



Flash Flood Guidance System On-going Enhancements

Hydrologic Research Center

FFG System Enhancements

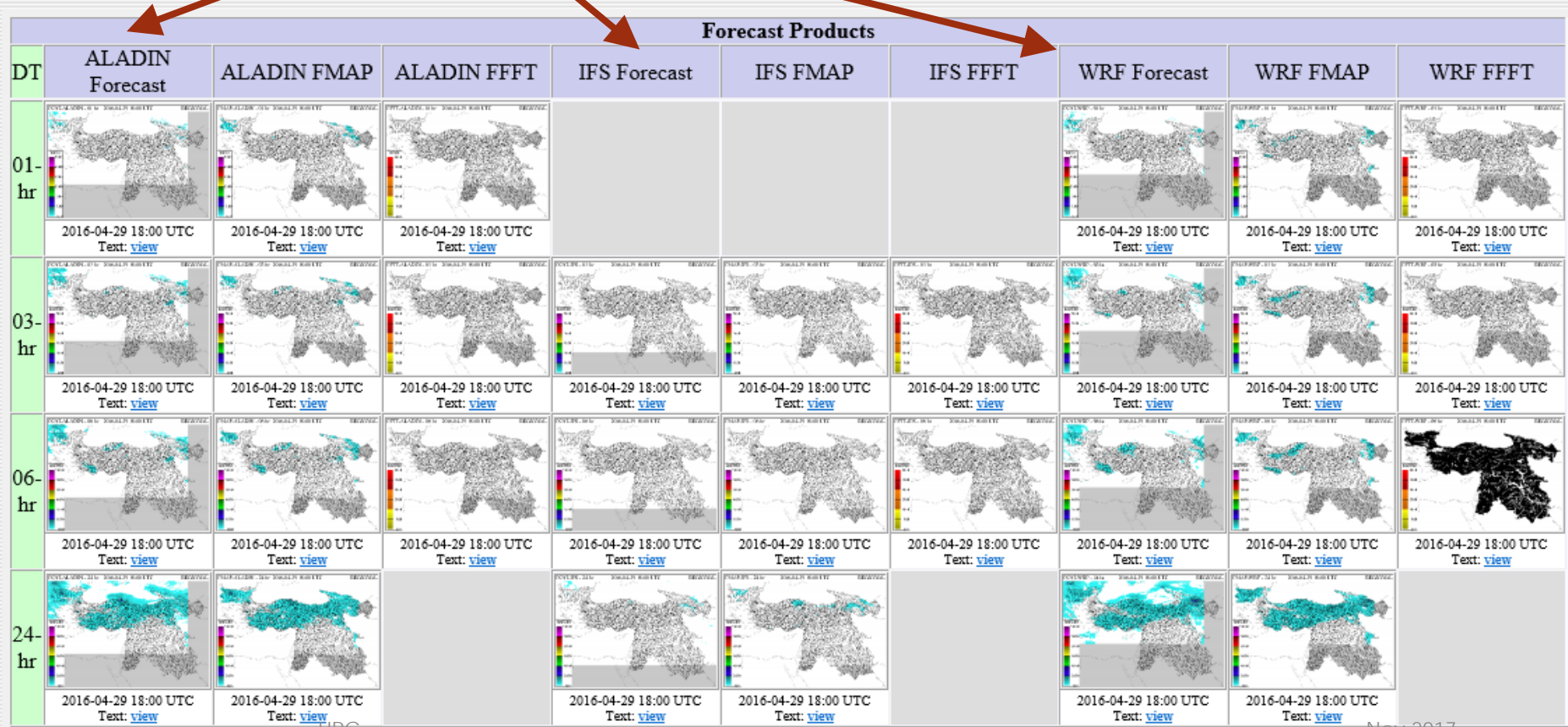
The following enhancements are in various stages of development and implementation based on specific country needs, expressed interest, funding priorities and cooperation.

- ❖ *Multi-model quantitative precipitation forecast (QPF) use within FFG systems*
- ❖ *Landslide susceptibility and landslide occurrence prediction*
- ❖ *Urban Flash Flood Warning*
- ❖ *Riverine routing and discharge ensemble prediction*
- ❖ *Seasonal to Sub-seasonal Ensemble Forecasting*

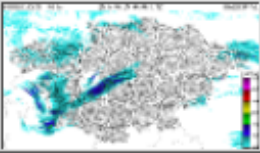
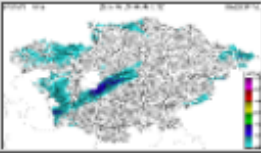

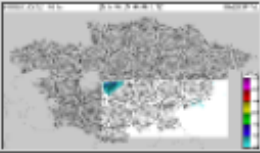


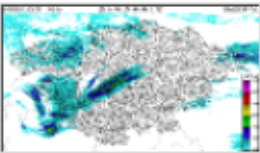
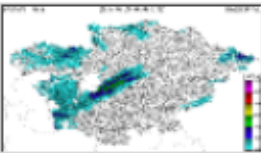
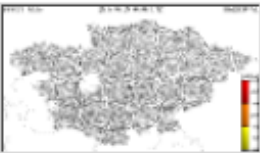
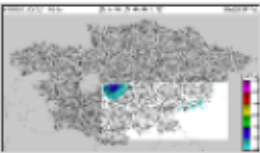
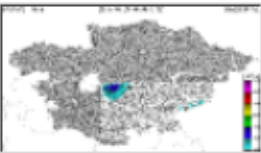

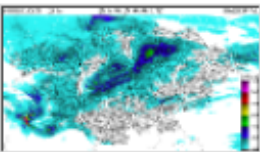
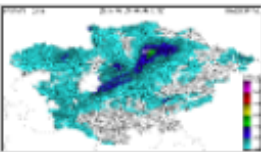
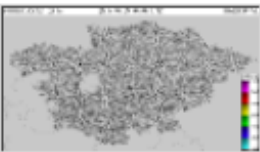
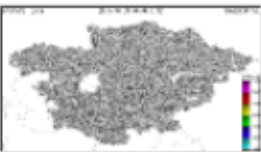
Multi-model QPF Use

Example from the Black Sea Middle East (BSMEFFGS)

QPF from 3 operational NWP models available to forecasters

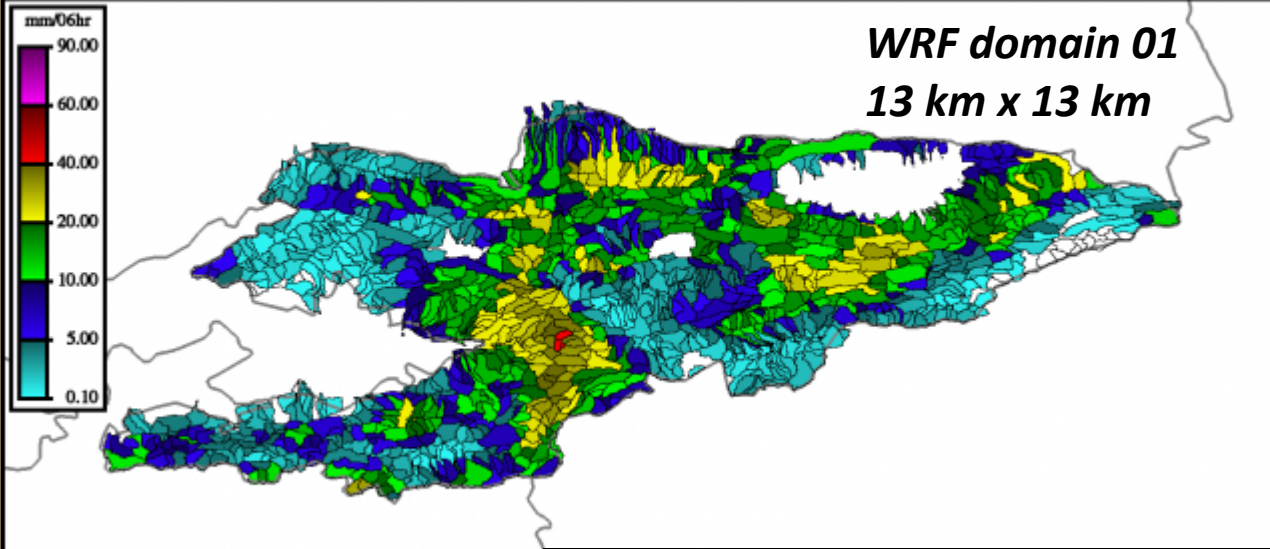


Multi-model QPF Use in CARFFG System

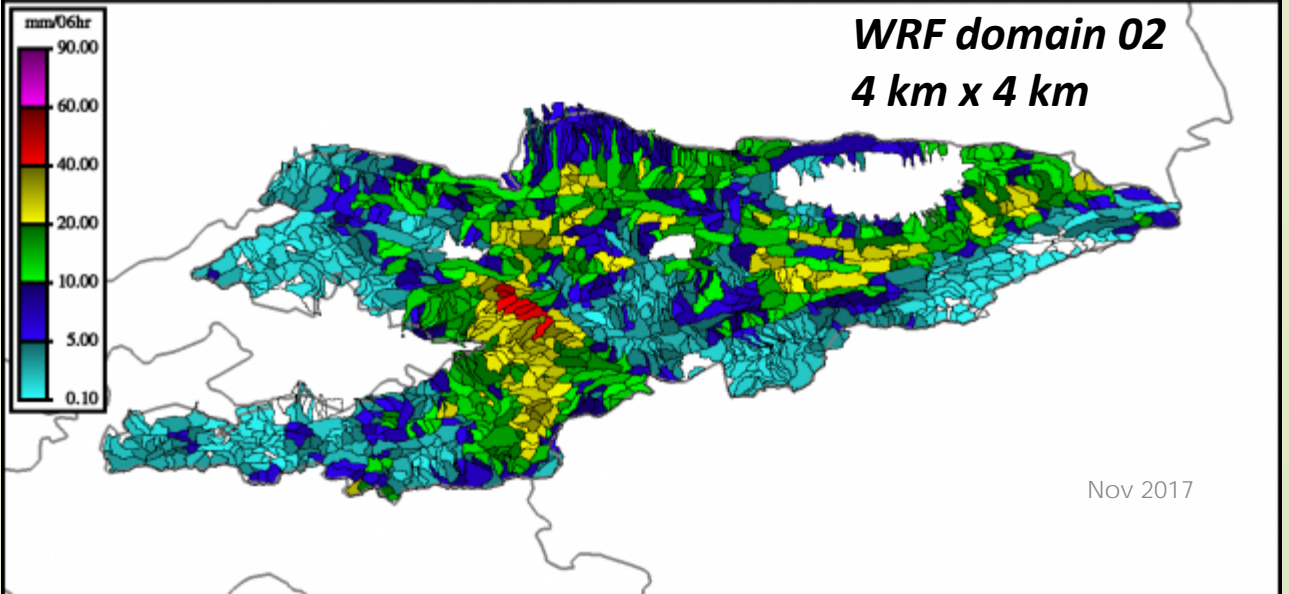
Forecast Products						
DT	WRF D01 Forecast	WRF D01 FMAP	WRF D01 FFFT	WRF D02 Forecast	WRF D02 FMAP	WRF D02 FFFT
01-hr						
03-hr	 <p>2016-09-29 06:00 UTC Text: view</p>	 <p>2016-09-29 06:00 UTC Text: view</p>	 <p>2016-09-29 06:00 UTC Text: view</p>	 <p>2016-09-29 06:00 UTC Text: view</p>	 <p>2016-09-29 06:00 UTC Text: view</p>	 <p>2016-09-29 06:00 UTC Text: view</p>
06-hr	 <p>2016-09-29 06:00 UTC Text: view</p>	 <p>2016-09-29 06:00 UTC Text: view</p>	 <p>2016-09-29 06:00 UTC Text: view</p>	 <p>2016-09-29 06:00 UTC Text: view</p>	 <p>2016-09-29 06:00 UTC Text: view</p>	 <p>2016-09-29 06:00 UTC Text: view</p>
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Multi-model QPF Use in CARFFG System

FMAP1 - 06 hr 2016-10-02 00:00 UTC KYRGYZSTAN



FMAP2 - 06 hr 2016-10-02 00:00 UTC KYRGYZSTAN

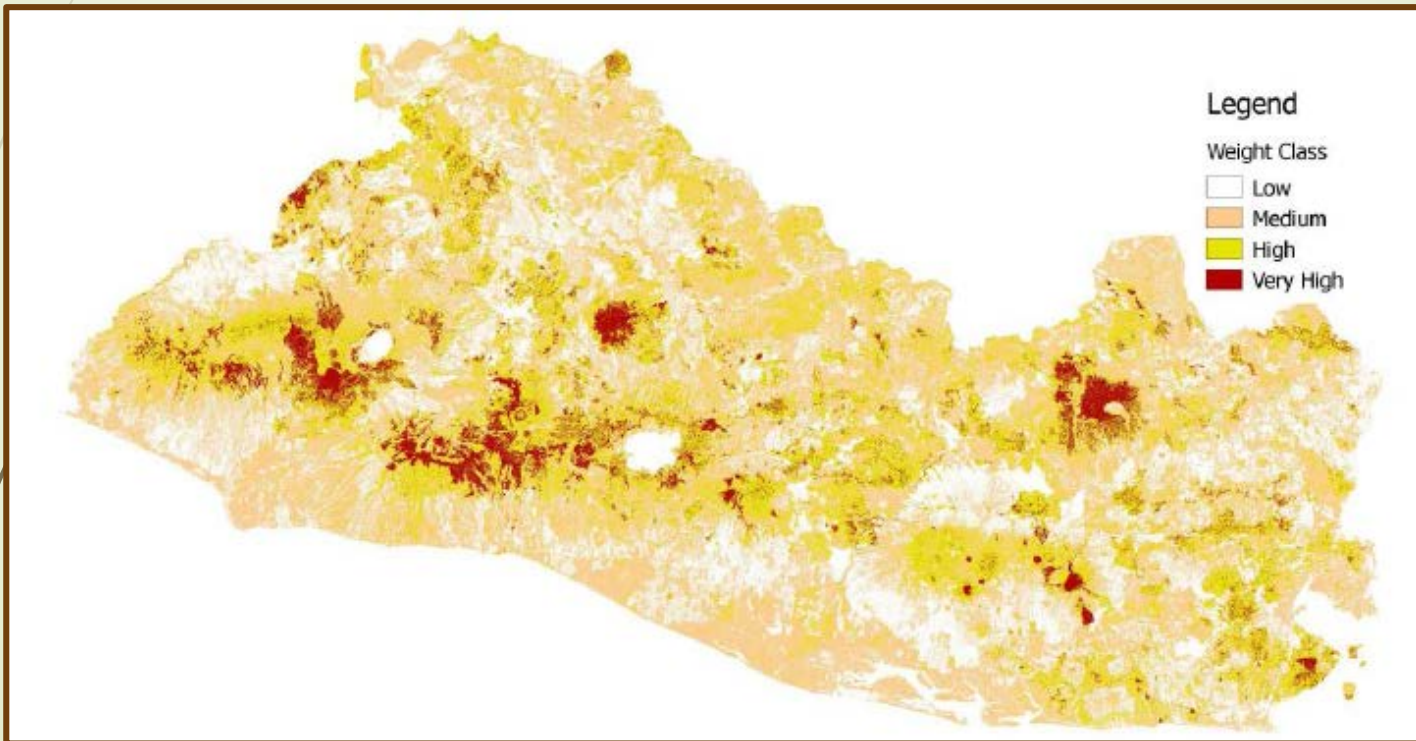


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Landslide Susceptibility

Relates susceptibility to landslides based on physical characteristics of land surface for historical landslide events, then extends to entire country/region.



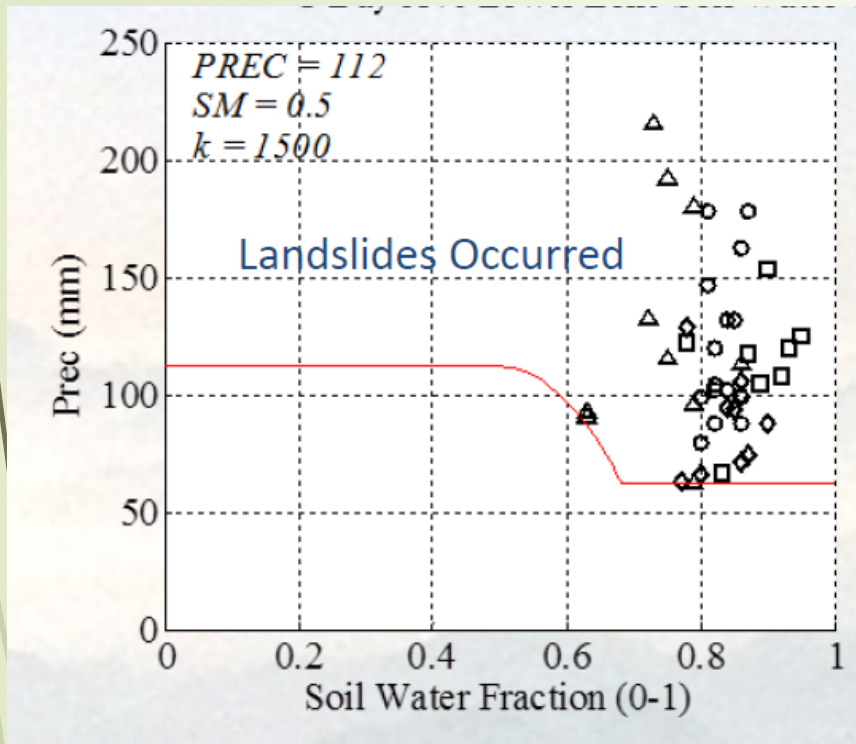
Example Susceptibility map for country of El Salvador within Central America FFG System (30m resolution). Categories of low, medium, high and very high.

Results from El Salvador then used throughout Central America.

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Landslide Assessment in Real-Time



Currently being deployed for Central America FFG System

1) From database of historical rain landslide events, develop threshold line of antecedent soil moisture condition and precipitation for those known events.

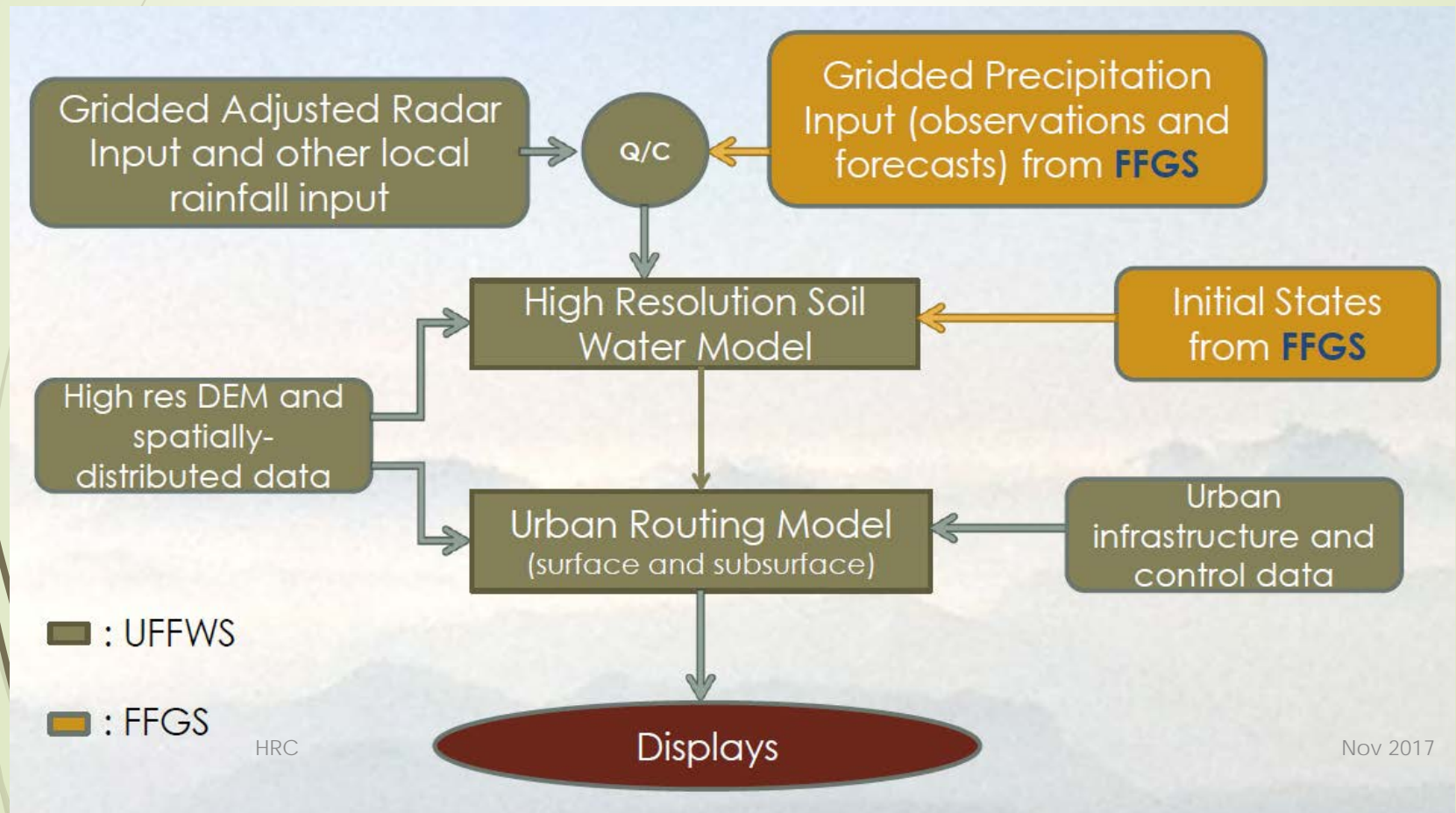
2) Use of real-time FFG system estimates of lower soil moisture and precipitation to identify at-risk watersheds.

3) And then the landslide susceptibility map to identify critical regions within watersheds.

Historical analysis is data-intensive, requiring quality records of landslide occurrence, location and other attributes.

Urban Flash Flood Warning

Builds upon data available from FFGS (precipitation, model conditions) and includes high resolution modeling in urban area to include both surface and subsurface flow routing.



Urban Flash Flood Warning

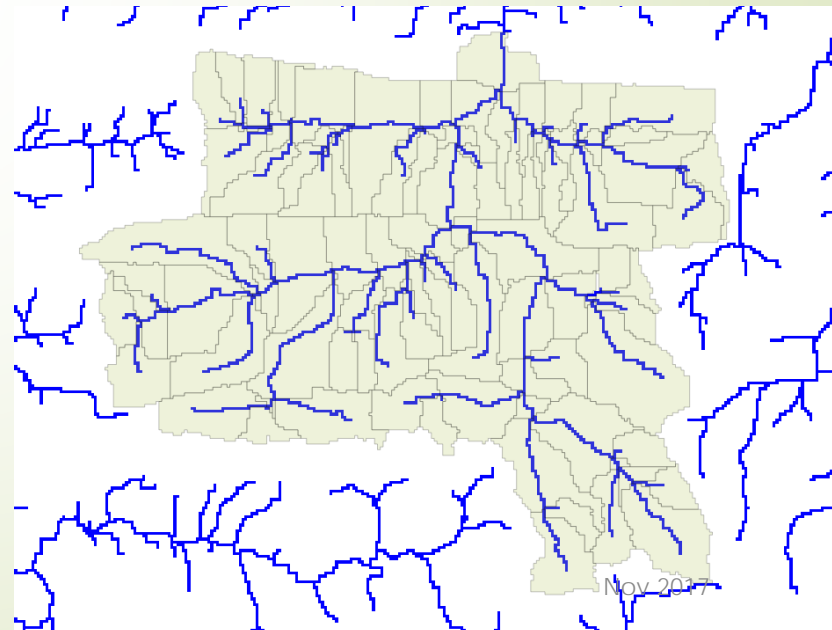
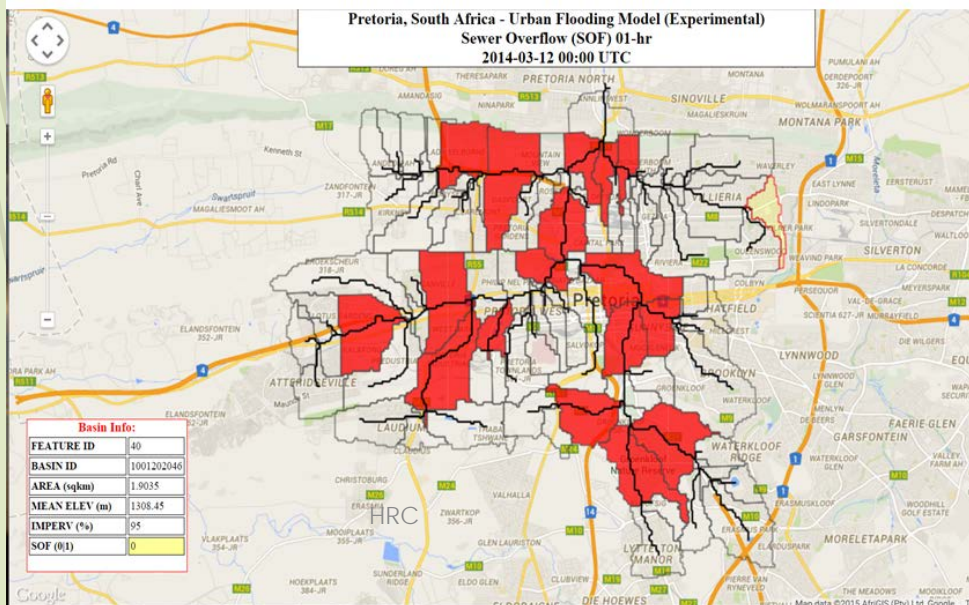
Demonstration for the municipality of Pretoria, Rep. of South Africa.

Requires urban storm sewer information.

Urban watersheds define at a resolution of 2km².

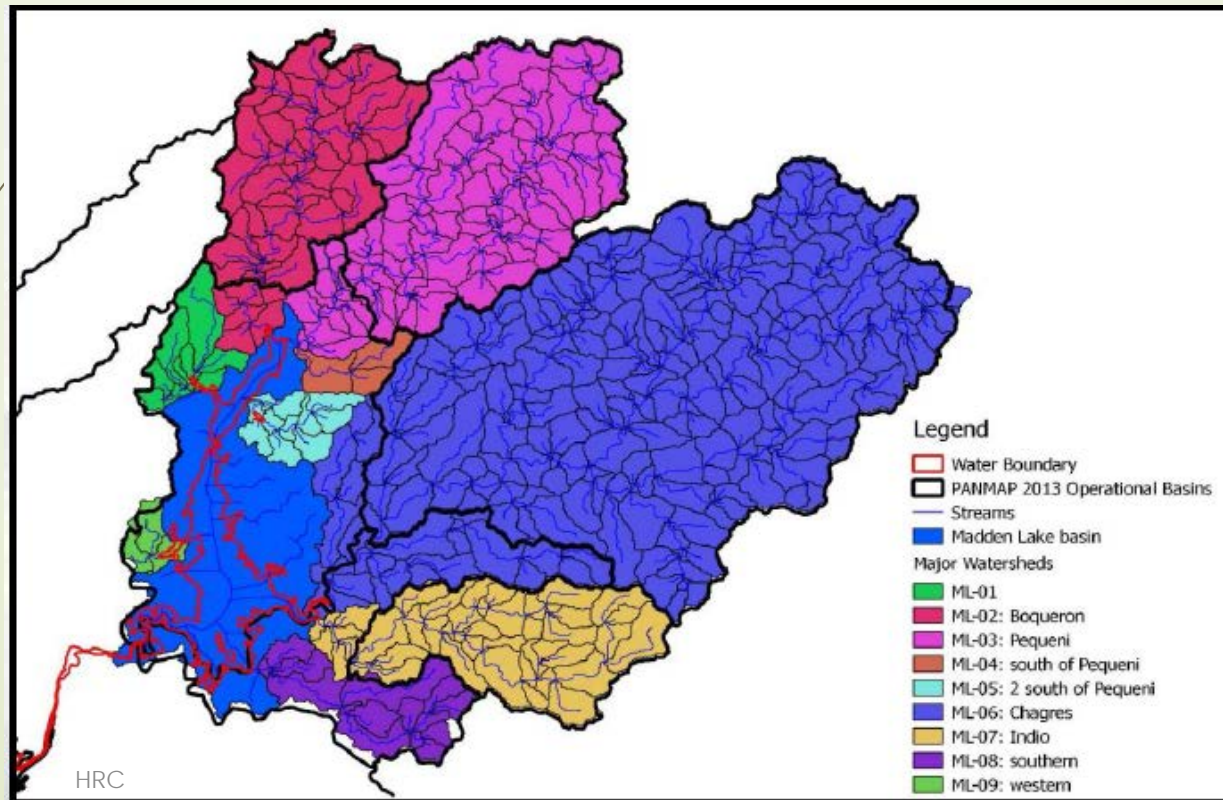
Surface and subsurface flow modeled.

Red watersheds below indicate where system indicates storm sewer overflow.



Riverine Routing and Ensemble Discharge Prediction

Extracts sub-catchment runoff from FFG System and routes river flow through channel network at high resolution to estimate discharges. Algorithms developed to consider operation of large reservoirs (requires information on operating curves).



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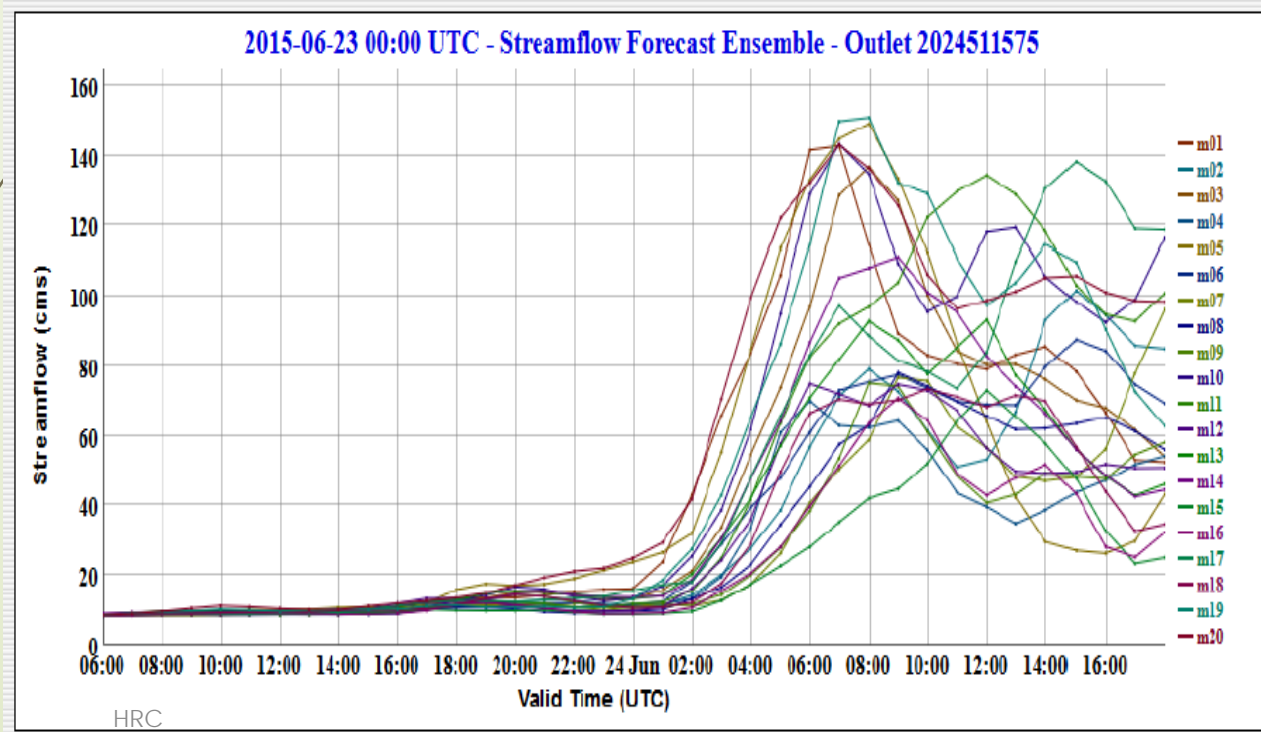
Example of distributed flow modeling network from the Panama Canal.

Riverine Routing and Ensemble Discharge Prediction

Ensemble discharge prediction if multiple NWP predictions or ensemble NWP results from single model are available.

Longer lead time of NWP predictions is required (> 48hours).

Bias adjustment on forecast precipitation will also be required.



Example of ensemble discharge prediction from Panama.

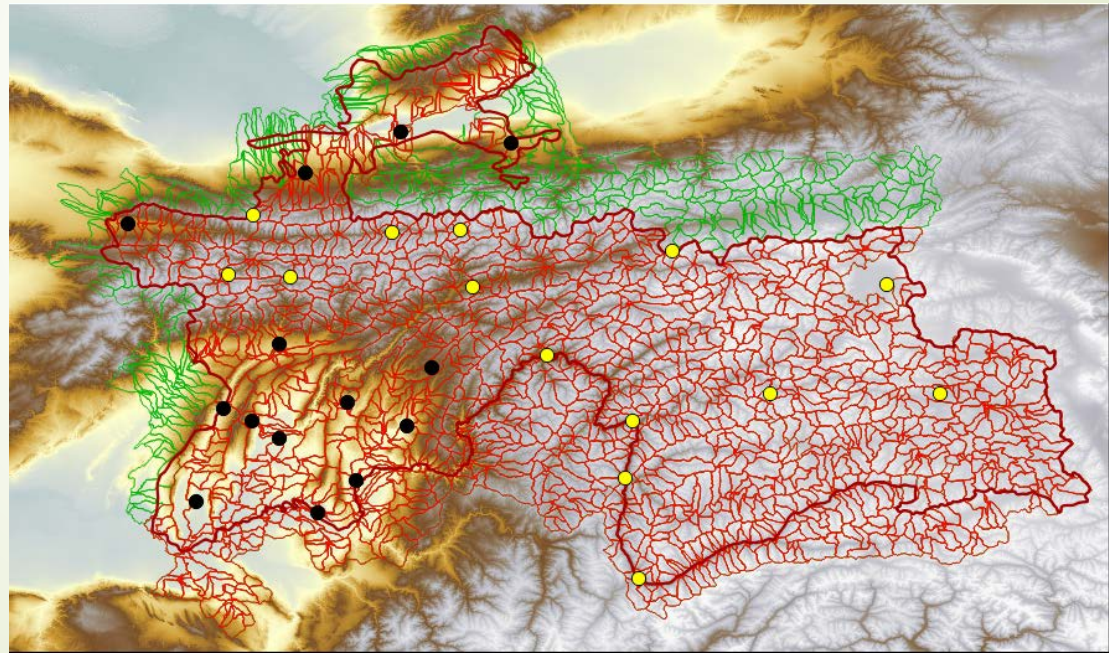
Seasonal to Sub-seasonal Ensemble Runoff and Flow Prediction

Objective:

To provide timely estimates of snow water equivalent, and of snowmelt and rain runoff for the FFGS Delineated Basins using the available data and FFG system enhanced models

Application:

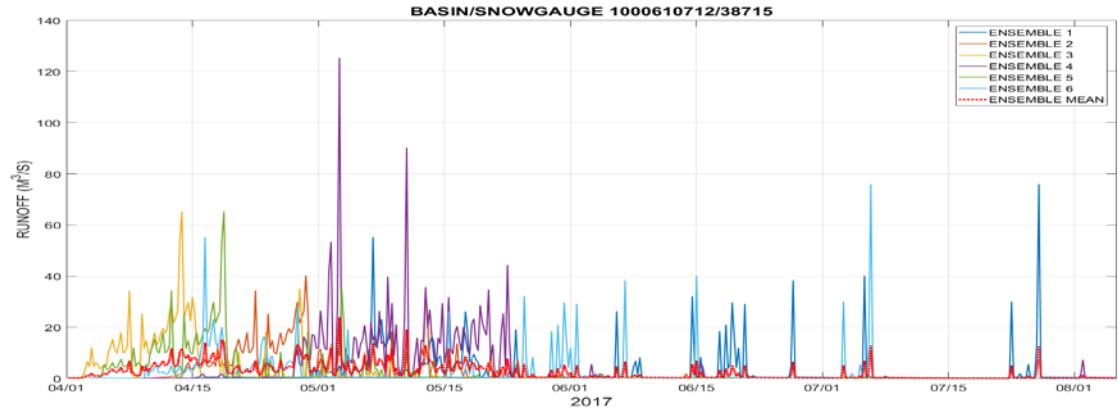
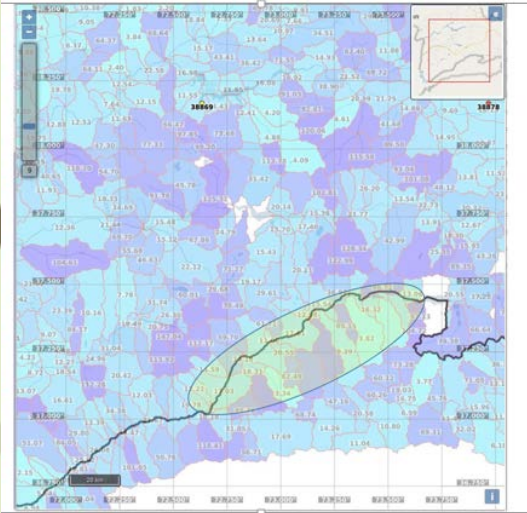
Tajikistan Off-Line using the CARFFG products



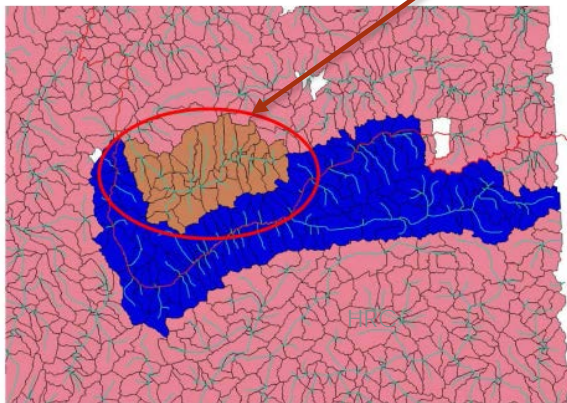
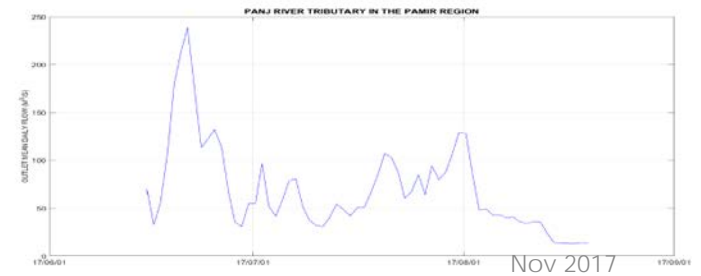
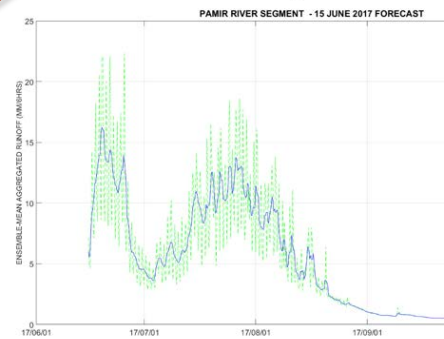
Seasonal to Sub-seasonal Ensemble Runoff and Flow Prediction

Ensemble Forecast Time Series for a 84.63-km² basin (1 April 2017)

Interactive Maps for Runoff Volume



Median Runoff and River Flows (South Tajikistan)



On-going Enhancements to FFG Systems

