HRC Role and Introduction to FFGS Concept

HYDROLOGIC RESEARCH CENTER

Central Asia Region Planning Workshop

5 May 2015

Role of HRC

In collaboration with USAID, WMO, NOAA and Countries

- Developed the FFGS concept and system design
- Tailors FFGS systems for specific regions (data, geomorphology and hydrometeorology)
- Implements system at a regional center in the region
- Trains Forecasters in the FFGS component and interface use for warnings
- Provides GHE (with agreement with NESDIS) and MWGHE (value added to GHE) to regional systems
- Maintains and enhances FFGS system implementations

What do we call 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 the result of intense rainfall over a ***relatively small area*** ”

A local hydrometeorological phenomenon that requires:

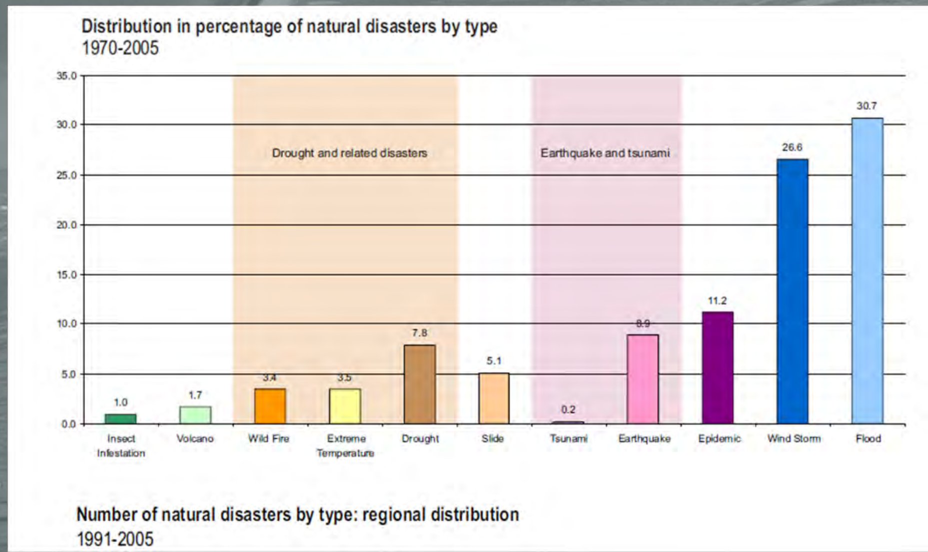
1. BOTH Hydrological and Meteorological expertise for real time forecasting/warning
2. Knowledge of local up to the hour information for effective warning

Usually, flow crest is reached within 6 hours of causative event

Why worry about Flash Flooding?

- “Recent findings of the WMO (2008) 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

U.N. International Strategy for Disaster Reduction



Why Worry About Flash Flooding?

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
- Climatic changes in several regions increase precipitation intensity and melt snow early

What are natural flash flood causes?

- Intense rainfall from ***slow moving*** thunderstorms or tropical systems
- Orographic rainfall in ***steep*** terrain
- Soil ***saturation or impervious*** land surfaces
- Hydraulic ***channel*** properties
- Sudden release of impounded water (natural dam or human-made dam)

Why is flash flooding different from large river flooding?

LRF

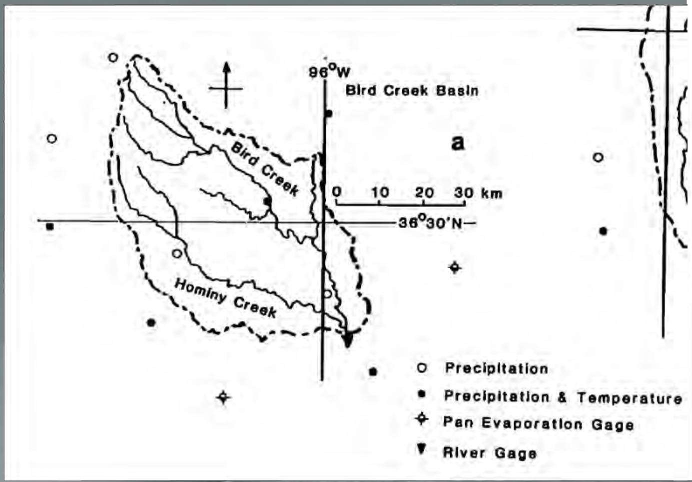
- ***Catchment response affords long lead times***
- ***Entire hydrographs can be produced w/ low uncertainty with good quality data***
- ***Local information less valuable***
- ***A hydrologic forecasting problem primarily***
- ***Affords time for coordination of flood response and damage mitigation***

FF

- ***Catchment response is very fast and allows very short lead times (< 12hrs)***
- ***Prediction of occurrence is of interest***
- ***Local information is very valuable***
- ***A truly hydro-meteorological forecasting problem***
- ***Coordination of forecasting and response is challenging over short times (Careful Planning Needed)***

Why is soil water important for flash flooding in addition to rainfall rate? –Summer Convection

Georgakakos et al. *WRR* **31**(3), 210-220, 1995.



658 GEORGAKAKOS ET AL.: HYDROCLIMATOLOGY OF WATERSHEDS, 1

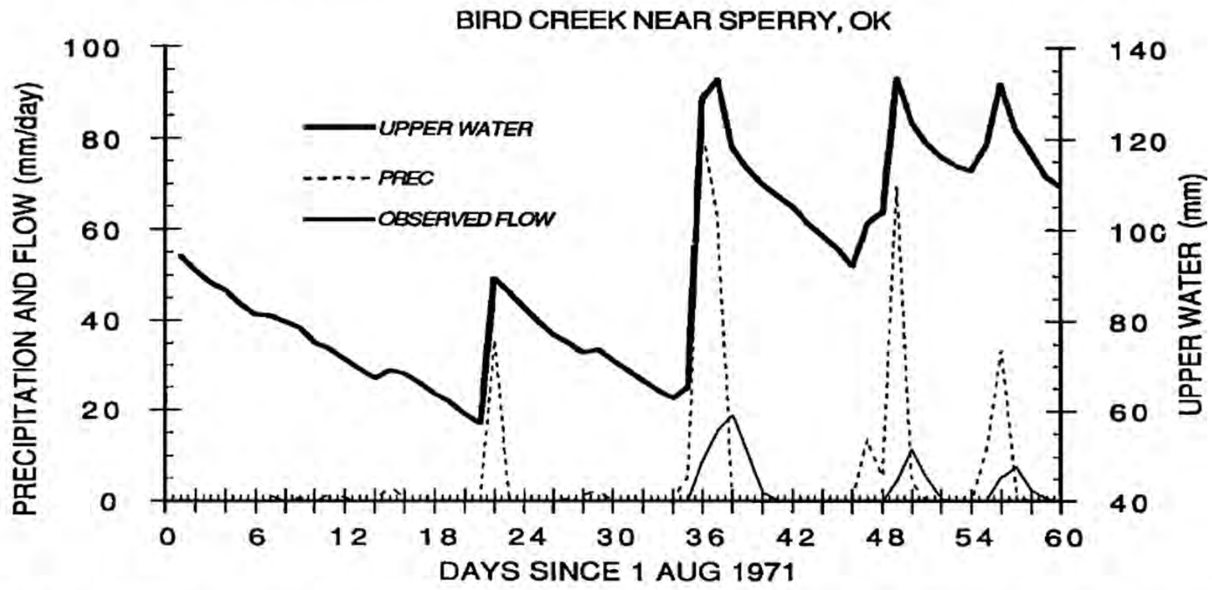
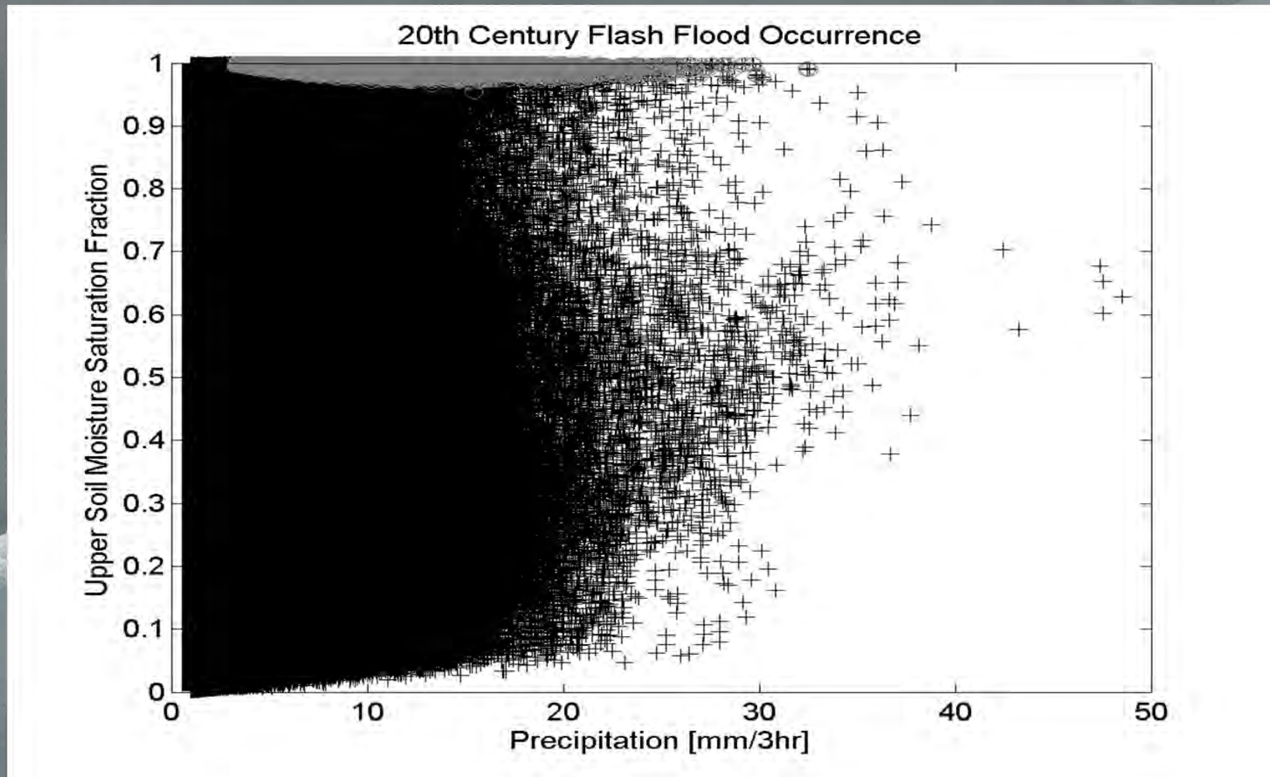


Figure 2. Daily values of rainfall rate (dashed line), flow rate (solid line), and upper soil water (heavy solid line) for Bird Creek near Sperry, Oklahoma, for August and September 1971. Rainfall and flow rates are in millimeters per day and are read on the left ordinate axis. Upper water is in millimeters and is read on the right ordinate axis. Upper water capacity is 135 mm.

Why is soil water important for flash flooding in addition to rainfall rate? – Winter Mediterranean Rain

Modrick & Georgakakos
JHRS **3**, 312-336, 2015



The plot shows that (a) flash flood events may occur with a wide range of precipitation forcing (from about 3 to about 30mm/3-hr) and (b) that high precipitation events do not yield flash flood events even at moderate soil moisture saturation.

What are processes for the production of surface runoff and flash flooding?

- SATURATION FROM BELOW – ALL RAIN INFILTRATES (DOMINANT FOR MOST SOILS)
- INFILTRATION CONTROLLED – RAIN RATES IN EXCESS OF INFILTRATION CAPACITY PRODUCE RUNOFF (CALY SOILS)
- COMBINED – HETEROGENEOUS AREAS AND PROFILES

Examples of soil texture and infiltration rates

Maximum Daily Rainfall observed
187 cm/day - Reunion

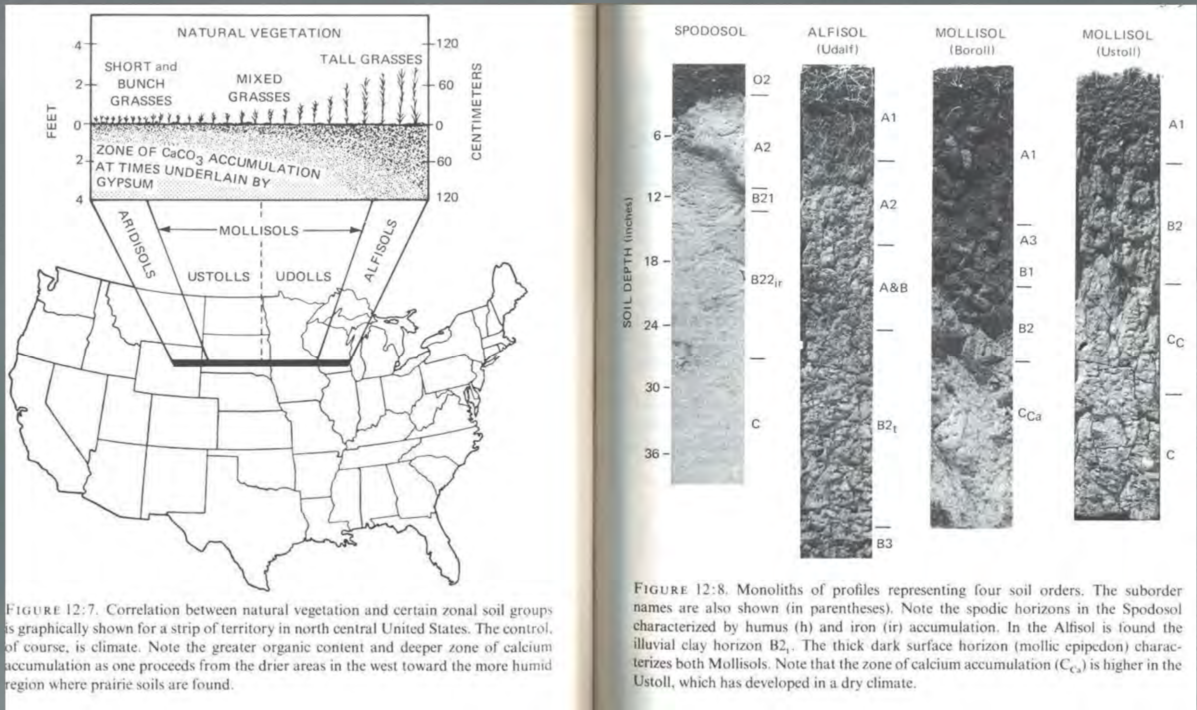


FIGURE 12:7. Correlation between natural vegetation and certain zonal soil groups is graphically shown for a strip of territory in north central United States. The control, of course, is climate. Note the greater organic content and deeper zone of calcium accumulation as one proceeds from the drier areas in the west toward the more humid region where prairie soils are found.

FIGURE 12:8. Monoliths of profiles representing four soil orders. The suborder names are also shown (in parentheses). Note the spodic horizons in the Spodosol characterized by humus (h) and iron (ir) accumulation. In the Alfisol is found the illuvial clay horizon $B2_t$. The thick dark surface horizon (mollic epipedon) characterizes both Mollisols. Note that the zone of calcium accumulation (C_{Ca}) is higher in the Ustoll, which has developed in a dry climate.

Brady, N.C., 1974: The nature and properties of soils. McMillan Publ. Co., NY.

Profile	Depth (cm)	Horizon Description	Upper Limit Infiltration Rate (cm/day)
RP-1	10	A/B	5,760
	40	C/Bt Clay in fractures	26
	80	C/Bt Clay in fractures	19
RP-2	40	Bt2	9
	80	Cox/t Saprolite with clay in fractures	55
RP-3	40	Cox/t Saprolite with clay in fractures	180
	80	Cox/t Saprolite with clay in fractures	160
RP-4	10	Bw/C Disturbed horizon	14,400
C-1	10	Bt	60
	120	Saprolite	180
	300	Saprolite	85
C-2	50	Bt	85

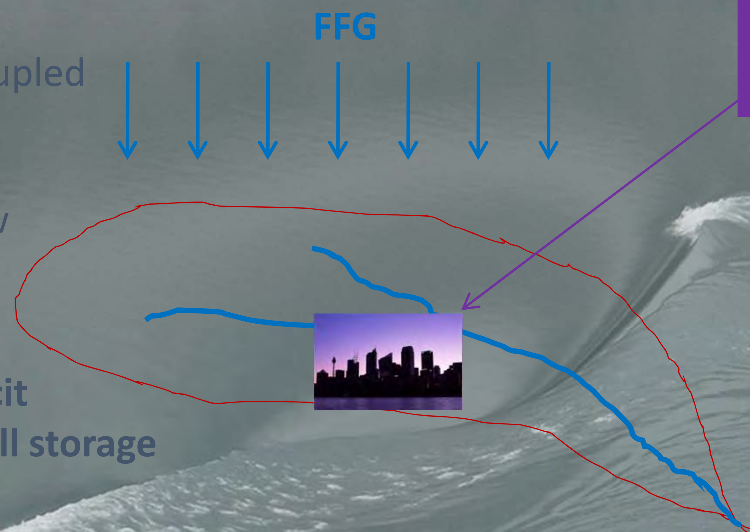
Harmon, R.,S., (ed.) 2005: The Rio Chagres, Panama. Springer, The Netherlands.

What is flash flood guidance?

Rainfall threshold (familiar concept)

Meteorology and hydrology decoupled
for adjustments

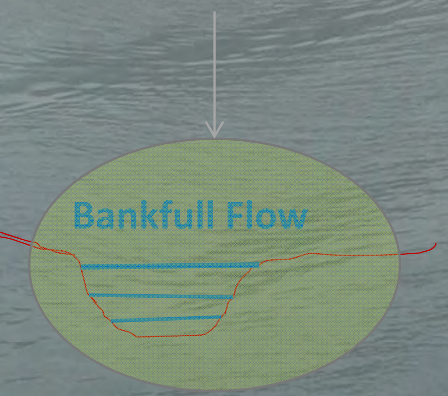
Concerned only with bankfull flow



Soil Water Deficit
Channel bankfull storage

Urban environment
- Not represented due to scale
- Not represented due to sewers

Location of Occurrence



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

Threshold exceedance concept to estimate occurrence only!

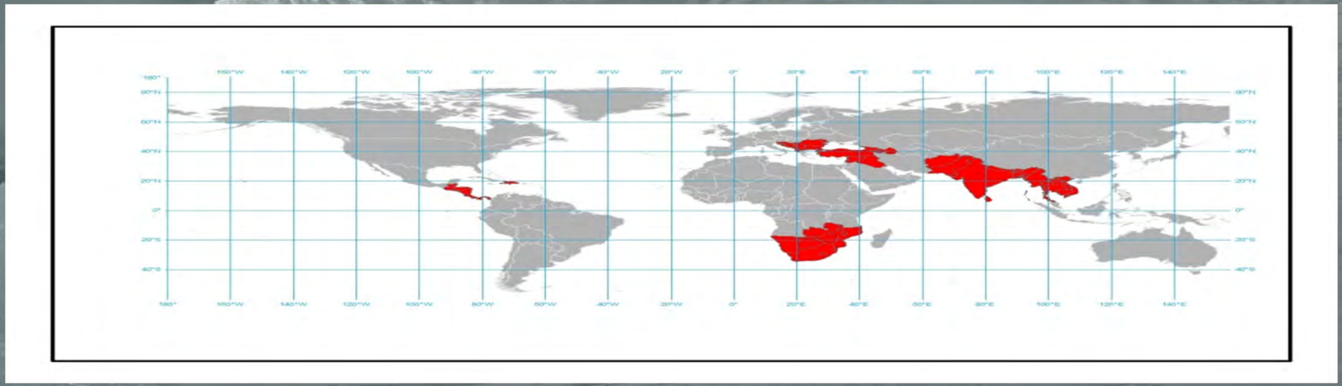
The Global Initiative for Flash Floods

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).



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

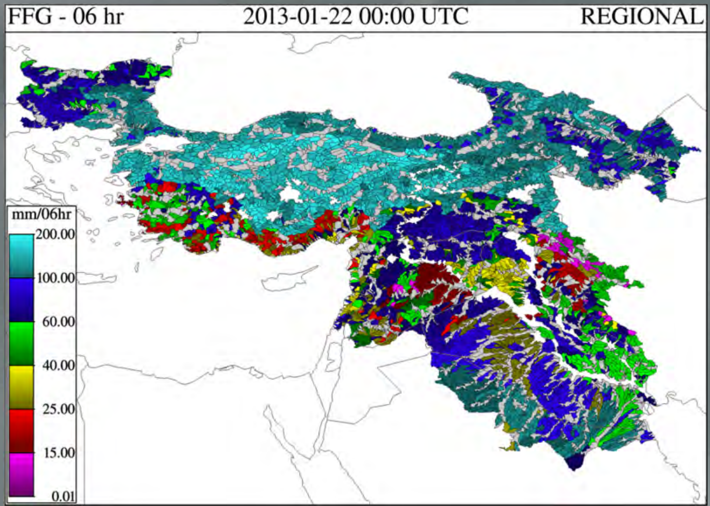
- **1993-2005**: HRC continues **research** in various aspects of the FFG process and system (sparsely gauged basins and uncertainty issues, forcing and models). The development of **prototype regional systems** using FFG is proposed and accepted in work plan of **WMO CHy Working Group on Applications** (**2002-2003**)

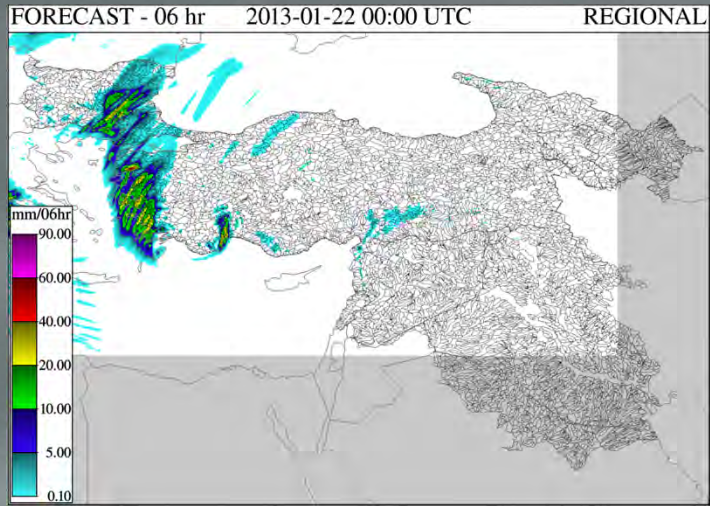
- **2004**: The **Central America Flash Flood Guidance System becomes operational** (serves 7 countries in CA)

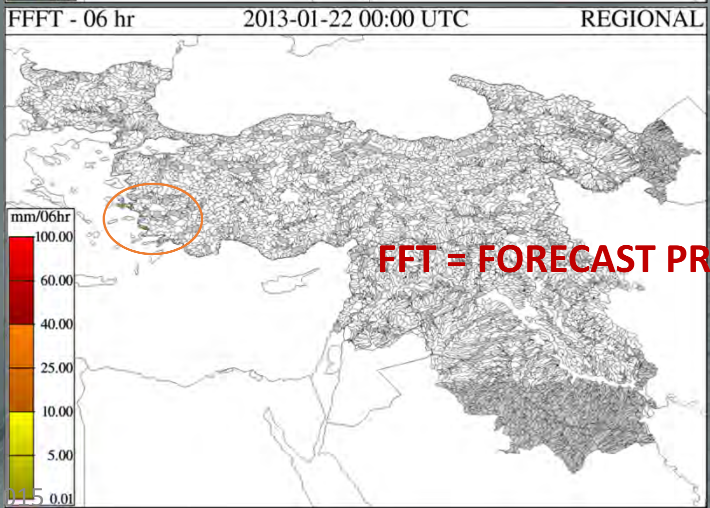
- **2008: WMO, USAID, NOAA, HRC sign a quad-part Memorandum of Understanding to collaborate in the development of a global flash flood guidance system (currently in second 5-year phase)**

- **2012-2013 BSMEFFG Operational and high-resolution version for radar ingest in Turkey**

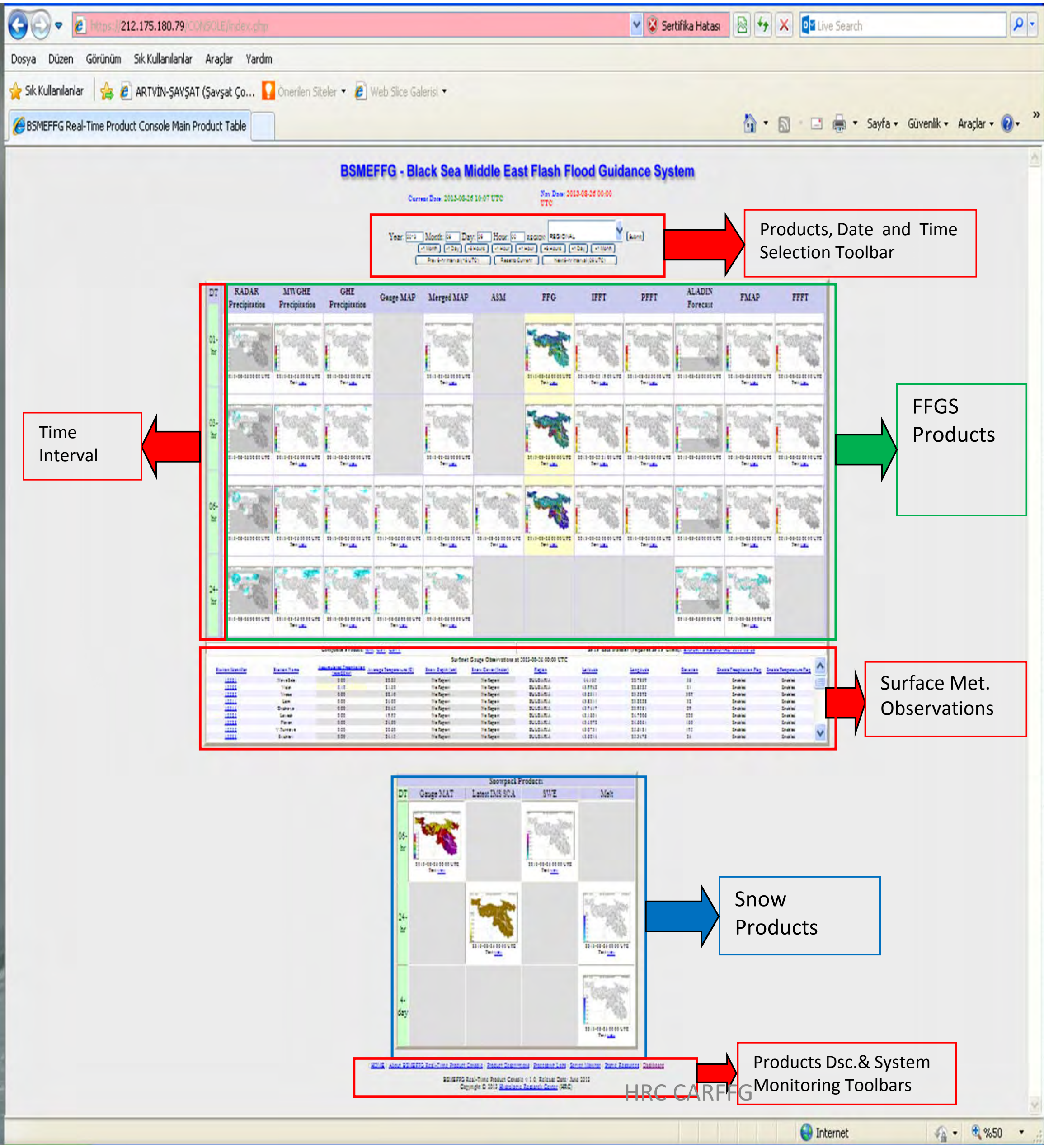
BSMEFFG Example





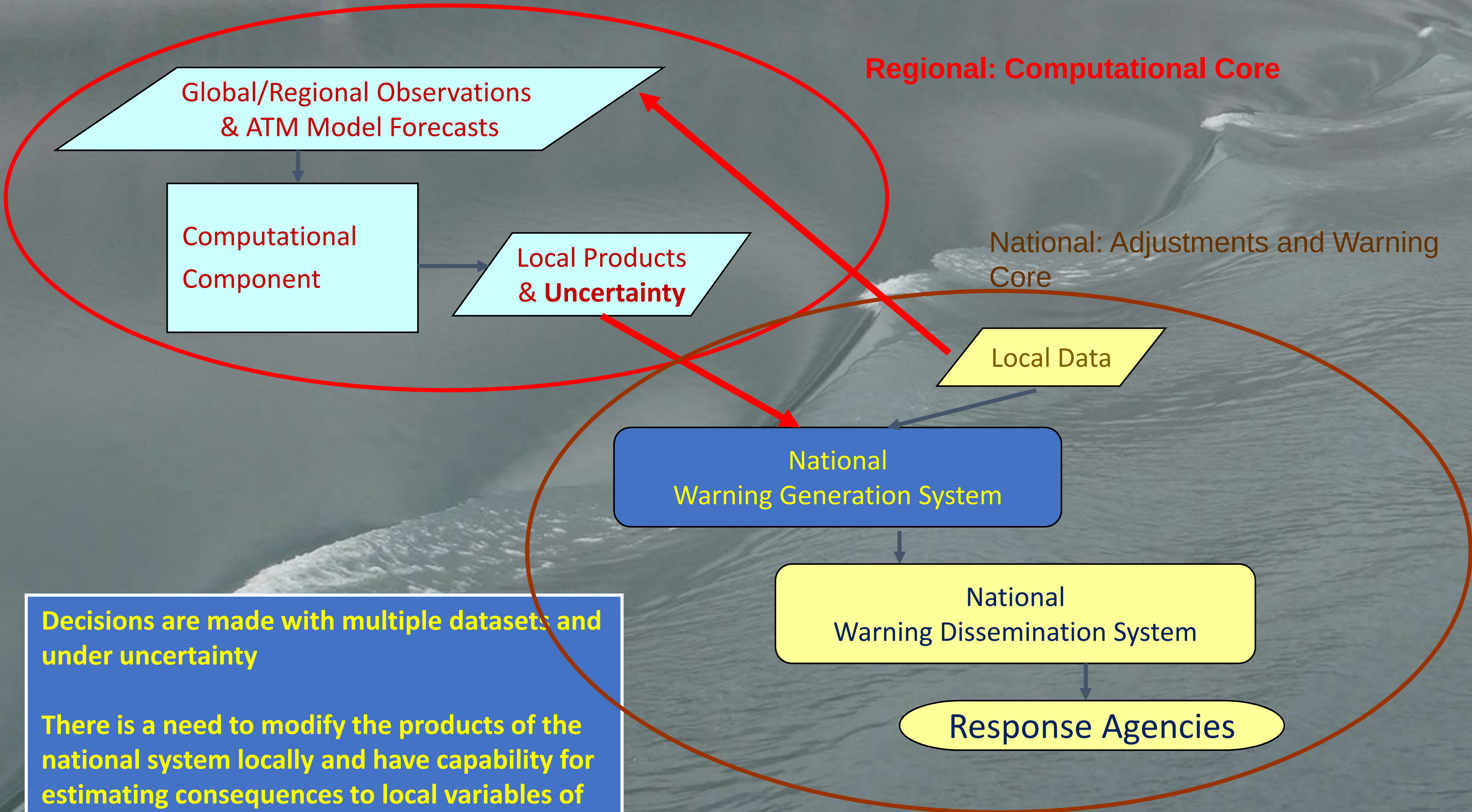


FFT = FORECAST PRECIPITATION OF DURATION T – FFG OF DURATION T



BSMEFFG - Black Sea Middle East Flash Flood Guidance System
Products, Date and Time Selection Toolbar
Time Interval
FFGS Products
Surface Met. Observations
Snow Products
Products Dsc.& System Monitoring Toolbars
BSMEFFG Real-Time Product Console Main Product Table
RADAR Precipitation
MWGHE Precipitation
GHE Precipitation
Gauge MAP
Merged MAP
ASM
FFG
IFFT
PFFT
ALADIN Forecast
FMAP
FFFT
Gauge MAT
Latest IMS SCA
SWE
Melt

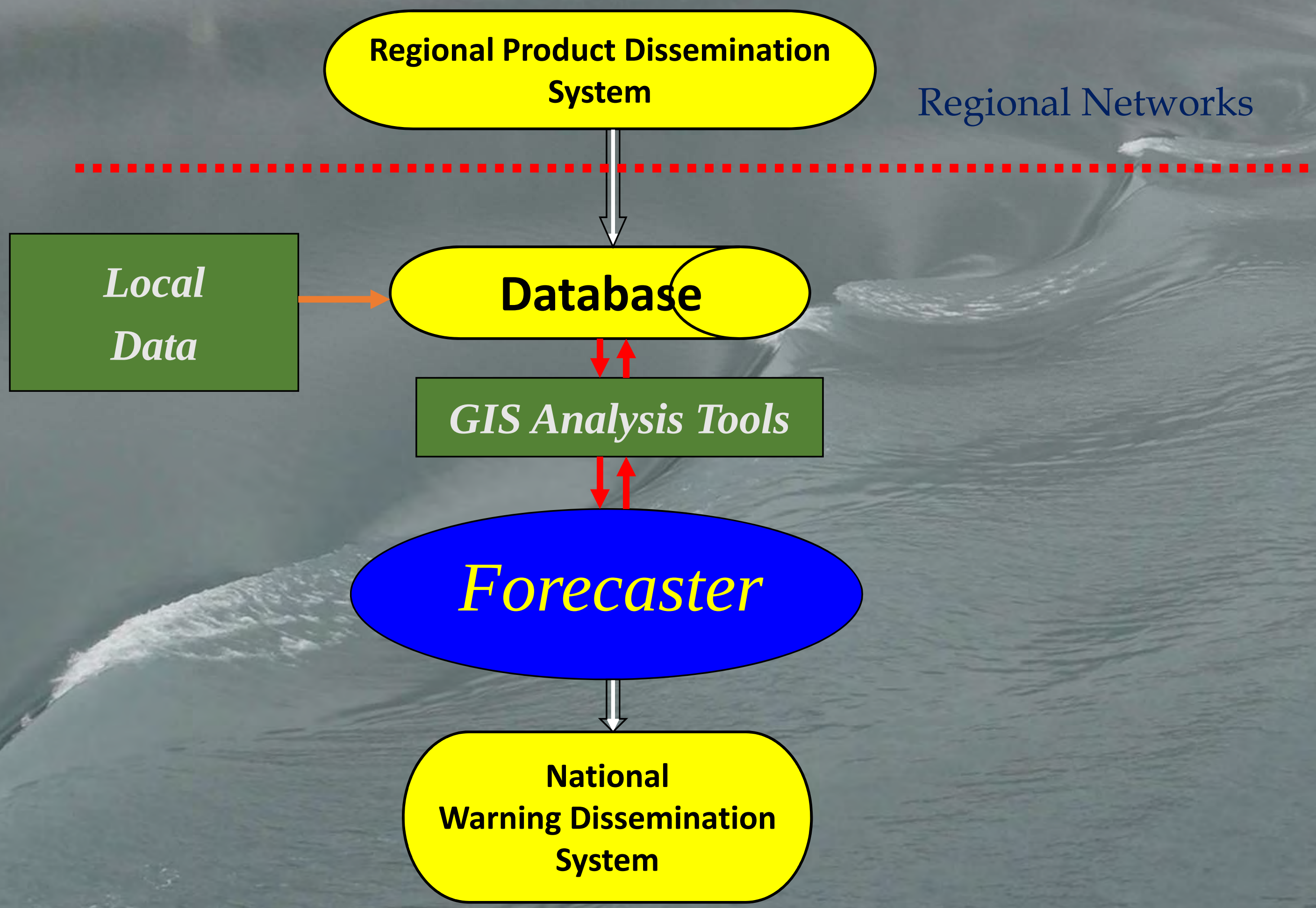
FLASH FLOOD GUIDANCE SYSTEM
From Global Data and Regional Hydrometeorology to National Data and Warnings



Decisions are made with multiple datasets and under uncertainty

There is a need to modify the products of the national system locally and have capability for estimating consequences to local variables of interest

National System for Warnings



Integrated Systems for Real-Time Warning