

WMO Congress Meeting
11 May 2007
Geneva, Switzerland



SYSTEM FLASH FLOOD GUIDANCE
FFGS

A PROSPECTUS FOR IMPLEMENTATION

**Hydrologic Research Center
U.S. National Weather Service
U.S. Agency for International Development**

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

The Need

Flash Floods are very significant disasters globally ...

- Highest number of deaths per people affected

... **BUT** there are no discernible trends for loss reduction

- No flash flood warnings for vast populated areas of the world
- Lack of local expertise and of regional cooperation
- Little in situ data in small regions
- Large-river flood-warning strategies ineffective for flash floods

The Vision

Implement regional flash flood warning systems linked globally

in order to

improve response by governments, international organizations, NGOs, the private sector, and the public to occurrences of flash floods worldwide

Global Perspective

System with regional and country components worldwide

Global Level: Real-time global-data retrieval and operations maintenance
Powerful computing environment
Communications

Regional Level: Meteorological and Hydrological expertise
Communications

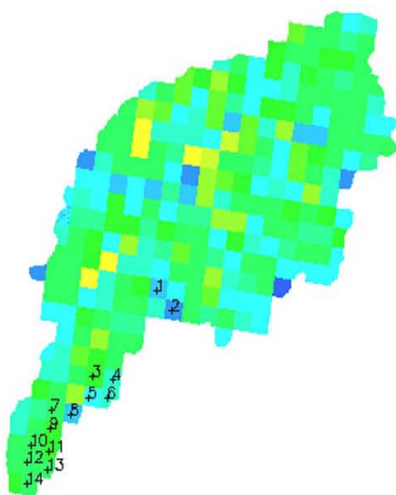
Country Level: Local information and processing
Forecasting and warning
Link to response agencies

Attributes of the Envisioned System

- Feasible/practical
- Demonstrated track record
- Facilitates capacity building
 - Meteorological and Hydrological Services (MHSs) within countries
 - Regional and global cooperation among MHSs
- Sustainable
 - It feeds into existing operational forecast and warning systems
- Effective
 - With due recognition of local uncertainty
- Economical
 - Using remote sensing products and other global data
- Amenable to regional system development

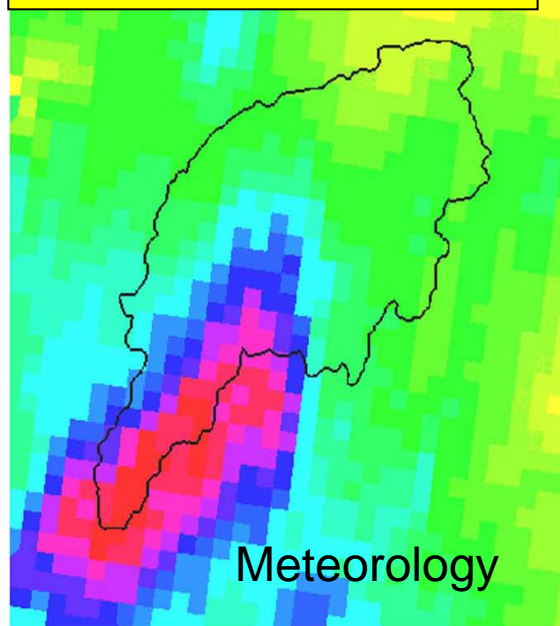
Flash Flood Guidance

Flash Flood Guidance (in/hr)



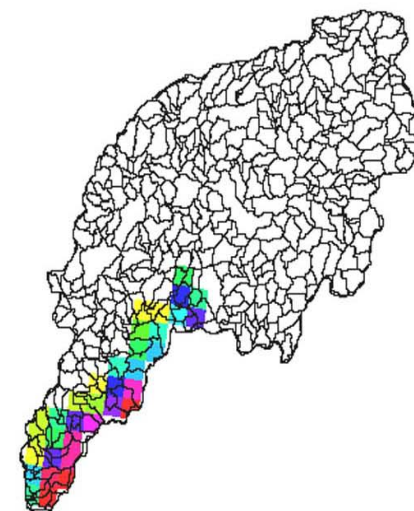
Hydrology

Gridded Rainfall (in/hr)



Meteorology

Excess Flooding (in/hr)



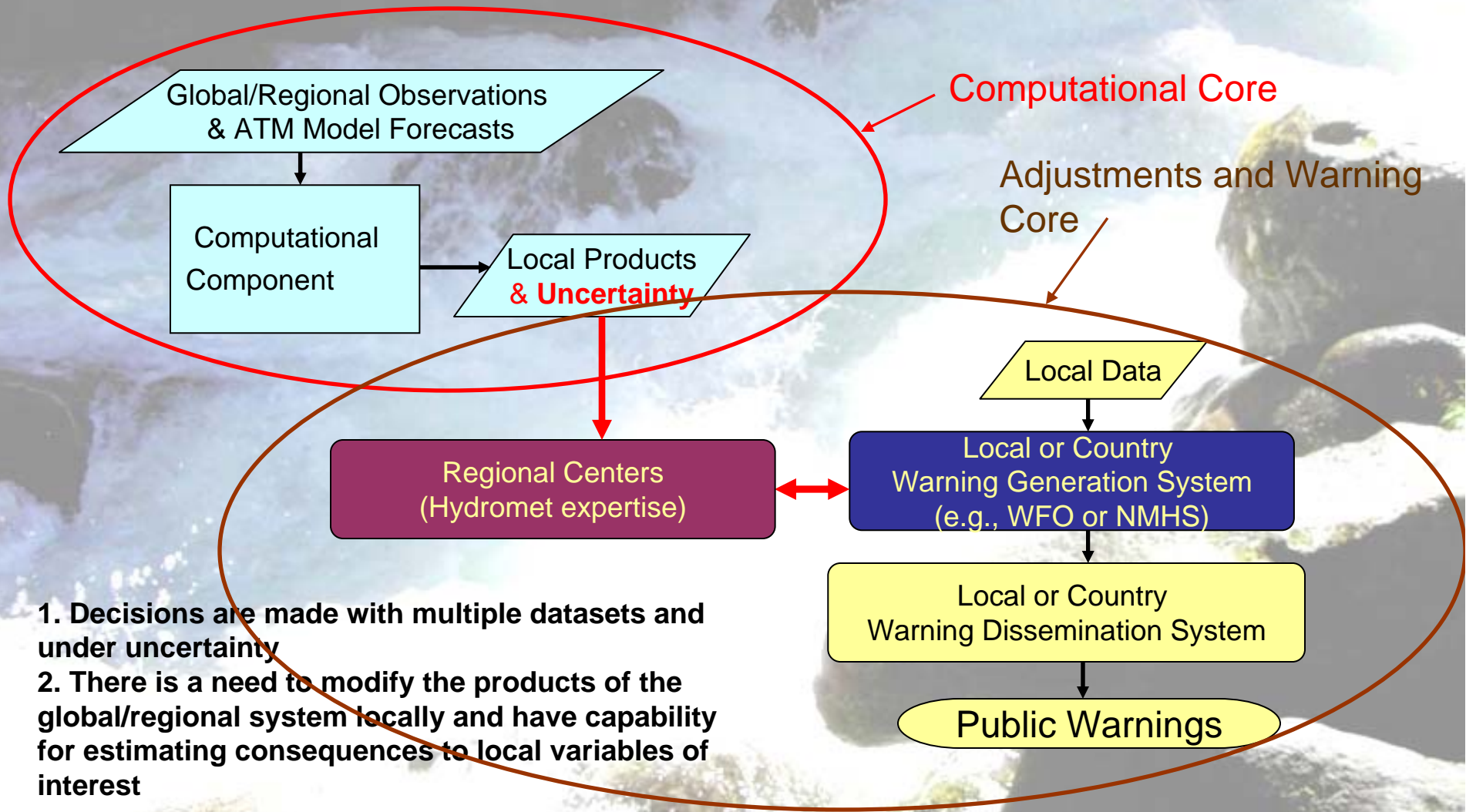
Hydrometeorology

Flash Flood Guidance (FFG): The amount of rainfall of a given duration required to generate bankfull flows at the outlet of a basin.

Attributes of FFG

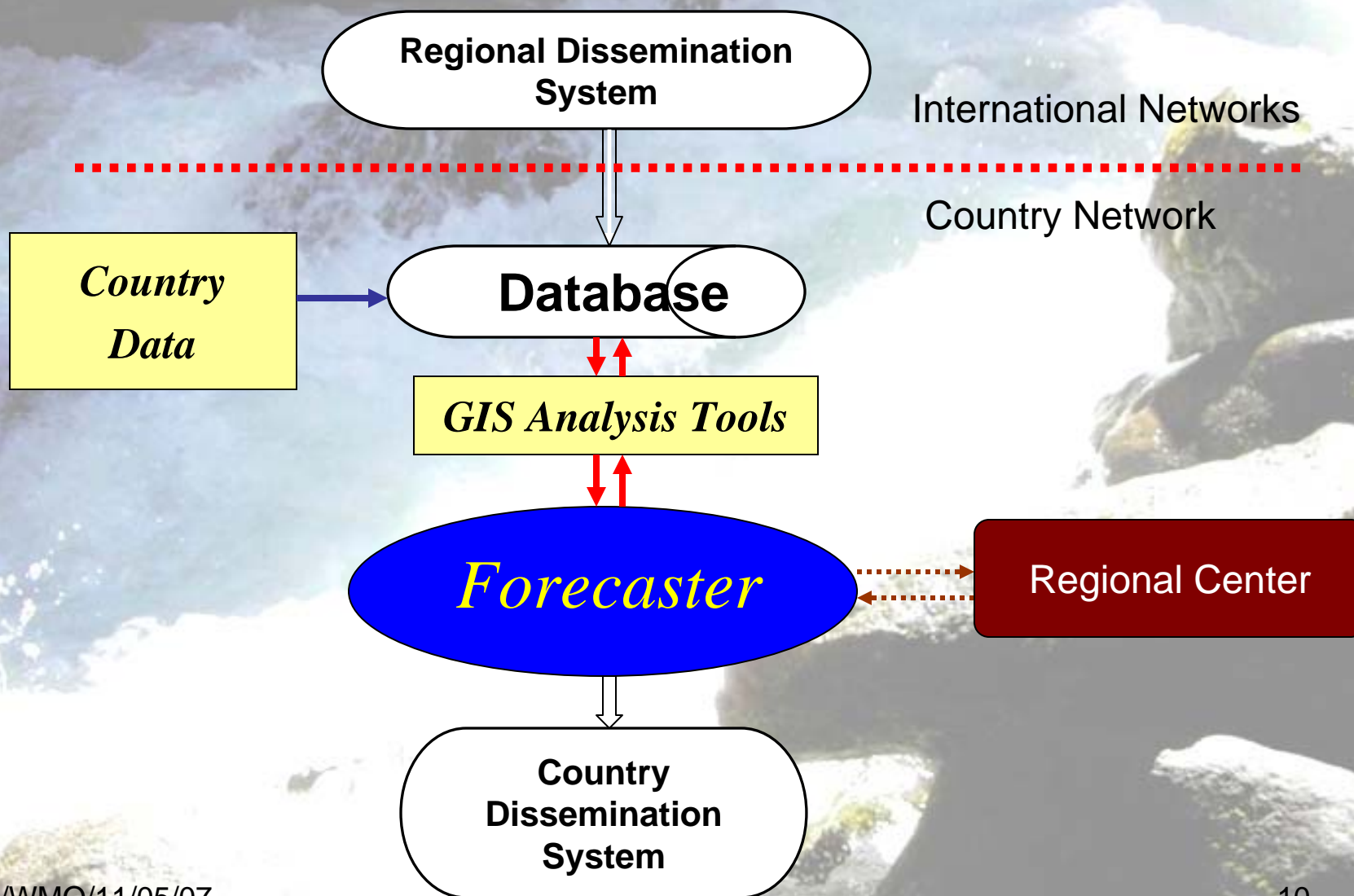
- *Diagnostic tool useful for quick flash flood occurrence potential diagnosis in real time to alert local forecasters of an impending danger*
- *Concerns bankfull flows*
- *Readily ingests local precipitation information*
- *Local forecaster adjustments easy*
- *Promotes Close Collaboration of Hydrologists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

From Global Data to Regional Hydrometeorology to Local Data and Warnings



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

Country System for Warnings



Research and Development History

- **1970-1988:** US NWS Produces **FFG statistically** for each River Forecast Center. Also, **research** in adaptive site specific FF prediction systems.
- **1988-1993:** IIHR/HRC develop **physically consistent FFG formulations based on GIS** and create the first operational codes for US NWS
- **1993-2005:** HRC continues **research** in various aspects of the FFG process and system (sparsely gauged basins and uncertainty issues, forcing and models). The development of **prototype regional systems** using FFG are proposed and accepted in work plan of **WMO CHy Working Group on Applications (2002-2003)**
- **2004:** The **Central America Flash Flood Guidance System becomes operational** (serves 7 countries in CA)
- **2006:** Additional systems are **under development** or **considered for deployment** in Korea, Romania and Southeast Asia

Key In-depth **References** (out of a total of 41 reports and papers):

Carpenter, T.M., et al. (1999) *Journal of Hydrology* **224**, 21-44. – Threshold Runoff

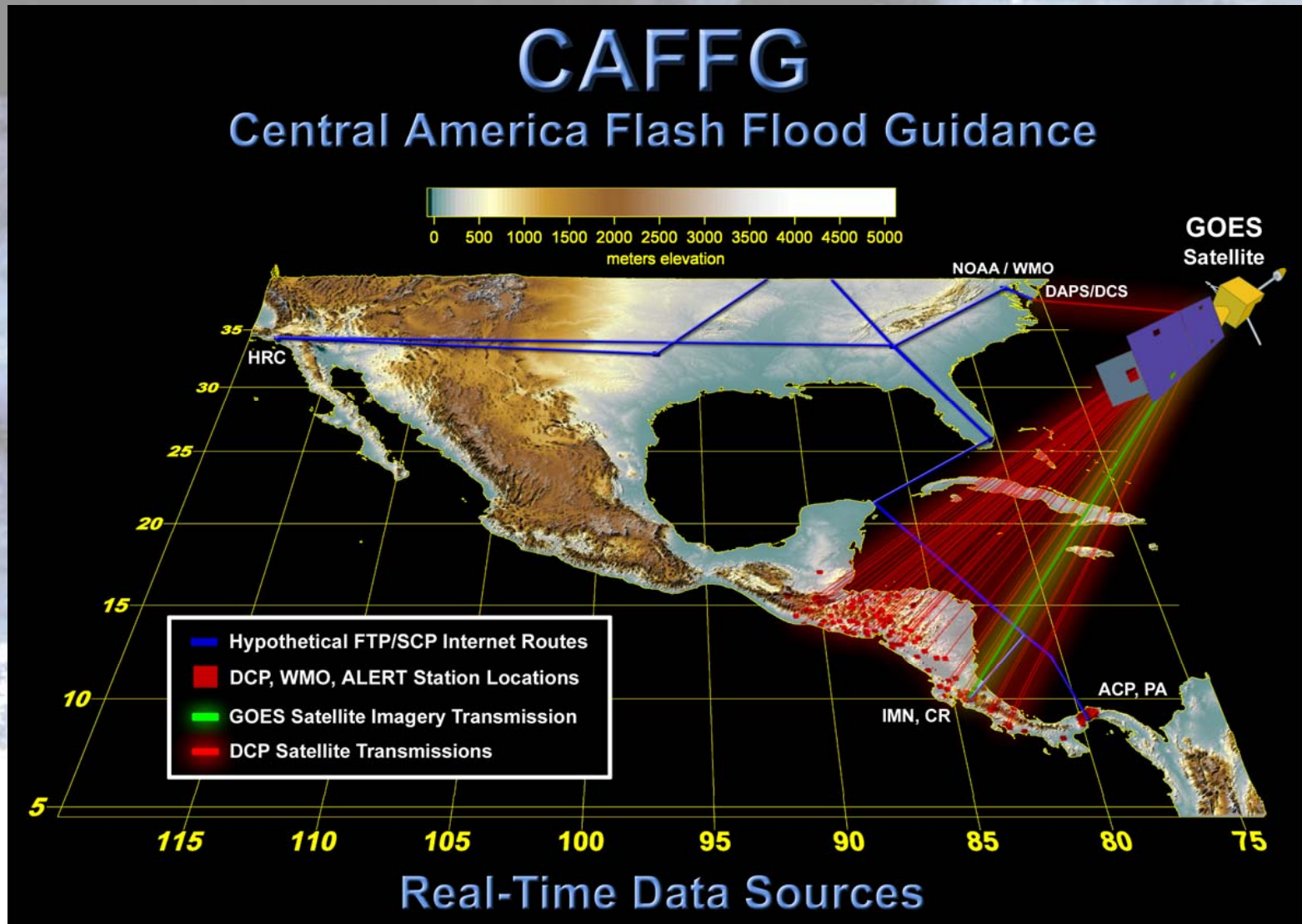
Georgakakos, K.P. (2005) *Journal of Hydrology* **317**, 81-103. – Soil Moisture/FFG

Ntelekos, A.A., et al. (2006), *J. Hydrometeorology*, **7**(5), 896-915. – Uncertainty in FFG

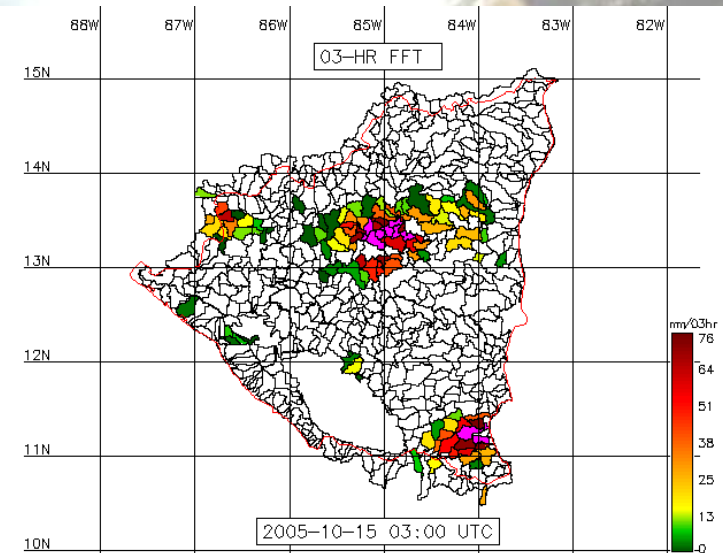
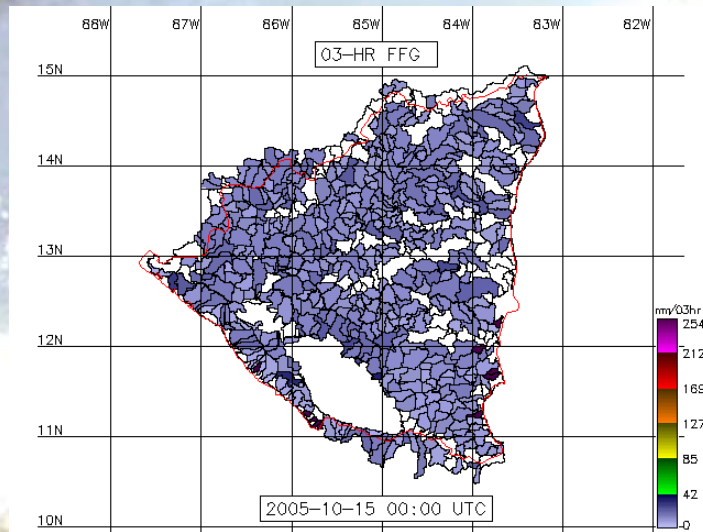
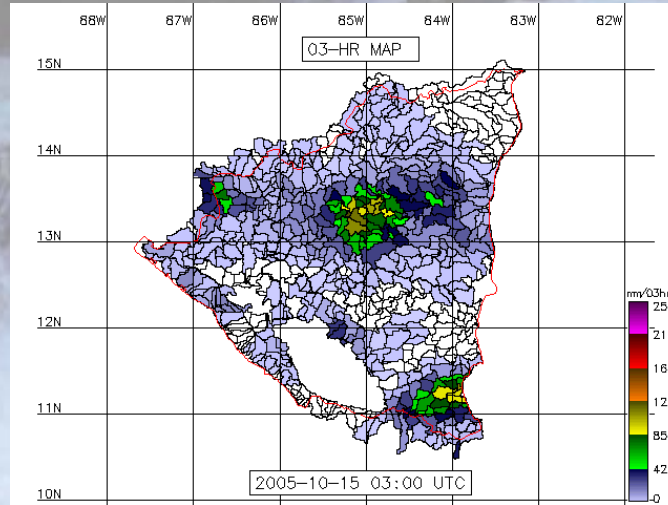
Georgakakos, K.P. (2005/2007) *ACTIF Norway 05 Conf. Proc. & Journal of Hydrometeorology (in review)*

Sperfslage, J.A., et al. (2004) *HRC Limited Distribution Report – Operational System Implementation*

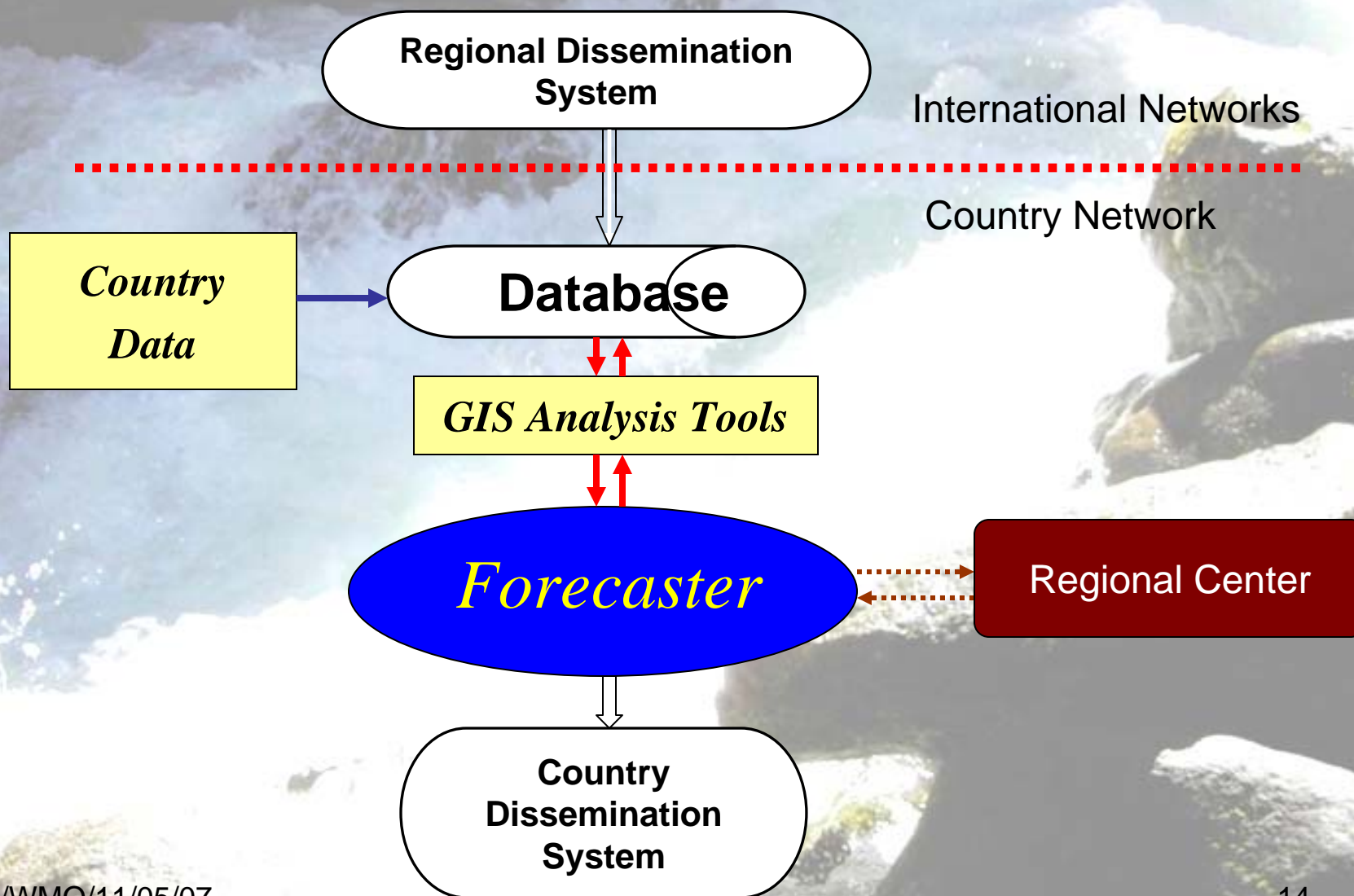
Regional Warning System



CAFFG NMHS PRODUCTS



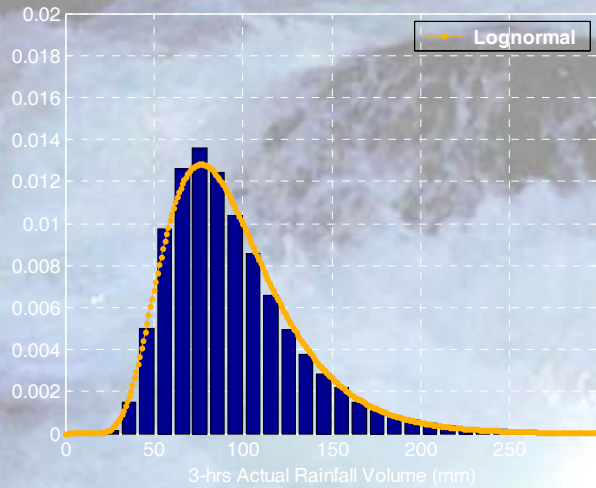
Country System for Warnings



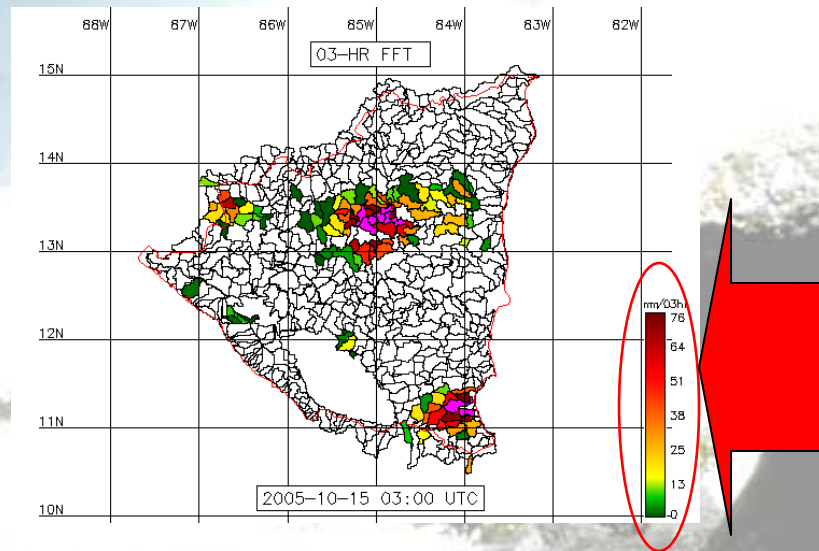
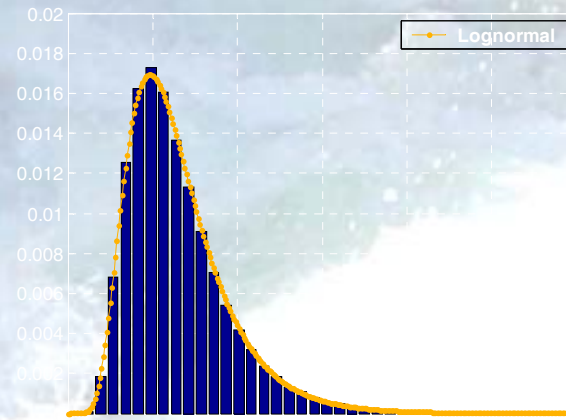
Uncertainty Estimation

3-hr Flash Flood Guidance Probability Density Function

Dry Soils



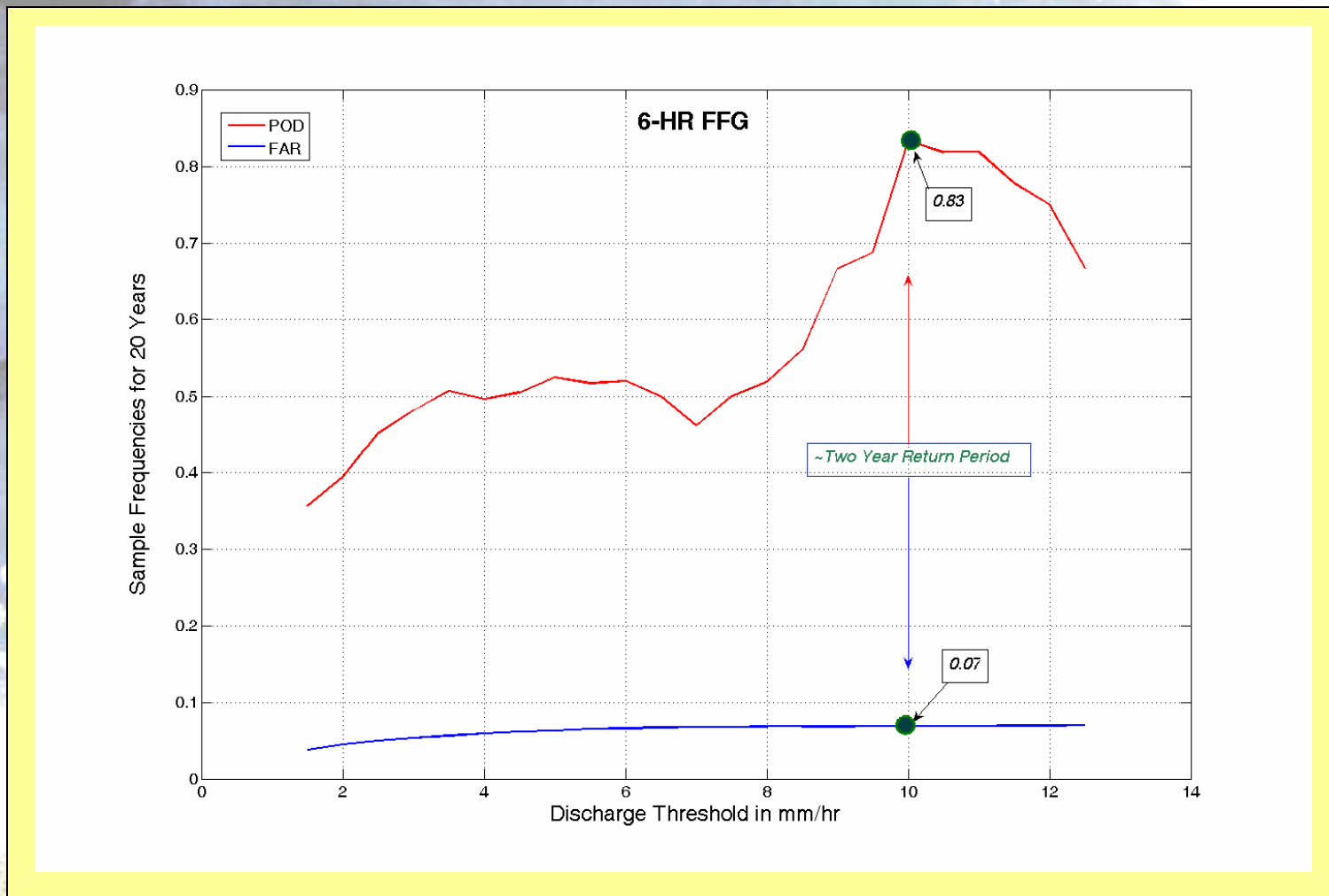
Wet Soils



+ User input

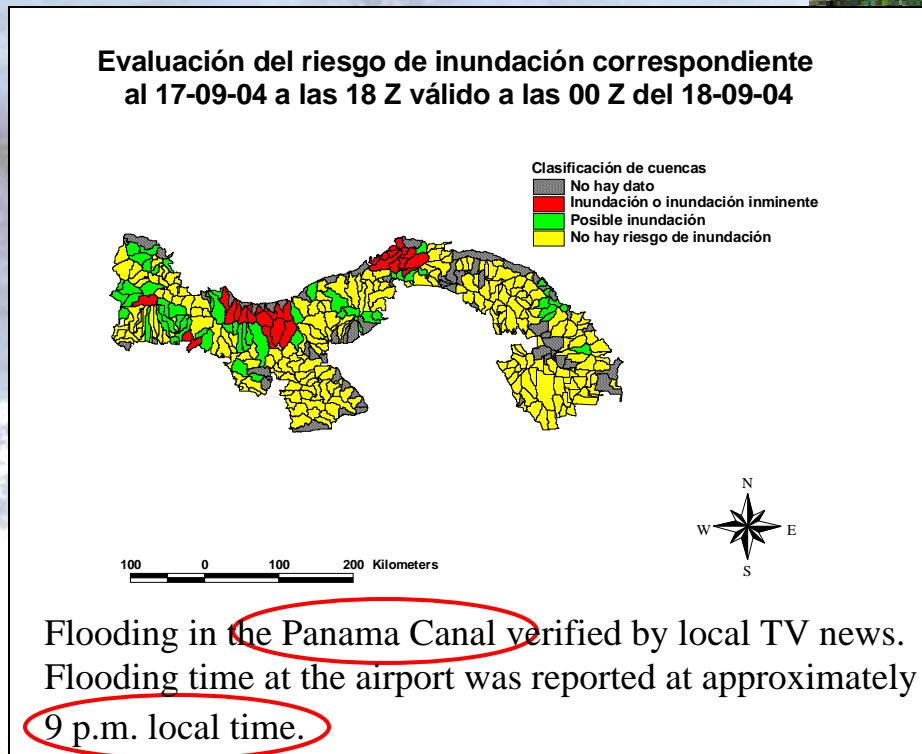
Single Basin Validation: Rio Chagres, Panama

Gauge Interpolated Precipitation – Upper Bound



CAFFG Initial Validation

System operators from Costa Rica and El Salvador were in daily communication with Country Agencies to receive community information regarding local flooding



3-Hourly FF Threat (*adjst*):
Hits: 57% (63 – 100%)
False: 30% (0 - 21%)
Misses: 13% (0 - 16%)

Design Concept for GFFS

Primary Target:

Developing Countries with no resources to develop flash flood warning capability and countries with no flash flood warning/response procedures

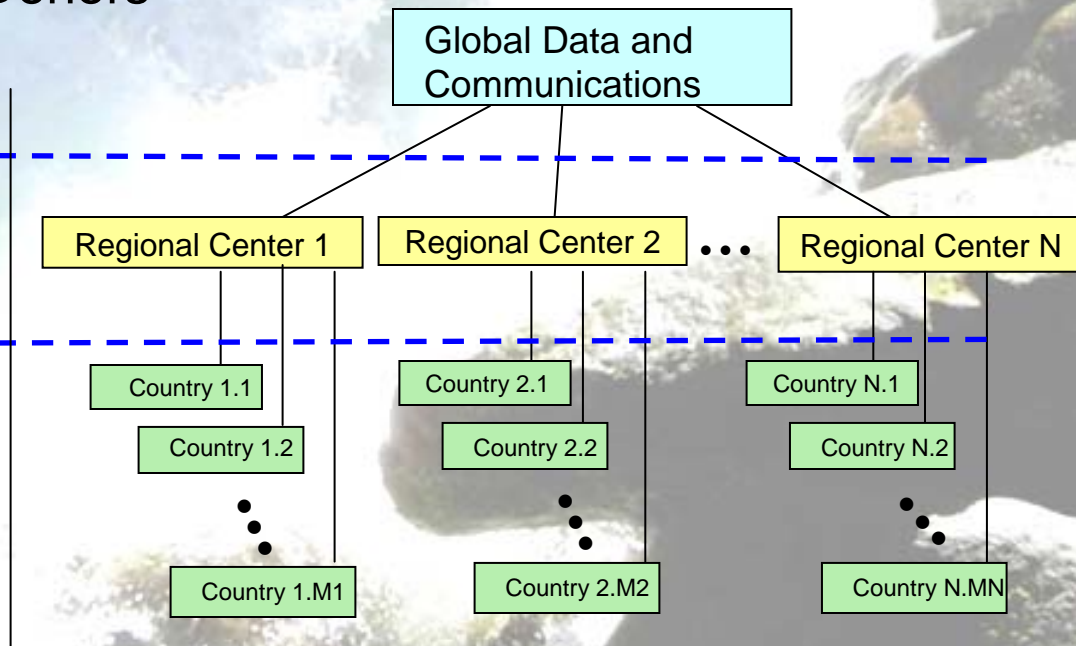
Funding Consortium:

Private and Public Donors

Operational Global Data Ingest and QC

Regional Hydromet Analysis
Alert Communications to Countries
Regional Training
Regional Validation

Country Hydromet Analysis
Country Modifications
Local Warnings/Watches
Country Validation
Feedback to Regional Level



Disaster Risk Reduction Component

Objective:

Ensure effective integration of the flash flood guidance information in disaster risk reduction

Aim:

Effective utilization of flash flood warnings for protection of lives, livelihoods and property.

Means:

Strengthen cooperation among the technical and civil protection agencies
Develop joint training programs
Develop validation programs and information
Assist in developing public outreach and awareness programs (regional to local)

Envisioned WMO Role

- **Communications**

 - Weather Information System**

- **Liaison for Meteorological and Hydrological Services and Civil Protection Authorities**

 - Training/Capacity Building**

 - Regional-country coordination and collaboration**

 - Forging links between Met and Hyd; and Forecast and Emergency Plan/Response**

 - Validation coordination on regional and global scales (plans/meetings)**

In accordance with stated **WMO purposes**:

 - Facilitate development of systems for processing and rapid exchange of data**

 - Facilitate world-wide co-operation for disaster risk reduction**

Jan Engeland, Undersecretary General for Humanitarian Affairs, UN, and Head ISDR System (March 2006): "... but by being better prepared and by devising realistic and practical early warning mechanisms for all communities, we will decrease the risk of hazards turning into disasters."

Prospectus Document

**Provides more information and details on this FFGS Initiative
(WMO DHWR)**

**List of Technical Papers and Reports:
Hydrologic Research Center (<http://www.hrc-lab.org>)**

THANK YOU