Eastern Nile Flood Forecast and Early Warning System Enhancement

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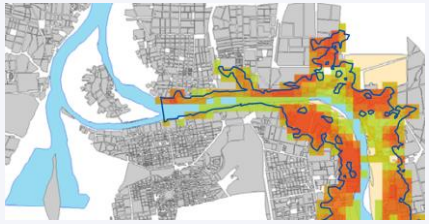
Outline

1. Major Flood Impacts in EN Countries
2. EN-FFEWS 2001-2023 Evolutions
3. The Current Flood Risk Mitigation Project (2021-2025) – Lesson learned
4. Challenges & Improvement Areas in FFEWS

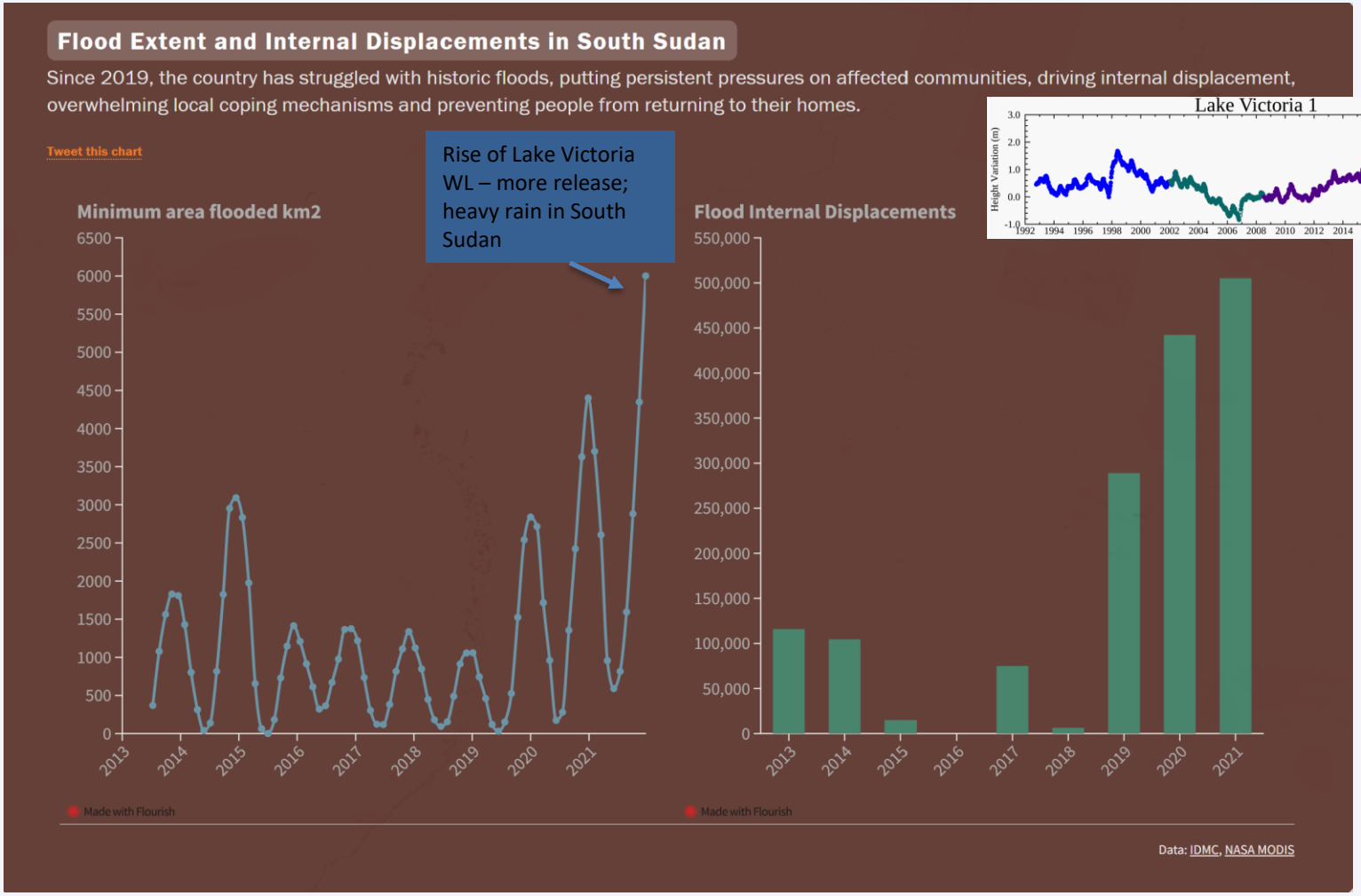


Flood impacts regularly Nile countries livelihoods and economies

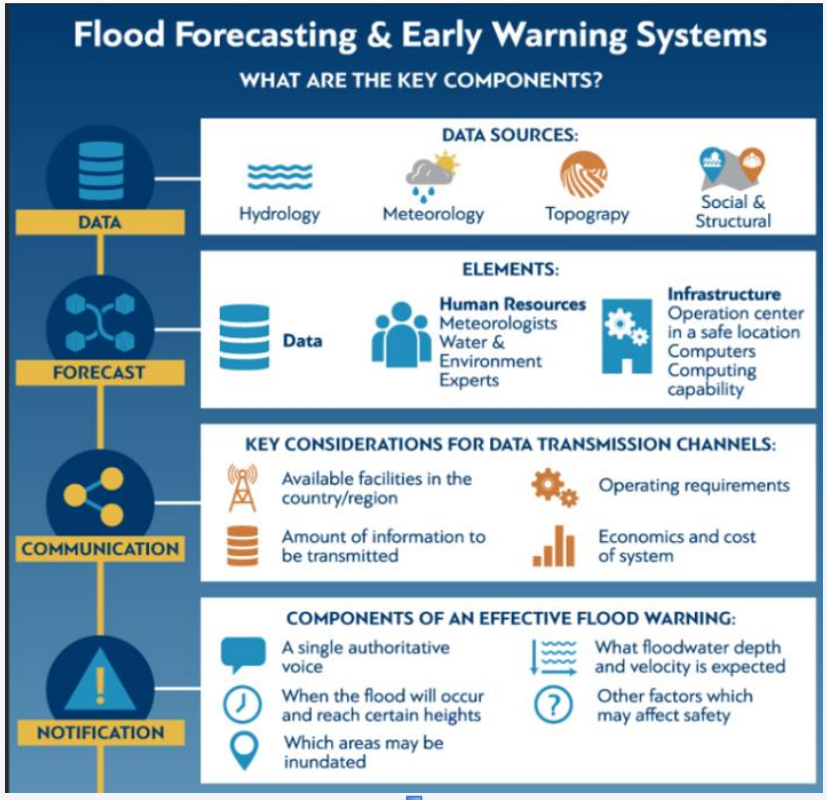
1876 / 1946/ 1988	1996/ 1998	2003	2006	2013	2014	2015/2016	2017	2020 / 2021/2022
• 1878, 1946 historic high flood records in Blue Nile • 1988 (> 200 mm Khartoum and Blue Nile flood), Gambela	• 1998 in Sudan Blue Nile: caused a direct flood damage of about US$ 24.3 million • 1996 Gambela 90 K people affected	<u>2003 in Sudan:</u> Major Impact on Irrigated Agriculture Sector; 115K Ha of Crops Damaged; 2412 Houses Damaged ; More than 250,000 families affected	2006 in Ethiopia: 600 affected, more than 35K people homeless; Nile flood in Sudan	<u>2013 in South Sudan</u>: Gambela and other towns which causes losses of many life and damage of properties; Flash flood Khartoum (15 K homes destroyed)	<u>2014 in Sudan</u>: 257 K people in ten states have been affected	<u>2016 in Egypt, Ethiopia</u>: Baro river -Gambela flood plain and Sudan: Blue Nile sub basin; South Sudan flood	2017 in Ethiopia – Lake Tana flood prone area , in some part of <u>South Sudan and Sudan</u>; Sudan 55K people affected.	• 2020 flood affected > 1.5 million peoples in <u>Ethiopia, South Sudan</u> and Sudan with 100 deaths costing > 24 Million USD in Sudan. • Worst in 2022 in South Sudan

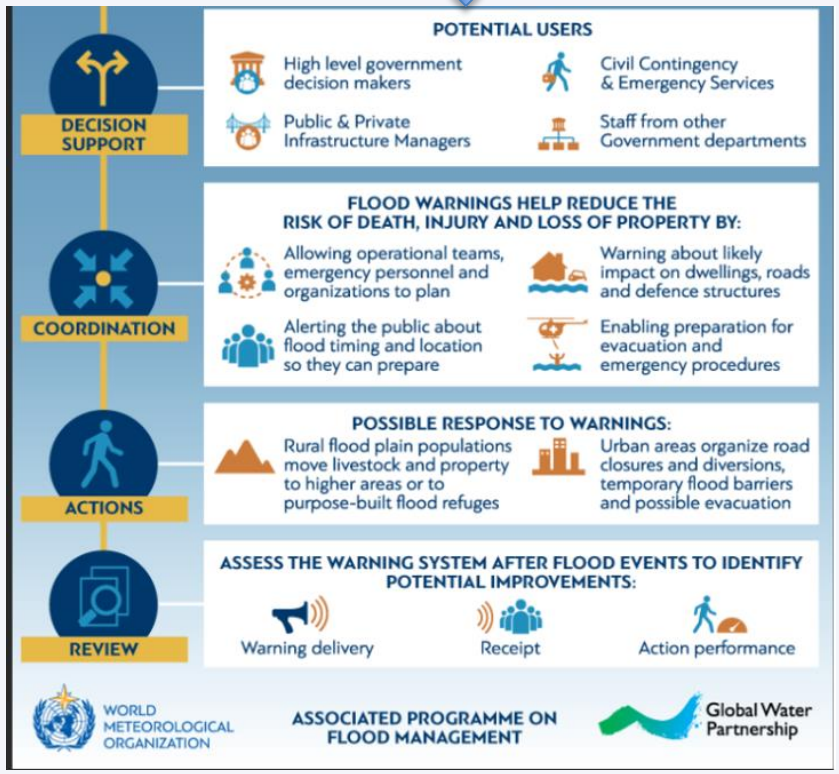
Mainly from https://www.emdat.be/

Flood impacts regularly Nile countries livelihoods and economies



https://southsudan.crisisgroup.org/


Flood Forecasting & Early Warning Systems
WHAT ARE THE KEY COMPONENTS?
DATA
DATA SOURCES:
Hydrology
Meteorology
Topograpy
Social & Structural
FORECAST
ELEMENTS:
Data
Human Resources
Meteorologists
Water & Environment Experts
Infrastructure
Operation center in a safe location
Computers
Computing capability
COMMUNICATION
KEY CONSIDERATIONS FOR DATA TRANSMISSION CHANNELS:
Available facilities in the country/region
Operating requirements
Amount of information to be transmitted
Economics and cost of system
NOTIFICATION
COMPONENTS OF AN EFFECTIVE FLOOD WARNING:
A single authoritative voice
What floodwater depth and velocity is expected
When the flood will occur and reach certain heights
Other factors which may affect safety
Which areas may be inundated


DECISION SUPPORT
POTENTIAL USERS
High level government decision makers
Civil Contingency & Emergency Services
Public & Private Infrastructure Managers
Staff from other Government departments
COORDINATION
FLOOD WARNINGS HELP REDUCE THE RISK OF DEATH, INJURY AND LOSS OF PROPERTY BY:
Allowing operational teams, emergency personnel and organizations to plan
Warning about likely impact on dwellings, roads and defence structures
Alerting the public about flood timing and location so they can prepare
Enabling preparation for evacuation and emergency procedures
ACTIONS
POSSIBLE RESPONSE TO WARNINGS:
Rural flood plain populations move livestock and property to higher areas or to purpose-built flood refuges
Urban areas organize road closures and diversions, temporary flood barriers and possible evacuation
REVIEW
ASSESS THE WARNING SYSTEM AFTER FLOOD EVENTS TO IDENTIFY POTENTIAL IMPROVEMENTS:
Warning delivery
Receipt
Action performance
WORLD METEOROLOGICAL ORGANIZATION
ASSOCIATED PROGRAMME ON FLOOD MANAGEMENT
Global Water Partnership

FFEW 2001-2023 EVOLUTIONS

Institutional

- The Nile basin is characterized by significant spatial and temporal rainfall and water resources variability, which is being amplified by climate change.
- Every year more than 0.5 million peoples' lives and livelihoods are affected by flood in the Eastern Nile countries of Egypt, Ethiopia, South Sudan and Sudan.
- Considering this flood impact, in March 2001, the Eastern Nile Council of Ministers (ENCOM) expressed their need to advance studies in Flood Forecast and Early Warning (EN-FFEW).

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FFEW 2001-2023 EVOLUTIONS

Institutional

- The Minsters agreed in the Flood Preparedness and Early Warning Project within Eastern Nile Subsidiary action program 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 the Nile Basin collaboration on the ground by creating projects in 2006-2010 which focused on building the institutional capacity and developing critical baseline information to enhance the readiness of EN countries to implement subsequent FPEW project.

FFEW 2001-2023 EVOLUTIONS

Institutional, Cooperation, Technical

2006-2010

- Component 1: Regional coordination: Putting in place an institutional mechanism for establishing inter-country coordination.

- Component 2: Flood forecasting warning & communication system: Aimed at improving flood forecasting institutions and developing a detailed design for EN flood forecasting, warning and communication system.

- Component 3: Pilot flood preparedness & emergency response: Strengthened flood preparedness and flood mitigation planning at different levels.

In 2020 the levels of the Nile in Khartoum were the highest recorded since 1912. Photo: lier4life/Shutterstock

FFEW 2001-2023 EVOLUTIONS

Reaching the affected people & CB

2011-2021(NCORE)

- Established the regional flood coordination unit at ENTRO and the National flood forecasting centers in the three EN countries;
- Developed real-time flood forecasting systems for Lake Tana floodplains in Ethiopia and the Blue/Main Nile River System in Sudan;
- Strengthened the Capability of the Nile Forecast Center in Egypt;
- Development of emergency response and preparedness plan for selected pilot communities;
- ENTRO Regular Activities: Flood Forecast (July-September) – has been daily issued at ENTRO since July 2010 with Interns from the Water Affairs Ministry of Ethiopia, Sudan and South Sudan

The Current Flood Risk Mitigation Project (2021-2025) – Lesson learned

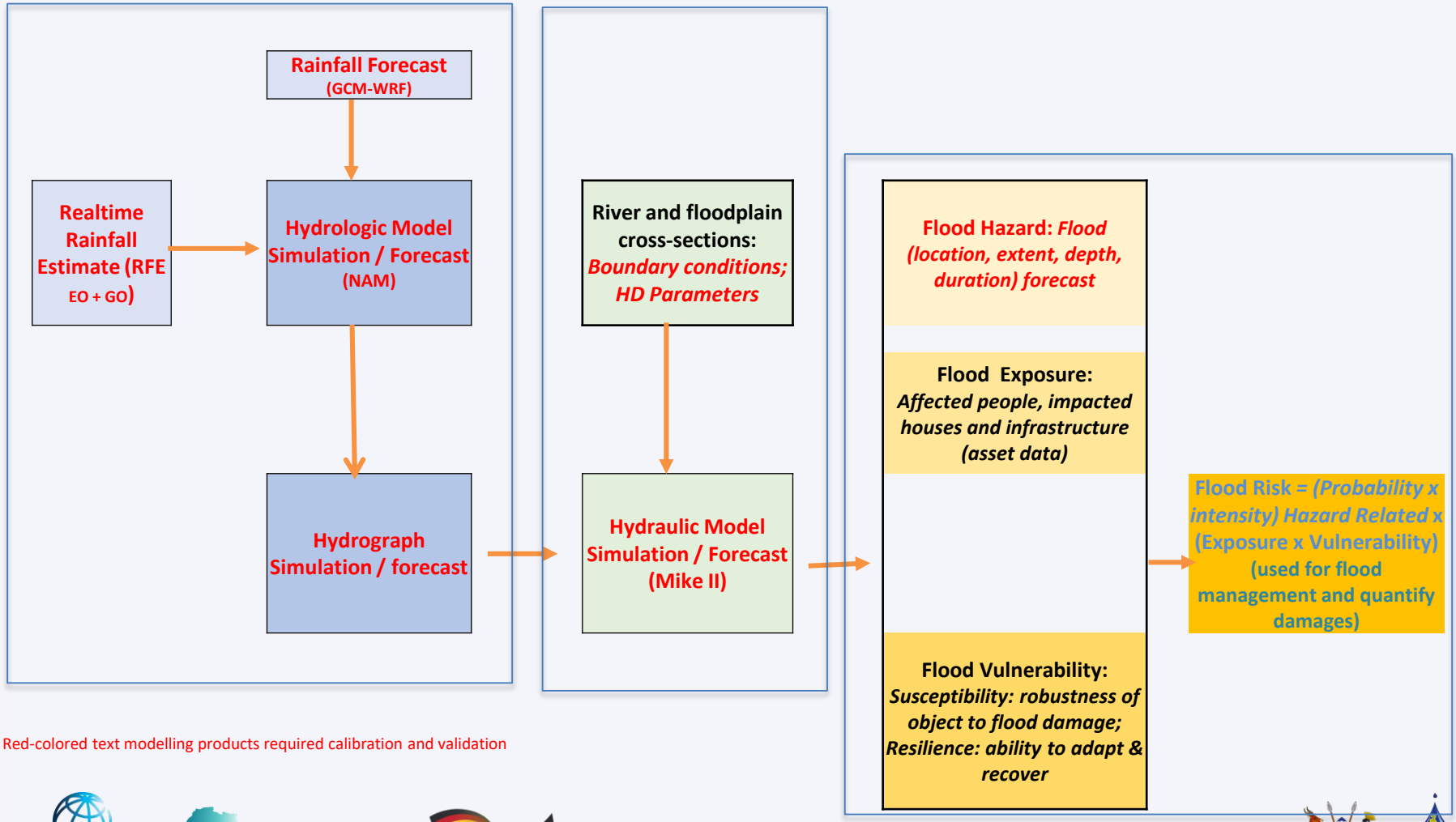
Lesson Learned (LR): After more than a decade FFEW experiences still continuous enhancement are required in areas of:

- Flood prone areas surveying and Data Collection (topographic, infrastructure, socio-economic) – LR: *Expensive and challenging works & critical data for FRM*

- Enhancement of the Eastern Nile Flood Forecasting and Early Warning System – *LR calibrating and validating rainfall forecast, flood forecast, hydrodynamic modelling and updating the Flood Risk Mapping is sustained task as technology and ground conditions varies with time.*

- Focusing on the support that ENTRO provides in Establishing Flood Community Awareness and Preparedness is also critical (the final beneficials saving life and properties).

The Current Flood Risk Mitigation Project (2021-2025)



Red-colored text modelling products required calibration and validation

Challenges and Improvement areas in FFEWS Rainfall

Hindcast (Near Realtime satellite-based rainfall estimate for calibration)		Forecast (Mesoscale numerical weather prediction system)	
RFE (NOAA)	• Continuous calibration is required. • Still the number of daily gauge observations incorporated into MSWEP are limited in the Nile basin. • The error propagates with positive linear relationship between errors in precipitation and simulated discharges (NANDING et al (2021) Assessment of Precipitation Error Propagation in Discharge Simulations over the Contiguous United States (DOI: 10.1175/JHM-D-20-0213.1))	WRF (3-day ahead, hr time step, 6km x 6km) National Center for Atmospheric Research (NCAR)	• Continuous calibration is required. ○ Example: in Ethiopia, WRF the 1-day to 3-day lead-times forecast are reasonable reproduces the observed data. The low (no rain and light rain) and high (>16 mm/day) rainfall forecast detection capability of the WRF model was good. ○ However, the detection ability of the model for rainfall intensities between 6 and 16 mm per day showed low. (Hailaye (2022) https://www.sciencedirect.com/science/article/pii/S2214581822002865)
MSWEP (3hr time step, with latency of 3hr) **NCAR**		GFS (1 hr dt, 13km x 13 km resolution), National Centers for Environmental Prediction (NCEP) The GFS is run four times a day, producing forecasts up to 16 days in advance. It produces hourly forecast output for the first 120 hours, then 3 hourly for days 5-16. https://www.emc.ncep.noaa.gov/emc/pages/numerical_forecast_systems/gfs.php	

Challenges and Improvement areas in FFEWS

Hydrology and hydrodynamic modelling ; way forward

Models / system	Key issues (research areas)	Challenges
Hydrological & Hydraulic Models **NAM / HEC-HMS** **Mike II / HEC-RAS**	• What are the sources of uncertainty in flood hydrology / hydraulics? • What are the greatest sources of uncertainty in modelling for flood risk management?	Generally: the forecast of Q and water level is a function of the reliability of the modelling and forecast of rainfall, hydrology and hydraulic. The current challenges are: Producing / acquiring data on: (a) Observed flood hydrographs and corresponding areal rainfall (b) Accuracy of rainfall forecast (WRF, up to 3-day lead time state of the knowledge) (c) Updated river rating curves (d) Floodplain high resolution topographic maps (0.5m vertical and 5 m horizontal) (e) Floodplain accurate asset and infrastructure maps with properties values, exposure and vulnerability spatially well quantified Iinstitutional and capacity building (a) Concise and relevant definition of early warning content, format and channel for all level of stakeholders (b) Well-established sustainable institution and their chains from forecast generation and emergency decision generation up to the flood affected communities, (c) Sustained actions on flood mitigation preparedness and emergency responses.
Way forward	• *It is recommended to conduct ensembles of forecasts of flood and including specifying the uncertainty of the forecast. By varying rainfall forecast model, and / or by changing % key parameters that inducing uncertainty in the hydrology and hydraulics.* • Enhanced awareness creation that the countries will gain more if they invest in a sustained way in flood forecasting, flood mitigation preparedness and well planned and drilled emergency responses. • *The National FFC should build their capacity in individual (expert skill & knowledge, …), organizational (regulations, manuals, infrastructure, …) and its enabling environment (national legislation, economic system that makes FFEW demandable, …)*	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