



Environment and  
Climate Change Canada



**Development and Implementation of International and  
Regional Flash Flood Guidance (FFG) and Early Warning  
Systems**

**Project Brief**

**REPUBLIC OF FIJI  
FLASH FLOOD GUIDANCE SYSTEM**

## SUMMARY

The purpose of this project is the development and implementation of a flash flood guidance system specifically for the Republic of Fiji. The approach will entail development of technology, training, protocols and procedures to address the issues of mitigating the impacts of flash floods and the application of such a system allowing the provision of critical and timely information by the Fiji Meteorological Service (FMS).

To accomplish this, the World Meteorological Organization (WMO) will cooperate with the Hydrologic Research Centre (HRC), San Diego, USA to implement a flash flood guidance and early warning system designed along the lines of similar systems that have been made operational in different parts of the world. The project will be executed by the FMS with the HRC providing technical assistance for the system implementation and training; and WMO providing technical backstopping and supervisory services including monitoring and evaluation of the project. Funding is provided as part of the Climate Risk and Early Warning System (CREWS) program through an agreement between Environment and Climate Change Canada (ECCC) and WMO for the project entitled *Building Resilience to High-Impact Hydrometeorological Events through Strengthening Multi-Hazard Early Warning Systems (MHEWS) in Small Island Developing States (SIDS) and Southeast Asia (SeA)*. This agreement was signed on 19 February 2017.

Based on estimation of rainfall from satellite, radar and available gauges, the system will provide FMS with an estimate of the precipitation amount and an indication (guidance), based on physically-based hydrological modelling, as whether it would generate a bankfull discharge (e.g., minor flooding) at the outlets of small, flash flood prone basins throughout the country. The FMS will integrate local knowledge from other sources (their national networks, observers report, etc.) to validate the guidance and issue as required a warning through channels proper to each country.

Technical assistance includes the development and implementation of the flash flood guidance system as well as research and development into system enhancements, including inclusion of infrared and microwave technology for satellite rainfall estimates, as needed for the different implementations, and training and capacity building on system operations and applications to disaster risk reduction (i.e., an end-to-end system approach). The approach will provide a tool for FMS to access the data and information needed to develop alerts and warnings for flash floods.

***The main objective of this project is, therefore, to contribute towards reducing the vulnerability of the country to hydrometeorological disasters, specifically flash floods, by developing and implementing a flash flood guidance system to strengthen national capacity to develop timely and accurate flash flood warnings.***

### 1. Beneficiaries

In many areas of the world, flash floods are a regular phenomenon accounting for loss of human life and significant economic and social damages, adding up to hundreds of millions of United States Dollars (USD) for a single event. Flash floods can affect not only mountainous and hilly rural areas with sparse settlements but also major urban areas. In addition, an increase in their frequency and magnitude is anticipated as a consequence of climate change. Implementation of a flash flood guidance system would provide benefits to all societal and economic stakeholders in Fiji.

A key benefit of the proposed system is that it is capable to provide early awareness of impending local flash flood threats for all potentially vulnerable communities. A true value of the system will be to provide rapid assessments of the potential of flash floods allowing improvement of the early warnings for the occurrence of a flash flood and therefore allowing for more rapid mobilization of response agencies.

The system implementation also provides capacity building and cooperation for effectively mitigating disasters from flash floods. Training and capacity building will be a strong component of the implementation of this program. There will be opportunities in cross-training of hydrologists and meteorologists with different backgrounds and skills in hydrometeorology, which forms the basis of flash flood detection and prediction.

Primarily aiming to improve national service delivery capabilities to deal with flash flood threats, the implementation of the flash flood guidance system will also provide the opportunity for enhancement of collaboration of disaster mitigation and response agencies and improvement of community awareness of flash flood disaster threat and mitigation.

Training programs will be designed to include the FMS to develop strong scientific and technical capabilities to use the FFG system and further to include disaster management agencies where the responsible agencies will be involved in system validation programs which will require determinations of where flooding did or did not occur. The issuing of warnings based on flash flood guidance and flash flood threat products will conform to establish national practices, if existing; alternatively the project could provide support to a national dialogue for their development. The establishment of such criteria requires understanding of the hydrometeorological processes and prediction uncertainties, as well as capabilities of the population to take effective action. Such a process will encourage the national agencies to interact with local communities both in establishing such criteria, and in regular reviews of their effectiveness. The responsible agencies will need to design awareness campaigns for both municipal agencies and the public at large concerning the interpretation of flash flood warnings and effective action strategies (i.e., what to do in when flash flood warnings are received). To be effective, this effort will require input from local community representatives (emergency response agencies and the public at large). Maintaining these public awareness campaigns and information distribution as ongoing efforts required to reduce flash flood casualties will be needed.

The flash flood guidance system functions at one level as a disaster mitigation tool by mitigating loss of life and livelihoods, and by rapidly targeting disaster response agencies to potential problem areas. On another level it can be used to provide maps of flash flood probabilities, threats and decision-aiding for imminent actions. These maps can be used to provide a risk assessment tool and guidance concerning the development of infrastructure – that is, as a guide to where special care should be taken in the design and locations of particular facilities as the population expands to live in flash-flood prone areas.

All these agencies will be involved in system validation programs which will require determinations of where flooding did or did not occur. To be effective, this effort will also require input from local community representatives (emergency response agencies and the public at large).

## **2. Sector-Level Coordination**

Through the project partners, the technical aspects of the system implementation and operation will be brought together with agencies in disaster risk reduction to develop a detailed work plan

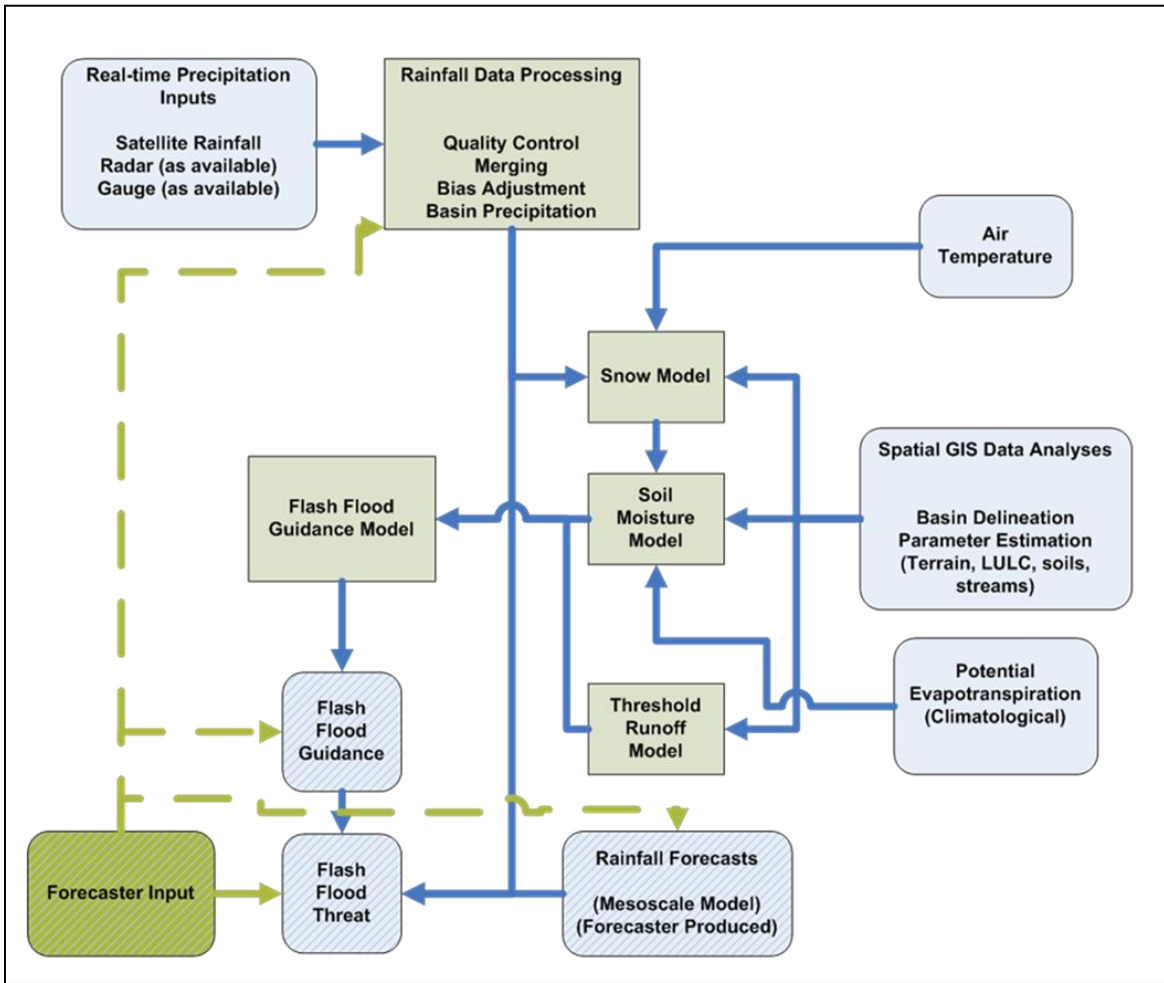
that will enable operational engagement of technical and disaster risk reduction agencies for implementation of the system.

The work plan for disaster risk reduction will address activities such as joint training programs and public outreach and awareness programs. This effort will provide the opportunity for enhancement of collaboration with disaster risk management agencies and improvement of community awareness of flash flood disaster threat and mitigation. Training programs will be designed to include the FMS and the disaster management agencies.

### **3. Technical Design**

Flash floods are a hydrometeorological phenomenon that requires (a) integration of meteorology and hydrology in real time and (b) ingestion of local information and expertise for reliable warnings. The system design aims to allow for both. This system will serve as a catalyst to develop protocols in line with country norms pertaining to other event warnings. The system allows that FMS can develop their own manner of system configuration and use adapted to local requirements as a tool for developing flash flood warnings and watches together with other local timely information.

Important technical elements of the Flash Flood Guidance System are the development and use of a bias-corrected satellite precipitation estimate field, high-resolution numerical weather prediction model outputs (where available), and physically-based hydrological modelling to determine flash flood guidance and flash flood threat. These system elements can now be applied anywhere in the world. Real-time estimates of high resolution precipitation data from satellite are now routinely available globally (and could be further enhanced with any available local radar estimates of precipitation). Global digital terrain elevation databases and geographic information systems may be used to delineate small basins and their stream network topology anywhere in the world. In addition, there are global soil and land cover spatial databases available to support the development of physically-based soil moisture accounting models (see flow chart in Figure 1). The real-time satellite precipitation estimates needed to drive the FFG systems on a global scale (using global data provided by the U.S. National Oceanic and Atmospheric Administration, NOAA) will be developed first followed by the development of specialized products.



**Figure 1: Schematic Flow Chart of the Flash Flood Guidance System**

The system allows the forecaster to use preferred local nowcast/short-term-forecast methods to issue the warnings, including (and strongly recommended) local forecaster adjustments. The system design allows this coupling with the existing or developing approaches on a national or even local scale.

System flexibility and system capability to engage local forecasters should help greatly towards the development of protocols for integration within existing warning dissemination systems.

The system will provide evaluations for the threat of flash flooding over time scales of hourly to six hours and for basins on the order of 10-25 sq. km. Given the computational burden and depending on available computational resources, it is very likely that the most valuable lead times for system use will be 3 - 6 hours. Efforts can also be undertaken through the application of numerical weather prediction model outputs to extend the range of threat prediction to 48 hours.

#### **4. Implementation Approach**

The system design is such that it allows for efficient global data ingest in addition to any necessary local hydrometeorological data provided by FMS. Computations and product dissemination will occur within the FMS and support its operational functions through the timely provision of local data, analysis software (e.g., spreadsheet, GIS), hardware (local PCs) and internal training. The FFG software will be installed on and run on servers (computation and dissemination servers) provided by the project and installed at a location designated by FMS. Graphical and text products are then disseminated within FMS and/or to its authorized partners/users through a secure LAN or internet connection.

During system operation, basic FMS responsibilities will include:

- Collecting available real-time local meteorological data for ingest to the FFGS for the development of products;
- Providing validation of products and formulation of plans for improvements;
- Providing communications of system modifications necessary to system developers;
- Developing an historical archive of the system products;
- Supporting WMO and developers with in-house and partner/user training of product use and interpretation; and,
- Providing routine maintenance and IT support for the FFGS servers.

The FMS specific use of the flash flood guidance and warning system will include:

- Providing hydrometeorological analysis using the system products and information and other local products and information;
- Providing system product modifications for flash flood guidance and precipitation nowcasts on the basis of most-recent data and information;
- Developing local flash flood watches and warnings;
- Monitoring of system performance (availability and effectiveness); and,
- Linking to within-country disaster management agencies for effective disaster risk reduction.

It is expected that the products available from the system will be adequate to support a range of processing capabilities at the FMS, from those that can be performed on a PC with spreadsheet software to those that support interactive graphical generation of products. This provision will allow the FMS to develop real time flash flood forecasts and watches/warnings using the global-data information and their local data and information.

One key to sustainability is confidence in a reliable, accurate system. To accomplish this, reliability evaluations will be included in the concept of operations.

#### **5. Transition and Exit Strategy**

Upon completion of the project, the FMS will have access to the flash flood guidance and early warning system data and products from the servers for use on local PCs. The required data will be accessed and processed through the computational server at FMS. Only a PC and internet connectivity (for outside partners/users) will be required to access the data and products required to evaluate potential flash flood threat, making the system very sustainable.

Much of the effort to ensure sustainability of the flash flood guidance and early warning system will be through training and cooperative development efforts. This approach is intended to ensure ownership and full operations responsibility. In addition, a concept for the operation of the system within the existing operations protocols of the countries will be outlined for each country during training. A User Guide will be developed for system operations and maintenance.

## **6. Project Implementation**

Project implementation is based on the basis of a Project Implementation Plan (PIP) that will be discussed during the initial planning meeting. The Plan will provide information with regard to essential requirements and criteria that need to be met for the successful implementation of the project. These requirements include: availability and accessibility of critical input data and information including geo-spatial information, historical and near real-time meteorological and hydrological data, basic institutional infrastructure and technical/professional expertise FMS.

The PIP including a work plan will be discussed during the initial planning meeting with principal stakeholders and beneficiaries of the project.

## **7. Institutional status**

Funding is provided as part of the Climate Risk and Early Warning System (CREWS) program through an agreement between Environment and Climate Change Canada (ECCC) and WMO for the project entitled *Building Resilience to High-Impact Hydrometeorological Events through Strengthening Multi-Hazard Early Warning Systems (MHEWS) in Small Island Developing States (SIDS) and Southeast Asia (SeA)*. This agreement was signed on 19 February 2017.

As a result of the expression of interest of FMS, an initial planning meeting has been arranged. This meeting will allow:

- FMS and its partners to see first-hand the technical components of the FFG system;
- FMS and its partners to assess the potential utility of adopting such a system within their operations;
- Understanding of the requirements of FMS during development, implementation, and operation of the system;
- Understanding of the primary data collection required for the initiation of the project; and
- FMS to consider the overall project and whether it wishes to commit to undertaking and supporting the implementation of the project.

WMO in collaboration with financial and technical partners now plans to organize the initial planning meeting where FMS through the Permanent Representative of WMO Members and its Hydrological Advisor or designated alternates are expected to discuss all aspects of the proposed project and eventually express whether they commit to participate and cooperate in the project activities and provide technical information that is critical for the successful implementation of the project.

Aside from the commitment made by FMS, it will be essential to have full details available on issues such as in-kind contributions through infrastructure and personnel, areal information specifying the area(s) to be covered by project activities, availability of supporting data and information including geospatial and historical hydrometeorological information. Likewise, the governance of the project and the roles and responsibilities of the FMS will be on the agenda of discussion with expected recommendations and decisions to be made during the meeting. This will be compiled through information received on the basis of an Implementations Requirements Document to be developed and provided to FMS.

The project will be phased over a period of several years that will be determined during the initial planning meeting, with the bulk of the development and implementation activities occurring during the first year to two years. The remaining years of the project will focus on training, system operations/evaluation and validation of system outputs to ensure on-going sustainability.