WMO

Training for Trainers
Workshop on Integrated approach to flash flood and flood risk management

24-28 October 2010 Kathmandu, Nepal

Regional Flash Flood Guidance and Early Warning System

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Associated Programme on Flood Management
WMO

Flash Floods

WORLD METEOROLOGICAL ORGANIZATION (WMO):

" A flood of short duration with a relatively high peak discharge "

AMERICAN METEOROLOGICAL SOCIETY (AMS):

" A flood that rises and falls quite rapidly with little or no advance warning, usually as the result of intense rainfall over a relatively small area "

A local hydrometeorological phenomenon that requires:

1. BOTH Hydrological and Meteorological expertise for real time forecasting/warning
2. Knowledge of local up to the hour information for effective warning (24 - 7 operation)

For this effort: response time is 6 hours or less

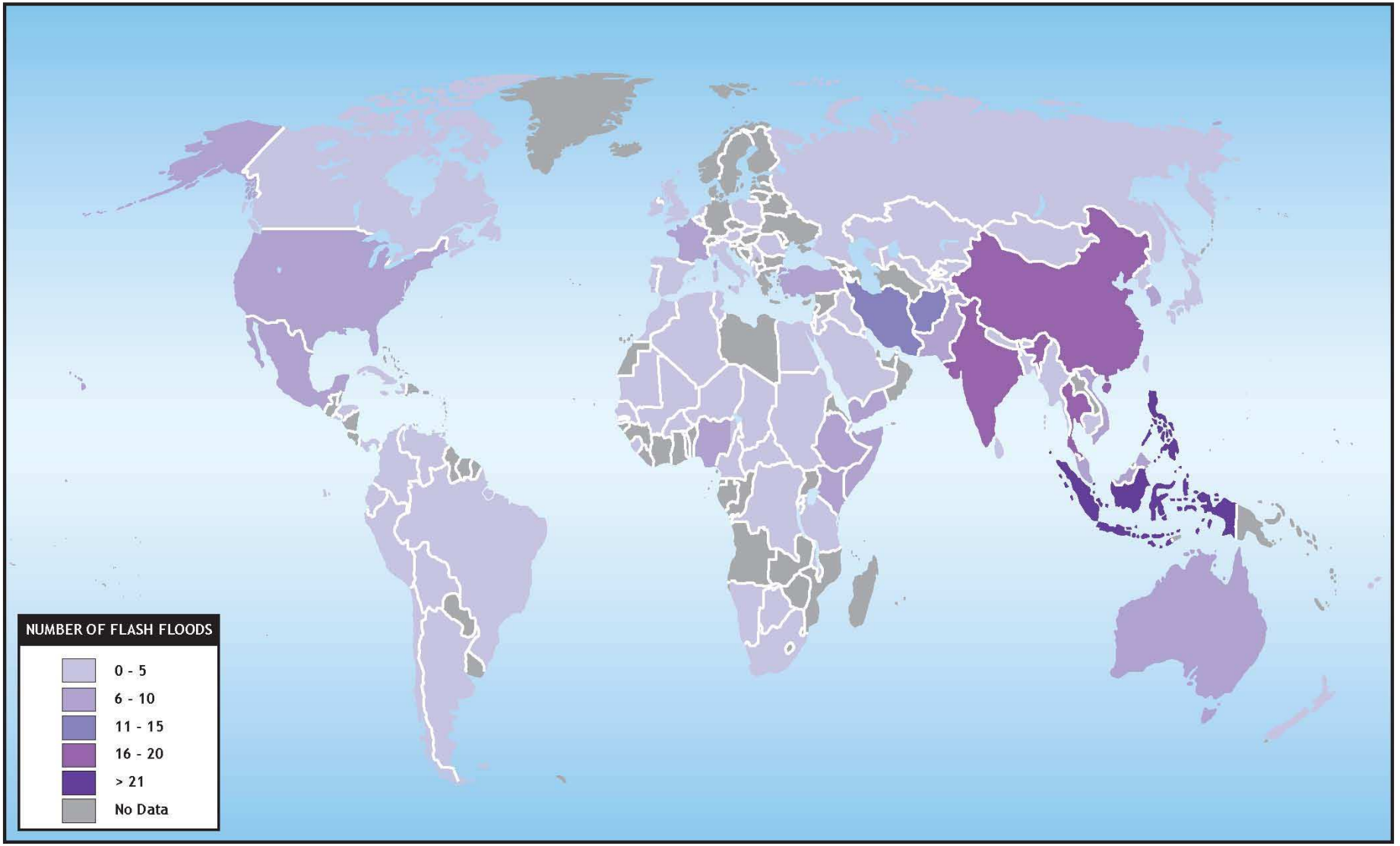
Flash Floods in Perspective

- "Recent findings of the WMO country-level survey where of the 139 countries, 105 indicated that *flash floods* were among the top two most important hazards around the world and require special attention"
- "On the average, these events kill more people worldwide than any other natural disaster – in an average year, flash floods kill over 5,000 unsuspecting people and cause millions of dollars of property damage"

(WMO 2008)

USAID
FROM THE AMERICAN PEOPLE

SIGNIFICANT FLASH FLOODS RECORDED BETWEEN 1979 - 2009



Flood Forecasting Initiative

Addressing Communication Gaps

1) Between meteorological and hydrological services

- Information and forecasts not provided in a form usable for hydrological forecasting,
- Non-standardized data archiving, data formats and transmission protocols,
- Use of different forecasting concepts, methods and technical language.

2) Between forecasters and forecast users

- Forecasting is often not objective-driven;
- Use technical vocabulary in forecast and warning dissemination

Initiative on Regional Flash Flood Guidance Systems

- WMO involved in an international initiative on flash floods globally
- Aim to improve regional flash flood warnings
- Based on the systems implemented in Central America and Mekong River Basin
- Developed by US Hydrologic Research Center
- Funded by USAID
- SARFFG is the first regional project of WMO
  - ✓ Cover basins in SADC countries,
  - ✓ Implemented over the next 5 years

Flash Floods vs River Floods

- **River floods** are caused by heavy rain over long periods (days) in the upper catchment leading to rising water levels and flooding as the flood wave takes days to move down river
- **Flash floods** are quick response flood events causing sudden flooding in small river basins. Flooding follows within **6 hours or less** after the heavy rain event
  - **Typically associated with small fast responding basins**
  - **Can occur in normally dry areas with no visible stream channel, including urban areas**

Main objective of the project

To contribute towards reducing the vulnerability of regions around the world to hydrometeorological disasters,

specifically flash floods,

by developing and implementing flash flood guidance systems to strengthen regional capacity to develop timely and accurate flash flood warnings

Flash Floods

Purpose of the Regional Flash Flood Guidance System

Example of Black Sea and Middle East Regions - component (BSME-FFG)

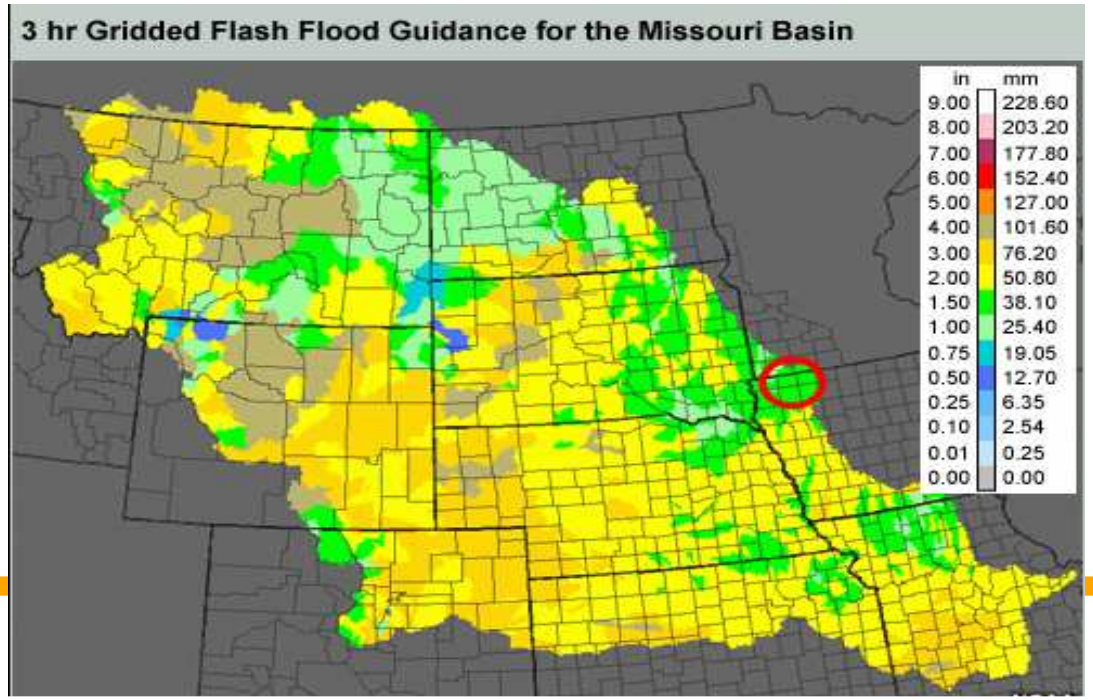
Development and implementation of a regional flash flood guidance and early warning system in the Black Sea and Middle East Regions.

The approach will entail development of infrastructure first on a global scale to then support the development of the regional implementation of technology, training, protocols and procedures to address the issues of mitigating the impacts of flash floods.

FLASH FLOOD GUIDANCE SYSTEM

What is Flash Flood Guidance (FFG)

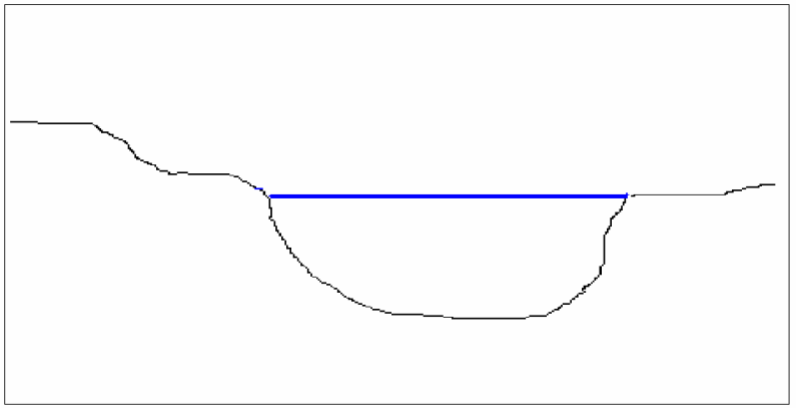
- Crude Definition: FFG is an estimate of **how much rainfall over a specified time in a small basin is needed to initiate flooding on small streams**
- Example: 3-hour FFG = 50 mm, flooding should begin on small streams if that amount or more falls in a 3-hour period over the basin



- Adapted FFG system implemented in a few other parts of the world (Central America, Romania, Mekong)

Flash flood guidance is the amount of rainfall for a given duration over a small basin needed to create minor flooding (bankfull) conditions at the outlet of the basin. So, FFG is an index that indicates how much rainfall is needed to cause minimal flooding in a basin.

- Bankfull flow is employed as the flow associated with flooding



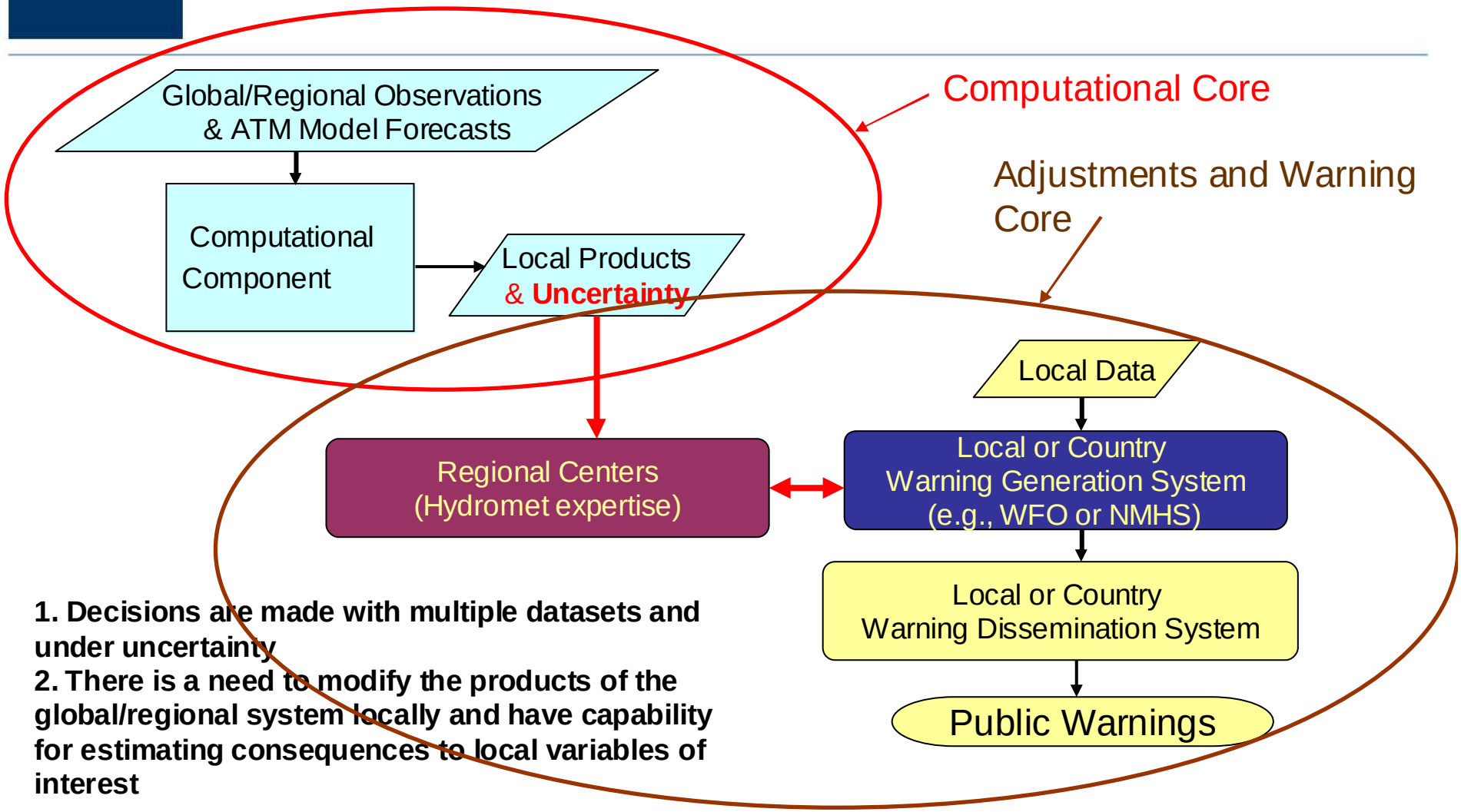
Attributes of FFG

- ***Diagnostic tool useful for quick flash flood occurrence potential diagnosis in real time to alert local forecasters of an impeding danger***
- ***Concerns bankfull flows***
- ***Readily ingests local precipitation information***
- ***Local forecaster adjustments easy***
- ***Promotes Close Collaboration of Hydrologists with Meteorologists***

How will the SARFFG work?

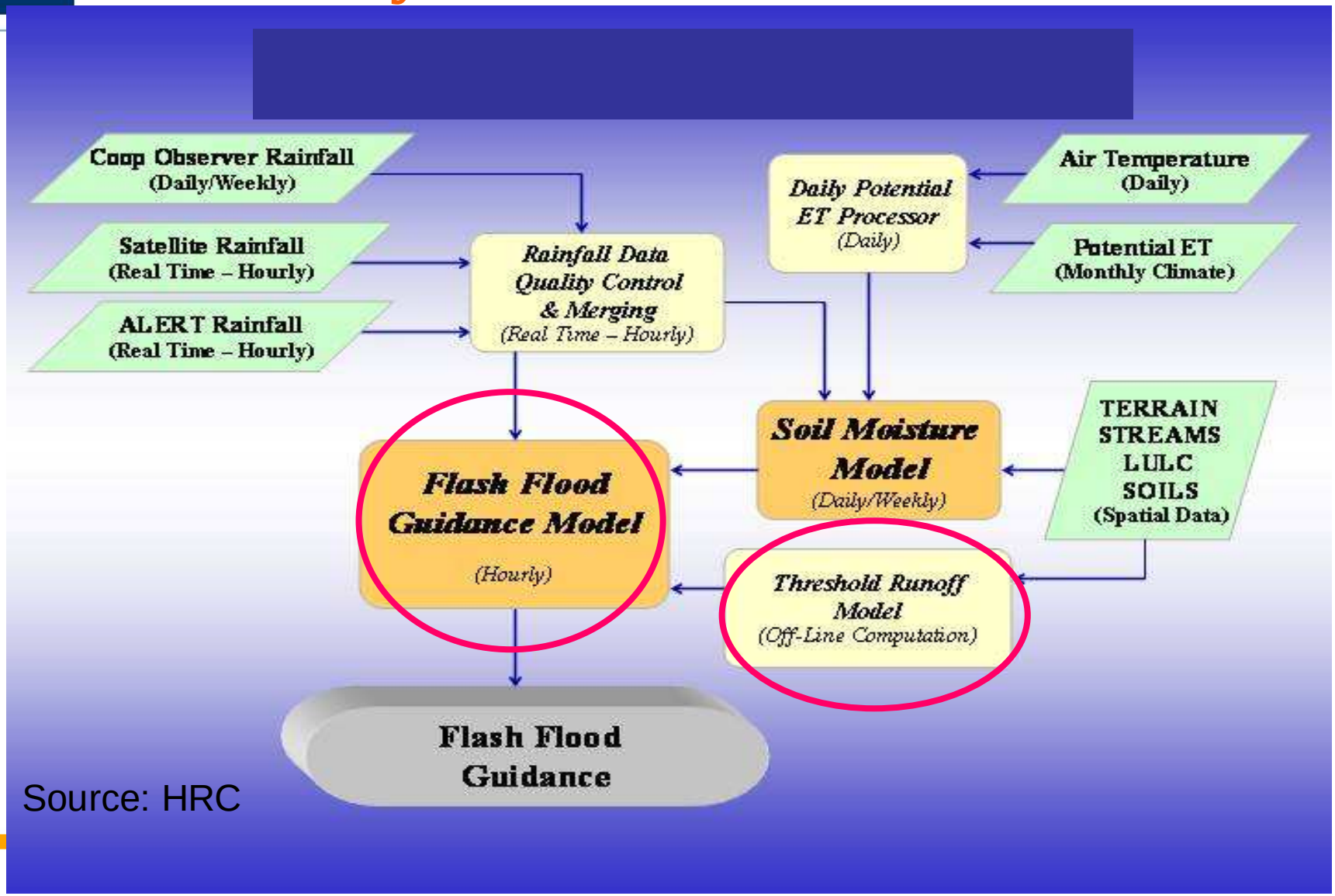
- Combination of weather information and hydrological information in real-time to give an indication which small river basin is in danger of flooding in the next 0-6 hours
- Hydrology:
  - Hydrologic systems regularly (6-hourly) calculates FFG value for each small basin based on soil moisture and run-off modeling using latest rainfall
- Meteorology:
  - Forecaster continuously monitors the weather, assesses FFG guidance, and if needed adapt rain products
  - Produce warnings to disaster management structures

From Global to Regional to Local



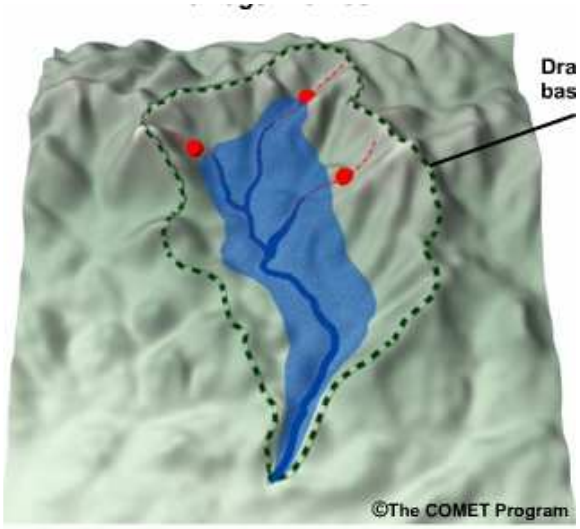
1. Decisions are made with multiple datasets and under uncertainty
2. There is a need to modify the products of the global/regional system locally and have capability for estimating consequences to local variables of interest

Flash Flood Guidance System Flow Chart



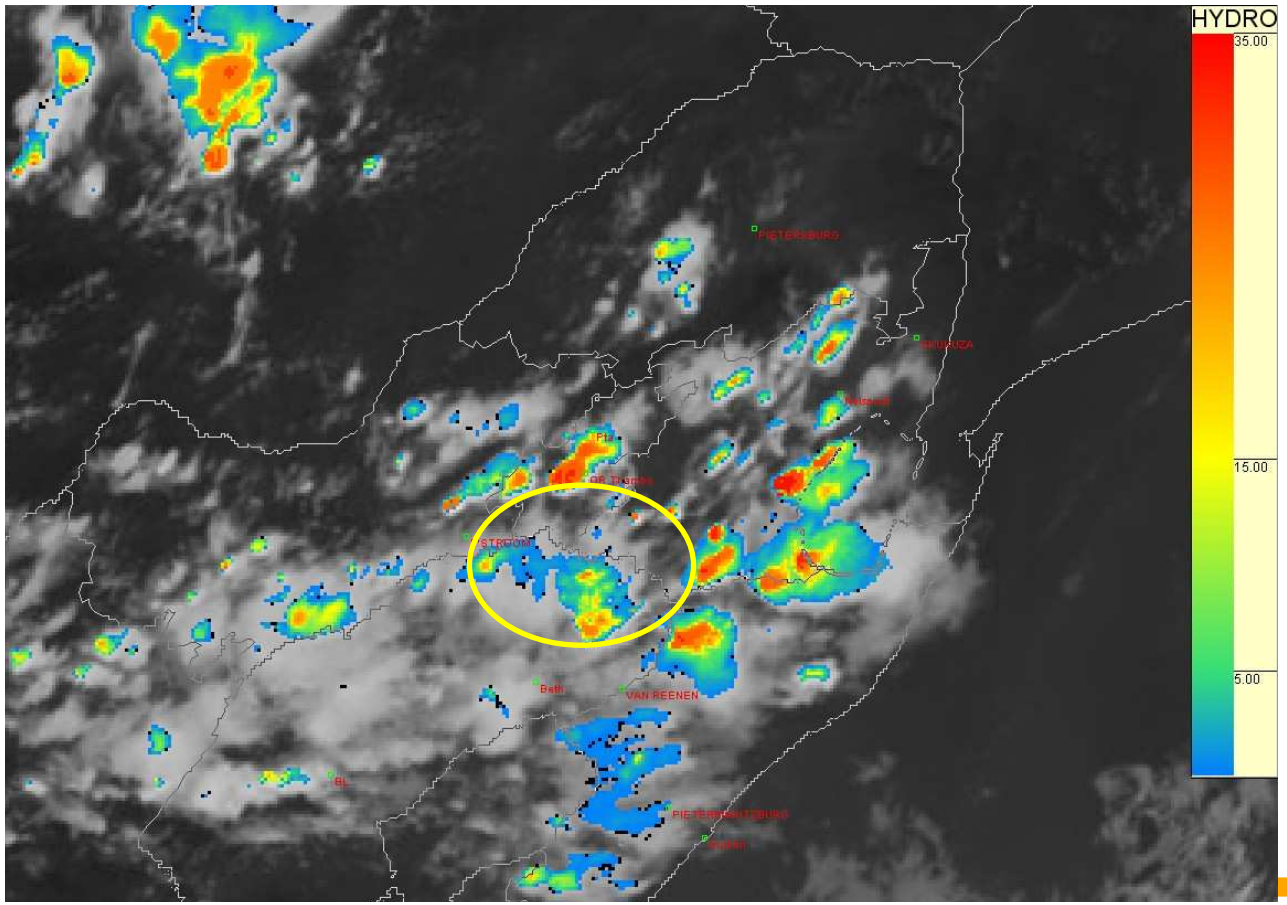
Source: HRC

Hydrologic modelling



- During the development:
  - Use satellite Digital Elevation Map (DEM) to delineate small catchments of 200 km^2
  - True or satellite based GIS information on vegetation, soil properties, land-use, etc
  - Climate information on temperature and rainfall for evapotranspiration
- Operationally use latest rainfall and temperature information:
  - Calculate every 6 hours new soil moisture and FFG per basin
  - Calculates Mean Arial Precipitation (MAP) per basin from satellite info
  - Bias correct satellite rainfall estimation using gauges

Meteorological systems: Rainfall estimation with Hydroestimator

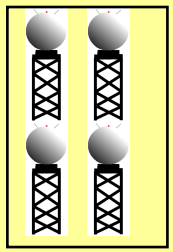


- Based on MSG satellite
- Combines with UM NWP model
- Rain rate every 15 minutes
- Bias corrected with rain gauge data

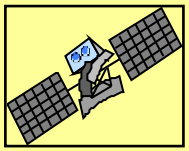
Rain gauges provides vital input

- Any real-time rainfall measurement provides vital input into the SARFFG
  - Calculations of soil moisture and FFG
  - Bias correction of satellite rainfall estimation (Hydroestimator)
- Also updates forecaster and disaster manager continually about the rain in hazardous areas

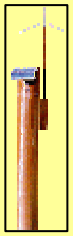
- Most useful is automated rainfall stations like the ARS
- Disseminating rainfall reports using GPRS in real-time, when raining



Radar

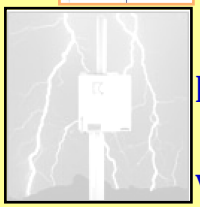


satellite



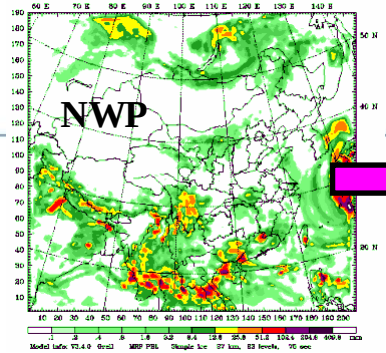
Precipitation

sounding

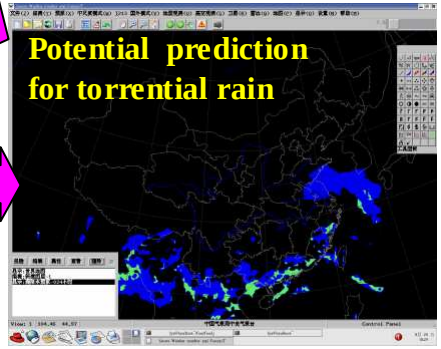


lightning、
G P S、
wind profile

Data analysis system



multi-data

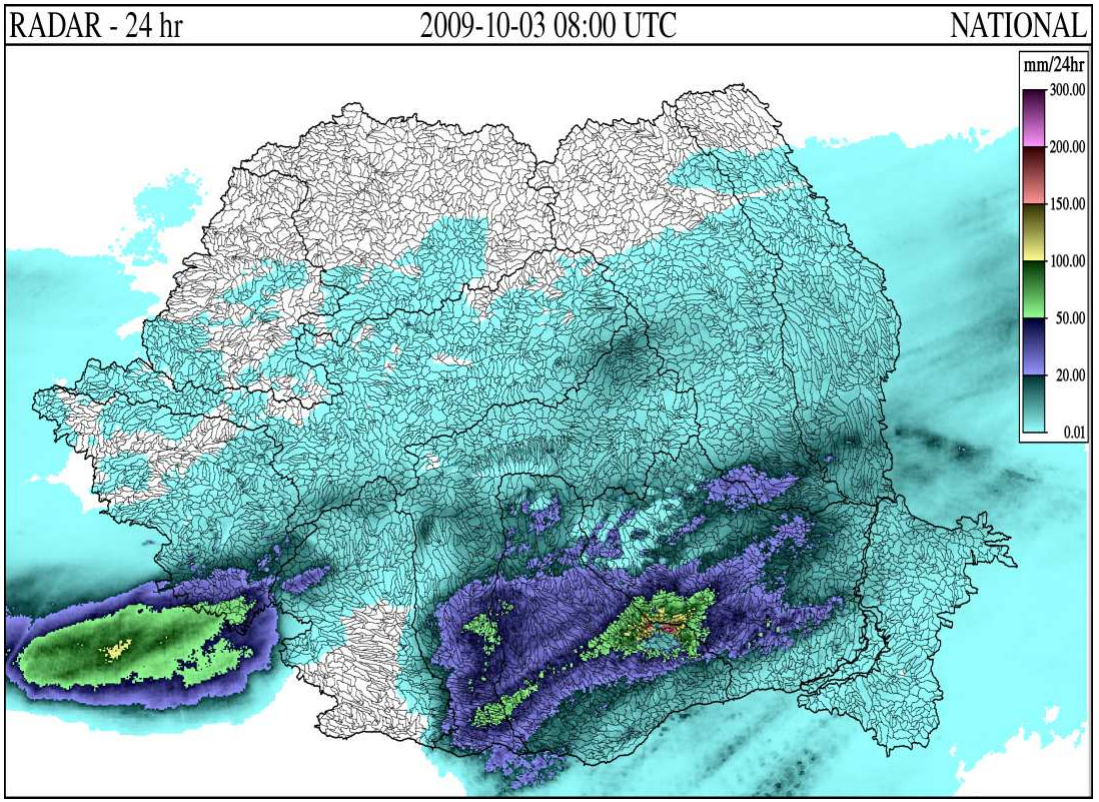


torrential rain forecast

The way to predict convective weather: monitoring and now-casting ; To develop a technique to combine all the data sources on the working station.

RADAR

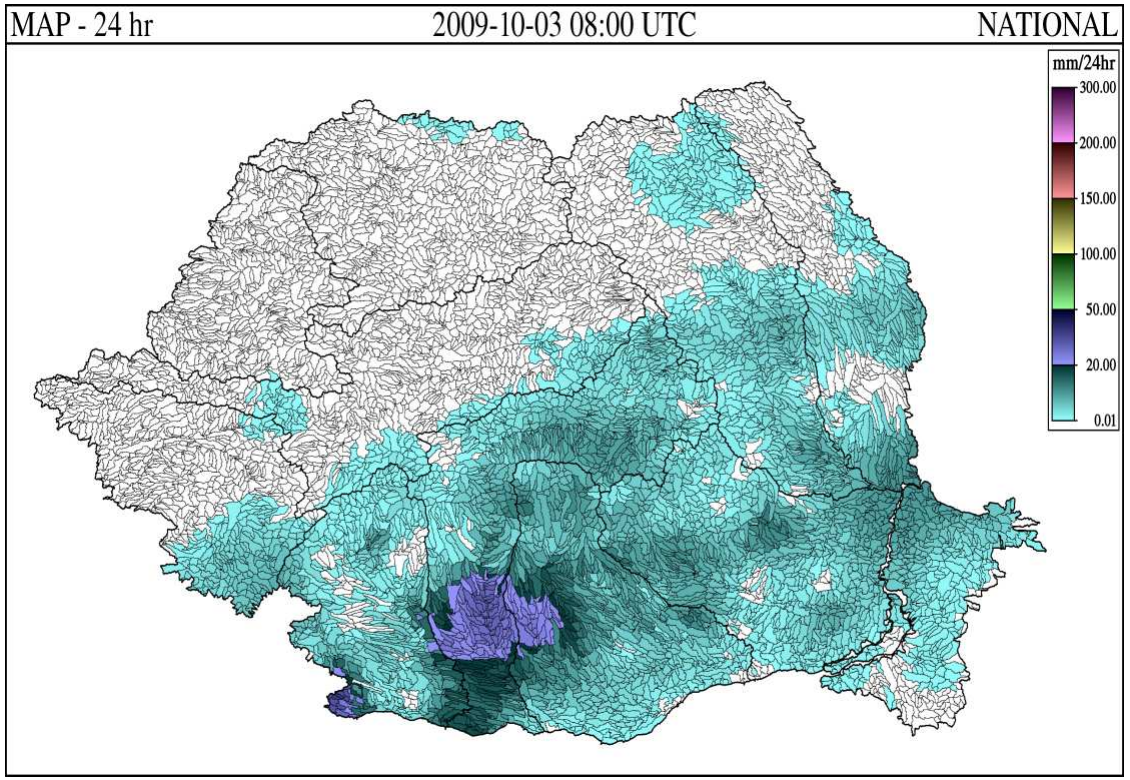
- Un-biased corrected rainfall for 1, 3, 6 and 24 hour accumulation (based on radar rainfall estimates from the Romania radar network) – only images



MERGED MAP

- Mean areal precipitation for each basin for 1, 3, 6 and 24 hour accumulations based on bias corrected radar rainfall estimates and/or in-situ gauge estimates

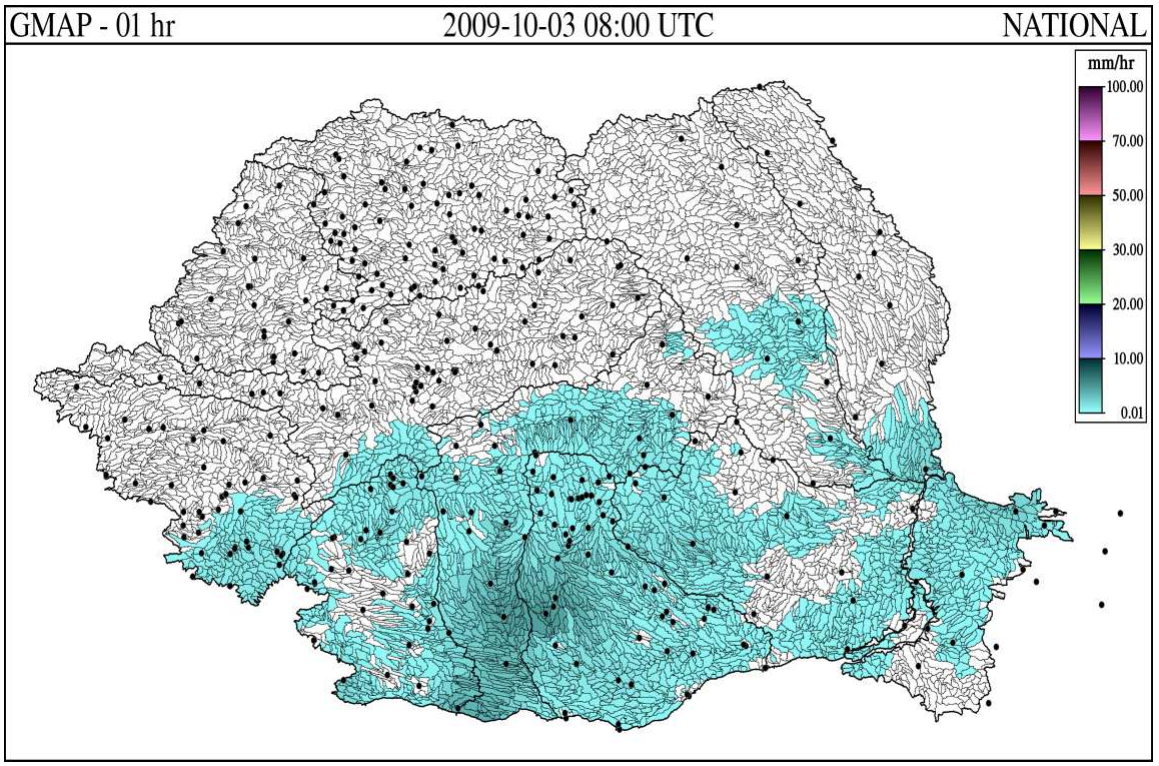
  - text table and images



GMAP (GAUGE MAP)

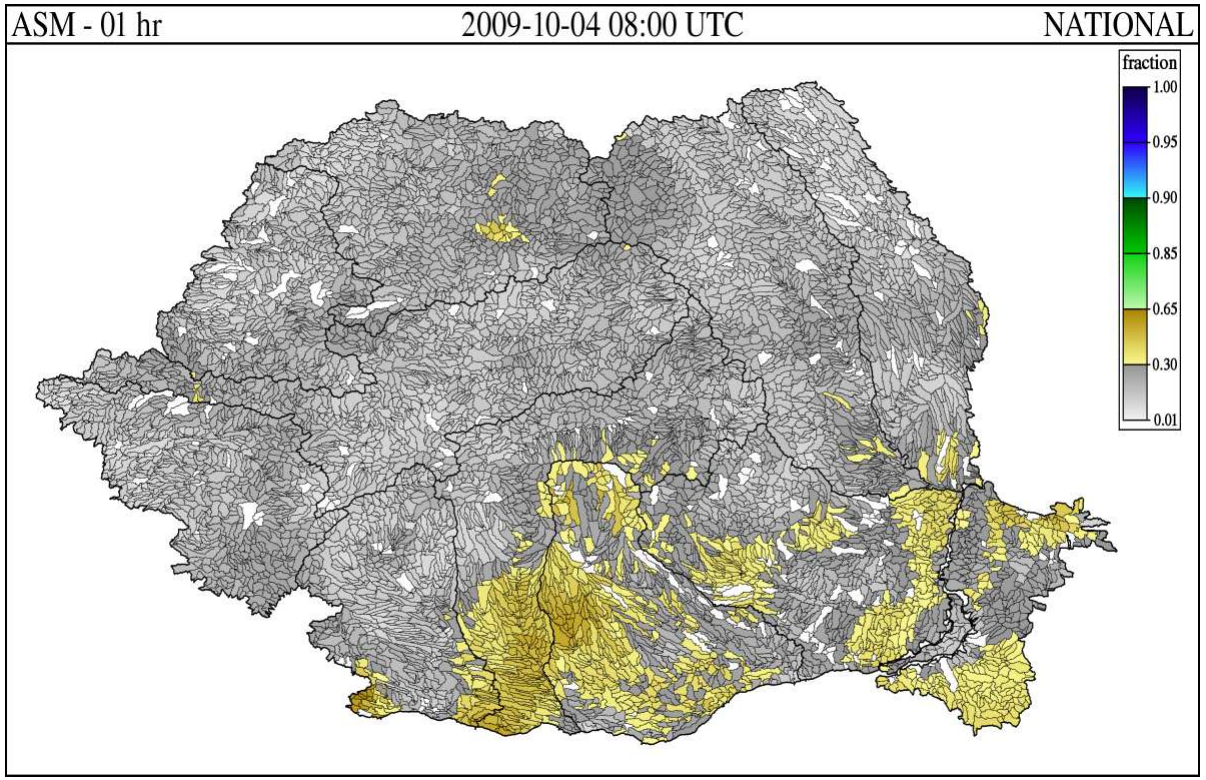
- Mean areal precipitation for each basin for 1 hour (only) accumulation based on available gauge data

  - text table and image



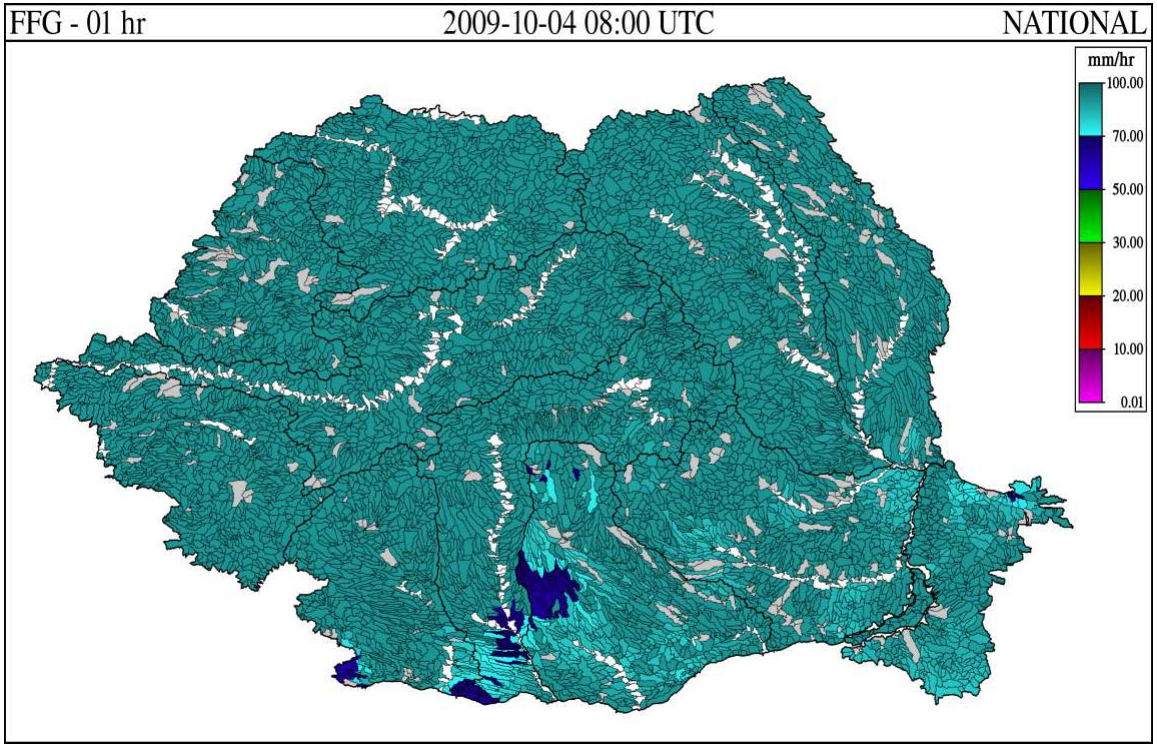
ASM (Average Soil Moisture)

- Average soil water content for each basin (fraction of saturation for the upper soil layer , nominally 20 cm)
  - text table and image



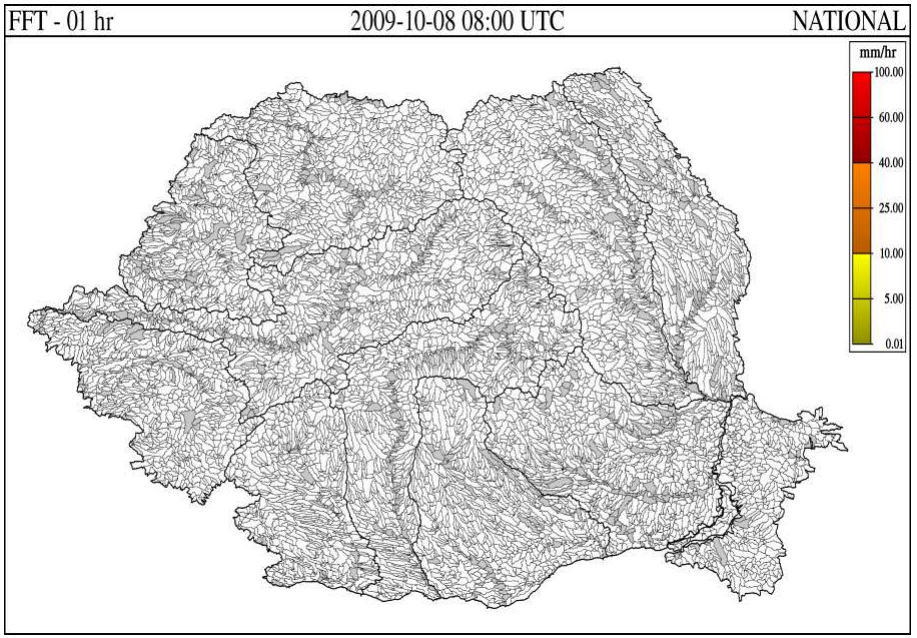
FFG (Flash Flood Guidance)

- Flash flood guidance for each small basin for 1, 3 and 6 hours
  - text tables and images

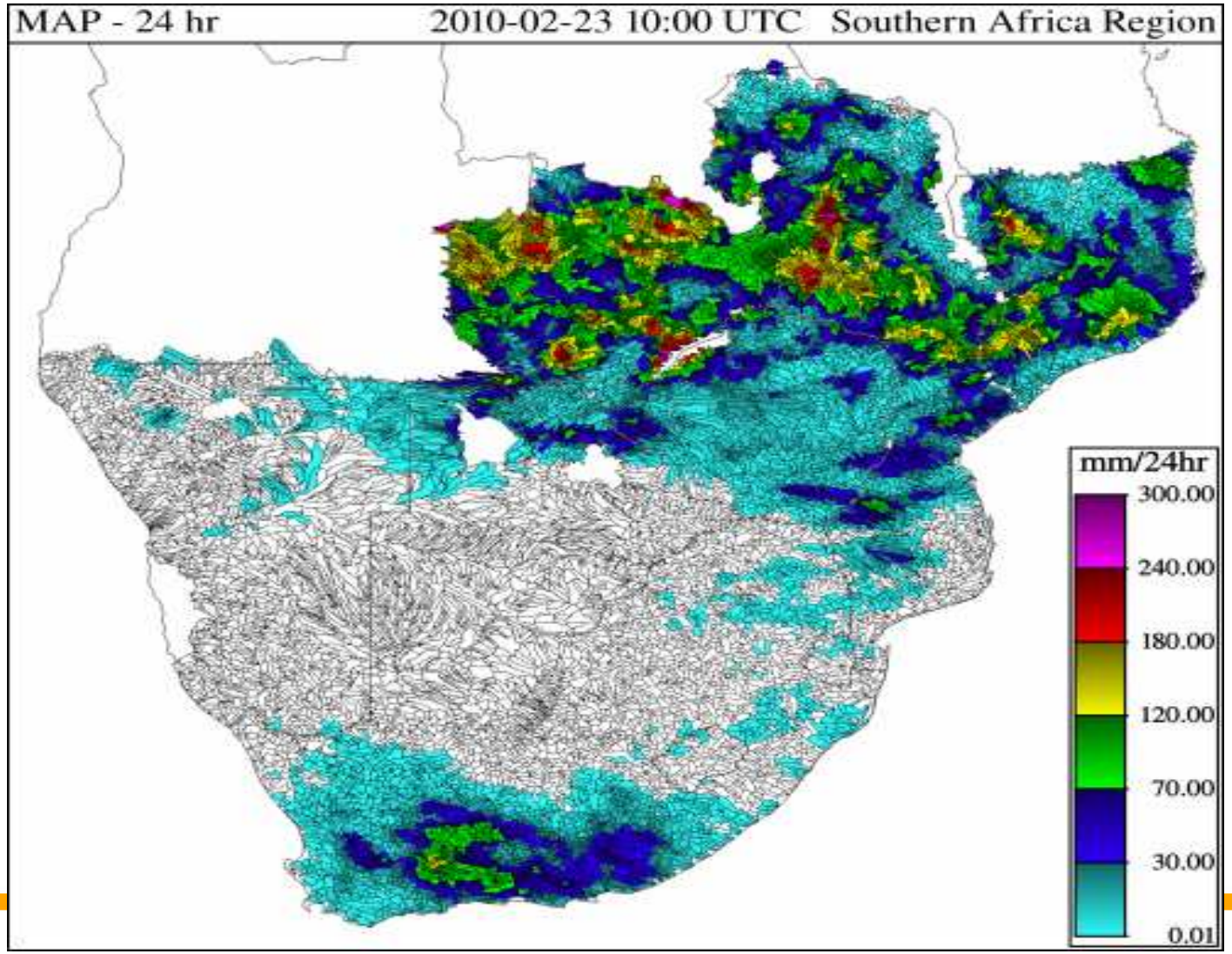


FFT (Flash Flood Threat)

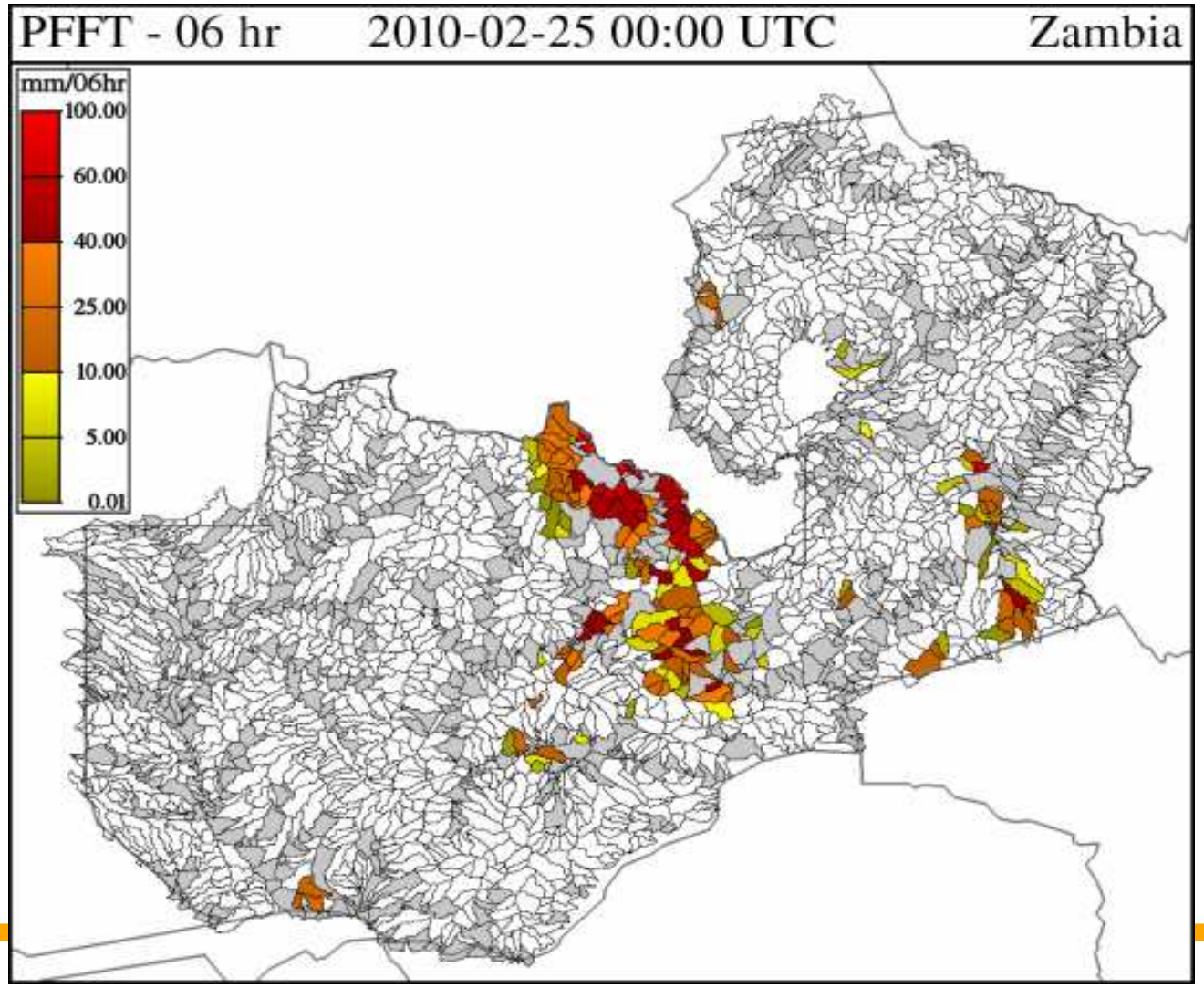
- FFT is the amount of rainfall of a given duration in excess of the corresponding FFG value.
- The FFT when used with existing or forecast rainfall is an index that provides an indication of areas where flooding is imminent or occurring and where immediate action is or will be shortly needed
  - text table and images



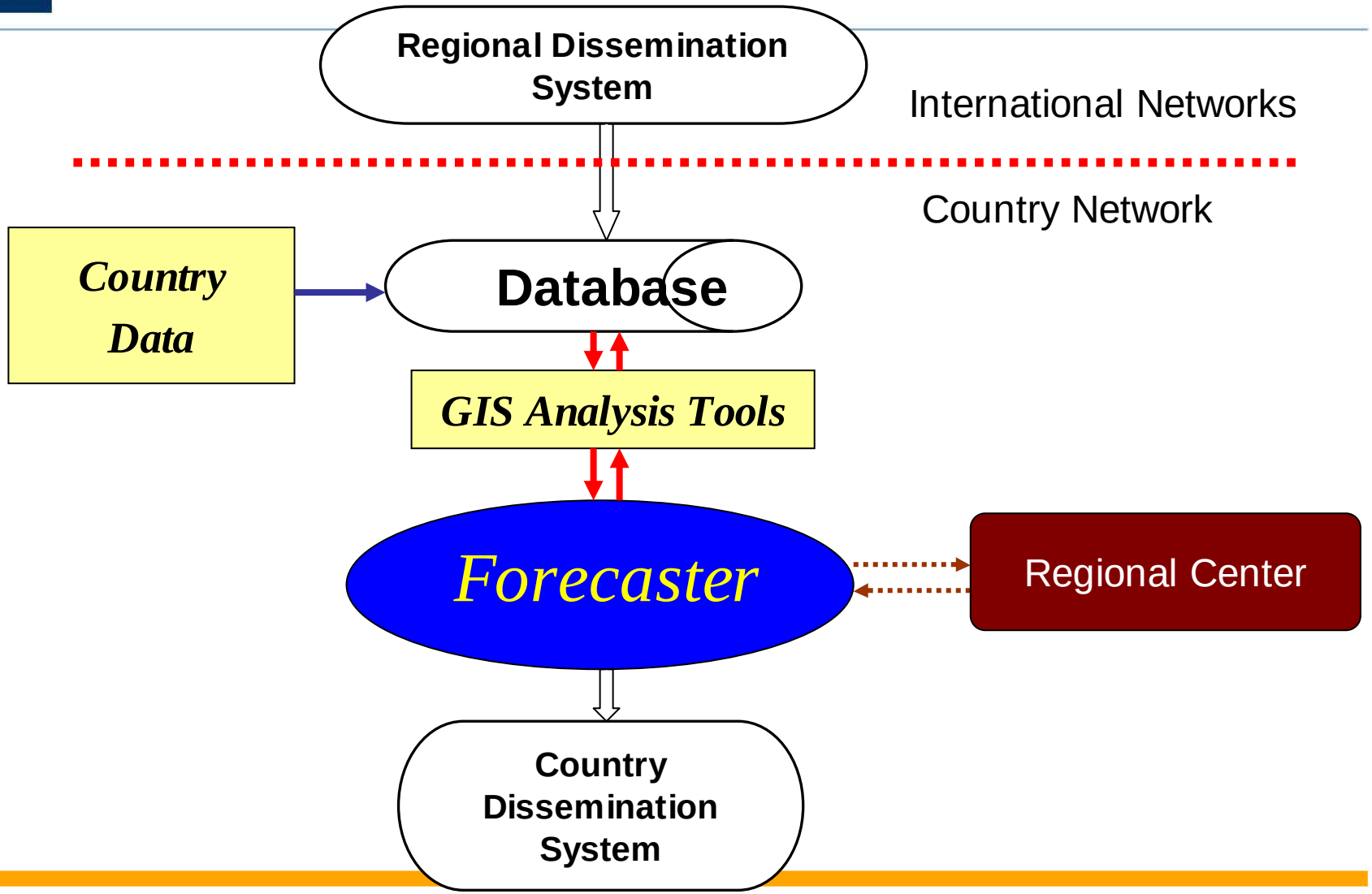
4-hour mean areal precipitation for each basin for the region ending at 10Z on 23 February showing the extent of the precipitation event



PFFT is flash flood threat based on a 6 hour persistence forecast of rainfall, effectively "forecasting" flash flooding at 25 February 06Z for Zambia



Country System for Warnings



Rainfall equipment
with alarm unit

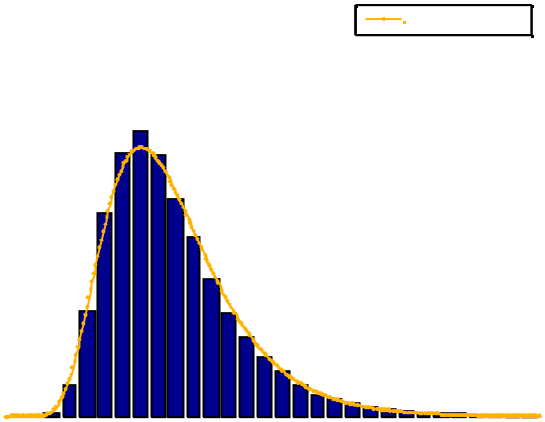
Alarming local community
by radio transmitter

Simple technology is effective enough in many cases.

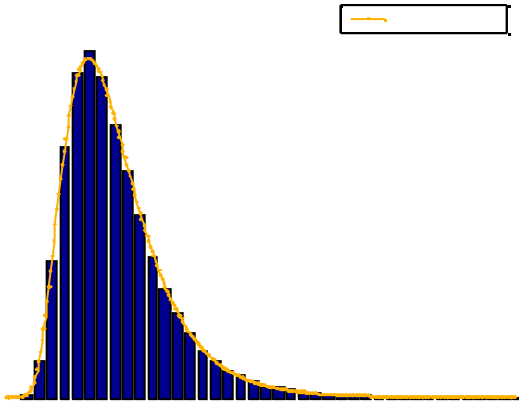
Uncertainty Estimation

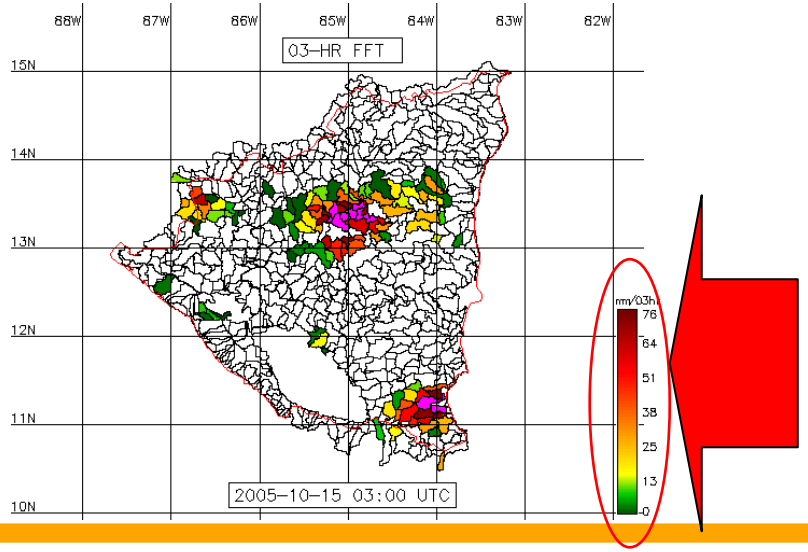
3-hr Flash Flood Guidance Probability Density Function

Dry Soils



Wet Soils





+ User input

Disaster Management Integration

- Role of the local disaster manager is very important
  - Involved at impact point
- Intensive workshops are needed between NMHSs and DMCs to understand what products disaster managers will need, and how it must be packaged and sent to them
- Training workshops with forecasters and DMCs
  - Provide training to understand the products
  - Develop operational procedures to use it by DMCs
  - To finalize dissemination and communication procedures

Thank you for your attention