



**USAID**  
FROM THE AMERICAN PEOPLE



# The Flash Flood Guidance System

## Design, Functionalities and Products

Konstantine P. Georgakakos, Sc.D.

HYDROLOGIC RESEARCH CENTER

22 May 2018

# IMAGINE A PANAMA FORECASTER ON 1:00PM LST 21 NOVEMBER 2015 (Saturday)

Panama Time = UTC – 5 hours

*It has been raining in Western Panama ....*

**What is the rainfall forecast?**

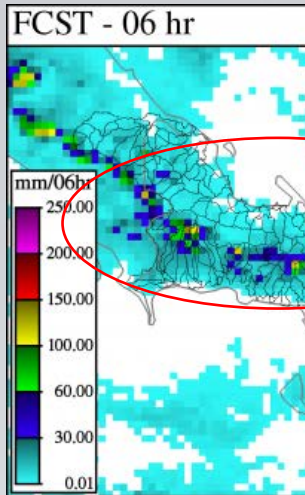
**FFG System WRF shows:**

**What is the current saturation of the land?**

**FFG System Upper Soil Saturation Fraction:**

**Which small basins are at risk?**

**FFG System Flash Flood Threat shows:**



Home » News » Panama » 12 homes affected in Boquete floods

## 12 homes affected in Boquete floods

Posted on November 22, 2015 in Panama

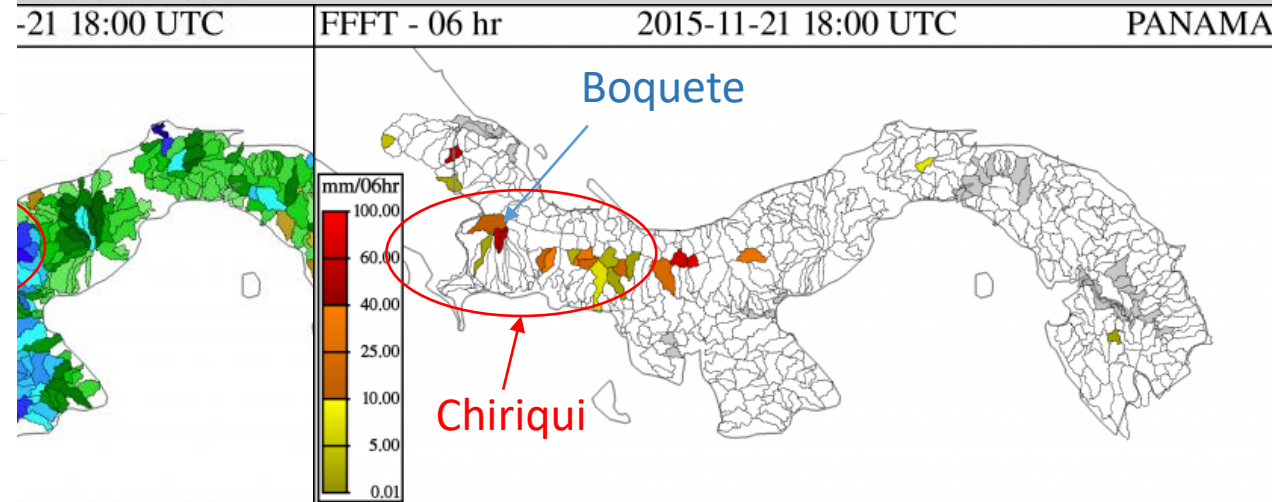
**HEAVY DOWNPOURS** throughout the weekend led to flooding and land slides in Chiriqui and Bocas Del Toro with at least 12 homes affected in the district of Boquete.



Share:    

Post Views: 562

The Joint Task Force (FTC), led by the National Civil Protection System (Sinaproc), said the torrential rain has wreaked havoc in several localities in western Panama, near the border with Costa Rica.



# CAFFG - Central America Flash Flood Guidance System

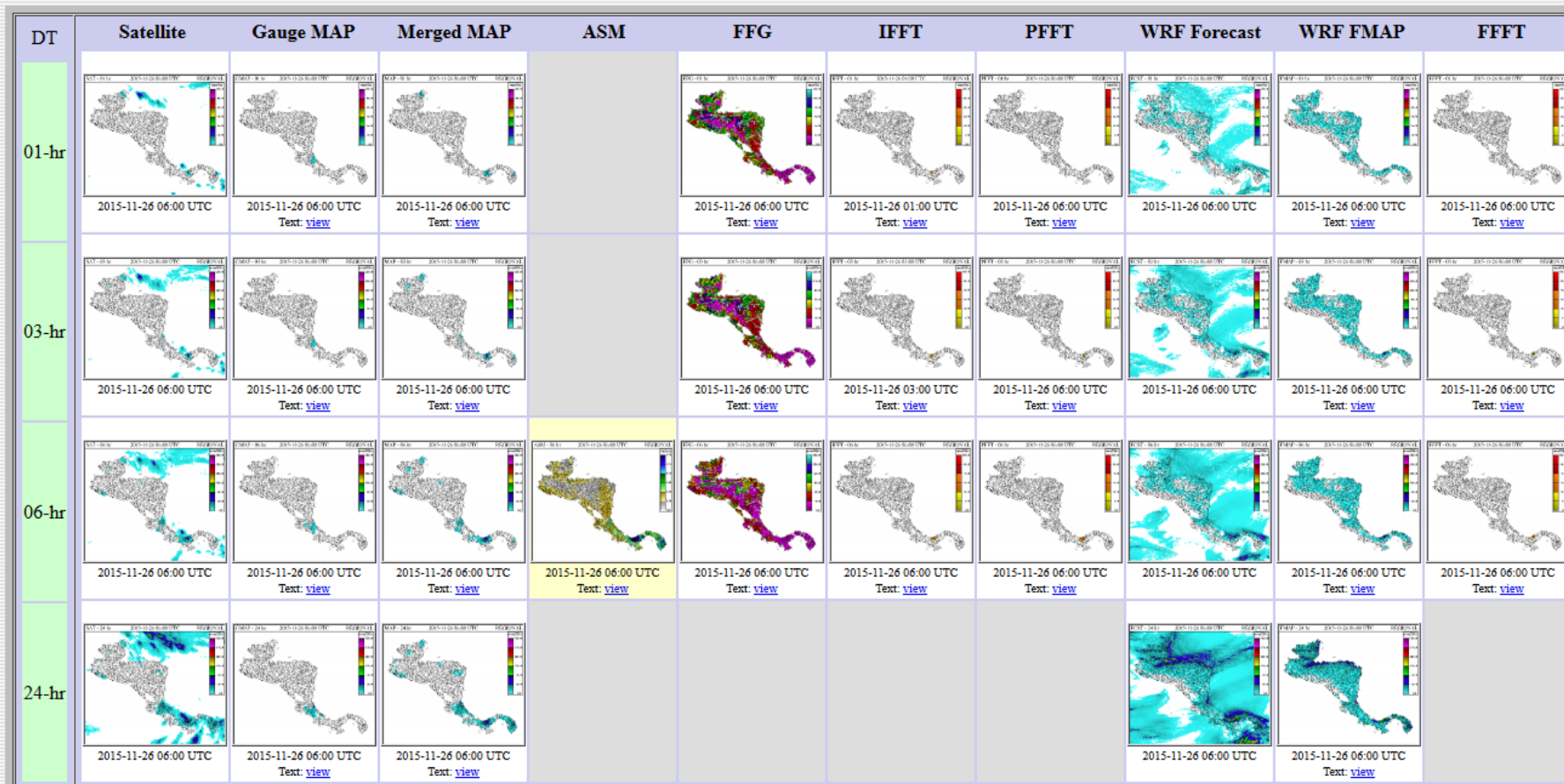
Current Date: 2016-02-01 06:12 UTC

Nav Date: 2015-11-26 06:00 UTC

Year: 2015 Month: 11 Day: 26 Hour: 06 REGION: REGIONAL OPTION: MEDIAN Submit

-1 Month -1 Day -6 Hours -1 Hour +1 Hour +6 Hours +1 Day +1 Month

Prev 6-hr Interval (00 UTC) Reset to Current Next 6-hr Interval (12 UTC)



Composite Product... [text](#), [DBF](#)

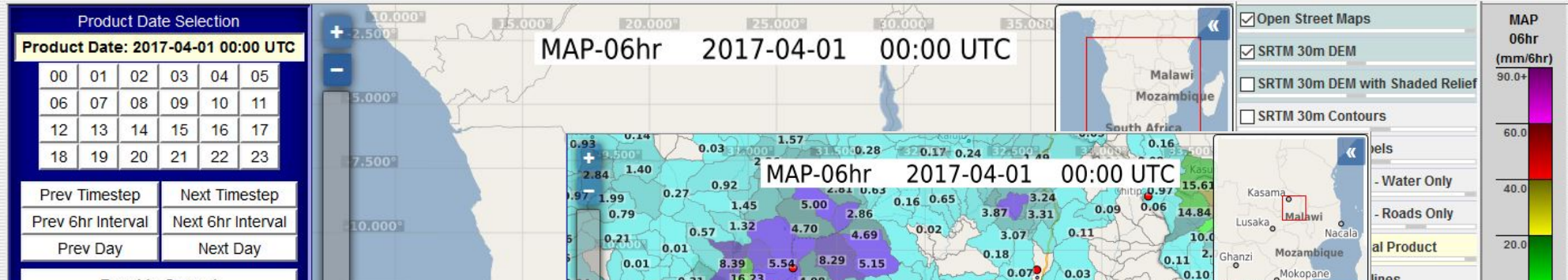
SFTP data transfer (requires SFTP Client): [EXPORTS/REGIONAL/2015/11/26](#)

## Surfmet Gauge Observations at 2015-11-26 06:00 UTC

Station Identifier	Station Name	01-hr Accumulated Precipitation (mm)	01-hr Average Temperature (C)	Region	Latitude	Longitude	Enable Precipitation Flag	Enable Temperature Flag
<a href="#">0500072A</a>	EL BOQUETE	No Report	No Report	NICARAGUA	11.982222222	-86.394722222	Disabled	Disabled
<a href="#">0500145C</a>	EL ROSARIO	0.00	No Report	NICARAGUA	11.846111111	-86.166666667	Enabled	Disabled
<a href="#">050071BA</a>	ALTAMIRA (ARROCERA)	No Report	No Report	NICARAGUA	12.133055556	-85.713611111	Enabled	Disabled
<a href="#">0500C234</a>	MATAGALPA	No Report	No Report	NICARAGUA	12.947777778	-85.871111111	Disabled	Disabled
<a href="#">0500E4D8</a>	SIUNA	0.00	No Report	NICARAGUA	13.716111111	-84.775	Enabled	Disabled
<a href="#">050146DA</a>	SAN DIONISIO	No Report	No Report	NICARAGUA	12.756388889	-85.845833333	Enabled	Disabled

# SARFFG - Southern Africa Region Flash Flood Guidance System

2017-08-31 17:22:47 UTC



## SARFFG - Southern Africa Region Flash Flood Guidance System

2017-08-31 19:52:00 UTC

FFG-Gram plot demo - 1-hr, 3-hr, and 6-hr durations - Basin: 2002702501

Start: 2017-03-20 18:00 UTC End: 2017-04-04 18:00 UTC

Product Date: 2017-04-04 18:00 UTC

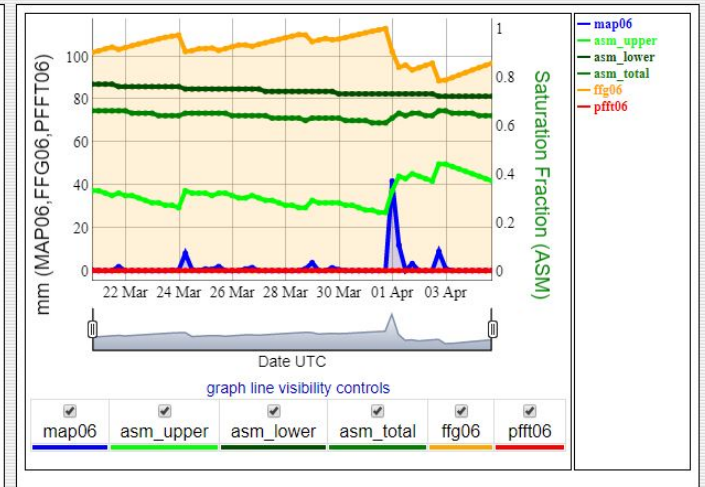
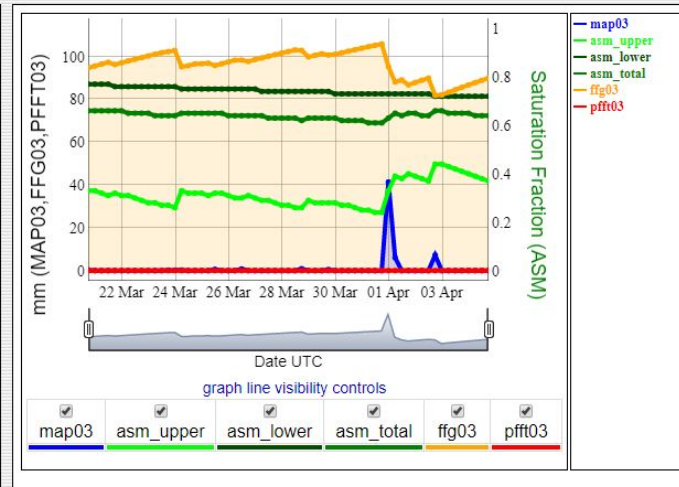
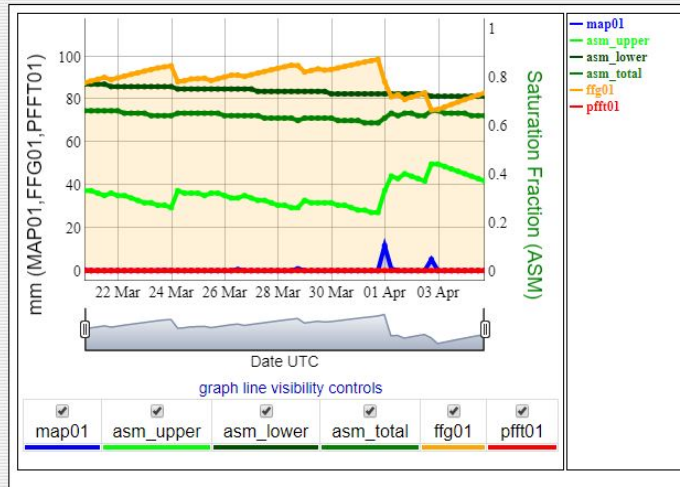
00 06 12 18

Prev 6hr Interval Next 6hr Interval

Prev Day Next Day

Reset to Current

Scope: 15 days

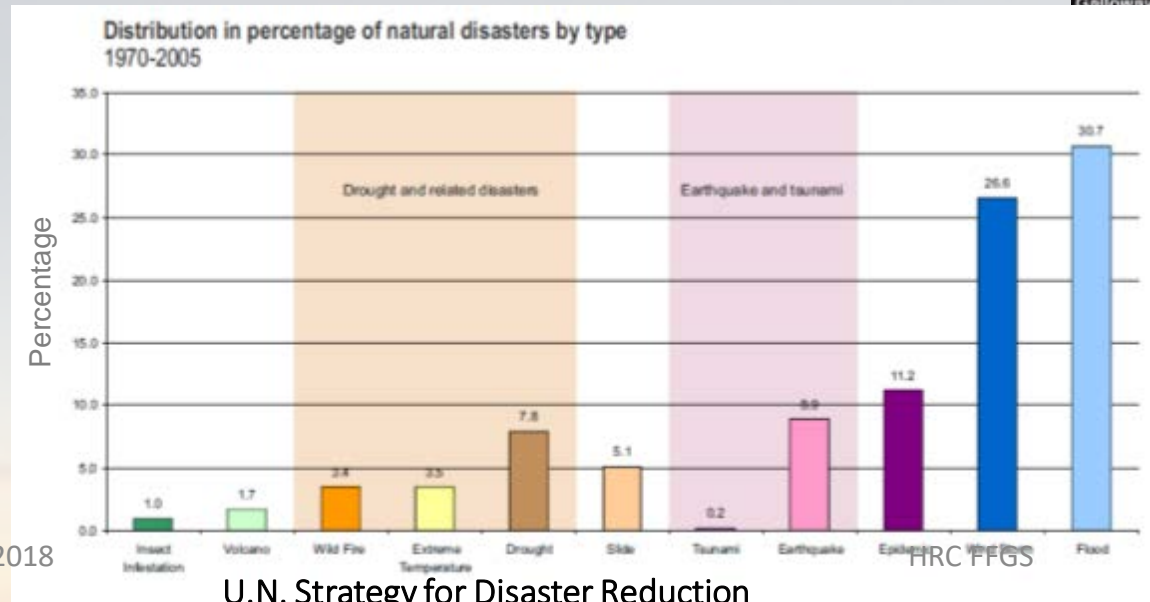


[Product Viewer](#) | [Product Comparison](#) | [Server Monitor Plots](#)

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# Purpose: Support Flash Flood Warning

- WMO (2008) country-level survey of 139 countries around the world, 105 indicated that flash flooding was among top *two* most important hazards that require attention.
- 5,000 flash flood fatalities per year globally
- 85% of flood-related deaths due to flash flooding and with highest mortality rate (deaths/people affected)



***No discernable trend  
for loss reduction!***

# The Need

- 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

Lytle Creek, CA  
October, 20, 2004  
[www.life.com](http://www.life.com)



# The Global Initiative for Flash Floods

The **Hydrologic Research Center (HRC)** has signed a joint Memorandum of Understanding to implement regional flash flood guidance systems worldwide with:

*the United Nations – World Meteorological Organization (WMO)*

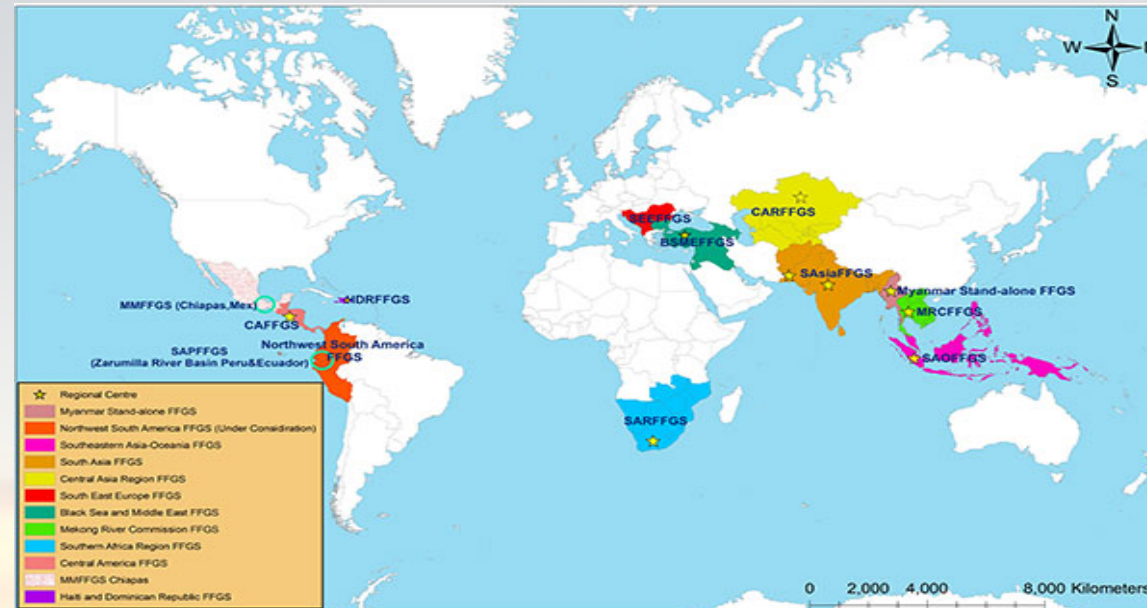
*the U.S. Agency for International Development/Office of U.S. Foreign Disaster Assistance (USAID/OFDA)*

*and the U.S. National Oceanic and Atmospheric Administration (NOAA).*

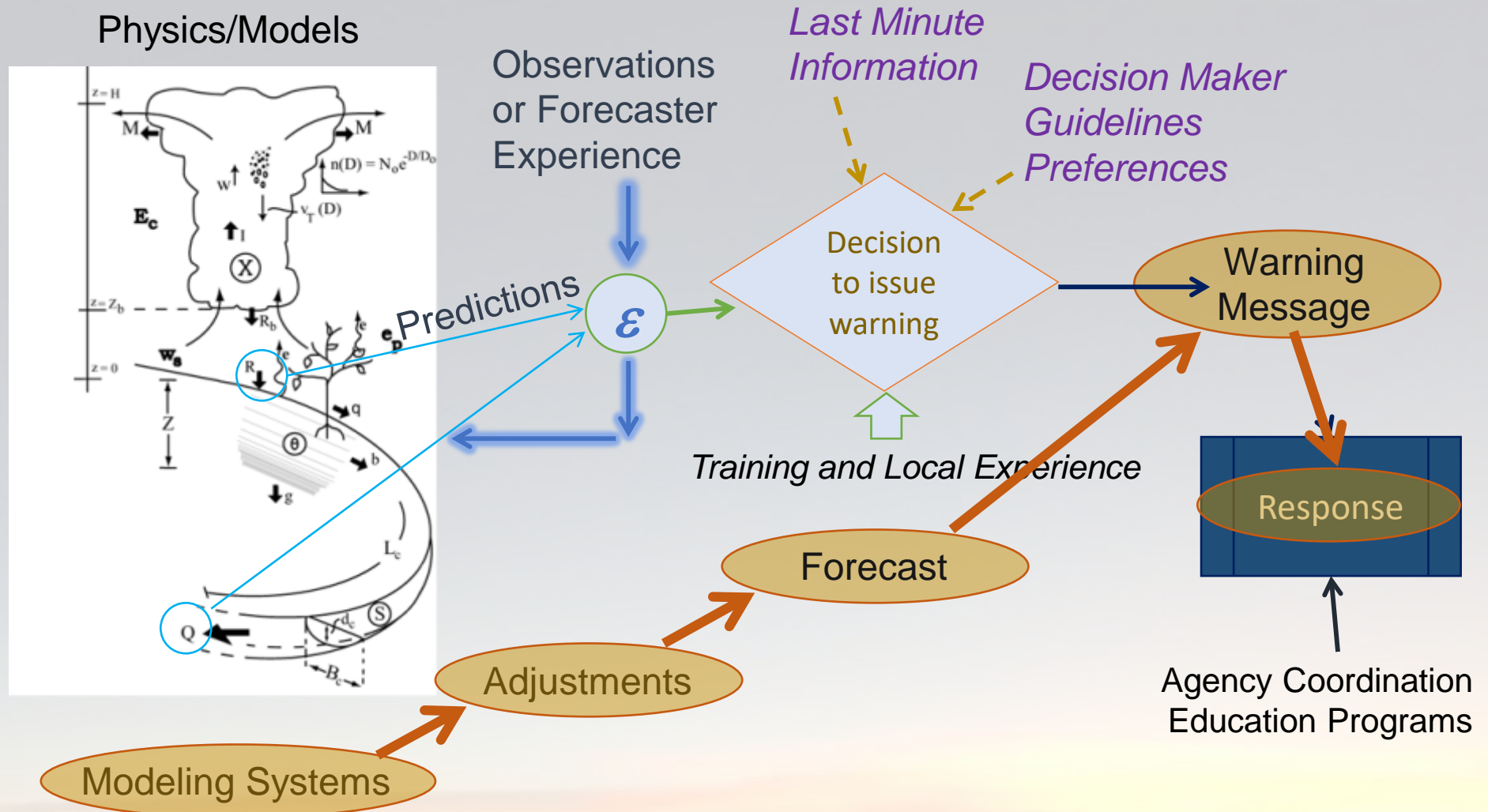
## GOAL:

To support National Meteorological and Hydrological Services worldwide to:

1. provide reliable and effective flash-flood warnings and
2. improve disaster management efficiency



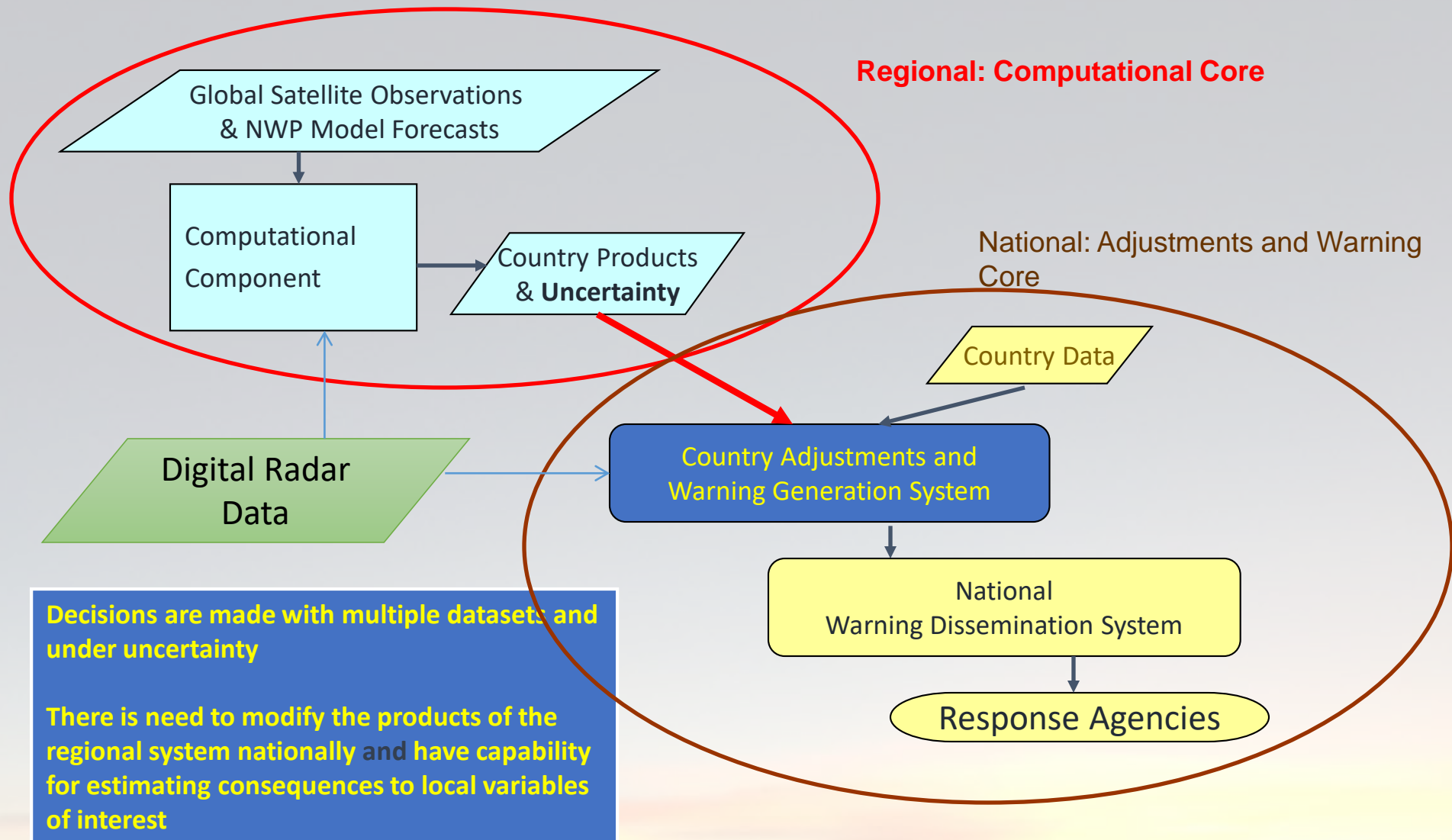
# Integration of Data, Models and Human Experience Toward Saving Lives





# REGIONAL FFGS COMPONENTS

From Global Data and Regional Hydrometeorology to Country Data and Warnings

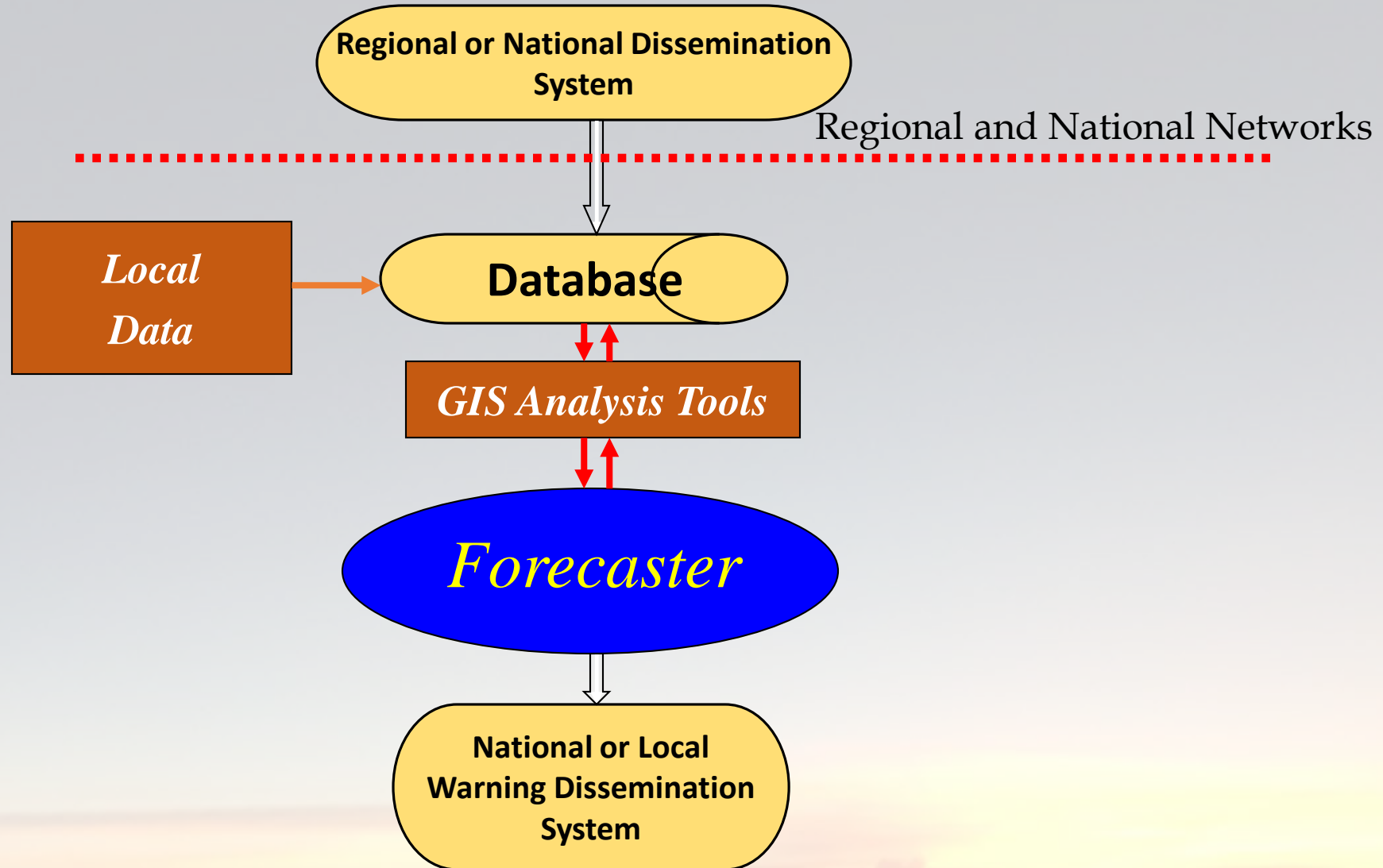


**Regional: Computational Core**

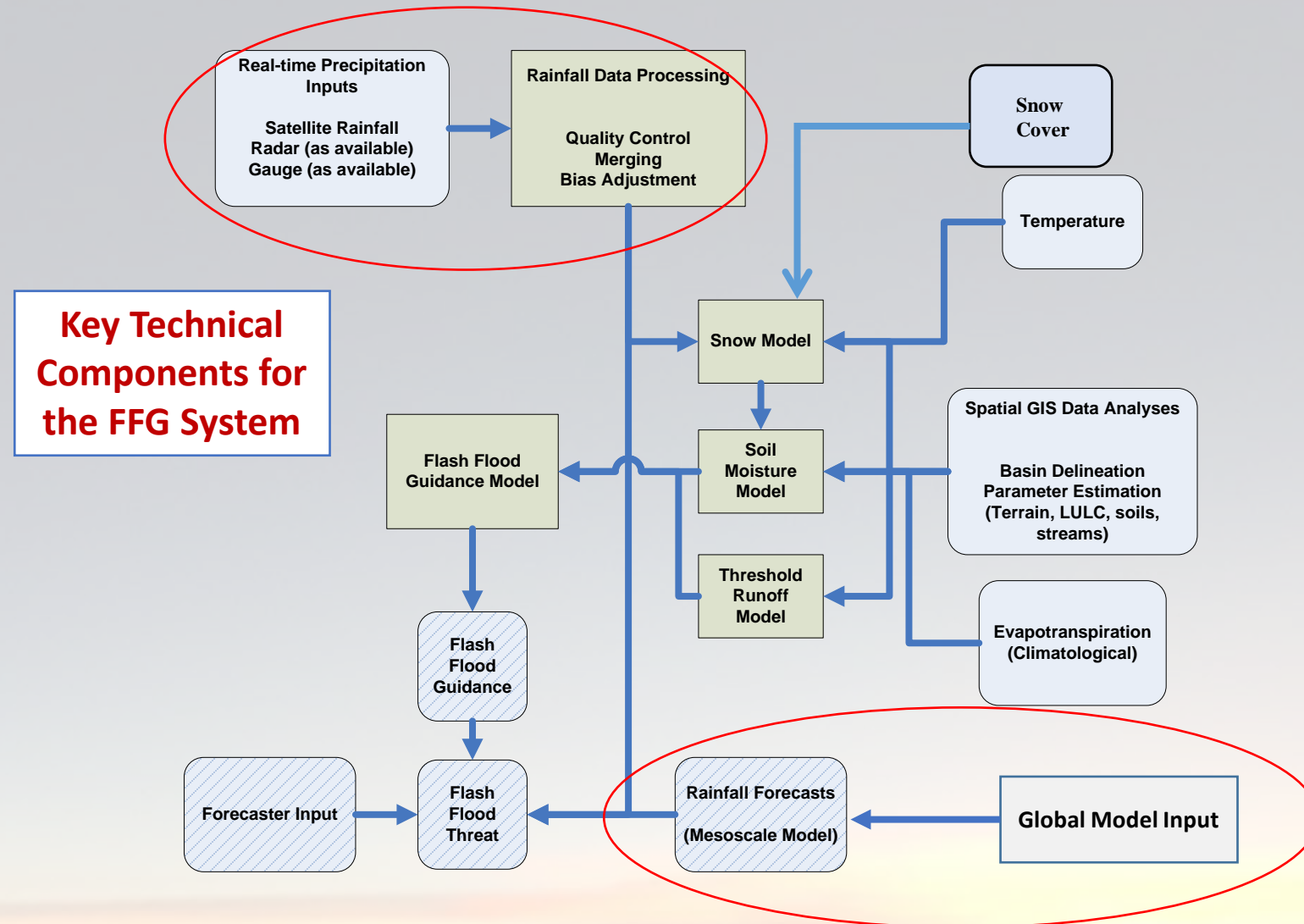
**National: Adjustments and Warning Core**

*Serve more than 60 countries*

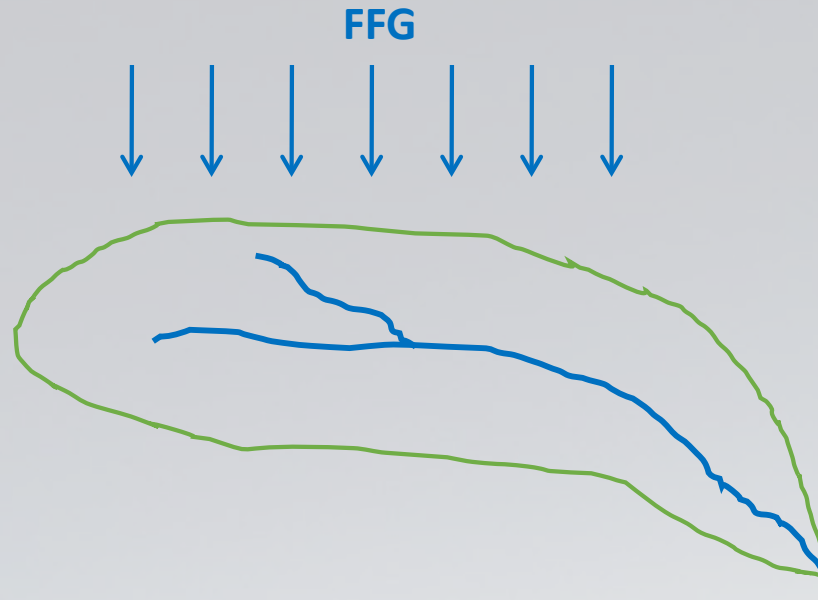
# National System for Warnings



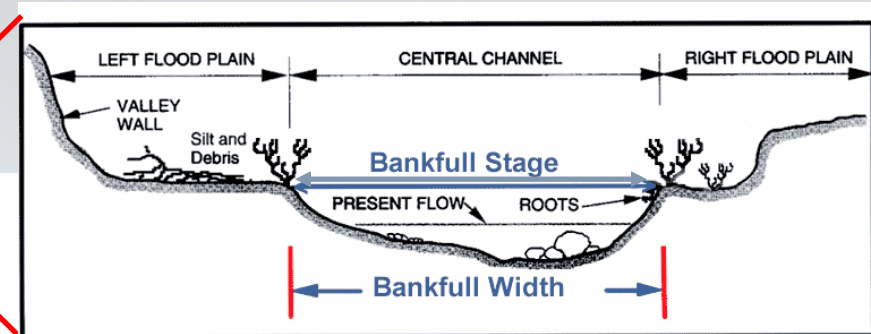
# SOURCES OF INFORMATION FOR THE FFGS



# Concept of Flash Flood Guidance

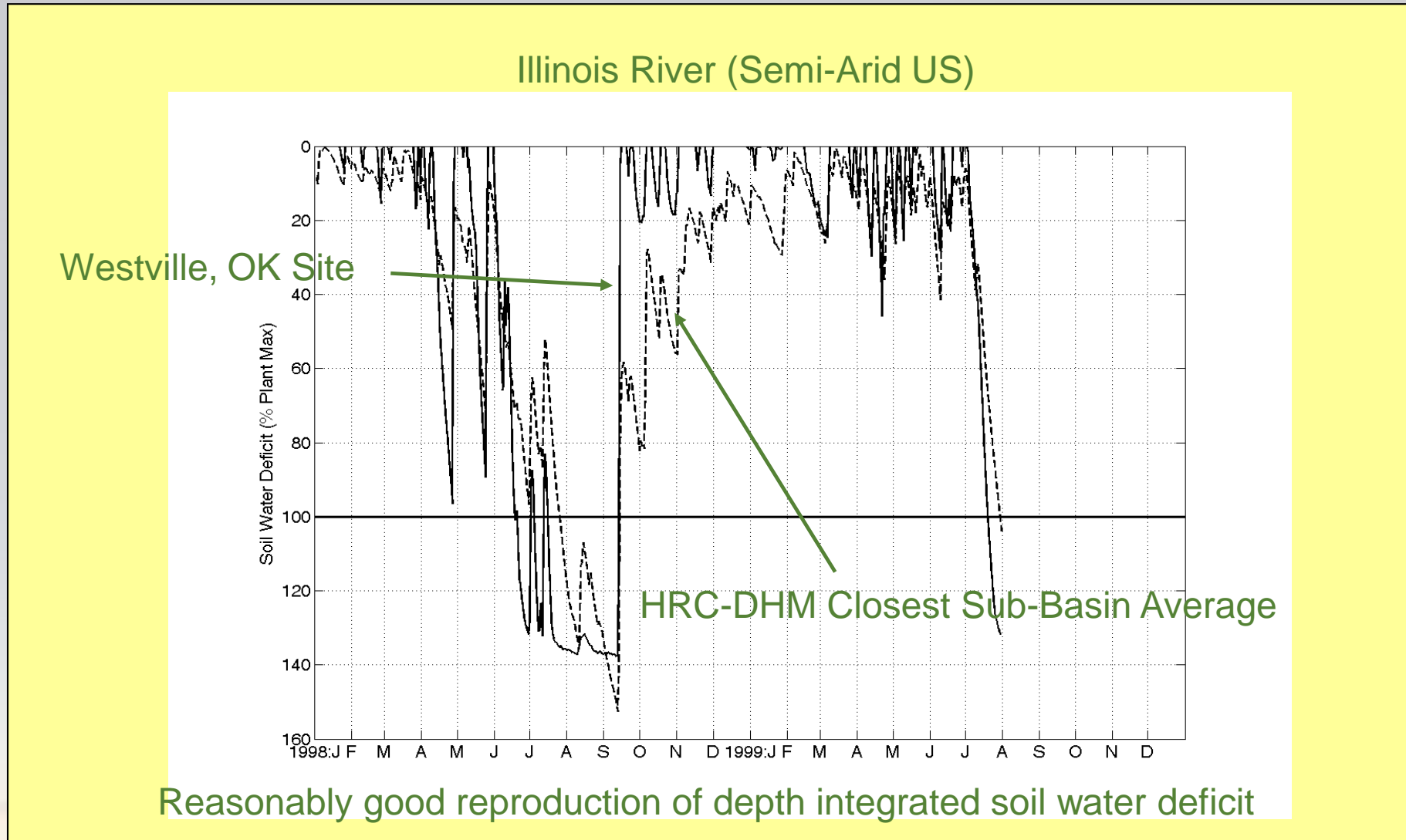


Of primary concern is the prediction of **occurrence** of flash flooding, particularly for data-sparse regions.



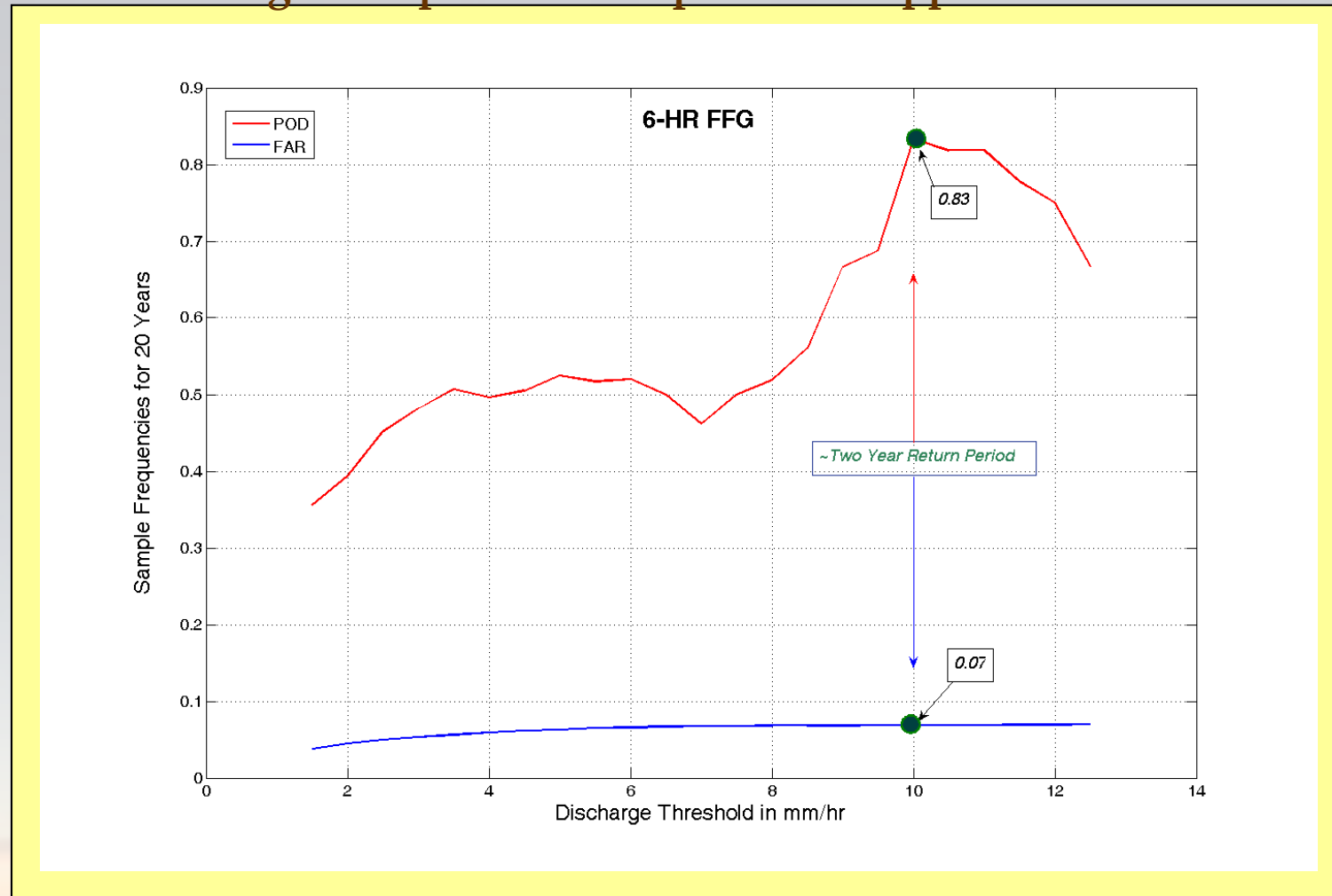
FFG: Amount of **rainfall** of a given duration and over a given catchment that is just enough to cause **bankfull conditions** at the outlet of the draining stream

# On Site Soil Water Deficit Validation



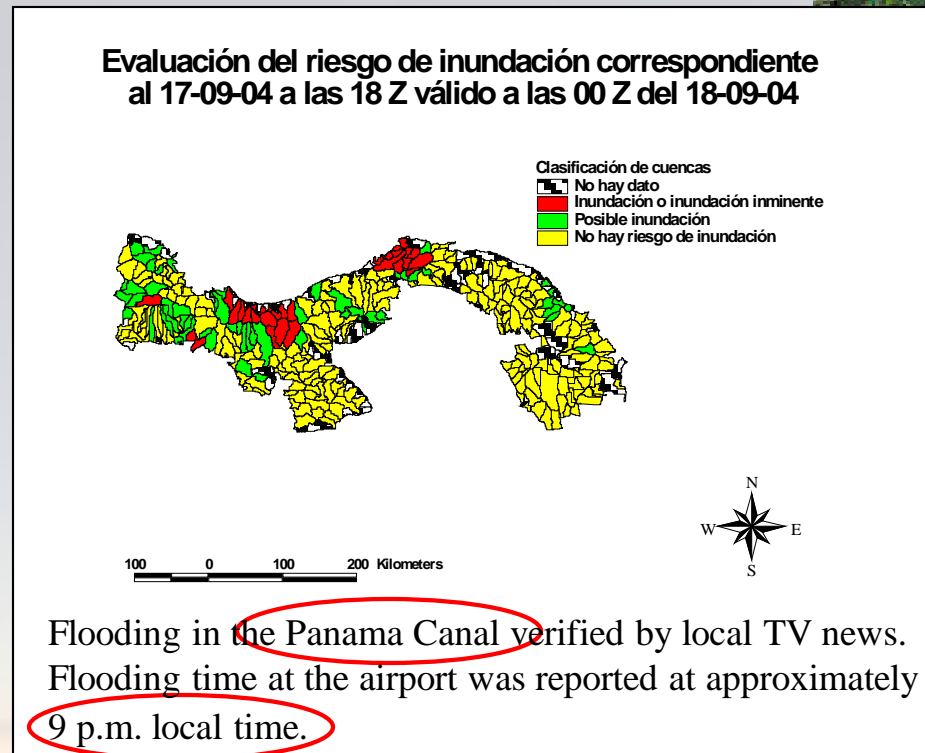
# Single Basin Validation: Rio Chagres, Panama

## Gauge Interpolated Precipitation - Upper Bound



# CAFFG 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%)

# Operational Utility of Systems with Forecaster Adjustments

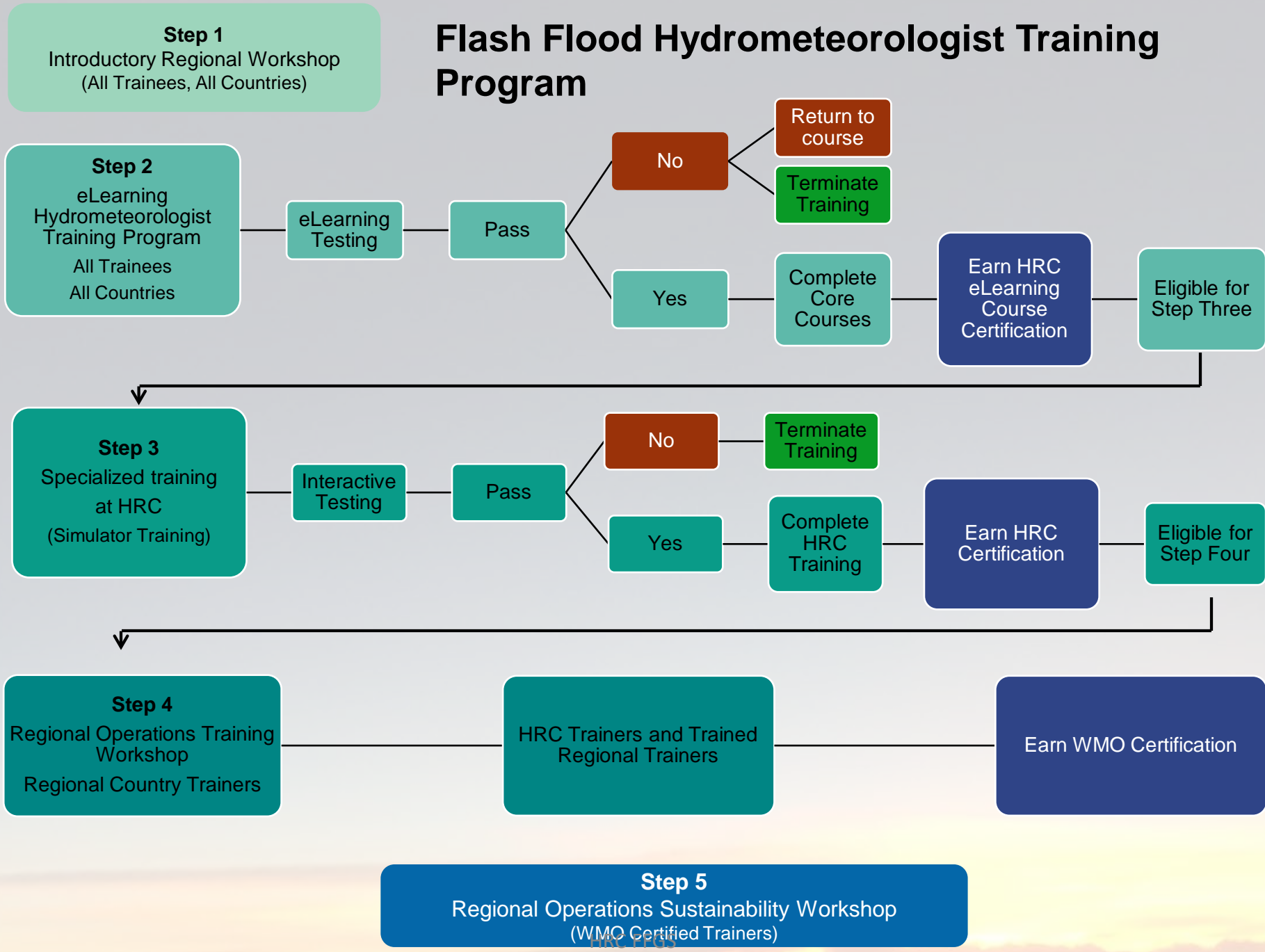
- Trained forecaster adjustments have a beneficial effect on warning reliability especially for local bias situations  
(Use of up to the minute information from the field very useful; Real-time cooperation of meteorologists and hydrologists very useful for effective adjustments)
- In-depth training of forecasters in system model behavior is required for sustainability  
(In most cases several-month efforts are required)
- A priori and real-time coordination of forecasters with response agencies necessary for high utility
- Local experience of forecasters invaluable for warnings against short-fuse hydrometeorological phenomena – Validation/Databases  
(Mesoscale model biases; hydrologic model biases; local soil behavior and flooding conditions)



# Implementation Steps

- Establishment of National Representatives and their Technical Appointees
- Data Collection (Historical and Real Time)
- Begin training program (on line courses)
- Development of high resolution delineations and review/corrections
- Development of input data quality control and tests with historical data
- Tailoring the regional (or national) and national (or local) system components to the country of interest (based on established operational protocols)
- System operational at HRC with secure net transmission of data and products to the countries involved
- Hands-on training at HRC (4 – 6 weeks) (simulator and real-time case studies)
- Initial validation and pre-installation adjustments
- On site implementation and IT plus operations training (WMO certification)
- Annual maintenance support and sustainability training

# Flash Flood Hydrometeorologist Training Program



# ON LINE COURSES

## HYDROLOGIC RESEARCH CENTER

A NON-PROFIT RESEARCH AND TECHNOLOGY TRANSFER CORPORATION, ESTABLISHED IN 1993

USERNAME

PASSWORD

Login

[Forgotten your username  
or password?](#)

REGISTER  
NEW USER

VISIT THE  
HRC WEBSITE

Eight courses  
Elements of Meteorology,  
Elements of Hydrology,  
Hydrometrological Statistics,  
Fluvial geomorphology,  
GIS basics,  
Flash Flood Guidance Model Products,  
Remote sensing and  
Early warning systems.

## VIEW COURSES

Filter Courses

### MEKONG RIVER COMMISSION MODULE

[Forum](#) [+ Add](#) [Edit](#) [Delete](#)

Courses	Course Material	Examination	Actions
Mekong River Commission Flash Flood Guidance Products Module	<a href="#">Add   View</a>	<a href="#">Add</a>	<a href="#">Edit</a> <a href="#">View</a> <a href="#">Delete</a>

### ELEMENTS OF METEOROLOGY

[Forum](#) [+ Add](#) [Edit](#) [Delete](#)

Courses	Course Material	Examination	Actions
Overview	<a href="#">Add   View</a>	<a href="#">Add</a>	<a href="#">Edit</a> <a href="#">View</a> <a href="#">Delete</a>

### FLASH FLOOD GUIDANCE PRODUCTS

[Forum](#) [+ Add](#) [Edit](#) [Delete](#)

Courses	Course Material	Examination	Actions
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### FORUM TEST

[Forum](#) [+ Add](#) [Edit](#) [Delete](#)

Courses	Course Material	Examination	Actions
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### ELEMENTS OF HYDROLOGY

[Forum](#) [+ Add](#) [Edit](#) [Delete](#)

# Training Simulator

Product navigation date is now set to the event Begin Date.

## GFFGS-SIM - Global Flash Flood Guidance System Simulator

[Return to Product Console](#)

Select Simulation Event Parameters:

Event Number: 1

Soil Type	Initial Conditions	Antecedent Precip	Event Precip	Forecast Precip
<input checked="" type="radio"/> Nominal	<input type="radio"/> +30%	<input type="radio"/> +30%	<input type="radio"/> +30%	<input type="radio"/> +30%
<input type="radio"/> Sandy	<input checked="" type="radio"/> Nominal	<input checked="" type="radio"/> Nominal	<input checked="" type="radio"/> Nominal	<input checked="" type="radio"/> Nominal
<input type="radio"/> Clay	<input type="radio"/> -30%	<input type="radio"/> -30%	<input type="radio"/> -30%	<input type="radio"/> -30%

[Activate New Parameter Selections](#)

**Event Product Preview**

MAP - 06hr 2013-01-08 00:00 UTC Event 1 | ASM - 06hr 2013-01-08 00:00 UTC Event 1 | FFG - 06hr 2013-01-08 00:00 UTC Event 1

[Open Preview Animation \(Pop-Up Window\)](#)

**Currently Selected Simulation Event Parameters:**

Event #	Soil Type	Initial Condition	Antecedent Precip	Event Precip	Forecast Precip	Begin Date	End Date	Event Code
1	Nominal	Nominal	Nominal	Nominal	Nominal	2013-01-08 00:00 UTC	2013-01-13 18:00 UTC	E001-stnom-scm00-pm00-pm00-pm00

[HOME](#) | [About GFFGS-SIM](#) | [Product Descriptions](#) | [Static Resources](#) | [Event Parameters](#)

GFFGS-SIM v.1.0. Official Release Date: Apr 2014  
 Copyright © 2014 [Hydrologic Research Center](#) (HRC)

## FLASH FLOOD GUIDANCE GAZETTE

Welcome to the first issue of the Flash Flood Guidance (FFG) Gazette, a semi-annual newsletter bringing users of FFG products all the latest news – operational information, technical advances, case studies and soon introducing the new e-learning environment for the flash flood community.

### Hydrologic Research Center ~ Linking Science and Society

Flash floods are a world-wide hazard. Unlike other weather related events with specific geographic locations, every location where rain falls is vulnerable, from the tropics to the sub-polar regions. With flash floods being among the most devastating of natural disasters it is essential that flash flood warnings be formulated in a short time with as much specificity in timing and location as possible. As significant rainfall events may cover large areas, this information may be needed for multiple basins at once. This is a very challenging situation for forecasters and some type of guidance is necessary to organize the real-time data and information from multiple sources into easily usable and interpretable products, which are amenable to operational modification in a timely manner.

The HRC flash flood guidance systems aim to provide just that and to assist the forecasters in their effort to provide reliable and timely flash flood watches and warnings. They integrate observed data from remote sensing platforms, on-site automated sensors, and modeled data from atmospheric and land-surface models in an automated FFG software system. Although the use and interpretation of the FFG products requires minimal training, quantifying the uncertainty associated with these products in real time and for specific events requires substantial training of the forecasters.

In an effort to provide a means of communication that will provide forecasters with information on case studies suitable for training, valuable pointers from the field in the use and interpretation of the products, and a forum for the continuing validation of the FFG products and associated warnings, HRC is initiating the publication of a newsletter, the **FFG Gazette**. We would be glad to receive commentary pertinent to the use of the FFG systems from the field for inclusion in the **FFG Gazette**, as well as summaries of interesting FFG applications, validation results and suggestions for system improvements.

On behalf of HRC, I would like to take this opportunity to express our gratitude to those men and women that serve faithfully as forecasters during all hours of day and night in a vigilant effort to reduce life loss from natural disasters throughout the world. To them this effort is dedicated.

Konstantine P. Georgakakos, Sc.D.  
Director - Hydrologic Research Center  
San Diego, California, USA

We would like to ask you to share your suggestions, stories, pictures, experiences relating to flash floods and flash flood guidance systems. Please send your information to R. Graham (editor) at [rgraham@hrc-lab.org](mailto:rgraham@hrc-lab.org).



#### In this issue:

Welcome Note from Dr. Konstantine Georgakakos

Flash Flood Guidance systems around the World

Haiti and Tropical Storm Tomas

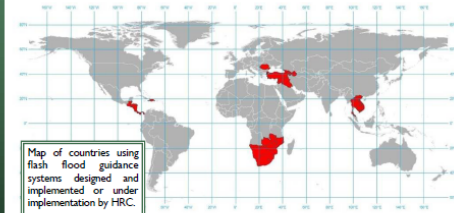
Operational Solutions-Sharing Knowledge: Case study Haiti

#### Special points of interest:

- HRC Global Initiative on FF Floods
- The NEW Southern Africa Regional Flash Flood Guidance System

## FLASH FLOOD GUIDANCE GAZETTE

### Flash Flood Guidance systems around the World



Map of countries using flash flood guidance systems designed and implemented or under implementation by HRC.

Since 1993 the Hydrologic Research Center (HRC) has led the technical development and application of flash flood guidance systems in thirty different countries.

In collaboration with the national meteorological and hydrological services, HRC Flash Flood Guidance systems will serve more than half a billion people worldwide by the end of 2011.

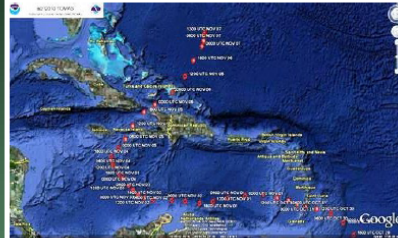
### The South Africa Regional Flash Flood Guidance System

The South Africa Regional Flash Flood Guidance (SARFFG) system will be the first fully automated real-time regional flash flood guidance system in the Southern Africa region, in operation in seven countries - South Africa, Botswana, Namibia, Malawi, Mozambique, Zambia and Zimbabwe in 2011.

The SARFFG system is a diagnostic tool for analyzing weather-related events that can initiate flash floods and is designed to allow the forecaster to add his/her experience with local conditions, incorporate information and any last-minute local observations, to assess the threat of a local flash flood.



### Haiti and Hurricane Tomas



Map illustrating the track of Tomas (October 30 to November 7, 2010). Source: U.S. National Weather Service/National Hurricane Center.

On 4th and 5th of November 2010, Haiti was impacted by Hurricane Tomas, with heavy rains and winds over various areas of the country. Tomas developed from a tropical wave east of the Windward Islands on 29th October and quickly intensified into a hurricane passing near Santa Lucia on 31st October.

During its closest passage to Haiti, Tomas was a Category 1 Hurricane per the U.S. National Weather Service, National Hurricane Center. See the following discussion to learn how the FFG system was used in Haiti.

For more information on the HDRFFG system see - [http://www.hrc-lab.org/right\\_nav\\_widgets/realtime\\_hdrffg/index.php](http://www.hrc-lab.org/right_nav_widgets/realtime_hdrffg/index.php)

## H FLOOD GUIDANCE GAZETTE

### Solutions-Sharing

#### Flash Flood Guidance System (HDRFFG)

with Météo-France, has implemented a Flash Flood Guidance system for Haiti and the HDRFFG. The HDRFFG became operational on 1st July, 2010 and was implemented in Haiti to the Centre National to develop flash flood warnings, a January 2010 earthquake.

#### for Haiti

Hurricane Tomas, the U.N. Office for Disaster Preparedness (UNDP) asked HRC to assess the potential flooding impacts in this, HRC provided UNDP and the National Meteorological Service forecasts of Flash Flood Threat and the impact of Tomas making landfall.

#### Assessment

In order to assess the accuracy of the HDRFFG system with respect to the areas impacted by flash floods from the storm.

Operational data were available for this storm, strong indications that the system was identifying impacted basins.

The system only evaluated the systems accuracy, including the application of rainfall inputs and whether or not warnings were issued and appropriate responses taken, which is the ultimate test of the system.

Operational storm Tomas, the use of rainfall forecasts to derive flash flood threat the HDRFFG system) provided valuable results in the identification of areas at risk. This provided useful information to disaster relief agencies on potential flooding. For a copy of the report please contact HRC at [admin@hrc-lab.org](mailto:admin@hrc-lab.org)

#### on Flash Floods:

Operational vulnerability and preserve resiliency in basic human needs: livelihoods, agriculture, water resources, and natural resources.

HRC in partnership with U.S. National Weather Service (NWS), U.N. World Meteorological Organization (WMO) and U.S. Agency for International Development/Office of U.S. Foreign Disaster Assistance (USAID/OFDA) is involved in an initiative to develop and implement a Global Flash Flood Guidance (GFFG) system designed to be used by weather services and disaster management agencies around the world to develop localized warnings for deadly flash floods. (For more information on the GFFG system see - [www.hrc-lab.org/publicbenefit/index.html](http://www.hrc-lab.org/publicbenefit/index.html)).

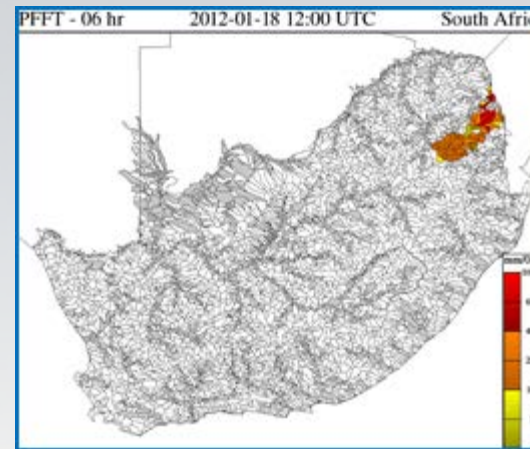
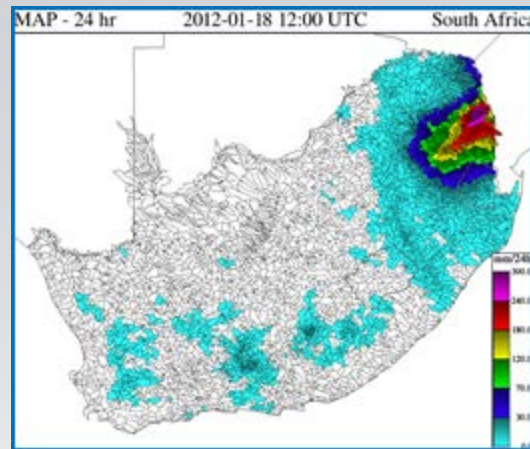
### CONGRATULATIONS TO DR THERESA CARPENTER UPON HER COMPLETION AND SUCCESSFUL DEFENSE OF THE DOCTORAL DISSERTATION - 'An Interdisciplinary Approach to Characterize Flash Flood Occurrence Frequency for Mountainous Southern California'.

We are very excited and proud to share this great news! Dr Carpenter, an HRC colleague has defended her Ph.D. dissertation on the 5th of January, 2011 at Scripps Institution of Oceanography, UCSD. (For a copy of her thesis contact Dr Carpenter at [tcarpenter@hrc-lab.org](mailto:tcarpenter@hrc-lab.org)).

# South Africa Case Study

January 2012, Tropical Storm Dando, Kruger National Park

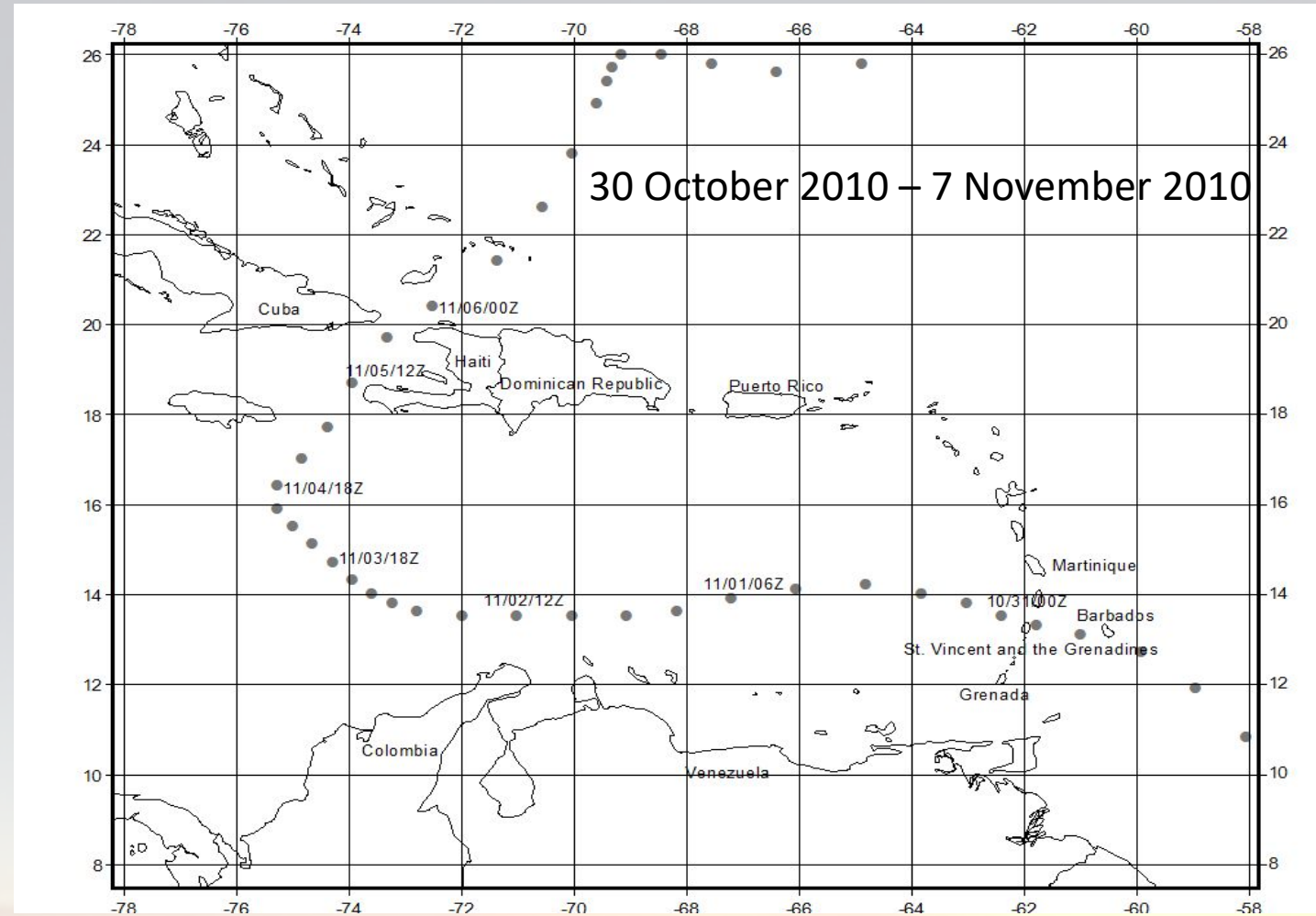
“An analysis of the storm by the South African Weather Service (SAWS) showed that the Southern Africa FFG system performed very well—indicating the areas of heavy rainfall (left figure) and flash flood threat (right figure) that were in agreement with the observed data.” (From Flash Flood Gazette, May 2012)



“Discussions between the South African Weather Service, the South Africa Department of Water Affairs, and the Kruger National Park officials indicated that the information and data available through the FFG system can be very useful in situations such as this.”

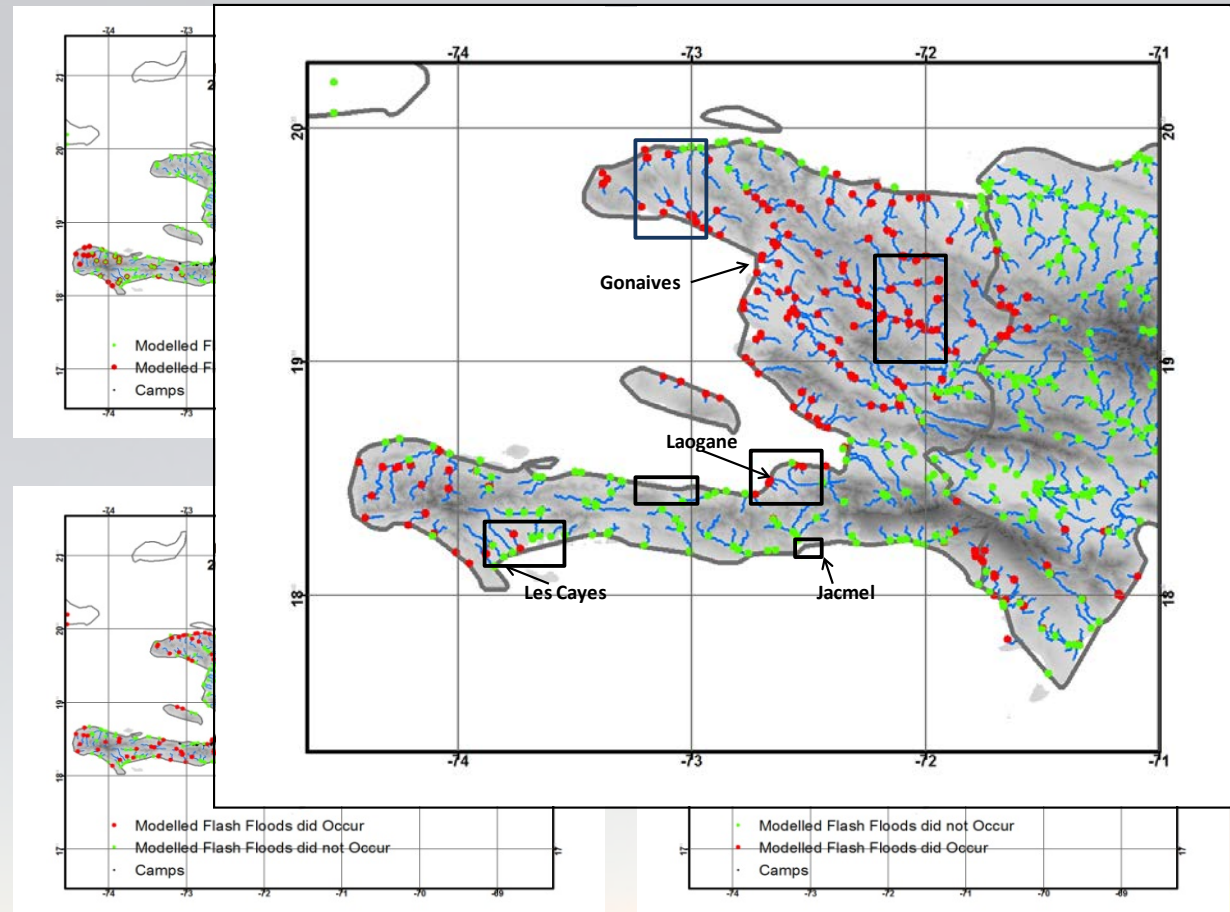
# Haiti Case Study 1

## Hurricane Thomas Passage



# Haiti Case Study 1

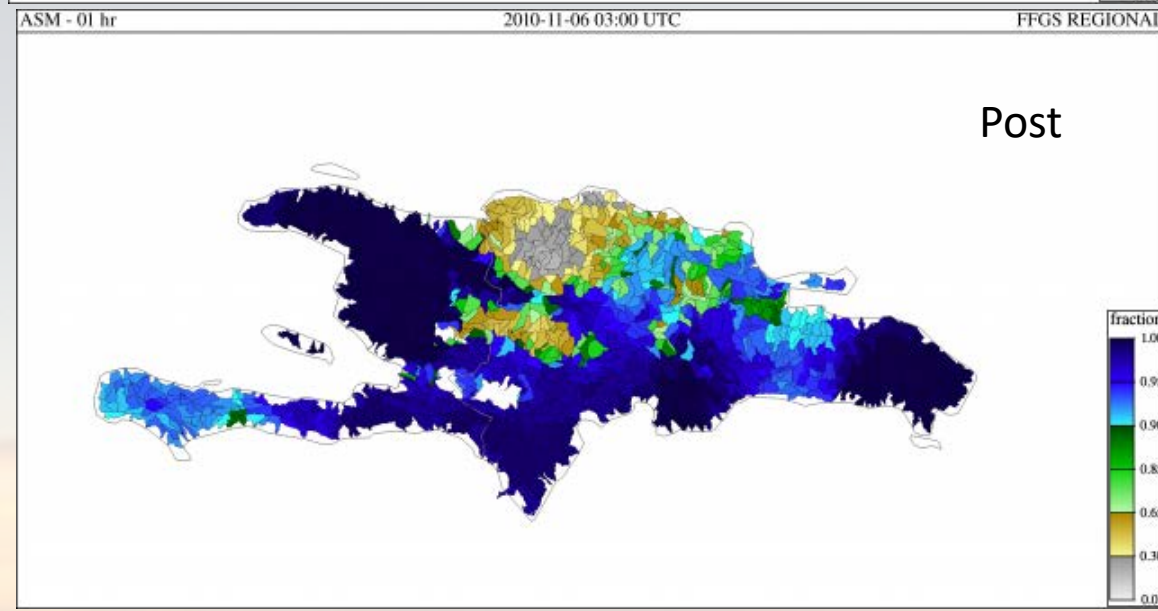
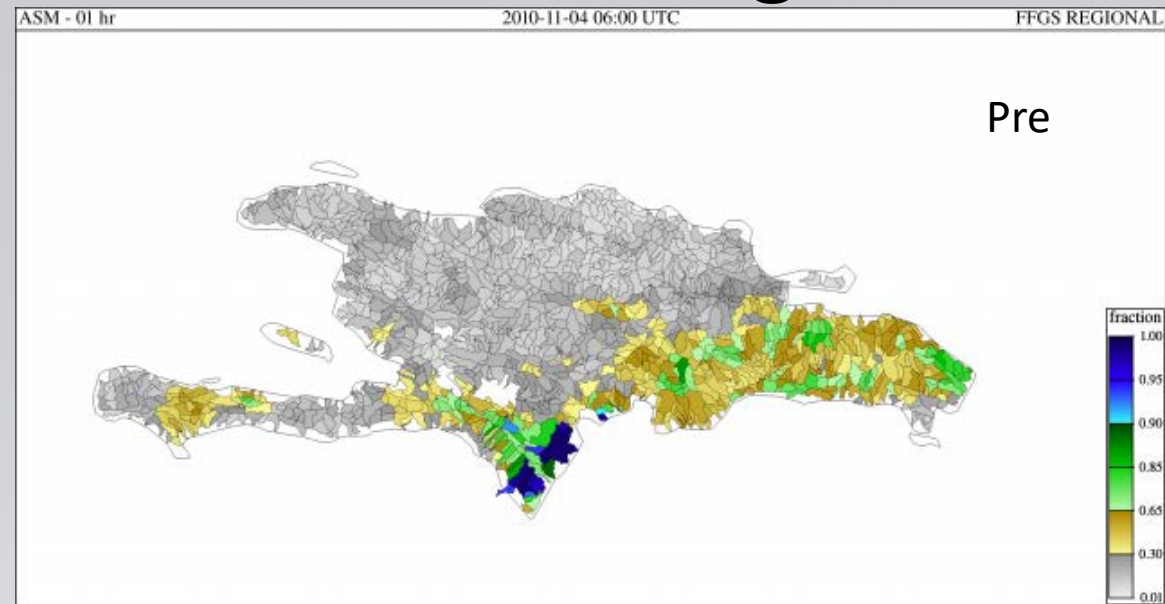
## Hurricane Thomas Passage





# Haiti Case Study 1

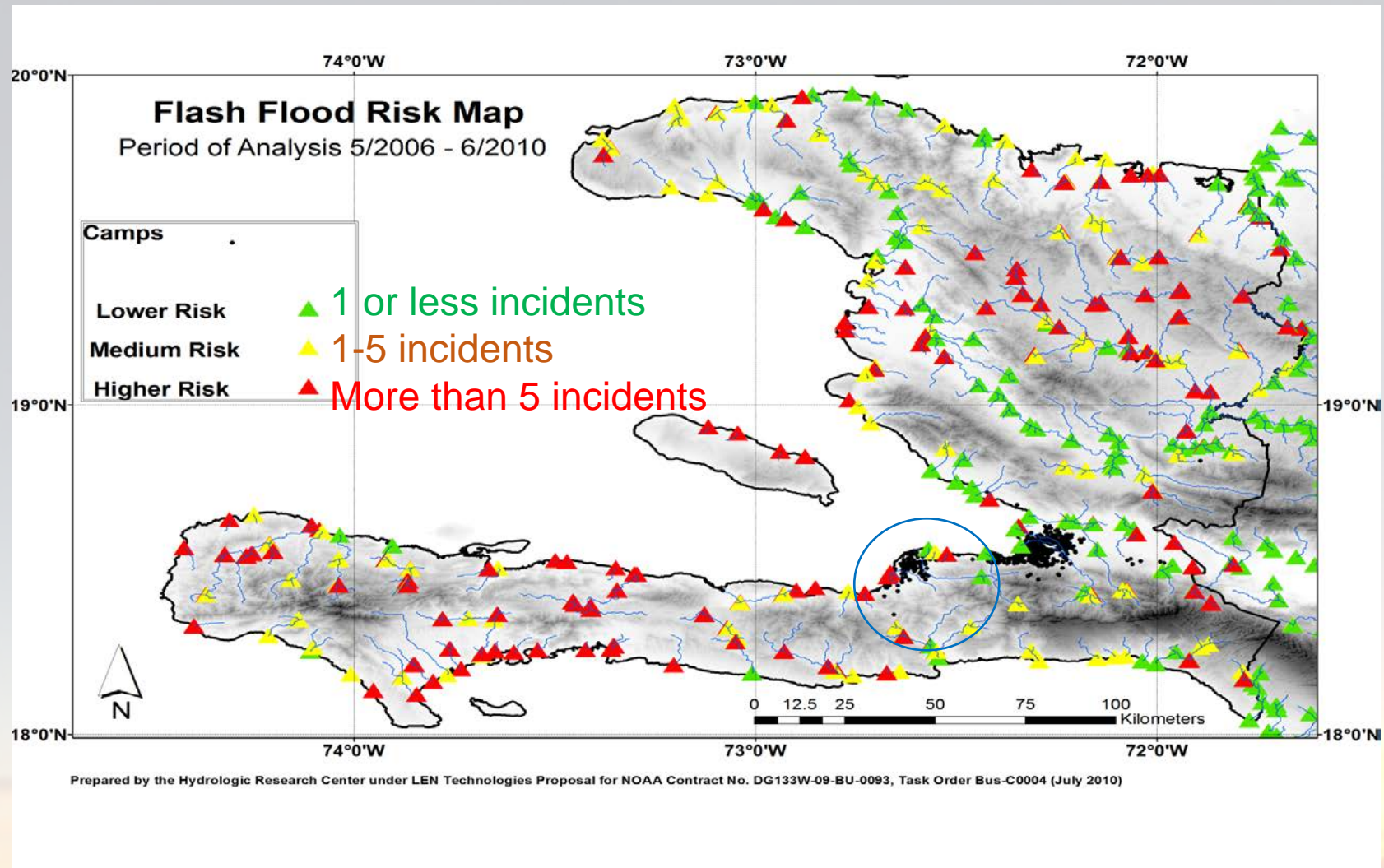
## Hurricane Thomas Passage



# Haiti Case Study 2

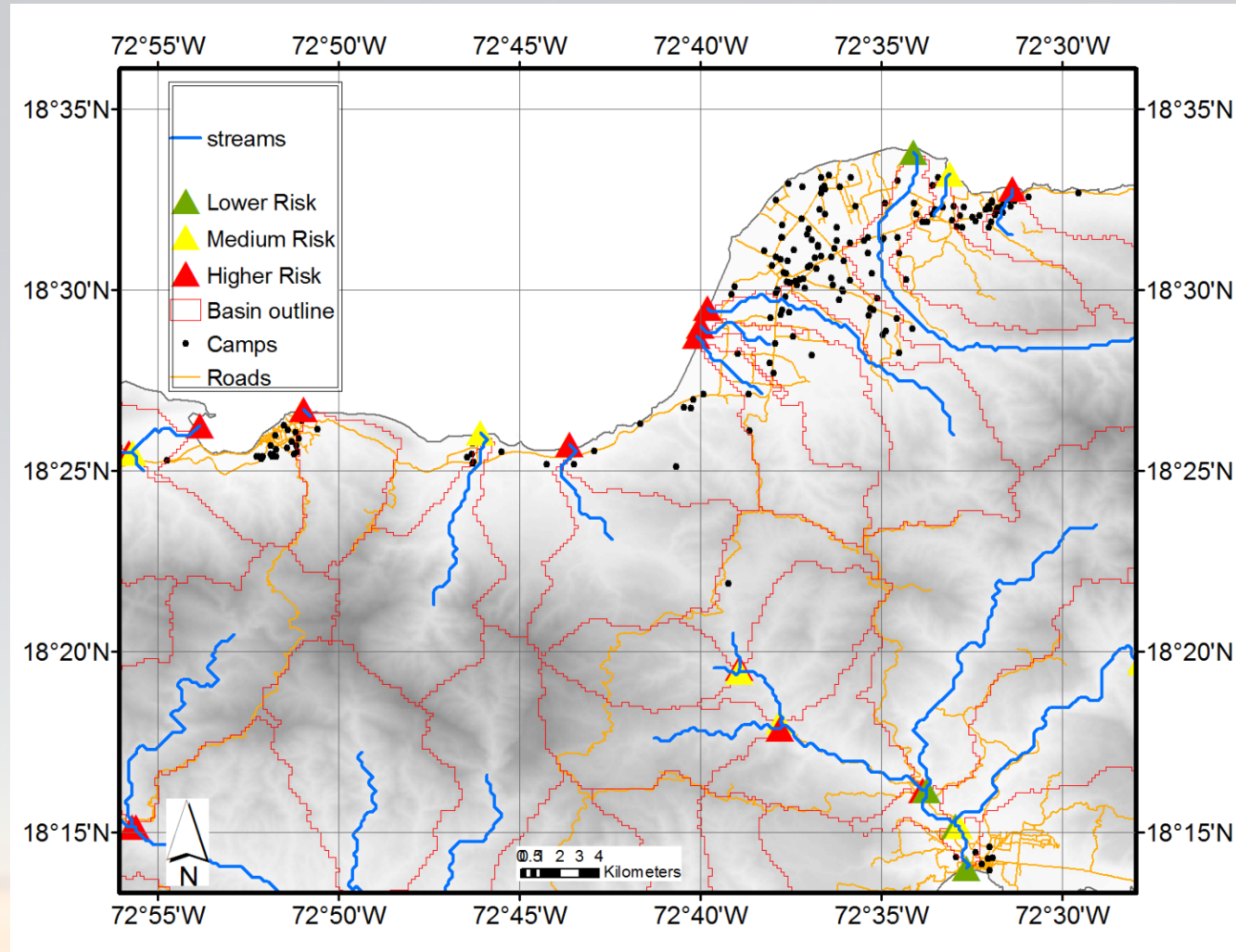
## Flash Flood Risk Assessment

Entire Haiti (Average Basin Area: 72 km<sup>2</sup>)



# Haiti Case Study 2

## Flash Flood Risk Assessment



# FFGS Development and Implementation Team at HRC

**Randall Banks**

**Zhengyang Cheng**

**Konstantine Georgakakos**

**Rochelle Graham**

**Robert Jubach**

**Theresa Modrick**

**Eylon Shamir**

**Cris Spencer**

**Jason Sperflage**



# Thank you

**The strong support of the country National Meteorological, Hydrological and Disaster Management Services has been essential for the useful operational utilization of the regional FFG systems.**