Tools and Technologies for Forecasting Hydrological Hazards

Strengthening Regional Cooperation to Support Forecasting with Multi-Hazard Approach in RA IV

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Large River Floods and Flash Floods

Large River Floods

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

Flash Floods

- Catchment response is very fast and allows very short lead times (< 6-12hrs)
- Coordination of forecasting and response is challenging over short times
- Prediction of occurrence is of interest
- Local information is very valuable
- A truly hydro-meteorological forecasting problem

Flash Floods

Flash Floods

Flash Floods

- World Meteorological Organization - A flood of short duration with a relatively high peak discharge

- American Meteorological Society – 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

- Response time is 6 hours or less

Flash Floods

Flash Flood Approaches

- Site Specific – costly to implement, limited basin coverage, data intensive
- Distributed Modeling – costly to implement, limited basin coverage, data intensive
- Flash Flood Guidance – areal approaches

Basic Features of FFG Technology

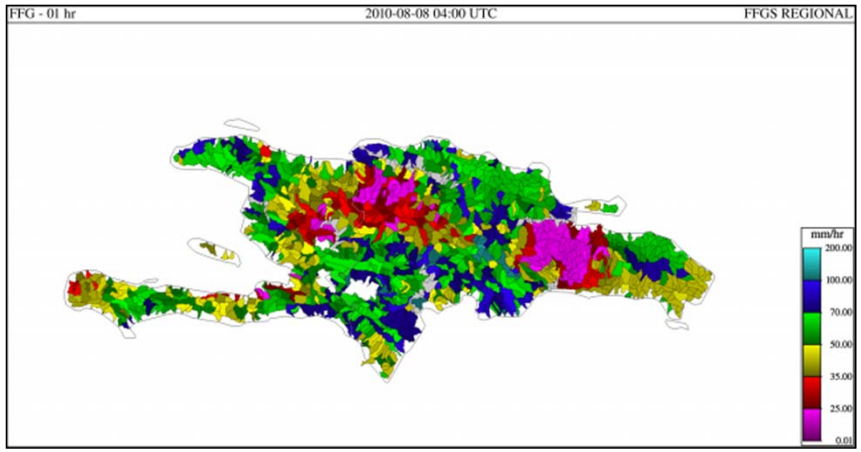
- Flash Flood Guidance – volume of rainfall of a given duration (1-6 hours) over a given small catchment that is just enough to cause bank full flow at the outlet

- Flash Flood Threat – rainfall of a given duration in excess of the corresponding Flash Flood Guidance value (past or "forecast" rainfall; measure of uncertainty)

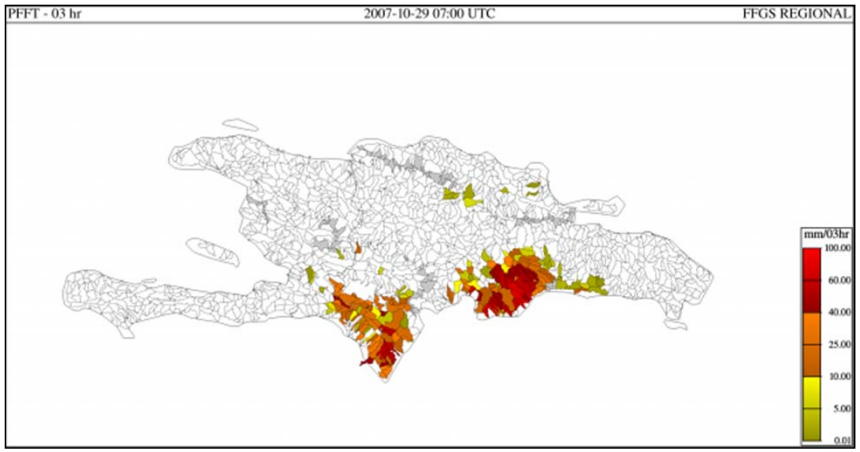
Combination of the two provides critical information for Flash Flood Alerts and Warnings

Flash Flood Guidance System

A TOOL PROVIDING INDICES OF FLASH FLOOD POTENTIAL

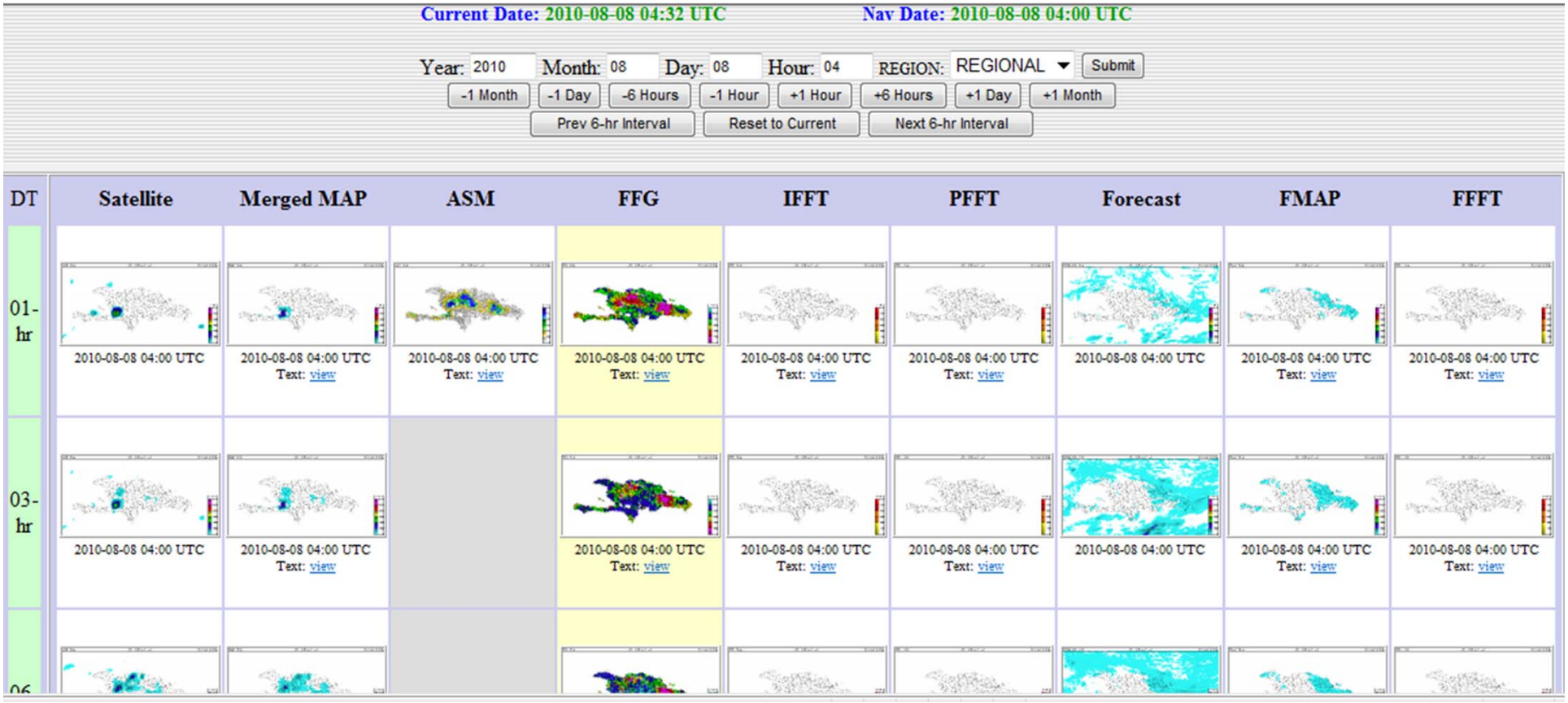


FLASH FLOOD GUIDANCE



FLASH FLOOD THREAT

Flash Flood Guidance System



Basic Features of FFG Technology

- Bank Full Flow
  - Bank full flow is a conservative measure of flooding as it may not be associated with significant flood damage.

Basic Features of FFG Technology

- Threshold runoff of the desired duration and over the desired drainage basin – Expresses ability of land-surface slopes and small streams to convey and store rainwater just prior to flooding occurrence. Produces overland flow that results in direct runoff (saturated soils). Basin runoff characteristics.

- Soil water deficit at the current time – Expresses the ability of the surface soils to store and convey rainwater to streams in a continuous manner for a given drainage basin.

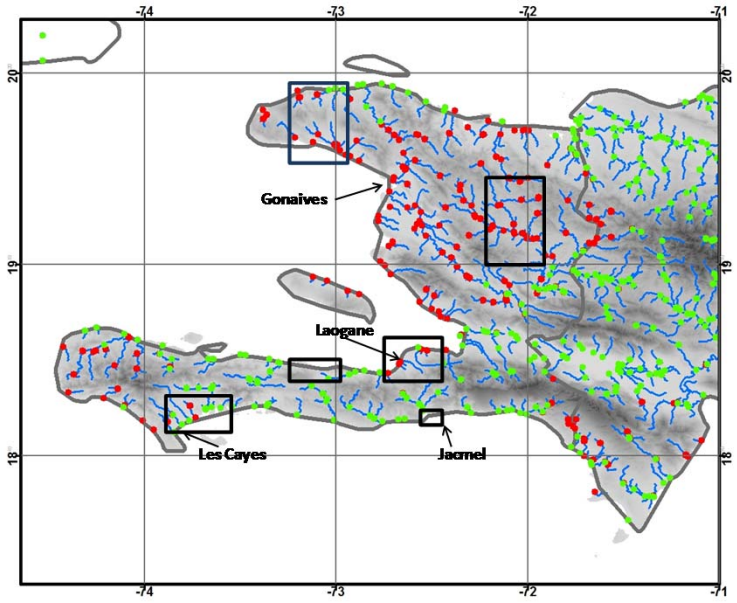
- Flash flooding begins when both the surface and subsurface elements lead to bank full conditions at the stream outlet of a given drainage basin.

Basic Features of FFG Technology

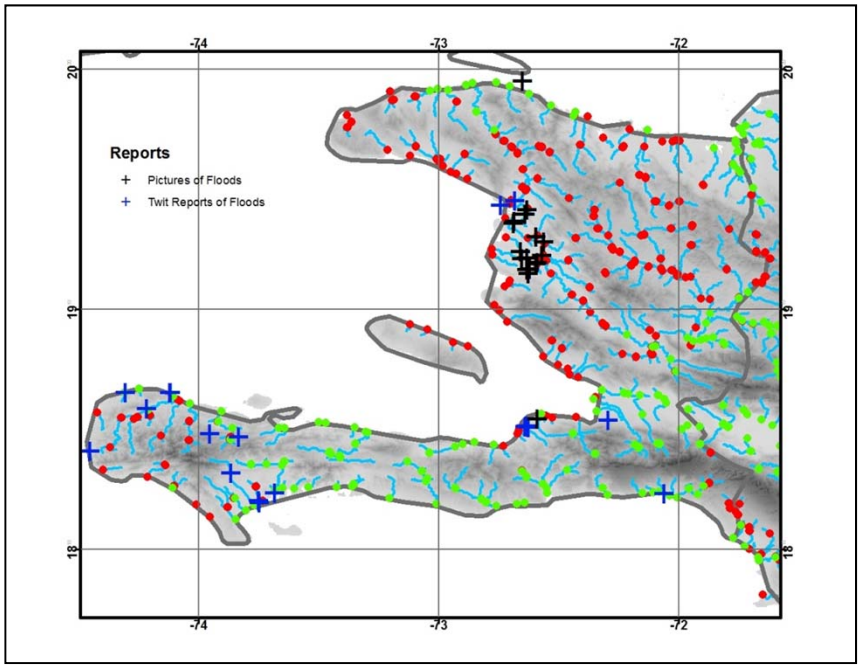
- A soil moisture model (e.g., Sacramento Soil Moisture Accounting Model) is applied to each delineated flash flood basin to determine soil water deficit
- The moisture states of the soil as calculated by the soil model are used in the calculation of flash flood guidance
- The model parameter estimation uses spatial analyses of various available Geographical Information System data layers such as soil properties, land use-land cover, and terrain information (slope, etc.)
  - *A priori* parameterization approach

Flash Flood Guidance

36 – HOUR FORECAST V. FIELD REPORTS



36 – HOUR FORECAST V. PHOUTOS AND TWITTER



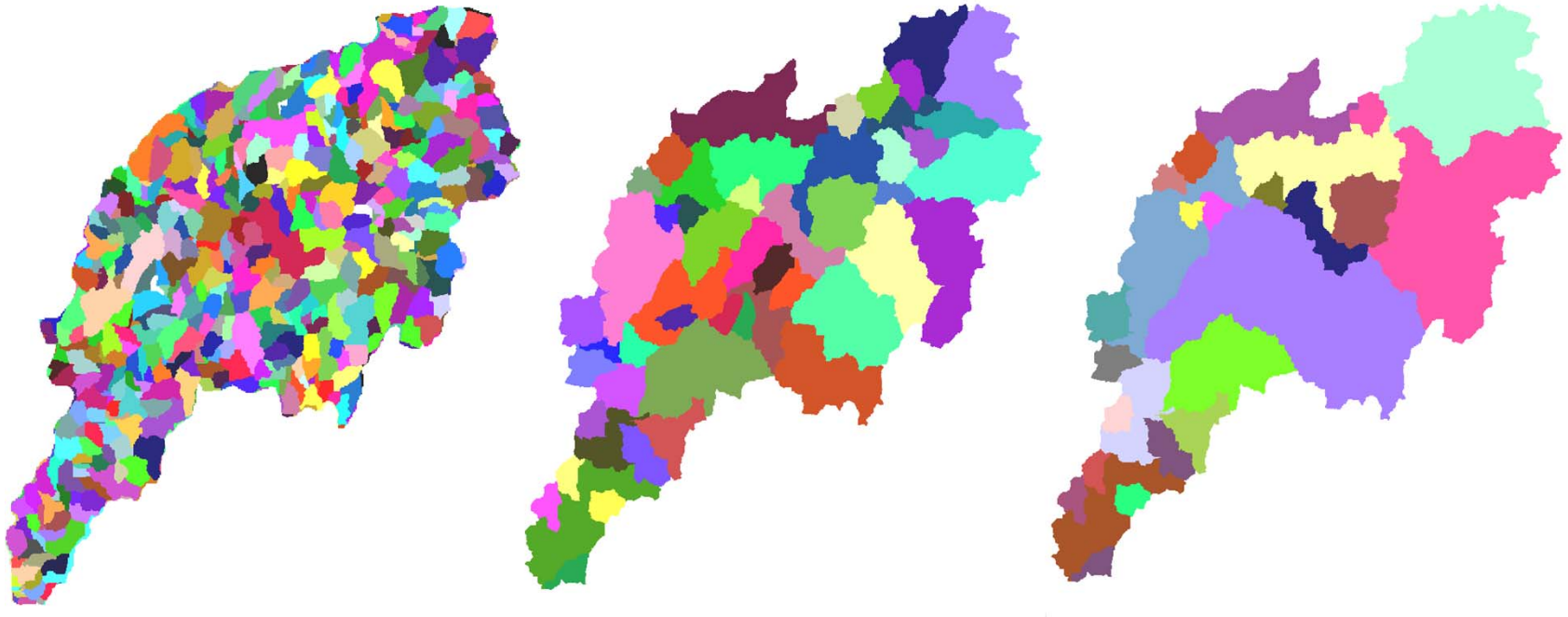
Large River Floods

Large River Flooding

- Need for advanced hydrologic models for river (flood) and water resources forecasting to complement traditional river forecasting
- Advances in hydrologic science are toward models that are more accurate and robust
- These advances have focused on modeling on smaller scales

Large River Flooding

It's a Matter of Scale – Lumped v. Distributed



High Resolution Low

Large River Flooding

- Lumped approach – historical precedence
  - Uses assumptions of uniform conditions (one unit), which distort the hydrologic characteristics of the basin
  - Model parameters are spatially averaged over the basin
    - Uniform terrain, soils, vegetation, land-use
    - Uniform model forcing (temporal and spatial distribution of precipitation)

Large River Flooding

- Distributed modeling – looks to address the shortcomings of the lumped models
  - Represents hydrologic processes in more spatial detail
  - Become more of an option with availability of higher resolution data sets (terrain, soils, land use)
  - Increase in computer capabilities

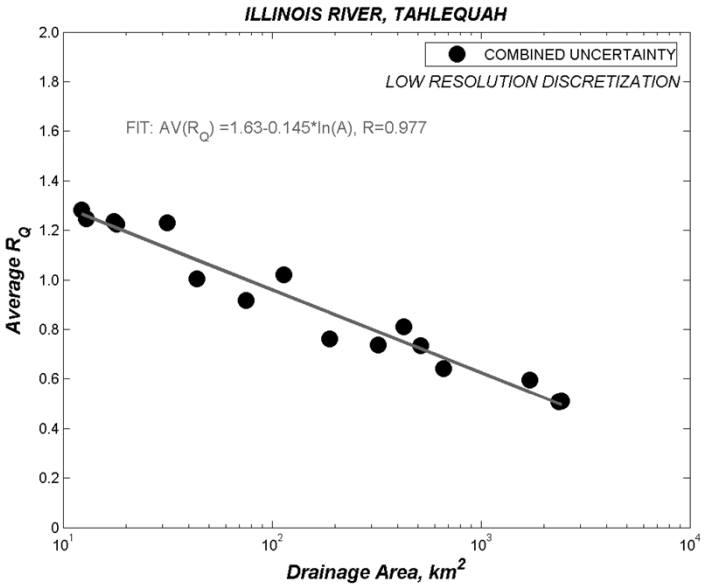
These allow for calculations on smaller scales

Large River Flooding

- Distributed Models
  - Use model parameters related to spatial variability of the physical characteristics of the basin (terrain, soils, land cover)
  - Incorporate spatial variability of precipitation – accounting for:
    - Orographic precipitation
    - Rain v. snow
  - Can obtain hydrographs at ungauged locations in the basin

Large River Flooding

- Distributed models – howevers
  - Smaller scales mean greater uncertainty



Combined uncertainty for model parameters and precipitation

Large River Flooding

- Distributed Model – howevers
  - Do they really provide more accurate flow simulations
  - How good are the interior hydrographs
  - How well do they work in an operational setting
    - Forecasters provide runtime modifications and updates
    - Computer requirements to run in real-time
  - What are precipitation input requirements
  - Studies – DMIP by U.S. NWS

Water Resources Management

Operational GFS Weather Forecasts
20 ensemble members
Twice a day 0-16 days

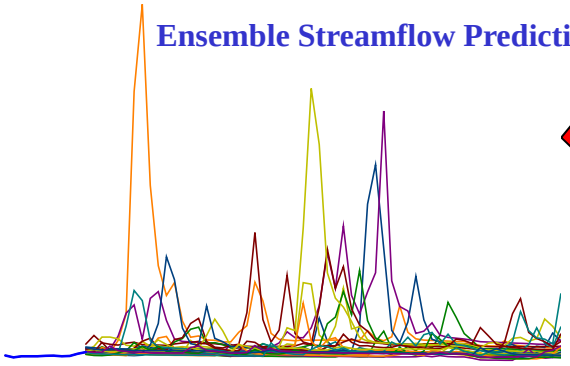
Operational CFS
0-30 days
Once a day 16 – ensemble members

Downscale

WRF - Mesoscale atmospheric circulation model

ICRM - Simplified land surface model

Ensemble Streamflow Prediction



Hydrologic model
(streamflow and soil moisture)

Reservoir Operation Model


Thank You