation network	N/a outside scope of the Project
Technical equipment, suited to local conditions and circumstances in place and personnel trained in its use and maintenance.	SLMD operates and maintains an observation network around Sierra Leone. There are currently 20 stations within the country with 8 new automatic weather stations recently installed and plans to replace 4 more existing stations. However there is little functioning meteorological equipment in the department; The Ministry of water resources is also lacking the operational hydro meteorological network to allow the monitoring of river flow and contribute to flood forecast	N/a outside scope of the Project

Applicable data and analysis from regional networks, adjacent territories and international sources accessible.	Currently there are readily available model forecast data produced by Earth Networks available on their website but the challenge is the SLMD getting access to this data for further analysis because of lack of internet connection and facilities.	Earth Networks provides readily available model forecast data that will be integrated into the CIDMEWS platform.
Data received, processed and available in meaningful formats in real time, or near-real time.	The newly installed automatic weather stations by Earth Networks produces data in meaningful formats in real time, however the Met Department are not currently able to monitor the weather frequently due to lack of connectivity. With the current capacity at the Met Department there is no way to visualize the observations from their offices or the computer room	Earth Networks provides readily available model forecast data that will be integrated into the CIDMEWS platform
Strategy in place for obtaining, reviewing and disseminating data on vulnerabilities associated with relevant hazards.	No strategy is currently in place for the SLMD to do this.	The CIDMEWS will enable the SLMD to generate and disseminate information to facilitate the sharing of disaster management, meteorological, climatic and hydrological data and information and good practices between information suppliers and user communities
Data routinely archived and accessible for research purposes.	Archived data available but in hard copies	The CIDMEWS aims to establish Meteorological Information Systems that will be able to handle, manage, store, process and archive all data and products used operationally within meteorology
Forecasting and Warning Systems Established		
Data analysis, predication and warning generation based on accepted scientific and technical methodologies.	No warning service currently in place	The CIDMEWS project will develop warning generation system and products based around thresholds in line with similar systems elsewhere in the world and will support the use of World Meteorological Organization or other relevant standards

Data and warning products issued within international standards and protocols.	No warning service currently in place	The CIDMEWS project will develop warning generation system and products based around thresholds in line with similar systems elsewhere in the world and will support the use of World Meteorological Organization or other relevant standards
Warning analysis trained to appropriate international standards.	The UNDP has recently sponsored the training of two meteorologist in Reading, UK who are now fully engaged in the activities of the project.	The new trained forecasters and meteorologist, although still requiring on the job training to improve their competencies, will be a key part of the CIDMEWS system. The project will provide a range of support to improve forecaster capability to deliver severe weather warning products. However, further on-the-job training will be vital for the newly trained forecasters to become fully competent
Warning centres equipped with appropriate equipment needed to handle data and run predication models.	The MET department is lacking the basic human and technical capacity to handle data and run predictions.	The CIDMEWS project does not currently include for procurement of any equipment.
Fail safe systems in place, such as power back-up, equipment redundancy and on-call personnel systems.	There is no backup or fail systems in place neither at the SLMD or the ONS	There is a need for a more robust backup or fail system but this falls outside the scope of the CIDMEWS.
Warnings generated and disseminated in an efficient and timely manner and in a format suited to user needs.	Hazards and vulnerabilities are monitor and information is shared with communities Much progress has being made in this domain. Currently, both the SLMD and the ONS-DMD use normal media channels (TV, Radio, Newspapers) to disseminated forecast and warnings.	The CIDMEWS project will Establish institutional mechanisms within the SLMD, ONS-DMD, MWR and EPA-SL to collect information about early warning systems aimed at empowering individuals and communities threatened by hazards to act in sufficient time and in an appropriate manner to reduce the possibility of personal injury, loss of life and damage to property and the environment

Plan implemented to routinely monitor and evaluate operational processes, including data quality and warning performance.	No monitoring and evaluation processes implemented in the MET department but the OND-DMD have established standard operating procedures.	The EWS project will support the development of SOPs for routine monitoring during the pilot phase of the project to ensure these are adhered to and in addition, a verification scheme will be established for the CIDMEWS before it becomes operational. The Quality Management System which is planned to be introduced into Met department should improve operational processes, data quality and forecast verification

12.3.3 Key Element 3: Dissemination and Communication

Aim: Develop communication and dissemination systems to ensure people and communities are warned in advance of impending natural hazard events and facilitate national and regional coordination and information exchange

Table 12:3 UN-ISDR Framework –Dissemination and Communication Assessment

	Summary Of Existing Situation	Contribution made by Project
Organisational and Decision Making Processes Institutionalized		
Warning dissemination chain enforced through government policy or legislation.	The Disaster Management Policy includes strengthening of the communication systems as one of the key strategies. This is also one of the main objectives of the CIDMEWS projects.	Policy and legislation issues fall outside the scope of the project. However, clear roles and responsibilities for disseminating severe weather warning messages will need to be developed and formalized as part of the project.
Recognized authorities empowered to disseminate warning messages.	Currently ONS is the main institution authorised by the government to disseminate warnings messages.	The project will support the development of clear functions, roles and responsibilities for the issuing of severe weather warning messages.
Functions, roles and responsibilities of each actor in the warning dissemination process specified in legislation or government policy.	The Disaster Management Plan and National Disaster Management Policy covers disaster prevention, preparedness, and response and it clearly spells out the roles and responsibilities of agencies and institutions in disaster preparedness, mitigation and response	The project will support the development of clear functions, roles and responsibilities for the issuing of severe weather warning messages.
Roles and responsibilities of regional or cross border early warning centres defined, including the dissemination of warnings to neighbouring countries.	The roles and responsibilities of regional or cross border early warning centres is not clearly defined but it is being driven by the MRU	N/a outside scope of the Project

	Summary Of Existing Situation	Contribution made by Project
Organisational and Decision Making Processes Institutionalized		
Volunteer network trained and empowered to receive and widely disseminate hazard warnings to remote households and communities	The ONS in collaboration with other key stakeholders have developed a capacity building plan and community based volunteers have been trained at both provincial and district levels.	The CIDMEWS aims to engage community-focused NGOs and CBOs to assist with capacity building; develop and implement community and volunteer education and training programmes; and ensure community educated on how warnings will be disseminated and which sources are reliable and how to respond to different types of hazards after an early warning message is received
Effective Communication Systems and Equipment Installed		
Communication and dissemination systems tailored to the needs of individuals communities.	ONS have established DDMC in all 14 districts in the country which have communication systems in place that work through a system of first responders from the center down to the village level. There is a need to assess the effectiveness of the system.	The CIDMEWS project will use existing or planned communication systems for warning messages and will facilitate putting in place any required agreements or protocols to formalise the communication arrangements. Proposed warning products will be tailored for different end-users and communication methods.
Warning communication technology reaches the whole population, including seasonal populations and remote locations.	The ONS-DMD already have in place planned communication systems that work through a system of first responders from the centre down to the village level.	The CIDMEWS project will use existing or planned communication systems for warning messages and will facilitate putting in place any required agreements or protocols to formalise the communication arrangements. Proposed warning products will be tailored for different end-users and communication methods
International organisations or experts consulted to assist with identification and procurement of appropriate equipment.	It is standardised in the UNISDR format	N/a outside scope of the Project

	Summary Of Existing Situation	Contribution made by Project
Organisational and Decision Making Processes Institutionalized		
Multiple communication mediums used for warning dissemination.	Currently, both the SLMD and the ONS-DMD use normal media channels (TV, Radio, Newspapers) to disseminated forecast and warnings.	The CIDMEWS will enable the use of multiple communication tools for disaster management, meteorological, climatic and hydrological data and early warning information dissemination, such as Short Message Service (SMS) (cellular phone text messaging), social media (WhatsApp, Twitter, etc.), and email, radio, TV and web service
Agreements developed to utilise private sector resources where appropriate.	Engagement and partnerships with, private sector have been fostered at various levels such that they all form the membership of the disaster management committees at all levels.	N/a outside scope of project.
Communication systems are two-way and interactive to allow for verification that warnings have been received.	The ONS-DMD disaster management systems have functionality to offer two way interactive communications	The CIDMEWS project will investigate how existing communication systems can be best used to assist in verification of weather warnings
Equipment maintenance and upgrade programme implemented and redundancies enforced so back-up systems are in place in the event of failure.	No backup systems in place	N/a outside scope of the Project
Warning Messages Recognized and Understood		
Warning alerts and messages tailored to the specific needs of those at risk.	SLMD does not currently have specific warning or alert products,However the ONS-DMD are understood to have standard phrases and terminology that is used in their disaster management communications	The development of CIDMEWS includes a process to ensure that warning alerts and messages meets the specific needs. Standard tailored messages will be incorporated into warning products as/if required.

	Summary Of Existing Situation	Contribution made by Project
Organisational and Decision Making Processes Institutionalized		
Warning alerts and messages are geographically-specific to ensure warnings are targeted to those at risk only.	SLMD does not currently have specific warning or alert products. Existing forecasts are not considered to be geographically specific enough for disaster planners or responders.	Severe weather warning products will initially be geographically specific to the district and potentially sector level. Products will be able to be made more geographically specific as the capacity and tools and equipment within Met department and the Ministry of water resources improves.
Messages incorporate the understanding of the values, concerns and interests of those who will need to take action.	SLMD does not currently have specific warning or alert products, However the ONS-DMD uses standard phrases and terminology that address the values, concerns and interests of those who need to take action.	Standard tailored messages used by others could be incorporated into warning products as/if required. This will be investigated during the product development stage.
Warning alerts clearly recognizable and consistent over time and include follow-up actions when required.	SLMD does not currently have specific warning or alert products, However the ONS-DMD uses standard phrases and terminology that address the values, concerns and interests of those who need to take action.	Standard tailored messages used by others could be incorporated into warning products as/if required. This will be investigated during the product development stage.
Warnings specific about the nature of the threat and its impacts.	SLMD does not currently have specific warning or alert products.	N/a outside scope of Project
Mechanisms in place to inform the community when the threat is ended.	Information is transmitted via the same medium of warning dissemination i.e. radio, TV.	N/a outside scope of Project

	Summary Of Existing Situation	Contribution made by Project
Organisational and Decision Making Processes Institutionalized		
Study into how people access and interpret early warning messages undertaken and lessons learnt incorporated into message formats and dissemination processes. Warnings generated and distributed to those at risk by credible sources (e.g. government, spiritual leaders, respected community organisations).	Study into how people access and interpret early warning messages have been conducted and lesson learnt incorporated into message formats and dissemination processes to build on the existing systems in place	The CIDMEWS project will use, synthesized lessons learned for replication elsewhere with the ultimate goal of improving EWS performance.

12.3.4 Key Element 4: Response Capability

Aim: Strengthen the ability of communities to respond to natural disasters through enhanced education of natural hazard risks, community participation and disaster preparedness.

Table 12:4 UN-ISDR Framework –Response Capability Assessment

	Summary Of Existing Situation	**Contribution Made by Project**
Warnings Respected		
Warnings generated and distributed to those at risk by credible sources (e.g. government, spiritual leaders, respected community organisations).	It is the responsibility of the SLMD to establish/generate whilst responsibility to plan disseminate and coordinate the appropriate responses, based on the information supplied rests with ONS .This means that production of any warning that includes advice on response will require agreement with ONS and SLMD	The proposed product development process that the CIDMEWS will support includes identification of who warnings will be issued to and how they will be distributed, leading to a formalisation of those arrangements
Public perceptions of natural hazard risks and the warning service analysed to predict community responses.	As part of its public education campaign, the Disaster Management Department has engaged in numerous assessments warning services to predict community responses.	The proposed product development process that the CIDMEWS will support includes trainings and workshops with end users to ensure clear and understandable messaging. INTEGEMS will work with SLMD and ONS to develop suitable messaging for warning and response
Strategies to build credibility and trust in warnings developed (e.g. Understanding the difference between forecasts and warnings).	Warning messages are disseminated and presented in a way that allows the intended user to actually receive, understand, believe and act upon the information. However there is need for a well-organized and coordinated public education and awareness.	The CIDEWS project will include actions to support this.
False alarms minimised and improvements communicated to maintain trust in the warning system.	Warning messages are disseminated and presented in a way that allows the intended user to actually receive, understand, believe and act upon	Improvements in the products can be communicated once CIDMEWS is established. False alarms can be minimised thought the ‘

	the information. However there is need for improvement improvements in forecaster skills and a well-organized and coordinated public education and awareness.	
Disaster preparedness and response plans established		
Disaster preparedness and response plans empowered by law.	The disaster management law, DM policy and DM plan all set out responsibilities for disaster preparedness and response plans.	Meteorological inputs into preparedness and response plans can be provided by the CIDMEWS once established.
Disaster preparedness and response plans targeted to the individual needs of vulnerable communities.	DM policy and DM plan sets out 'bottom up' approach to preparedness and response plans	N/a, outside scope of project.
Hazard and vulnerability maps utilized to develop emergency preparedness and response plans	DM Policy and DM Plan support this approach.	Geographic Information Systems (GIS) mapping will be done for vulnerable areas, meteorological information on flooding, droughts and severe storms, and community-based and/or traditional early warning systems. It would provide indicators for monitoring the impacts of climate change and facilitate climate hazard preparedness and adaptation planning
Up-to-date emergency preparedness and response plans developed, disseminated to the community and practiced.	This requirement is set out in the DM Policy and DM Plan. Implementation has not been assessed	N/a, outside scope of project.
Previous disaster events and responses analyses, and lessons learned incorporated into disaster management plans.	This requirement is set out in the DM Policy and DM Plan. Implementation has not been assessed	N/a, outside scope of project.

Strategies implemented to maintain preparedness for recurrent hazard events.	This requirement is set out in the DM policy and DM plan. Implementation has not been assessed	N/a, outside scope of project
Regular tests and drills undertaken to test the effectiveness of the early warning dissemination processes and responses.	The DMD-ONS conducts regular simulation exercises to test the disaster management systems, At the local level, DDMCs have a number of responsibilities to keep disaster management arrangements up to date.simulation exercises have also been conducted to test institutional capacities.	As part of the implementation of the CIDMEWS,INTEGEMS will conduct regular drills involving all actors of future early warning systems and in particular women and youth associations to test effectiveness and readiness of the communication and information sharing tool
Community response capacity assessed and strengthened		
Community ability to respond effectively to early warnings assessed.	This requirement is set out in the DM Policy and DM Plan but extent to which this presently happens has not been assessed.	Field visits will be organised to engage community-focused organisations to undertake stakeholder consultations and capacity building exercises to analyse responses to previous early warning advisories and warnings and incorporate lessons learnt into future capacity building strategies.
Response to previous disasters analysed and lessons learnt incorporated into future capacity building strategies.	This requirement is set out in the DM Policy and DM Plan but extent to which this presently happens has not been assessed	Field visits will be organised to engage community-focused organisations to undertake stakeholder consultations and capacity building exercises to analyse responses to previous early warning advisories and warnings and incorporate lessons learnt into future capacity building strategies.
Community and volunteer education and training programmes developed and implemented.	The ONS in collaboration with other key stakeholders have developed a capacity building plan and community based volunteers have been trained at both provincial and district levels	The CIDMEWS aims to engage community-focused NGOs and CBOs to assist with capacity building; develop and implement community and volunteer education and training programmes; and ensure community educated on how warnings will be disseminated and which sources are reliable and how to respond to different types of hazards after an early warning message is received

Public awareness and education enhanced	Awareness raising programmes using an all hazard approach also on-going and continual	The project will enhance public awareness and education campaigns and ensure they are tailored to the specific need of each audience (e.g. children, emergency managers, media, etc.)
Simple information on hazards, vulnerabilities, risks, and how to reduce disaster impacts disseminated to vulnerable communities and decision-makers.	No warning products are currently being issued. However, ONS and SLMD have an existing education programme on DRM which can form the basis for the introduction of information on meteorological hazards, if this is not already included.	The project will enhance the systematic and standardized process to communicate and disseminate warnings response plans share data, maps and trends on hazards and vulnerabilities
Community educated on how warnings will be disseminated and which sources are reliable and how to respond to different types of hazards after an early warning message is received.	Awareness raising programmes using an all hazard approach also on-going and continual	The project will enhance public awareness and education campaigns and ensure they are tailored to the specific need of each audience (e.g. children, emergency managers, media, etc.)
Community trained to recognise simple hydro-meteorological and geophysical hazard signals to allow immediate response.	Awareness raising programmes using an all hazard approach also on-going and continual	The project will enhance public awareness and education campaigns and ensure they are tailored to the specific need of each audience (e.g. children, emergency managers, media, etc.)
On-going public awareness and education built into school curricula from primary schools to university	Awareness raising programmes using an all hazard approach also on-going and continual	The project will enhance public awareness and education campaigns and ensure they are tailored to the specific need of each audience (e.g. children, emergency managers, media, etc.)
Mass media and folk or alternative media utilised to improve public awareness.	Awareness raising programmes using an all hazard approach also on-going and continual.	The project will enhance public awareness and education campaigns and ensure they are tailored to the specific need of each audience (e.g. children, emergency managers, media, etc.)

Public awareness and education campaigns tailored to the specific need of each audience (e.g. Children, emergency managers, and media).	Awareness raising programmes using an all hazard approach also on-going and continual.	The project will enhance public awareness and education campaigns and ensure they are tailored to the specific need of each audience (e.g. children, emergency managers, media, etc.)
Public awareness strategies and programmes evaluated at least once per year and updated where required.	Awareness raising programmes using an all hazard approach also on-going and continual.	The project will enhance public awareness and education campaigns and ensure they are tailored to the specific need of each audience (e.g. children, emergency managers, media, etc.)

12.3.5 Key Element 5: Governance and Institutional Arrangements

Table 12:5 UN-ISDR Framework –Governance and Institutional Assessment

	Summary Of Existing Situation	Contribution Made by Project
Early Warning Secured as a Long Term National and Local Priority		
Economic benefits of early warning highlighted to senior government and political leaders using practical methods such as a cost-benefit analysis of previous disasters.	Not assessed. However, there is strong political will to implement the EWS system amongst political leaders and senior government officials	N/a
Examples and case studies of successful early warning systems disseminated to senior government and political leaders.	Not assessed. However there is strong political will to implement the EWS system amongst political leaders and senior government officials.	N/a

Early warning role models or champions engaged to advocate early warning and promote its benefits.	Not assessed	N/a
The priority natural hazard risk requirement an early warning system identified, and operational arrangements within multi-hazard framework established.	National and local risk assessments based on hazard data and vulnerability information are available and include risk assessments for key sectors	INTEGEMS will design, develop and implement an integrated **Climate Information, Disaster Management and Early Warning Systems (CIDMEWS)** for disaster management, meteorological, climatological, hydrological and early warning information.
Early warning integrated into national economic planning.	Plans are in place to integrate early warning into economic planning but there is a need for a well-defined and operational early warning system	The CIDMEWS project will make a contribution this implementation once approved
Legal and Policy Frameworks to Support Early Warning Established		
National legislation or policies developed to provide an institutional and legal basis for implementing early warning systems.	The Disaster Management Policy provide the legal basis for implementing early warning systems, and sets out the institutional framework.	N/a, outside scope of project
Clear roles and responsibilities defined for all organisations involved in early warning.	The disaster management and flood response plan clearly spells out the roles and responsibilities of agencies and institutions in disaster preparedness, mitigation and response.	N/a, outside scope of project
Overall responsibility and authority for coordination of early warning assigned to one national agency.	The government of Sierra Leone has established a National Disaster Management Department (DMD) in the Office of National Security (ONS) within the Office of the President which has the overall responsibility and authority for coordination of all disaster management including early warning.	N/a, outside scope of project

One political leader or senior government official empowered by law as the national decision maker	National decision making is made by the national disaster management committee which falls under the jurisdiction of The ONS	N/a
Policies developed to decentralise disaster management and encourage community participation	The DM policy sets out that functions and actions for disaster management should be undertaken at the lowest or least centralised competent level possible. Existing arrangements include a structure for disaster management from national down to village level	N/a
Local decision making and implementation of early warning systems placed within broader administrative and resource capabilities at the national or regional level.	The Disaster Management Department has engaged all sectors to ensure that they incorporate disaster risk reduction into sustainable development initiatives. In this regard, the government has included disaster risk reduction into Pillar Two and Three of the Poverty Reduction Strategy Paper (PRSP).	N/a
Regional and cross-border agreements established to ensure early warning systems are integrated where possible.	Sub regional meetings are held on a regular basis to develop sub-regional hazard/vulnerability/risk assessments with sub-regional response plans. For localized disasters/risks that have the propensity to become sub-regional, meetings have also been done at various levels to map out contingency plans to address this.	N/a
Relationships and partnerships between all organisations involved in early warning institutionalised and coordination mechanisms mandated	The Disaster Management Department has engaged all sectors to ensure that they incorporate disaster risk reduction into sustainable development initiatives. In this regard, the government has included disaster risk reduction into Pillar Two and Three of the Poverty Reduction Strategy Paper (PRSP).	The project aims to establish institutional mechanisms within the SLMD, ONS-DMD, MWR and EPA-SL to collect information about early warning systems aimed at empowering individuals and communities threatened by hazards to act in sufficient time and in an appropriate manner to reduce the possibility of personal injury, loss of life and damage to property and the environment
Early warning integrated into disaster reduction and development policies.	There is need for a well-defined and operational early warning system.	N/a

Monitoring and enforcement regime in place to support policies and legislation.	The Disaster Management Department has engaged all sectors to ensure that they incorporate disaster risk reduction into sustainable development initiatives. In this respect government has included disaster risk reduction into Pillar Two and Three of the Poverty Reduction Strategy Paper (PRSP).	N/a
Institutional Capacities Assessed and Enhanced		
Capacities of all organisations and institutions involved assessed and capacity building plans and training programmes developed and resourced.	A gap analysis of the relevant key institutions has been undertaken and recommendations made as to capacity building and training required to enable severe weather warning products to be effectively produced.	INTEGEMS will undertake a comprehensive stock-taking, assessment and a gap analysis of the key institutions, ONS-DMD, MWR, EPA and SLMD to identify potential improvements to the functional domains.
Non-governmental sector engaged and encouraged to contribute to capacity building.	ONS work in close coordination with Sierra Leone Red Cross who manages a first response network and provide a range of capacity building initiatives.	The project will assist to establish strategic and operational partnerships with local NGOs and CBOs for a systematic, standardized process and capacity building to communicate and disseminate response plans and collect, assess and share data, maps and trends on hazards and vulnerabilities.
Financial Resources Secured		
Government funding mechanism for early warning and disaster preparedness developed and institutionalised.	Overall national funding for Early Warning System has not been assessed as there is no specific allocation of budget for Disaster Risk Reduction in the national budget. Most DRR activities at the	N/a

	national level are supported by partners such as the UNDP.	
Access to funding at the international or regional level explored.	Access to future international or regional funding has not been assessed in detail but funding could be available through a number of sources.	N/a
Public/private partnerships utilised to assist with early warning system development.	Potential for public/private partnerships to assist early warning systems development has not been assessed.	N/a

12.4 Photo Plates

Figure 12-1: Consultations with Mr Kaindaneh at the SLMD

Figure 12-2: Work Stations donated for this project by UNDP and Earth Networks to the SLMD

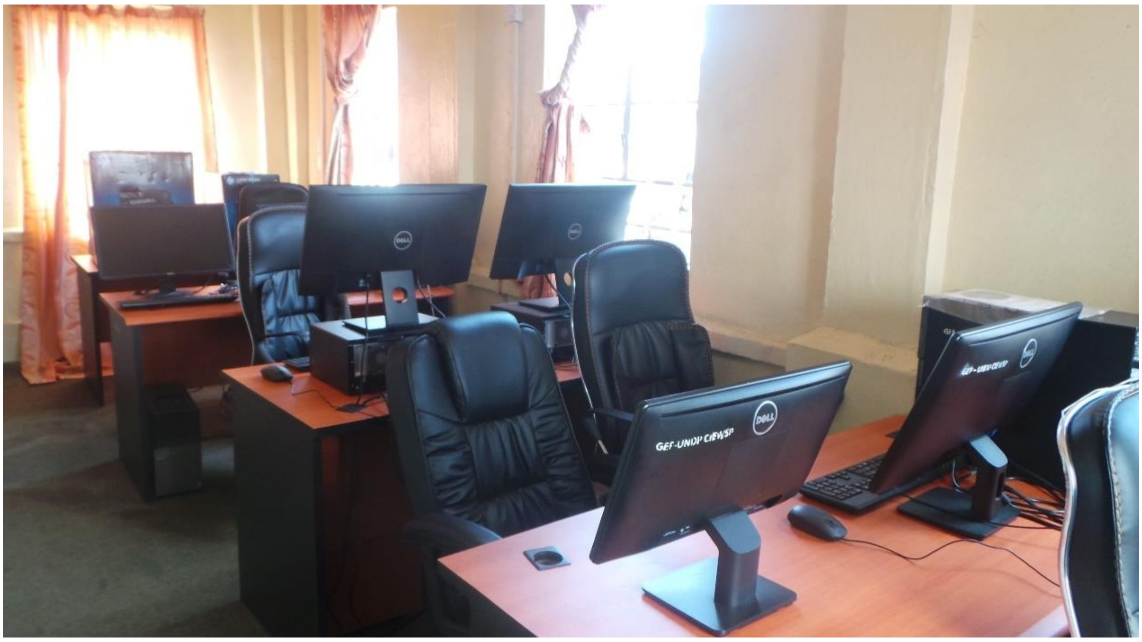


Figure 12-3: Work Stations donated for this project by UNDP and Earth Networks to the SLMD

Figure 12-4: SLMD Server

Figure 12-5: SLMD Server Room/2nd Server

Figure 12-6: SLMD SLMD 2nd Server

Figure 12-7: Consultations with Mr Kamara, GIS Director, at the EPA-SL

Figure 12-8: Consultations with EPA-SL IT staff in the EPA server room

Figure 12-9: EPA-SL File Server

Figure 12-10: EPA-SL 2nd Server

Figure 12-11: Consultations with ONS GIS team

Figure 12-12: Consultations with ONS GIS team

Figure 12-13: Consultations with ONS IT team

Figure 12-14: ONS server room