Disaster Vulnerability Reduction Project

**TERMS OF REFERENCE
FOR THE
DEVELOPMENT OF SPECIFICATIONS FOR AN INTEGRATION SOLUTION FOR
HYDRO-METEOROLOGICAL DATA AND INFORMATION DISSEMINATION FOR
THE GOVERNMENT OF SAINT LUCIA**

1. Background

The occurrence of climate extremes has increased in Saint Lucia with droughts followed by severe floods occurring as recently as 2013, during the Christmas Eve Trough. In addition, climate change related impacts are expected, including shifts in precipitation patterns, increased tropical cyclone and storm intensities, and sea-level rise resulting in saltwater intrusion and loss of coastal lands. These unavoidable adverse natural events and consequences of global warming, are coupled with high vulnerability and exposure of the population which, in turn, increases future catastrophic disaster risk. Developments on slopes, flood plains and high coastal population densities are key factors influencing exposure to threats, while inadequate design and construction increase vulnerability. Hydro-meteorological disasters, coupled with the climate change phenomenon impose large costs on the country's fragile economy and exacerbate poverty levels.

The Government of Saint Lucia (GoSL) has obtained assistance from the World Bank towards the financing of the Disaster Vulnerability Reduction Project (DVRP) aimed at reducing the Country's vulnerability to natural hazards. The project is part of the regional Disaster Vulnerability Reduction Adaptable Program Lending (APL-DVRP) for the Eastern Caribbean Region, along with Grenada, Saint Vincent and the Grenadines (SVG) and Dominica. In addition, Saint Lucia has been selected as a pilot country under the Climate Investment Fund's (CIF) Pilot Program for Climate Resilience (PPCR), a multi-donor Trust Fund which provides Grant funds and highly concessional loans to pilot countries to implement adaptation activities. Under the PPCR process, Saint Lucia prepared the Strategic Program for Climate Resilience (SPCR) outlining an adaptation investment plan that would be funded with PPCR funding. The DVRP and the PPCR program has been processed as a single project, financed with IDA Credit, PPCR grant and concessional loan.

In this regard, the Disaster Vulnerability Reduction Project (DVRP) aims to measurably reduce the vulnerability to natural hazards and climate change impacts in Saint Lucia. This includes various activities related to capacity building for open systems and platforms to create, share, analyze and use disaster risk and hydro-meteorological (hydromet) data and information. This would therefore help to improve decision making for risk reduction and climate change adaptation.

To this end, component two of the DVRP, "Technical Assistance for Improved Assessment and Application of Disaster and Climate Risk Information in Decision Making", includes the enhancement of hydro-meteorological service capacity (and delivery) of the main hydro-meteorological service providers in Saint Lucia, the Water Resources Management Agency (WRMA) and the Saint Lucia Meteorological Service (SLMS). WMRA is the main hydrological agency and SLMS is the operational meteorological agency.

This *Terms of Reference* (ToR) outlines the requirements of WRMA and SLMS for hiring a qualified consultant to undertake a set of tasks assisting the Government of Saint Lucia in improving their hydromet information collection, management and dissemination abilities.

1.1 Status quo on data management

Currently, both SLMS and WRMA collect and manage hydro-meteorological data independently. Both agencies have expressed a desire to unify their information management and reporting systems as well as improve their information dissemination ability. Both SLMS and WRMA have undertaken efforts, along with the Caribbean Institute of Meteorology and Hydrology (CIMH) and various development partners towards these goals. As a result of these efforts, the WRMA operates a database management system and online data portal providing access to hydrological time-series data collected from WRMA field instruments. Both SLMS and WRMA have instruments reporting through a recently upgraded TriLynx NovaStar5 platform. CIMH has established the DEWETRA platform to manage data from instruments they have installed in Saint Lucia and provide web based access to SLMS. While progress has been made, major obstacles remain, including; the coordination of standards compliant Database Management Systems (DBMS), data sharing solutions between SLMS and WRMA, and dissemination of datasets and information to end users and the general public.

Both WRMA and SLMS have been independently pursuing projects to improve their hydromet information collection, management and dissemination abilities. These efforts have produced information systems, however, moves towards integration were not prioritized by either agency. This project will investigate and assist the GoSL in creating specifications for the implementation of an integration architecture which will bring together the various data and information sources critical for meeting the needs of both hydromet data producers and users.

Under the DVRP, is expected that additional hydromet data will be collected and varied management infrastructures will be developed. The timing of this assignment will be critical in assisting the GoSL in ensuring that hydromet data providers and users are able to take full advantage of both existing and new data sources.

2.   Objectives

The primary objectives of this assignment are to:

(i) Create the specifications for data integration and access layers. The integration layer will interface with the various databases and data collection/production systems used by the WMRA and SLMS. The access layer will provide a set of unified technologies for SLMS and WRMA to access and manage hydromet data and information products produced by either agency.

(ii) Investigate and specify improvements to the provision and dissemination of hydromet data products, via the integration infrastructure, to end-users in the GoSL and various other sectors of Saint Lucia's economy.

(iii) Oversee the development of the integration solution and ensure that the specifications are met during implementation and that the work performed is of high quality.

3.   Scope of Work

The consultant will be expected to perform the following tasks in order to achieve the objectives of this project. The consultant will make reference to existing WMO standards and global best practices related to the objectives throughout the performance of this assignment.

Task 3.1 Inception Report and Work Plan

Prior to commencement of work, the consultant will provide a work plan, schedule and proposed methodology for completing the tasks described within this *Terms of Reference*.

Task 3.2 Requirements Elicitation

In order to understand the organizational structure and information flow at both the SLMS and WRMA the consultant will review reports, policy and documents related to such. A set of preliminary requirements are provided in Annex A. of these *Terms of Reference* which will be used by the consultant as a reference. Items for review shall include *inter alia*:

- Road Map for Modernization of Hydromet Services in Saint Lucia prepared under the Water Partnership Program (WPP).
- WRMA Strategic Plan

- Water and Sewerage Regulations
- Water and Sewerage Act
- Watershed Management Plans

The consultant shall assess the following existing information management portals *inter alia*:

- Webmap
- TriLynx NovaStar5
- GoSL Open Data Portal
- DEWETRA
- SLING
- Any other funded portals in development as of the date of effectiveness of this activity.

The consultant shall assess the following existing data management systems *inter alia*:

- Hydata
- Webmap
- TriLynx NovaStar5
- Integrated Water Resource Information System
- Any other data management systems or repositories hosted within the SLMS and the WRMA.

The consultant shall assess all existing early warning systems whose triggers are based on thresholds received from hydromet data provided by SLMS and/or WRMA field stations. Ongoing DVRP projects of note that will enhance the early warning systems are 1) modernization and upgrade of the existing hydromet monitoring system and 2) installation of a Flash Flood Guidance System (FFGS). A Common Alert Protocol (CAP) compliant early warning component will form part of the specifications to be integrated into the DBMS.

In addition to WRMA and SLMS, the consultant shall also meet with a selection of hydromet data end users, both in the GoSL and in Saint Lucia's private sector. End users within the GoSL shall include the Ministry of Agriculture, Ministry of Physical Development, Ministry of Infrastructure, Ministry of Economic Development, Government Information Service, Public Service Modernization Unit and any other Ministries deemed important by the client. In the private sector, the consultant shall meet with representatives from LUCELEC, the major telecom providers and any other organizations deemed important by the client. The consultant shall also contact representatives within the Caribbean Institute of Meteorology and Hydrology (CIMH).

The consultant shall also investigate the current use of social media and smartphones to disseminate hydromet information within Saint Lucia. The requirements shall include the use of these technologies by the GoSL in the dissemination of hydromet data and information products.

The requirements shall be divided into functional and technical sections; structured similarly to the preliminary requirements provided in Annex A. of these *Terms of Reference*. All requirements shall have an assigned priority for implementation divided into the following classes: 1. Absolute Must, 2. Needed but may be deferred, 3. Nice to have. The determination of these priorities shall be based on; (i) functional and technical need, (ii) institutional capacity, (iii) available budget for implementation, (iv) budget available at the GoSL agencies envisioned being responsible for long-term maintenance of the final integration architecture.

As mentioned in the Objectives of this *Terms of Reference*, it is expected that the integration architecture will consist of data access and integration layers. The integration layer is expected to interface with the varied systems within the GoSL in order to collect and organize data. The particular groupings of data within the integration layer will likely include tabular (time series, stage/discharge, rainfall grids), imagery (satellite scenes), and text (forecasts).

The consultant shall also assess the existing institutional framework and knowledge sharing agreements between SLMS and WRMA, in support of the unified approach for the technical and functional requirements of both agencies. The consultant will make suggestions for any improvements and changes to existing policies in order to facilitate the objectives in this *Terms of Reference*. The consultant will pay particular attention to the Open Data Policies of the GoSL and discuss with the GoSL staff responsible for maintenance and development of the GoSL Open Data Portal (data.govt.lc) optimal methods for hosting hydromet data on the platform.

Task 3.3   Gap Analysis

Based on the requirements elicitation in Task 3.2, the consultant will undertake a gap analysis based on hydromet data management and analysis technologies which already exist at both SLMS and WRMA, as well as those in funded projects under development. The consultant is undertaking the gap analysis to determine whether existing solutions solely managed by SLMS or WRMA, or a combination thereof, may meet the requirements developed in Task 3.2 of these *Terms of Reference*. The results of the gap analysis will be presented as a report detailing the particular compatibilities and gaps of existing solutions with the requirements developed in Task 3.2 of these *Terms of Reference*.

Task 3.4 Development of Specifications for an Integrated Hydro-meteorological Data Management and Information Dissemination Architecture

The results of the Tasks 3.2 and 3.3 will be used to inform the choice of procurement method (based on the version of World Bank Procurement Guidelines under which the DVRP operates) and development of specifications appropriate for contracting a firm, under the chosen procurement method, to undertake development of the architecture.

The consultant will prepare specifications for an architecture which clearly integrates the data services of SLMS and WRMA, based on the requirements developed in Task 3.2 of these *Terms of Reference* and taking into consideration the results of the Gap Analysis prepared in Task 3.3 of these *Terms of Reference*. Ideally, the architecture will make use of free and open source software wherever possible; but, in the cases that commercial software best suits the requirements, and is within budget, the consultant will include these software in the specifications. The architecture should also be extensible, allowing the future integration of new data sources and dissemination tools.

It is expected that there may be multiple solutions which could meet the requirements prepared in Task 3.2 of these *Terms of Reference*. The client wishes that the consultant prepare a set of at least three solution options for meeting the requirements. These options shall be presented at a high level and omit particular technical details of implementation but include an estimated level of effort along with a list of tasks, required inputs from the client and an estimated timeline; presented in a format such as a Gantt chart. Each option will also include estimated costs based appropriately for the current Eastern Caribbean market. These estimated costs will include both one time and recurring costs and may include the following; software development or purchase, hardware purchase, recurring costs for licenses, operation and maintenance, and any other costs deemed important by the client in consultation with the consultant. The consultant will work with the client to select an optimal solution for which specifications will be developed.

Based on the chosen implementation option, the consultant shall utilize the findings from the activities in Tasks 3.2 and 3.3 to develop specifications for a unified hydro-meteorological information management and dissemination architecture to be adopted by SLMS and WRMA. Within the specification, the consultant shall provide documentation for this unified architecture in the form of high level diagrams (entity relationships, data flow and workflow diagrams, pseudocode, related schematics etcetera). The required hardware and software needed for the proper functioning of the recommended architecture, including specifications appropriate for carrying out the purchase of hardware and software products as per World Bank Procurement Guidelines.

The final architecture specifications should provide the agencies with an interoperable, integrated data management and dissemination platform, facilitating ease of access to all hydro-meteorological datasets and information products.

Task 3.5 Assessment Support

After completion of specifications, the consultant will assist the client in:

(i)   Providing technical support required during the technical assessment of proposals based on the specifications developed in task 3.4 of these *Terms of Reference*
(ii)   Assessment of the solution being implemented as per a schedule agreed to by the client in concert with the consultant.

Task 3.6 Preparation of a Consultancy Completion Report

The consultant shall prepare a consultancy completion report highlighting the nature of the work undertaken, inter alia, the level of success and constraints in conducting the assigned tasks.

4.   Deliverables

The collected material, data and all final products shall be made readily available to SLMS, WRMA and the PCU. The consultant shall attempt to include opportunities for knowledge transfer.

All materials will be delivered in print and electronic formats, agreed to in consultation with the client, and written in the English language in a manner suitable for professional technical writing.

The consultant shall be expected to provide the following deliverables:

Deliverable (and relevant sections of this *Terms of Reference*)	Time after signing of contract
Inception Report (3.1)	2 weeks

Requirement Elicitation Outputs (3.2)	6 weeks
Gap Analysis Report (3.3)	8 weeks
Development of Solution Options (3.4)	16 weeks
Submission of draft Specifications for chosen Solution (3.4)	18 weeks
Submission of final specifications, including all hardware and software (3.4)	24 weeks
Assessment of the developed solution (3.5)	40-54 weeks (to allow for sufficient time for procurement, evaluation, award and submission of the performance security by the selected vendor)
Completion Report (3.6)	70 weeks

5. Duration of Assignment

The total duration of services provided by the consultant are expected to be up to 60 working days, over a period of 12 months from the time of contract signing to the completion of the major activities. These include at least 14 mission days to Saint Lucia as part of a fact finding mission with discussions and interviews with WRMA and SLMS among others, as well as to return to assess the development of the solution as per Task 3.5 of these *Terms of Reference.*

6. Qualifications

The consultant will demonstrate the following qualifications:

- Demonstrated experience with creating Data Management/Integration Services for NHMS or similar agencies in the last 5 years.

- Demonstrated experience with projects involving the processing and analysis common hydrometeorological data formats (NetCDF, HDF,XML,BUFR,GRIB,LRIT/HRIT).
- Demonstrated experience with the integration of meteorological satellite data with *in situ* sensor data.
- Proven experience with functional and technical requirements elicitation (business analysis) and gap analyses.
- Proven experience with the creation of hydromet information products meant for technical as well as non-technical audiences.
- Experience with WMO and OGC standards (Sensor Web) related to hydro-meteorological data collection, management and dissemination.
- Demonstrated experience with recent W3C standards for HTML5 and CSS3 as well as Web Content Accessibility Guidelines (WCAG) would be desirable.
- Demonstrated working experience with developing technical specifications for World Bank procurement documents. Experience with bidding documents is desirable.
- Previous working experience with the World Bank and/or WMO is desirable.
- Previous working experience in the Caribbean region is desirable.

7.   Responsibilities

The client will:
- Review and comment on submissions provided by the consultant within 12 working days (per the GoSL calendar of working days).
- Facilitate the arrangement of meetings during any in-country visits made by the consultant.
- Provide in country facilities for the consultant to undertake the creation of outputs required by this *Terms of Reference*.
- Respond to requests made by the client in a timely and thorough fashion.

The consultant will:
- Perform their assignment in a professional manner in line with the laws of St. Lucia.
- Seek to undertake knowledge transfer to the client whenever possible.

- Respond to requests, in the scope of these Terms of Reference, made by the client in a timely and thorough fashion.

Annex A. Solution Requirements

A.1 Technical Requirements

The solutions proposed for implementation shall:

1. Unify the hydro-meteorological information management systems of WRMA and SLMS.
2. Have very minimal (under 1000 USD /year) recurring costs unrelated to general technical maintenance and operation of the system.
3. Provide an accessible user friendly web-interface for public and institutional access to data, announcements, and derived forecast, early warning and analysis products from SLMS and WRMA.
4. Provide REST API functionality for programmatic access to observations and selected derived products.
5. Use open source and open standards solutions whenever possible.
6. Adhere to WMO standards and WMO endorsed OGC standards wherever possible.
7. Must be easy to use and maintain.
8. Provide sensor asset management capabilities to WRMA and SLMS.
9. Facilitate access to real time and archived datasets.
10. Be compatible with data from existing and planned sensor and satellite downlink installations at WRMA and SLMS
11. Shall not, through the implementation, trigger any World Bank Social or Environmental Safeguards unless absolutely necessary as determined in consultation with the client.
12. Be compatible with existing ICT infrastructure of the GoSL, to the extent possible.
13. Provide, or make use of an existing, off-site backup solution for all data.
14. Allow for convenient processing of data for preparation of informational products.

A.2 Functional Requirements

The proposed DBMS will interact with the following major segments; each segment will have multiple components in terms of hardware and software, the sections below outline requirements for those components per segment:

- Monitoring segment

- Data collection infrastructure including field sensors, data loggers and data transmission (GOES/UHF/VHF/GPRS).
- Aggregation segment
- GEONETCAST satellite downlink.
- VHF/UHF/GPRS base stations and decoding hardware/software.
- QA/QC software and data cleaning processes/procedures.
- Historical data
- Data Management segment
- DBMS
- Sensor observation service/ WaterML standards for data exchange
- Analysis segment
- Forecast models and tools
- Hydraulic and hydrologic models
- Communication Segment
- Forecast products
- Data products
- Early warning (CAP compliant)

The following sections outline the major components and their requirements per segment.

A.2.1 Pre-Processing Component

Item	Name	Segment	Description
1	QA/QC	Aggregation	Incoming data will be collected continuously, quality controlled, and processed before it is stored in the data base. Data validation should take place at the source of the data. Data flowing upstream from stations to DBMS cannot always be validated locally, therefore a Data quality control layer of the DBMS should contain functionality to validate observation data.

A.2.2 Hydro-Meteorological Database Component

Item	Name	Segment	Description
1	Continuous operation	Aggregation	The hydro-meteorological data base system will contain software to continuously manage the ingesting, processing, and management of incoming data being collected by both WRMA and SLMS.
2	Historical data	Aggregation	This contract will include population of all meta data in the parametric data base and population of the historical data base including historical precipitation, meteorological, stream gage and other hydro-meteorological data as needed.
3	Archiving of Processed data	Data Management	Data that is processed will be stored or forwarded for further use such as input to models, posting to the web sites of both WRMA and SLMS or archived for later use.
4	Archiving of Analysis Results	Analysis	Results of certain analyses will be stored within the DBMS.

5	Supported Tabular Data Types	Data Management	The following data sets will be stored: · Forecast grid time series · Scalar observation time series · Scalar forecast time series · Observed grid time series
6	Sensor health and uptime	Monitoring	The data access component should be used to automatically record daily information, within the database, regarding sensor uptime, reliability and other indicators deemed important in accessing the long term effectiveness of the whole system.
7	Supported Raster Data Types	Data Management	Satellite observations are currently obtained from the internet such as NOAA Polar orbiting satellite imagery and gridded data such as microwave observations and many processed satellite derived products such as satellite derived precipitation estimates (Ex. NOAA NESDIS Hydro-estimator products) will need to be accessed and stored in Data Base. Satellite imagery - This includes all GOES R data which will be received by purchased real time satellite downlink. This system will provide real time stream of acquired satellite imagery (GOES R products) which will need to be processed by DBMS, displayed, storied and forwarded to GFFG system.

| 8 | Supported Grid Data Types | Data Management | Radar imagery, reflectivity, -both gridded and raster. Currently raster (imagery only) images are received hourly by SLMS from the internet. As part of Flash Flood Guidance System to be implemented in the next year, radar gridded data and hourly precipitation estimates will need to be processed by DBMS, and sent to both SLMS and WRMA web sites for use by users and stored for eventual archive. |

A.2.3 Data Access Component

Item	Name	Segment	Description
1	Sensor Metadata	Monitoring	Based on the Sensor Observation Service, each sensor will have specific characteristics made available including; the sampling frequency (time step), grid resolution, forecast origin time, ensembles, variable time steps, data provider etc... Through a web API.

2	Observations	Data Management	API based access to the following:
			· Precipitation observations incremental time step and 24 hour total
			· Stream gage and water level observations
			· Tidal gage observations
			· Soil moisture probes
			· Water quality (option should be available, however this will not be part of the initial data provided)

| 3 | Forecast Products | Analysis | A web-based interface (preferably API) will be provided to access the following products (if available):

Routine Bulletin (text) weather forecasts

QPF time series and grid

Special weather forecasts, watches and warnings

Hurricane watches, warnings and information products

Drought Products

Global Numerical Weather Forecast model products

Mesoscale Weather Forecast Model products

Hydrologic model forecast products

Forecast Hydrograph time series

Flash Flood Forecast products and warnings

Flash Flood Guidance Products

Water Quality Models (should be made available for future use) |

4	Data Products	Analysis	A web-based interface (preferably API) will be provided to access the following products (if available):
			Discharge measurement data such as individual stream width cross section areas, velocities and flows.
			Observed Hydrograph time series at various time steps for both discharge and stage
			Reservoir inflow, pool elevation and storage, outflow and or tailwater
			Weather observations consisting of temperature, Dew Point and or relative humidity, Wind direction and velocity, current weather, cloud type/heights, precipitation and barometric pressure, evapotranspiration, evaporation, wind run and sunshine hours
			Water quality observations of water temperature, Total dissolved solids (sediments & sediment load), metals[LT17] , Dissolved Oxygen, Ph, Conductivity, turbidity, Biological oxygen demand (optional since laboratory testing would be required), Total suspended solids
5	Logging	Communication	All APIs will have logs which record data access

A.2.4 Website Component

Item	Name	Segment	Description
1	Coupling	Communication	These websites be based on a loosely coupled client/server paradigm with heavy emphasis on data access via APIs.
2	Accessibility	Communication	Will meet WCAG 2.0 Level A Accessibility standard for websites
3	Standards and Browser support	Communication	All websites will adhere to the latest widely supported W3C standards for HTML, CSS and Javascript. Website will be built with support for evergreen browsers, older browsers may be minimally supported via basic html and text.
4	Responsive Interface	Communication	Websites will be responsive and support mobile device screens as well as desktop.
5	User Experience	Communication	Development of websites will be iterative and user experience will be tested at various steps and the interface refined to provide a positive user experience.
6	GUI based administration	Communication	Content will be managed via a content management system. GoSL uses Drupal.

Item	Name	Segment	Description
7	Logging	Communication	The websites will run analytics packages which record each unique visit in a log including: · Anonymized IP address · Pages visited including length of time of visit and links clicked. · Data downloaded
8	User Feedback	Communication	A user feedback form will be designed and implemented on the website to record the satisfaction of users with the website and data products hosted therein.

A 2.5 Social Media Component

Item	Name	Segment	Description
1	Facebook outreach	Communication	Selected data products will be posted on facebook pages for WRMA/SLMS

A 2.6 Mobile Application Component

Item	Name	Segment	Description
1	App development	Communication	Native/Hybrid apps