



ENTRO  
**NILE BASIN INITIATIVE**  
INITIATIVE DU BASSIN DU NIL



**ENTRO-Flood Risk Mitigation Project**  
**NCCR Project Supported by World Bank - CIWA**  
**EN Flood Forecasting and Early Warning**  
**(Daily Forecast, July-September)**



Egypt



Ethiopia



South Sudan



Sudan





Egypt



Ethiopia



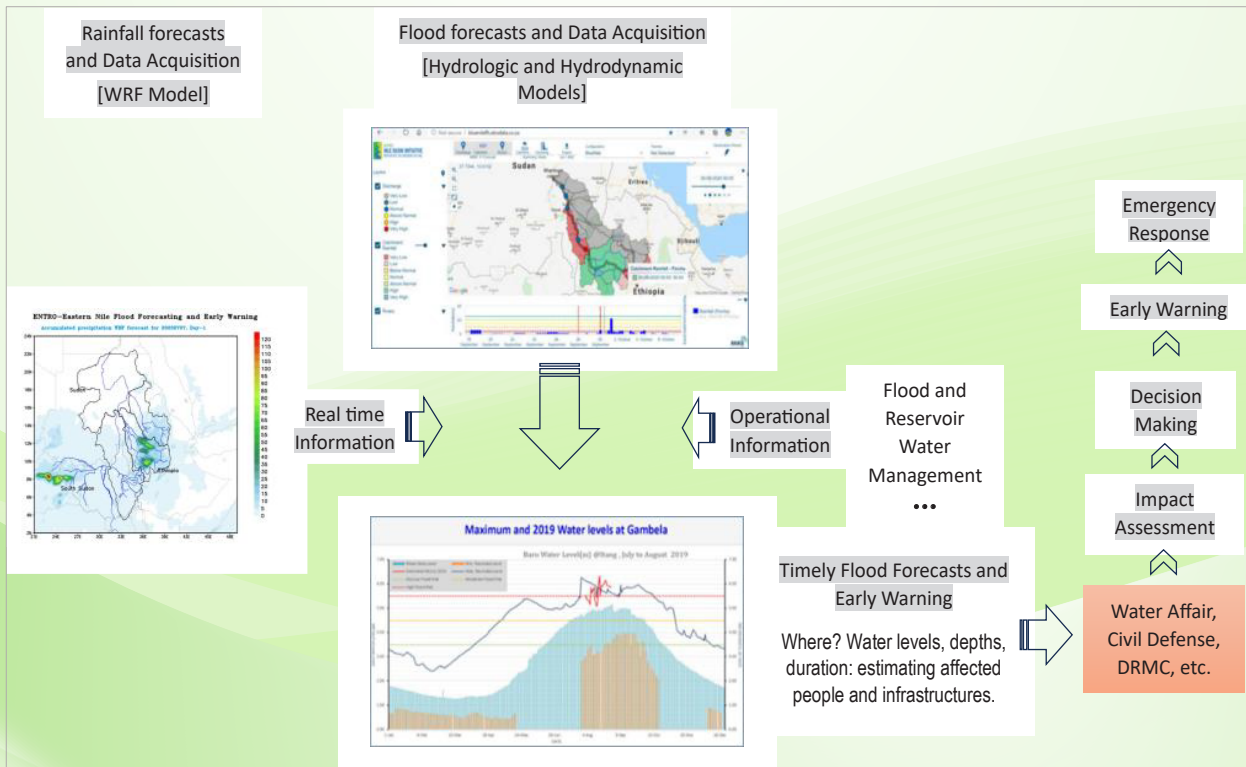
South Sudan



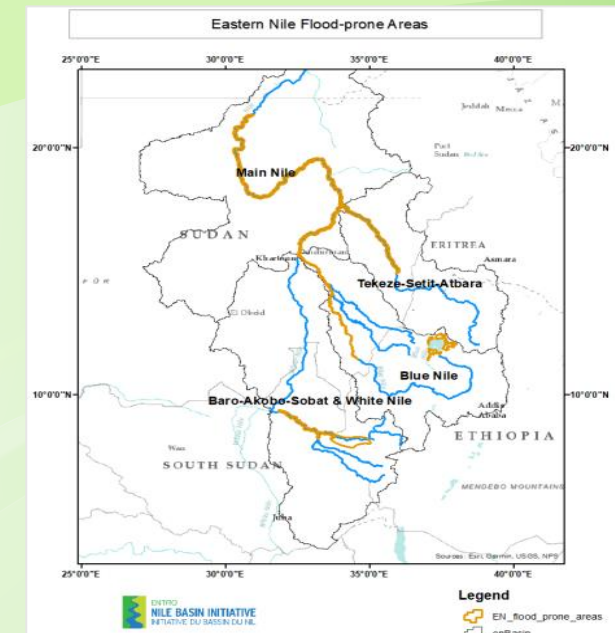
Sudan



## Eastern Nile technical regional Office (ENTRO)



The Eastern Nile Flood Forecast and Early Warning (EN-FFEW) service is a key component of ENTRO activities that has been continuously operational since 2010 every flood season, July through September. It is also an integrated near real time forecasting and early warning system that supports ENTRO, as well as regional and national stakeholders in flood forecasting and early warning. This enhanced system is operational and running.



The Eastern Nile technical regional Office (ENTRO) has been established by the Eastern Nile Council of Ministers (ENCOM) in June 2002 to identify, prepare, facilitate implementation and coordinate cooperative projects within the Eastern

Nile Basin. The overall purpose of ENTRO is to support ENSAPT and ENCOM in the complex task of developing, implementing, and managing the multi-country Eastern Nile Subsidiary Action program.



Emphasis is on enhancing regional collaboration and national capacity in flood risk management, including flood mitigation, flood forecasting and early warning, as well as flood emergency preparedness and response.

This activity strengthened regional collaboration through information sharing and strengthening national flood forecasting centers. Overall, the system reduced the risks of flood devastation for 2.2 million people living in flood-prone areas in the Eastern Nile Basins of Ethiopia, South Sudan, and Sudan. The FFEWS is supported by World Bank–CIWA under the Flood Risk Mitigation of the Nile Cooperation for Climate Resilient (NCCR) Project.

## Rivers causing flood in the Eastern Nile Region

Floods have significant impacts in the Eastern Nile Region, and both riverine floods and flash floods are common in the region. These flood prone areas located in four distinct EN-basins:



Lake Tana

1. **The Lake Tana sub-basin** (15,077 km<sup>2</sup> catchment area) is located upstream of the Blue Nile River. The

head waters of the catchments in this basin are steep hills with good forest cover. Flows coming from surrounding hills converge in plains to eventually enter Lake Tana (3,070 km<sup>2</sup> average surface area). Four major rivers entering to the lake are Dirma, Gumera, Megech and Ribb.



Near Bahr Dar (left) and community facing flooding on the Fogera flood plain in 2019 (right).



2. **The Blue Nile sub-basin** (313,861 km<sup>2</sup> catchment area) encompasses the catchments that drain into the Blue Nile River between Lake Tana and Khartoum. Relevant sub-basins in this

basin are those of the rivers Dinder and Rahad. The upper catchments in Ethiopia are mountainous and with forest cover, whereas the lower parts of the basin in Sudan are rather

flat and with less vegetation cover. Riverine flooding along the Blue Nile River reach from Rosaries Dam to Khartoum is common.



*Blue Nile River joining white Nile river at Khartoum flood threatening Tiuti Island, Khartoum and Omdurman cities.*



Egypt



Ethiopia



South Sudan



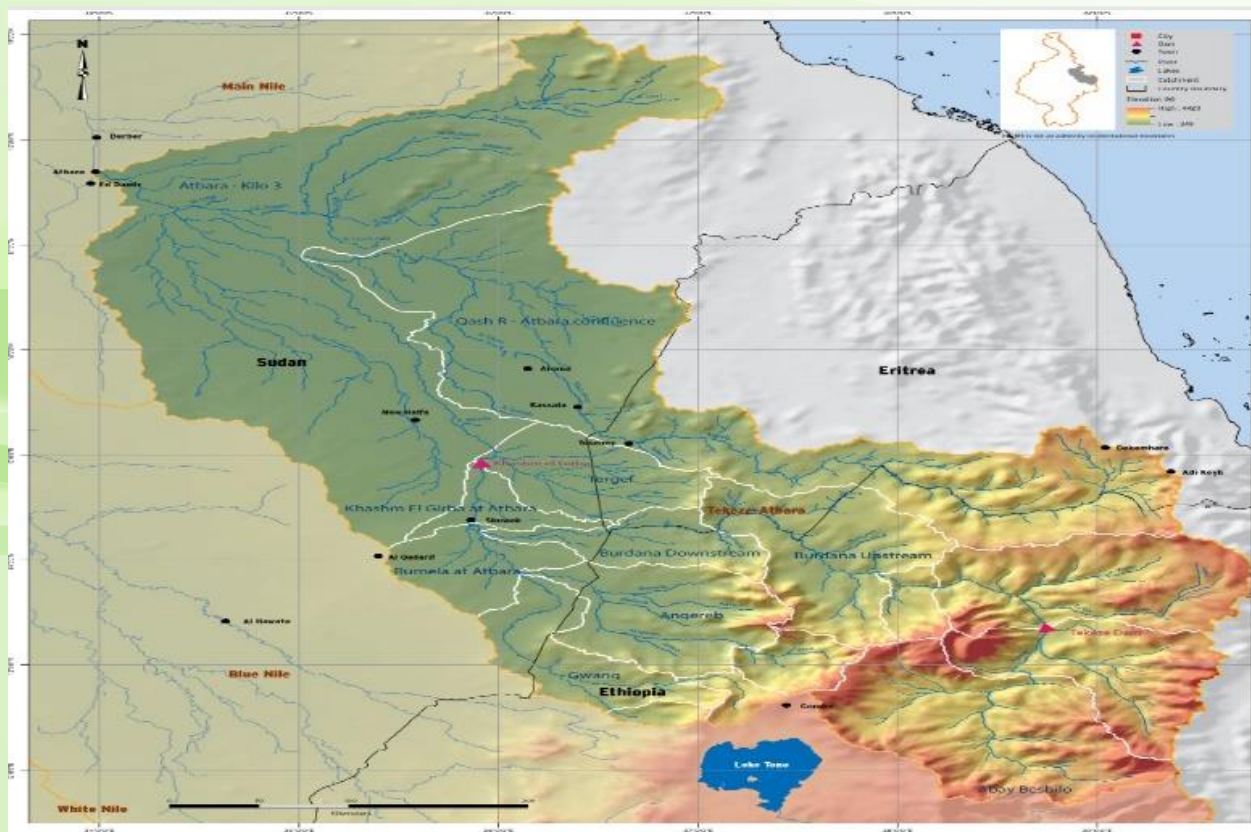
Sudan



3. **The Tekeze-Setit**-Atbara sub-basin (240,084 km<sup>2</sup> catchment area) head is in the northern highlands of Ethiopia. Its outlet is at the confluence of the Atbara River and the Main Nile near

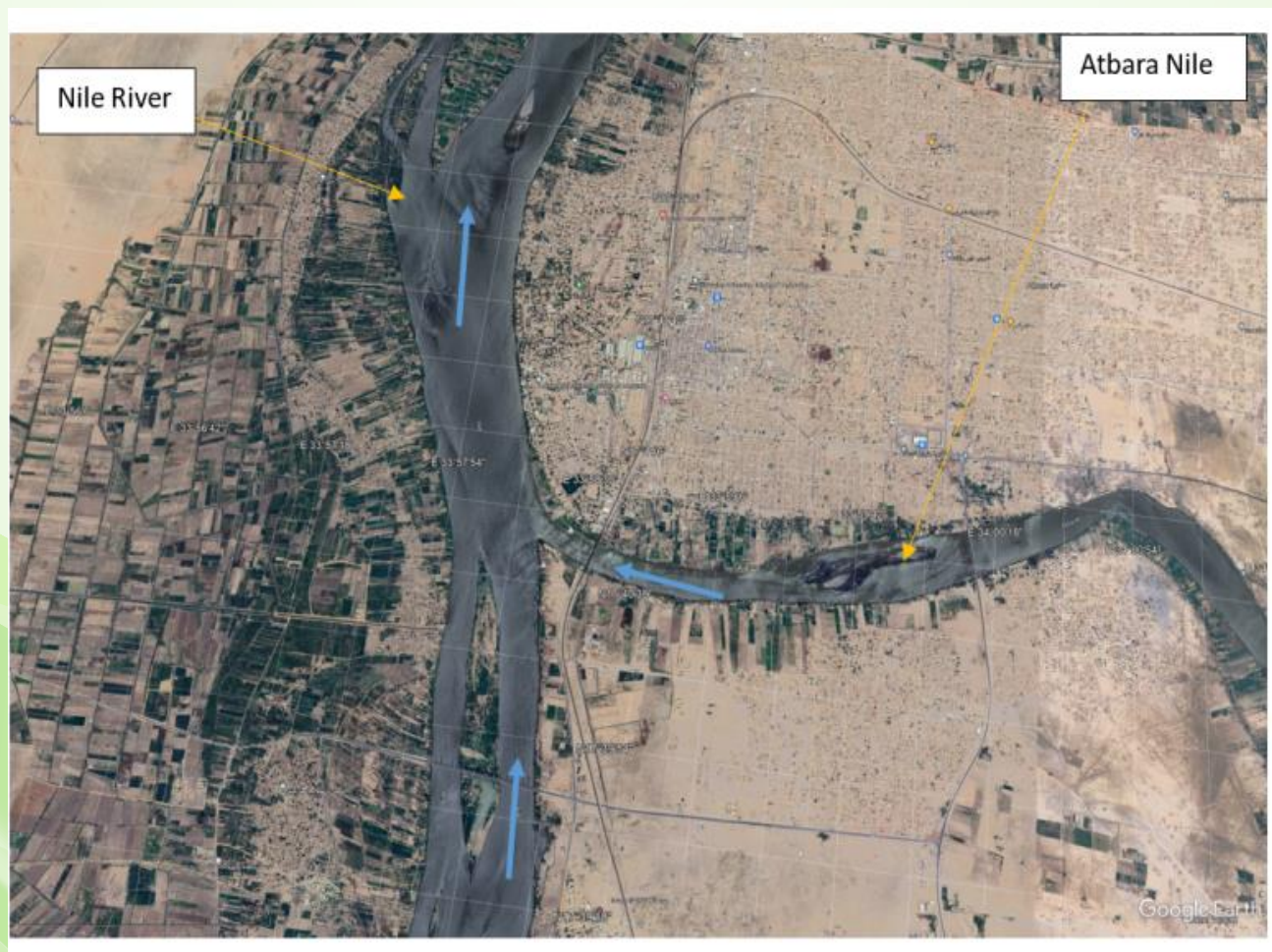
Atbara city. The upper catchments are in hilly terrain with forest cover and the lower parts of the basin after Humera town are relatively flat and have little vegetation.

The main rivers of the sub-basin are the Tekeze (also known as Setit in Sudan), Angereb (a tributary of Gwang) and Gwang. The Atbara is formed after Tekeze (Setit) is joined by Gwang River. Humera town and Atbara are main flood prone areas. Downstream of Humera, agricultural lands close to the rivers are also prone to flooding. There are three storage dams in the sub-basin that can regulate flood: TK5 (Total storage: 9.2 BCM) in Ethiopia, Khashim el Girba Dam (live storage: 654 MCM) Sudan and the new Upper Atbara dam complex recently built with a capacity of 3.0 BMCM.



Atbara River Basin





Atbara town at Atbara and Nile Junction (August 2023).

4. **The Baro-Akobo-Sobat sub-basin** (206,294 km<sup>2</sup> catchment area) encompasses the catchments of the Baro and Akobo rivers upstream as well as those of the Sobat River in South Sudan to White Nile confluence. Most of the runoff develops in the mountains and foothills of Ethiopia. Portions of the Baro flow spill through a series of channels to large wetlands known as the Machar Marshes. Pibor drains a wide area of plains, but only contributes significantly in times of high rainfall. The upstream catchments of the Baro towards the east of the basin are high elevation mountains with good forest cover. The lower part of the Baro river below Gambela town is prone to flooding, Nasir, Pibor Akobo towns including Malakal city are all flood prone areas in South Sudan.



Egypt



Ethiopia



South Sudan



Sudan

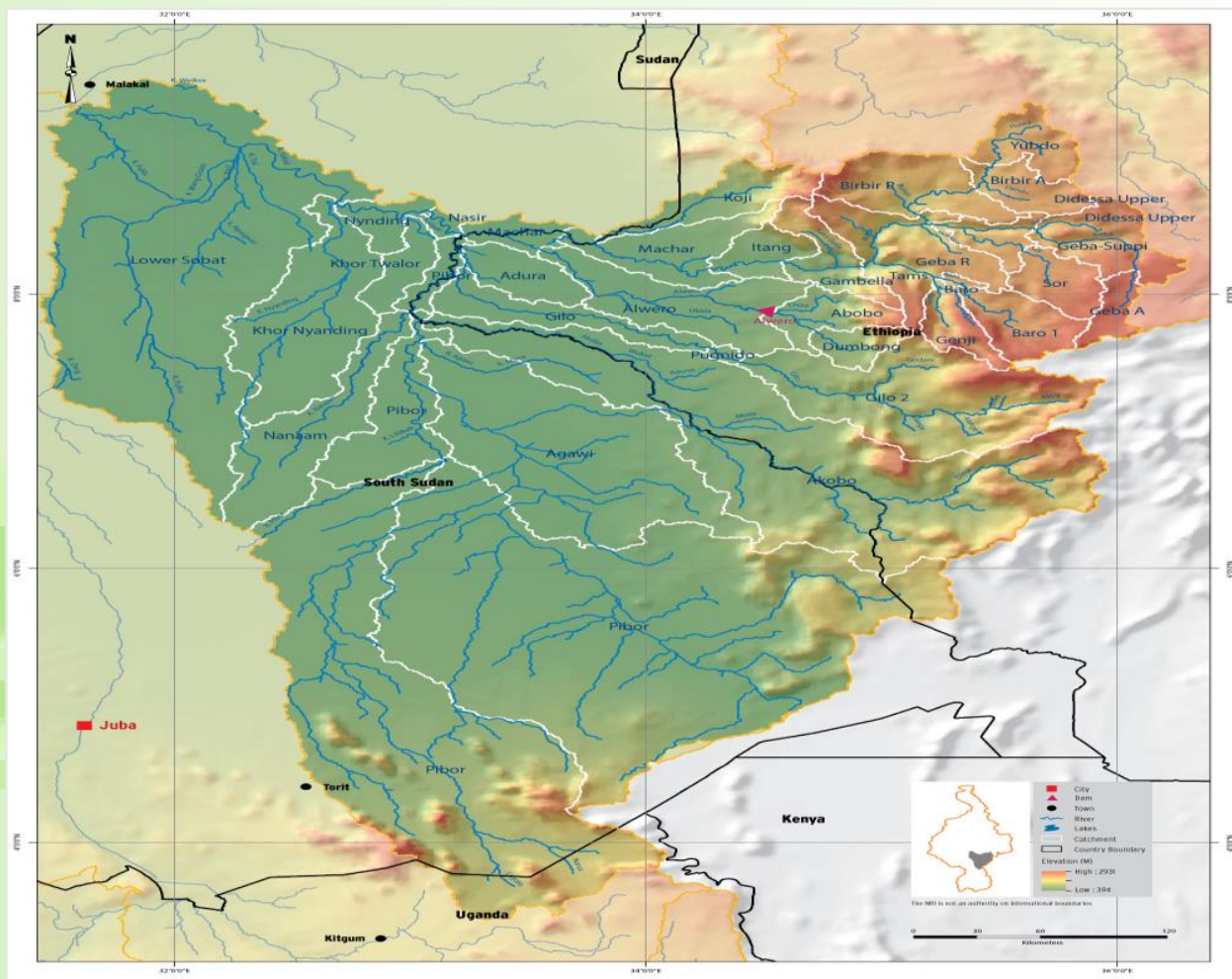


## Flood Vulnerabilities and Preparedness in EN

### Ethiopia

In the Eastern Nile (part of Ethiopia), the flood vulnerable areas are the floodplains at Lake Tana, Gambela, and the Humera area of the Tekeze basin (near Humara), as well as riverine floods at different locations.

1. **Lake Tana:** Flooding is a recurrent threat occurring almost every flood year in the Lake Tana area caused by the overflowing of the Dirma, Gilgel Abay, Gumera, Megech and Rib rivers and the spillover of Lake Tana.
2. **Gambella floodplains:** The floodplain area, belonging to the lowlands of Baro-Akobo sub-basin, is partially inundated by floodwaters every year. While most of the agrarian land use has adapted to the seasonal flux of floodwaters, rural and several settlements areas are affected by larger flooding incidents including the city of Gambela.



Baro Akobo Sobat River Basin







Flood in 2022 in Gabela Region, Ethiopia (<https://addisstandard.com/asdailycoop-floods-displace-more-than-75000-people-in-gambella-state/>)

3. **Tekeze near Humera:** The flat areas at Humera are flooded from overflow of the Tekeze river over its banks and flood prone areas. This occurs during extreme rainfall conditions in the upper catchment of Tekeze basin.

## South Sudan

In the Eastern Nile (part of Republic of South Sudan), riverine floods as well as flash floods regularly affects settlements in the Akobo and Sobat River plains. Most

people settle in flood prone areas since their livelihoods depend mainly on farming in floodplains, fishing, and/or livestock. The city of Malakal just downstream at the confluence of the Sobat and the White Nile is also affected by annually flooding occurrences. Reports indicate that flash floods affect about one million people regularly.



Flood damage and treat in South Sudan (left, September 2021, World Vision) and Floods in Unity State, South Sudan, October 2022. Photo: UN Peacekeeping.

The main vulnerable settlement areas are the following:

1. **Akobo:** Akobo town and Nasir town including surrounding small villages. These areas are affected by both flash floods and riverine floods.
2. **Malakal:** The vulnerable communities are the Shilluk, Dinka, Nuer and Burun, Koma and other small communities. There are many local communities with strong social structures. The local communities have their traditional way of responding to the early warning. They are prepared to store their food in their houses to be used in case of flood incidents. They also prepare drainage systems to bypass excess water from entering their houses during flood seasons.

## Sudan

Flood prone areas in Sudan are along the Blue Nile stretch from El Diem to Khartoum, along the main Nile north of Khartoum, the White Nile upstream Gebel Aulia Dam,



Egypt



Ethiopia



South Sudan



Sudan

the Gash River around Kassala town and around many cities and towns such as Nyala and El Fashir areas in the west of the country. Blue Nile catchment include river Dinder and Rahad in Sudan.



Sudan Flood (al-monitor) Sudan (Right-A Sudanese family sits next to their house in a flooded street on the outskirts of the capital Khartoum on August 10, 2013. (ASHRAF SHAZLY/AFP/Getty Images)

Flash floods caused by local rains occur most often than riverine floods and the most affected areas are the three main cities composing the capital Khartoum (Khartoum, Om Durman and Khartoum North), Areas along the main Nile from Khartoum to Dongola in the North, Many cities on the western part of the country, and along the Blue Nile, Dinder, Al-Rahad, Al-Gash and Tekeze-Atbara-Setit. Riverine

floods are caused by overbank river floods along the Nile River system and Al-Gash River. Floods impact houses and properties as well as physical/ infrastructural facilities. Thus floods impacts have socio-economic, and attitudinal dimensions.



## Who carries out the Flood Forecasting?

Every flood season, ENTRO invites one professional from the Flood Forecast Center (FFC) in each Eastern Nile Country to carry out the daily flood forecast and early warning bulletin and distribute it to all stakeholders in the region. The professionals utilize ENTRO data acquisition and modeling tools to produce

the daily flood forecasting bulletin for three months of the flood season, under the supervision of ENTRO Water Resources Planning Unit, Flood Modeler and Regional Interns Coordinator.

The team will be oriented during the first two weeks and then they produce the daily forecast bulletin and distribute it to their national flood units plus over 80 other stakeholders within the region.



Flood Forecasting team presenting at ENTRO their mid-term status of 2023 flood season, July 1 to August 15 (August 15, 2023)

The participation of the national flood forecasting staff is deliberately meant by ENTRO to build capacity and ownership of the forecast results. So far, ENTRO trained more than 70 flood forecast technical staff from Eastern Nile countries.



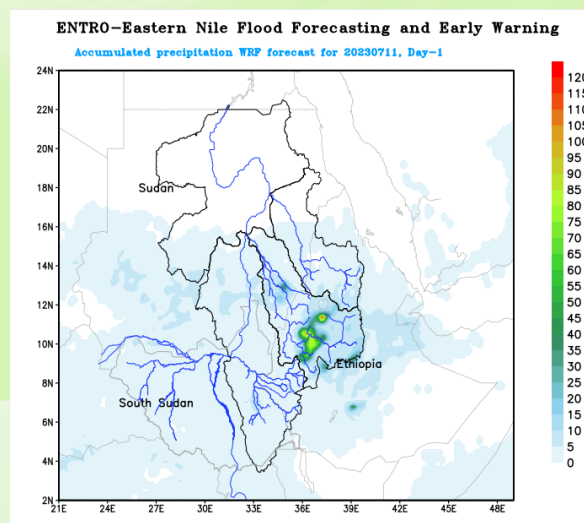


## About the FFEW system at ENTRO

The EN-FFEWS is currently deployed on a server at ENTRO and options to migrate the system to the Cloud are being investigated. One component of the EN-FFEWS is a customized version for the EN of the Weather Research and Forecasting (WRF) model. The other component builds upon DHI's decision support system, MIKE Operations with integrated modelling tools to simulate hydrological and hydrodynamic processes.

**Rainfall forecasts:** rainfall is forecasted by the Weather Research and Forecasting (WRF) model. The model is regional customization for the EN with global input from NCEP's Global Forecast System (GFS) to provide initial and boundary condition. WRF produces 3-days lead time forecasts with a spatial resolution of 6 km for Eastern

Nile model sub-basins and updated every day, and hourly temporal resolution forecasts. The meteorological forecast process starts with a scheduled download of NCEP'S Global Forecast System (GFS) with initial and boundary conditions. The WRF model run is automated.



**Runoff forecasts:** In the EN-FFEWS runoff forecasts in four EN sub-basins and flows at key locations in the river network are forecasted with the NAM hydrological modeling tool of DHI. The inputs for runoffs forecasting and flows at key river locations produced from rainfall forecasts using WRF model. Flood forecasts of flood water levels and flow rates at key river locations are estimated using MIKE 11 hydraulic model. The inputs to the hydrodynamic forecasts of flood water levels and flow rates come from NAM hydrological model forecasts.



Egypt



Ethiopia



South Sudan

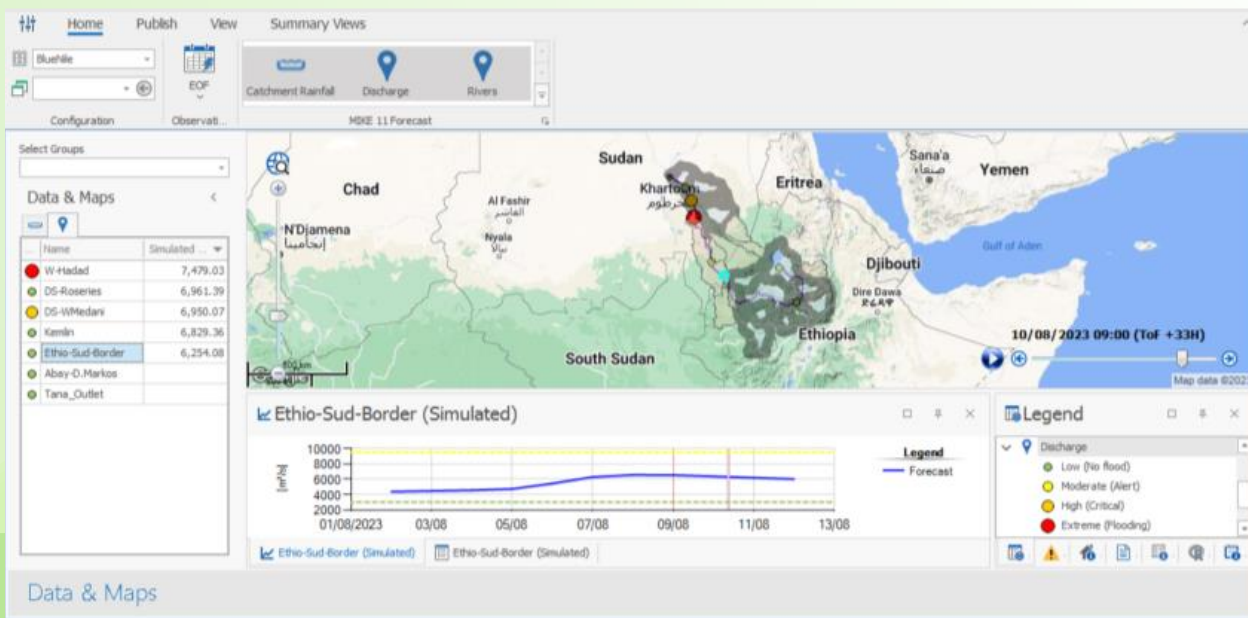


Sudan

## Achievements so far EN flood management

In the last 20 years ENTRO Created collaborative platform for the EN countries to work together chronologically including:

- In March 2001, the Eastern Nile Council of Ministers (ENCOM) requested that funding be sought to advance work in flood management. The Flood Preparedness and Early Warning Project (FPEW) is an agreed project within ENSAP to take joint action on the problems of flood management in the EN.
- In October 2004, ENCOM decided to fast-track the FPEW project to show tangible results of Nile Basin collaboration on the ground by creating projects in 2006-2010:
  - FPEW I – focused on building the institutional capacity and developing critical baseline information to enhance the readiness of EN countries to implement subsequent FPEW



**Integrated Forecast System:** The MIKE Operations platform integrates the meteorological, hydrological and flood forecast products in one window stop for visualization. The near real-time and forecasted data are regularly imported from the

central database (Postgres SQL) through scheduled data import jobs manager. Then the input time series is regularly updated using the real-time and forecasting processes and displayed in the GUI of MIKE Operation platform.





phases.

- o FPEW II – focuses on the structural measures and up-scaling of the pilot interventions (no funding for this).
- ENTRO initiated with Eastern Nile countries and created a regional FFEW system under the Eastern Nile Planning Model project (ENPM) and the FFEW activity continued since 2010 under the Nile Cooperation for Result project (NCORE).

The FFEW activity has strengthened national offices (equipment and training) in terms of capacity and overall reduced the risk of flood devastation for more than 100,000 thousands of people in the EN flood prone areas.

ENTRO regularly issues FFEW every day 3-day ahead forecast to the Ministry of water Affairs Flood Forecast Centers (FFC) and other stakeholders in the region. The FFC experts every year is hosted at ENTRO for training and to issue FFEW with ENTRO experts. The Water Affairs Ministries of

Ethiopia, South Sudan and Sudan use it as one input for their decisions to issue warnings for the flood prone areas.

The Ministry of Water Affairs of Ethiopia and Sudan had a baseline data on flood risk maps for critically flood prone areas, presently updating of these maps will be undertaken as part of the NCCR project as described below.

Efforts are underway to enhance the EN-FEWS system based on the following activities:

- Flood vulnerabilities and preparedness in the communities affected by floods have been identified by surveys undertaken at national level.
- Terrain and community surveys at Nine flood prone areas in BAS and TSA sub-basins where data lacks are being conducted (> 65% completed) and to be finalized in December 2023.
- Institutional level practices and collaborations at national levels have been identified. Issues related to data sharing, dissemination and communication have been identified.

- The Eastern Nile Flood Forecast Early Warning System (EN-FFEWS) and flood risk maps will be enhanced.

## Stakeholders and the Role of the EN-FFEWS

There are two types of roles of stakeholders in a FFEWS in general which ENTRO would like to collaborate with further closely:

1. Entities that provide datasets to the FFEWS, either real-time datasets like weather forecasts that are relevant to flood forecasts or rather static datasets ranging from contact information for dissemination of alerts to historical timeseries of flows and flood water levels to support model improvements.
2. Entities that receive flood-related information ranging from flood reports to real time flood warnings using various dissemination channels like e-mail, SMS, telephone, or VHF radio.



Egypt



Ethiopia



South Sudan



Sudan

## Interaction with Flood communities

ENTRO recognizes the importance of dealing with flood affected communities, therefore, ENTRO has undertaken field

visits to flood prone areas in the three countries to hear from them, get their reflection from the service so far delivered

by ENTRO, in an effort for improvement.



*Photo: ENTRO Team made consultation with Communities and local institutions at Tuti Island, Khartoum, Sudan.*

*As part of implementing the NCCRP Flood and Drought Risk Management thematic area, ENTRO is already in the process of improving the flood forecasting tools. ENTRO would like to thank CIWA-World Bank for their financial support through NCCRP.*





## ENTRO's

### Vision:

A credible EN institution fostering sustainable transboundary cooperative water resource management and development and promoting regional integration.

### Mission:

“We Work to realize shared benefits of cooperative Water Resources Development and Management in the Eastern Nile”.





**ONE RIVER**

**ONE PEOPLE**

**ONE VISION**



Burundi



DR Congo



Egypt



Ethiopia



Kenya



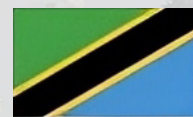
Rwanda



South Sudan



Sudan



Tanzania



Uganda

**CONTACTS**

**EASTERN NILE TECHNICAL REGIONAL OFFICE (ENTRO),  
DESSIE ROAD, IN FRONT OF ARARAT HOTEL,  
ADDIS ABABAETHIOPIA,**

**P. O. BOX 27173-1000,**

**TEL.: +251 116 461130**

**WEBSITE <http://entro.nilebasin.org/>, [ikp.nilebasin.org](http://ikp.nilebasin.org)**

**E-MAIL: [entro@nilebasin.org](mailto:entro@nilebasin.org) /[entro@nilebasin.org](mailto:entro@nilebasin.org) ,**