



## Improving Flood Forecasting and Early Warning in Somalia



### *Feasibility Study*

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## List of Abbreviations

ADCP	Acoustic Doppler Current Profiler
CEFA	Comitato Europeo per la Formazione e l'Agricoltura
CFMC	Community Flood Management Committees
DEM	Digital Elevation Model
EMWR	the Ethiopian Ministry of Water Resources
EROS	Earth Resources Observations and Science
FAO	Food and Agriculture Organisation of United Nations
FEWS NET	Famine Early Warning System Network
FFC	Flood Forecasting Centre
FFG	Flash Flood Guidance
FSAU	Food Security Analysis Unit - Somalia
FSDRSC	Food Security and Rural Development Sector Committee of the SSS
FWG	Flood Working Group
GAA	German Agro-Action
GFFS	Galway Real-Time River Flow Forecasting System
GFFS	Galway Real-Time River Flow Forecasting System
GFS	Global Forecast System
GFS	Global Forecast System
GSM	Global System for Mobile
GTS	Global Telecommunication System
ITCZ	Inter tropical Convergence Zone
JOSR	Jowhar off Stream Storage Reservoir
KMD	Kenya Meteorological Department
LVGFM	Linearly Varying Gain Factor Model
MoA	Ministry of Agriculture
MOFFS	Management Overview of Flood Forecasting System
MOLAE	Ministry of Livestock, Agriculture and Environment
MPWT	Ministry of Public Works and Transportation
NCEP	National Centres for Environmental Prediction
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Services
NWS	National Weather services
PET	Potential Evapotranspiration
QPF	Quantitative Precipitation Forecast
RFE	Rainfall Estimates
RFFCs	Regional Flood Forecast Centres
SFFM	Somalia Flood Forecasting Model
SSS	Somali Support Secretariat
SWALIM	Somalia Water and Land Information Management
UNDP	United Nations Development Programme
USGS	United States Geological Survey,
WMO	World Meteorological Organization

**Glossary of terms**

Deyr	October to November, minor wet season
Gu	April to June, major wet season
Hagaa	July to September, minor dry season
Jilal	December to March major dry season in Somalia
Togga	Anon perennial (seasonal) stream which deep and narrow
Waadi (Wadi)	A non-perennial (seasonal) stream which is wide and shallow

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## **Executive Summary**

Floods are the most prevalent form of natural disasters along the Juba and Shabelle Rivers in Southern Somalia, whereas flash floods are common occurrences along the intermittent streams in the northern part of the country. Both riverine and flash floods cause high numbers of casualties and economic impacts. As the population grows and urban development encroaches into traditional floodplain areas, in the riverine areas, and in the towns of Garowe and Hargeysa, the potential for loss of life and property will rise in the coming years. For example Hargeysa and Garowe cities in northern Somalia have grown rapidly due to high influx of immigrants resulted from the long civil war. Due to lack of legislations, many people have settled in floodplains risking their lives and introducing high vulnerability. Early warning and alert systems are not in place and if existed are rudimentary. Establishing flood early warning systems for the areas at risk of flooding is the most effective means to reduce the death toll caused by these floods.

One of the FAO SWALIM's mandates is support to the Somalia interagency efforts in developing information products and tools that will provide early warning information and aid preparedness and response to floods in Somalia. SWALIM has been providing supportive information and technical capacity to the interagency efforts for the past four years in collaboration with USGS and FEWSNET. This feasibility study was commissioned in line with these mandates with a main goal to improve flood forecasting and alert systems through assessment of existing capacities and lay out of technical options for the development of a river flood forecasting system for the Juba and Shabelle basins and flash flood alerts systems for Hargeysa and Garowe cities in Northern Somalia.

The report provides the basis for implementation of flood forecasting and flash flood alert systems for the above mentioned areas. As part of the preparation of this document, a number of documents that provided physical details of rivers and Wadis in Somalia were reviewed, assessment of the existing hydro-meteorological data collection network, and consultation with agencies and organizations that are active in flood response and relief within Somalia were carried out.

To put into effect a program to reduce the recurring losses in human lives and economic assets due to riverine flooding in the Juba and Shabelle Rivers, the following recommendations need to be implemented.

### **1. Establishment of automatic real-time hydrometeorological data collection, transmission and monitoring system**

The network can be housed and operated by the same organizations that are operating the manually read hydrometric and meteorological stations that are in place at selected key stations. Routine maintenance of the equipment and data archiving can be done by a central organization such as SWALIM or SWALIM in partnership with the Kenya Meteorological Department (KMD). As part of this real-time hydro-meteorological data collection network, the following steps are considered essential:

- i. Upgrading of some of the existing manually read hydrometric and rainfall recording stations (outlined in Figure 15) to automated stations.
- ii. Implement a proper satellite-based data telemetry system that is capable of transmitting data in the worst conditions of flooding possible in the area.
- iii. Implement training programmes for local personnel on equipment operation and maintenance for the hydro-meteorological measuring equipment.
- iv. Establish an operational maintenance plan for the hardware components of the hydro-meteorological data collection and transmission network.
- v. Establishment of a collaborative working relationship with KMD for the automatic weather stations equipment maintenance and data sharing.
- vi. Start a process that will add the automated weather stations installed under this program into the WMO Global Telecommunication System (GTS). In that regard, approach as soon as possible the WMO.
- vii. Institute hydrometric and weather data archiving and quality control procedures.
  - a) For the archiving of the hydrometric data, we suggest that SWALIM continues to use the HYDATA database.
  - b) For the archiving of the weather data, suitable software such as the FAO-supported AGRISOFT should be explored.

## **2. Establishment of an Operational Flood Forecasting Centre (FFC)**

The main task of the FFC will be the issuance of daily and sometimes sub-daily (during the course of a flood event) flood forecast advisories and bulletins for forecast service sites. The forecast service points should be expanded to include new locations along the two rivers as more points with stage/discharge rating relationships are made. The FFC should include:

- i. Hydrologic modelling capacity should be established at the FFC, and the personnel at the FFC should be capable of calibrating and adapting existing hydrologic models to the hydrologic and hydraulic conditions of the Juba and Shabelle rivers system. As a first phase of building the flood forecasting capabilities the following is recommended:
  - a) A forecasting model based solely on routing could be used. We recommend the parametric wetness-index-based Linearly Varying Gain Factor Model (LVGFM), a module of the Galway Real-Time River Flow Forecasting System (GFFS), a freely available software package developed by the Department of Engineering Hydrology of the National University of Ireland, Galway.
  - b) With time, we suggest that a semi-distributed physically based rainfall-runoff model (e.g., GeoSFM, version of the MIKE-SHE model), that could incorporate remotely sensed and observed rainfall, be used as a flood forecasting model; such a model should have a modelling domain that covers the whole Juba and Shabelle basins when implemented.

- c) Develop a flood warning dissemination protocol. For the dissemination of the warnings on river floods, investigate what kinds of data and information needs the potential users of the system have. For now, we suggest that SWALIM practice of disseminating warnings through e-mail be continued, but that effort should be extended to contact media outlets that are widely listened to and watched in Somalia, e.g. BBC Somali Service.
  - d) Implement a program of sensitizing and educating the communities at risk of river floods on the meaning and actions required during and after a flood alert or warning is issued.
- 3. For major settlements along the two rivers (Belet Weyne, Bulo Burdi, Jowhar and, Afgoi along Shabelle, and Luuq, Bardera, Jilib and Jamame along the Juba), create possible floods inundation maps. Such maps, if linked to observe/forecasted river levels and superimpose on high resolution satellite imagery (e.g., QuickBird imagery), will provide information on the potential number of properties and people affected by a flood. Such maps will also be useful for public awareness and for flood relief work.
- 4. Acquire high resolution Digital Elevation Model (DEM) data that cover the floodplains of the Juba and Shabelle. Closer to major settlements, the survey area should be widened when acquiring the elevation data source.
- 5. Delineate floodplains from hydrologic modelling and satellite imagery based on the peak historic floods that every area of interest has experienced. Such maps will be of immense value for areas with authorities who can enact land use laws that are needed to restrict economic activities in the river and streams natural floodplains.
- 6. Implement a program of updating the pre-war river stage/discharge rating curves for all the forecast locations.
- 7. For all the proposed hydrometric station locations we propose that stage–discharge relationship be develop using hydraulic models that are based on the complete one-dimensional equations of the unsteady flow.

To implement flash flood alert systems for the towns of Garowe and Hargeysa, we recommend the items listed below.

- 1. Establish a network of automatic rain and stream gauges in the two basins supported by real time satellite rainfall estimates.
- 2. Create a series of probable rainfall intensity estimates for the Garowe wadi at Garowe town and Hargeysa wadi at Hargeysa town.
- 3. Carry out community-based preparedness and early warning programs in the region to raise community awareness and capacity to reduce vulnerability to extreme floods.
- 4. Map the floodplains extent of the two wadis.