FFGS Additional Functionalities and Products

Konstantine P. Georgakakos, Sc.D.
HYDROLOGIC RESEARCH CENTER
23 May 2018

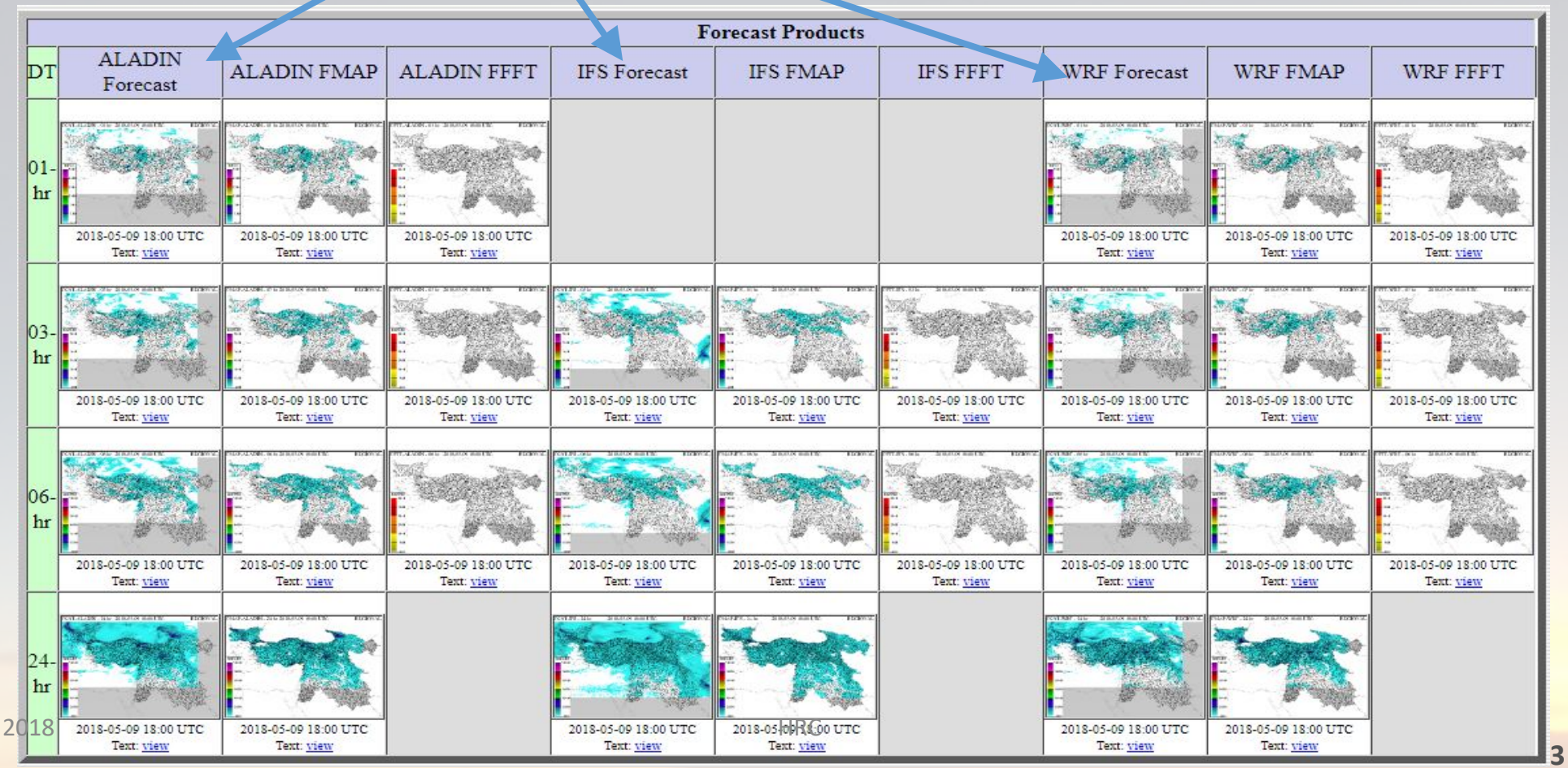
Advanced Functionalities

- 0. Multi-Model QPF
- A. Urban Flash Flood Warning
- B. Riverine Routing
- C. Landslide Occurrence Prediction
- D. Seasonal to Sub-seasonal Runoff and Flow Forecasting

0. Multi-Model QPF

Example from the Black Sea Middle East (BSMEFFGS)

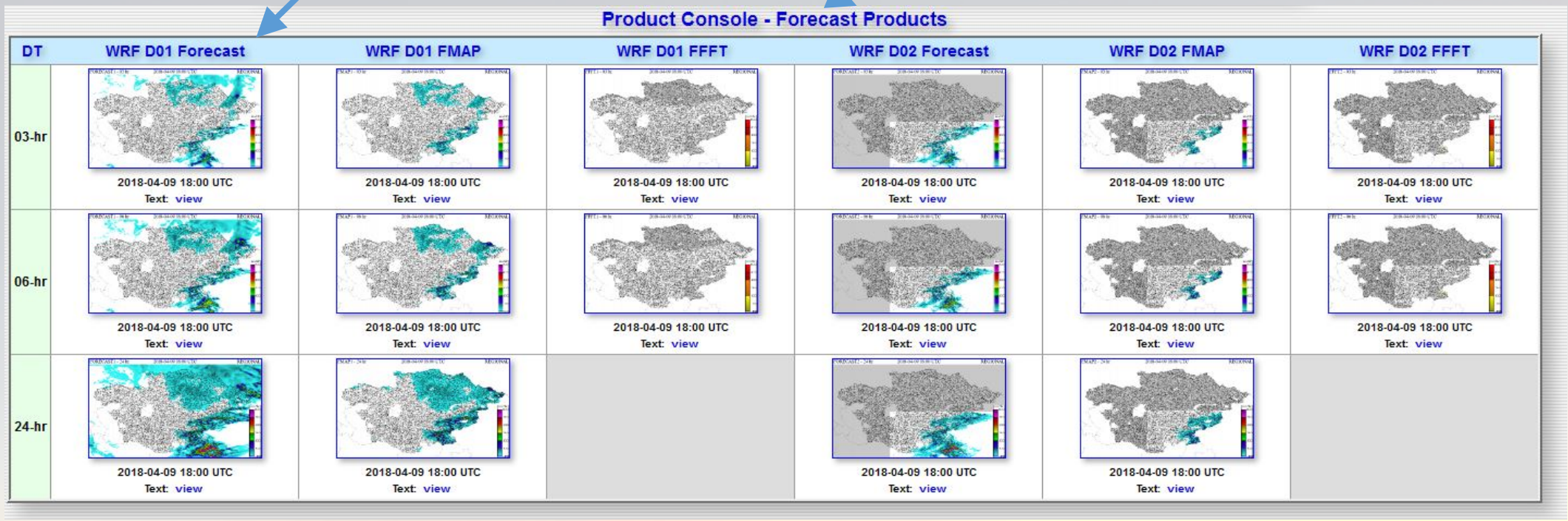
QPF from 3 operational NWP models available to forecasters



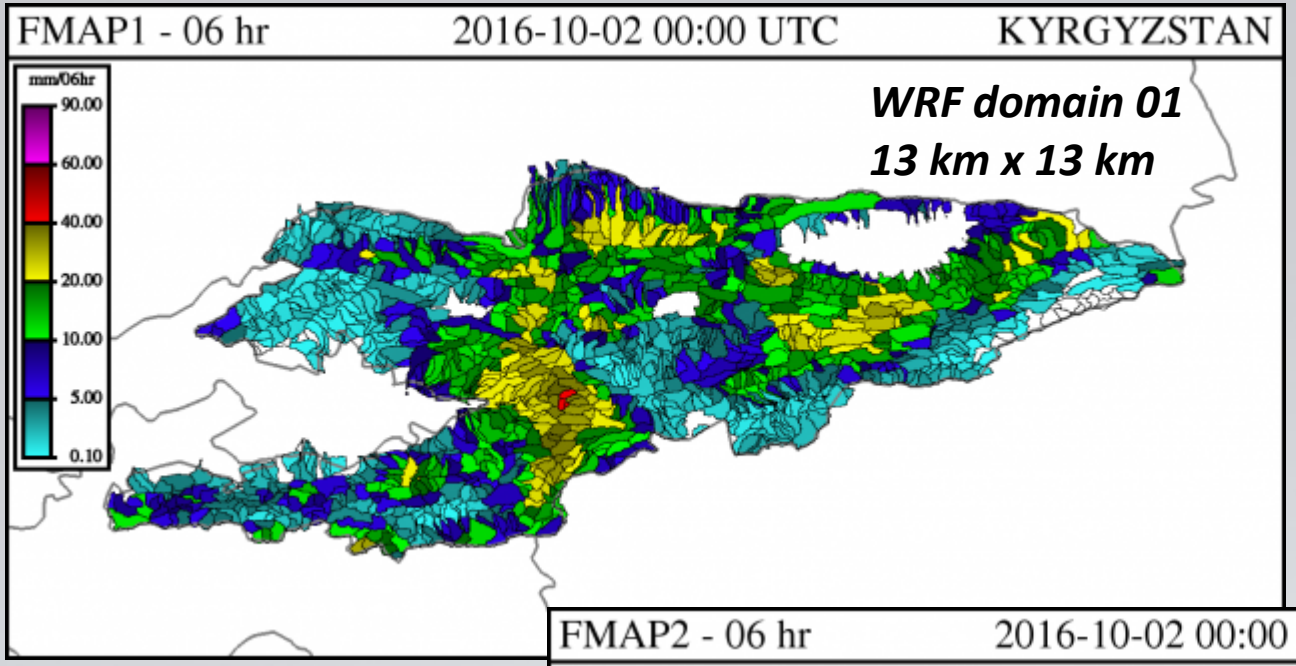
0. Multi-Model QPF

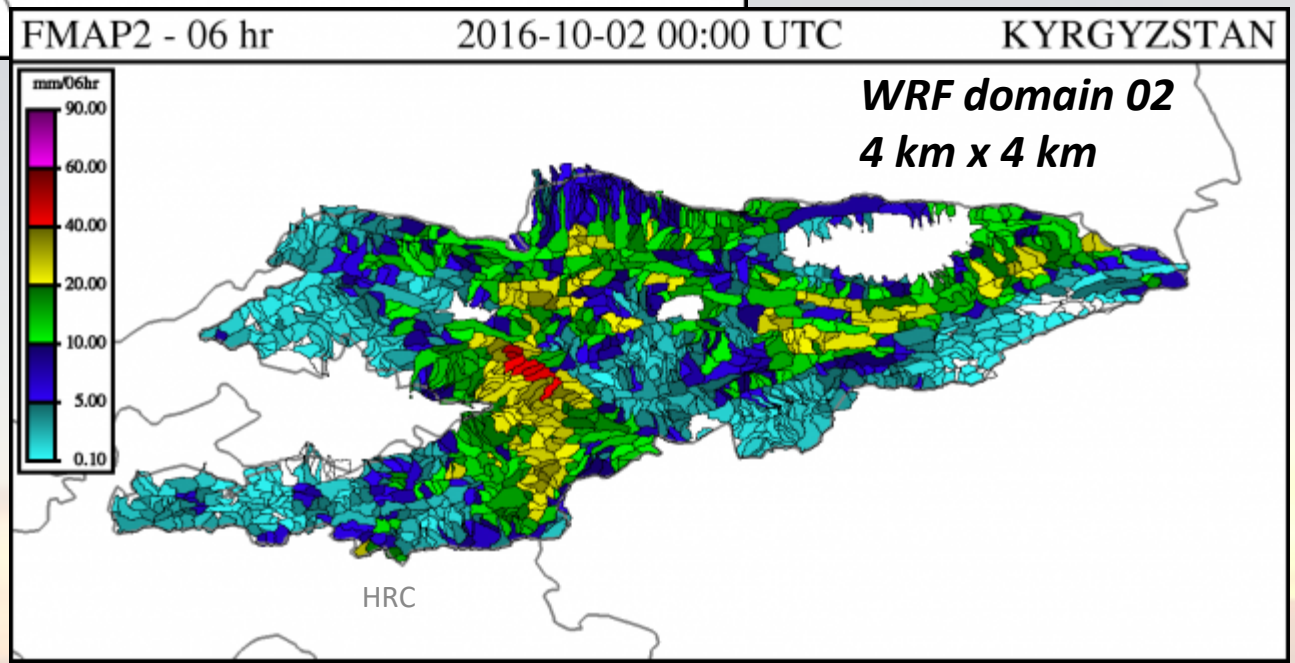
Example from the Central Asia Region (CARFFGS)

QPF from 2 operational NWP models available to forecasters

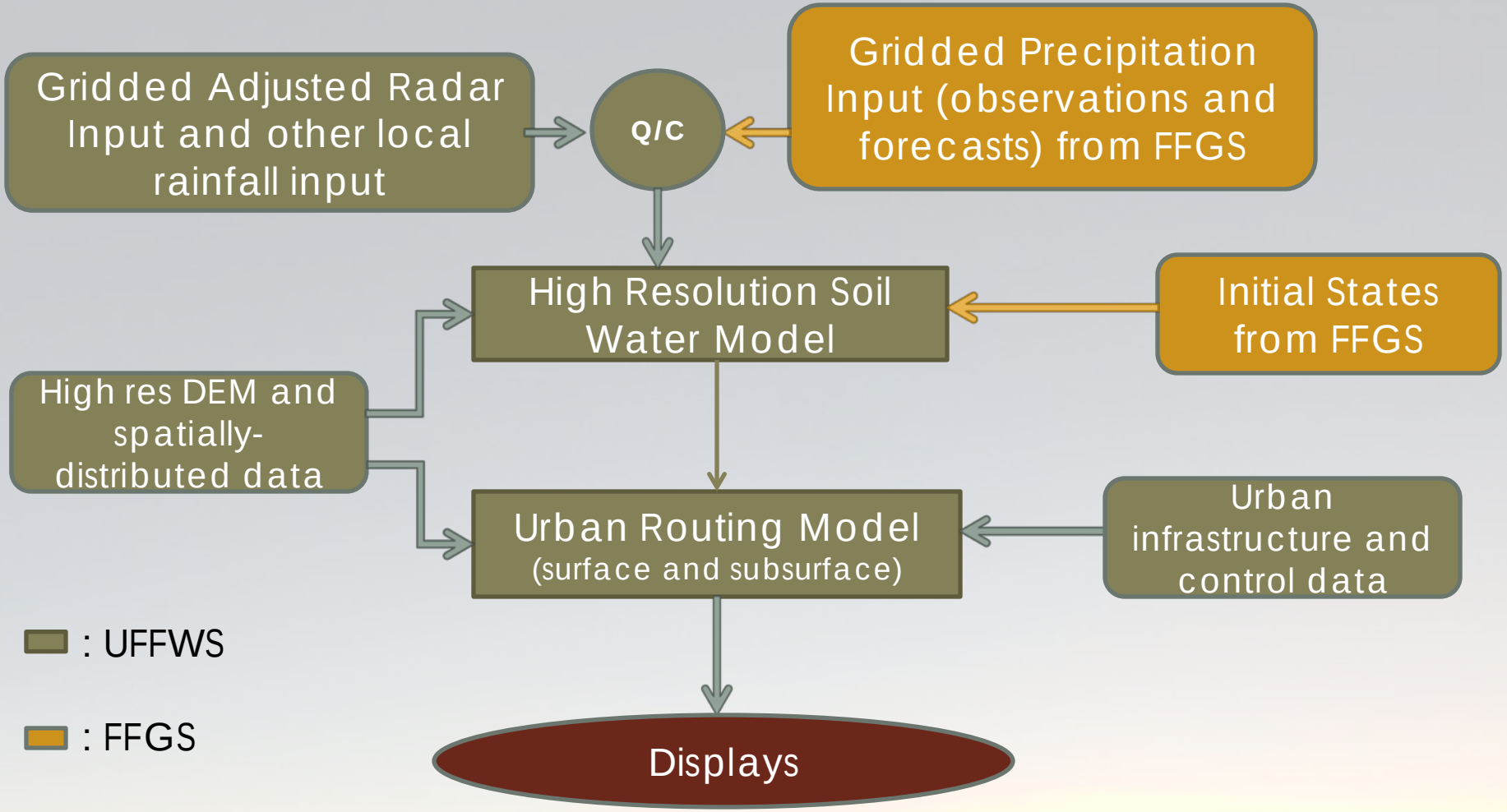


0. Multi-Model QPF

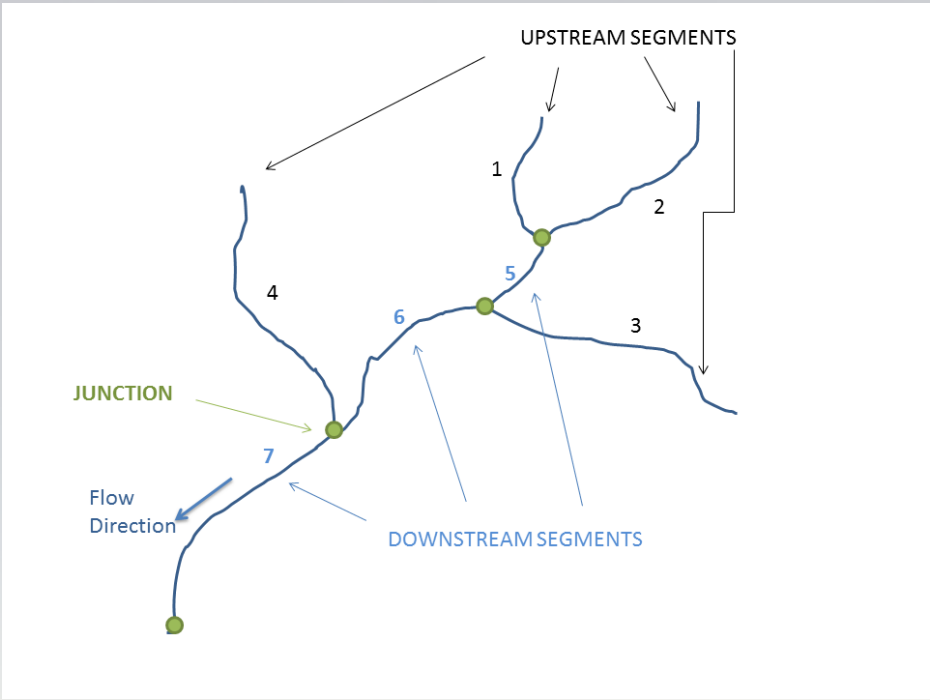


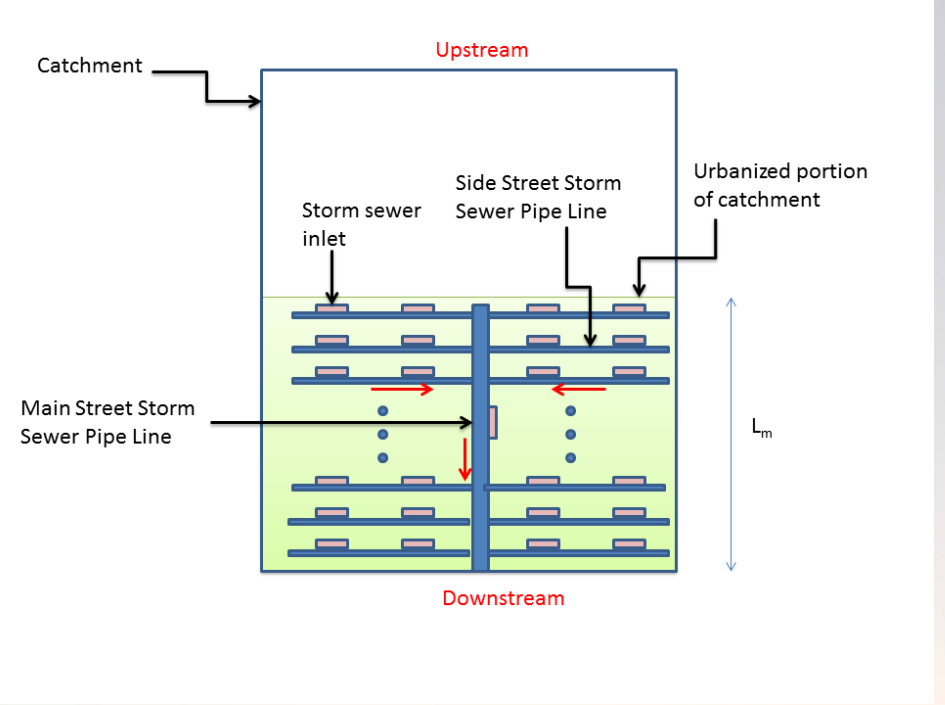


A. Urban Flash Flood Warning



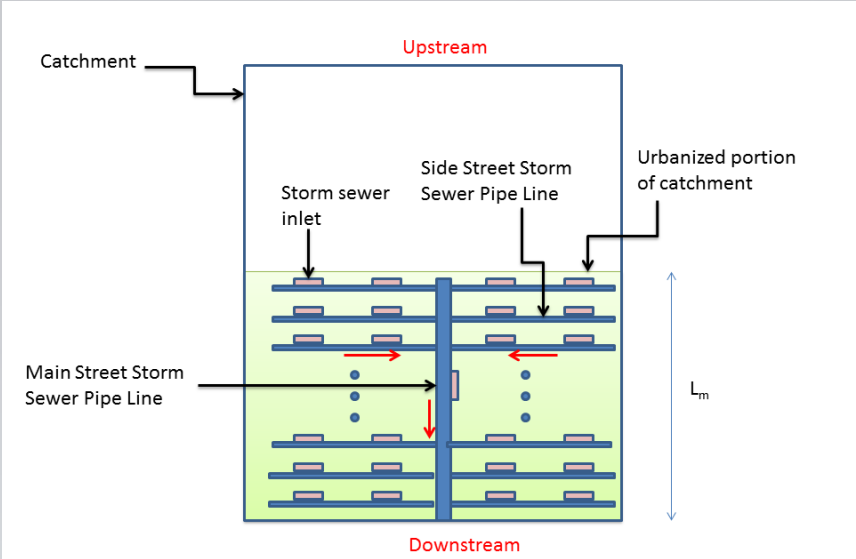
A.1 Basic Technical Elements UFFWS

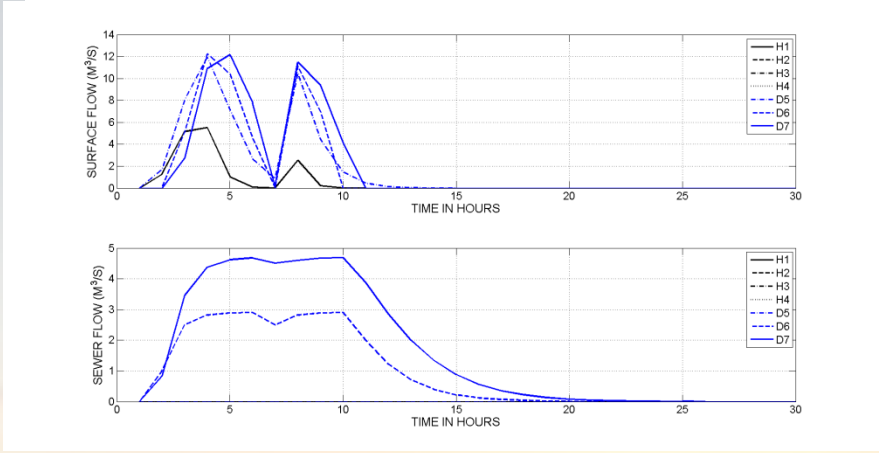




$$\partial y/\partial t + \partial(vy)/\partial x = 2q_L/B - f \qquad S_f = S_0 - \partial y/\partial x$$

A.1 Basic Technical Elements UFFWS





Total Rainfall Generating Inlet Capacity:

$(N_s+N_m)\ Q_T = (1/3.6)\ U_0 f_A\ A$

Total Storm Sewer Volume Capacity:

$$X_s^0 = \sum_{k=0}^{M} (\pi D_k^2 / 4)\ L_k$$

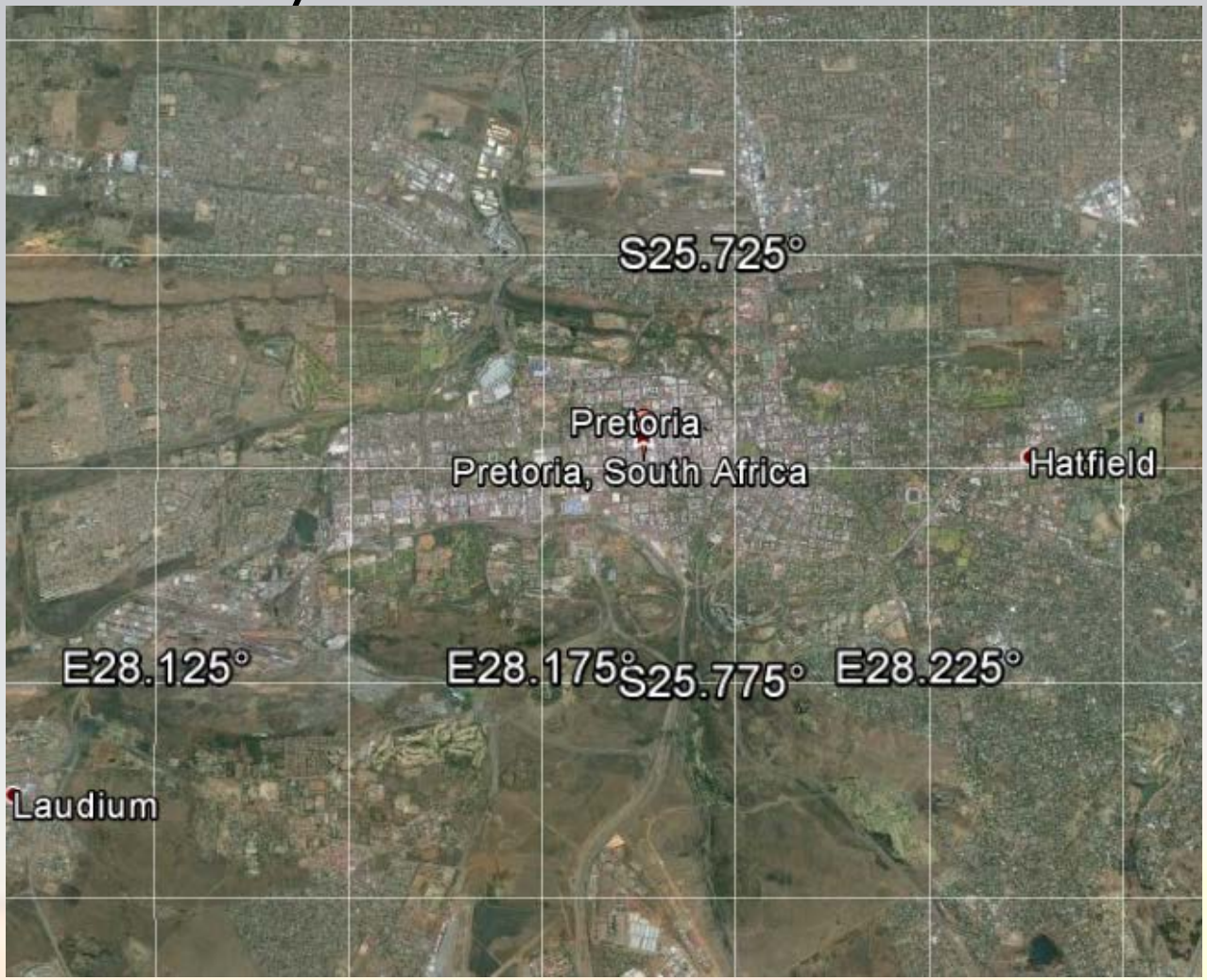
Time to Strom Sewer Overflow:

$T_s^0 = -(1/b)\ \mathbf{ln\{}1 - b\ X_s^0 / [(1/3.6)\ U_0 f_A\ A]\mathbf{\}}$

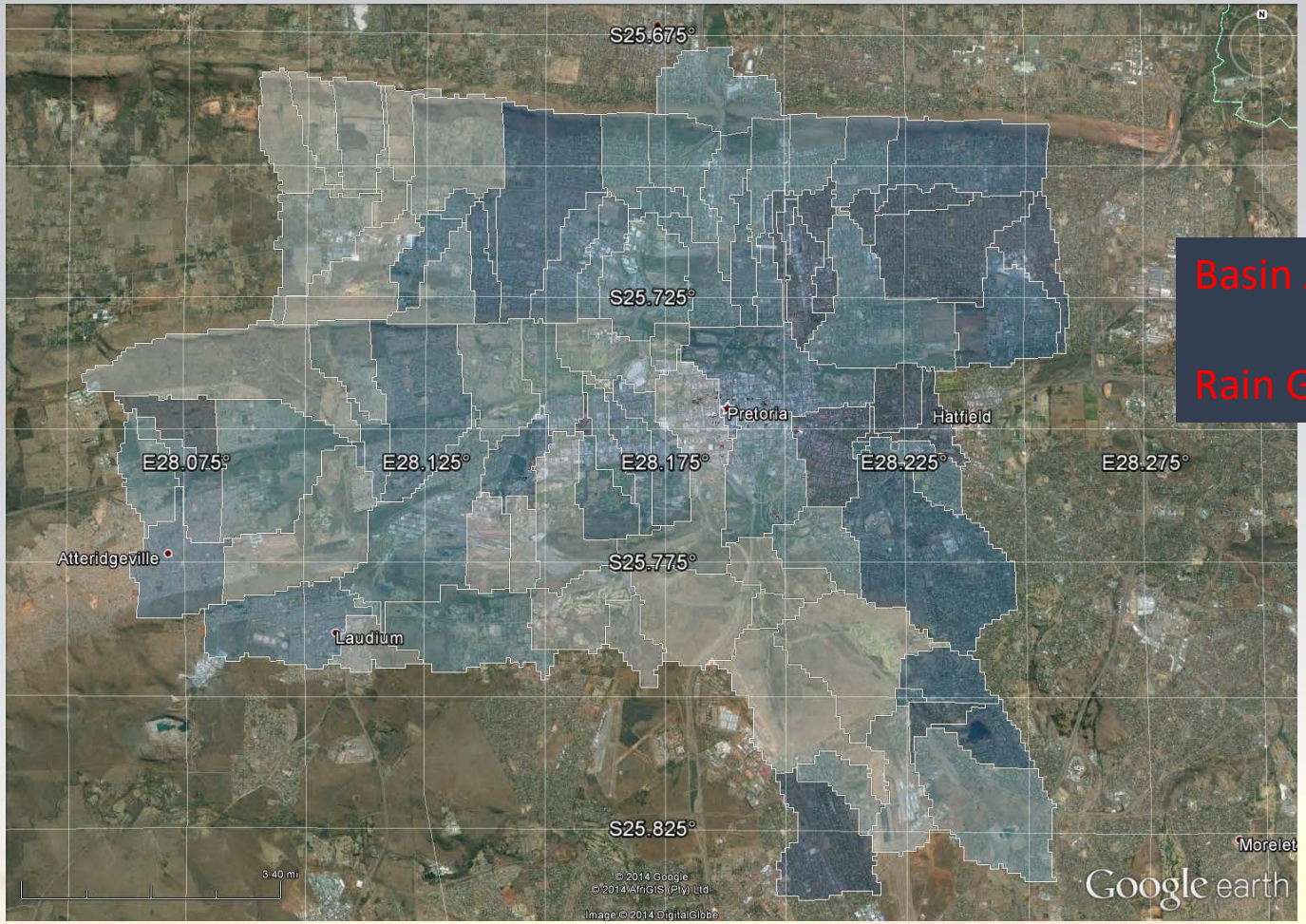
Scaling of Bankfull Q and Bankfull v:

$Q_{BNKF} = \alpha\ A^{\beta}$

A.2 Demonstration of Feasibility (City of Pretoria)



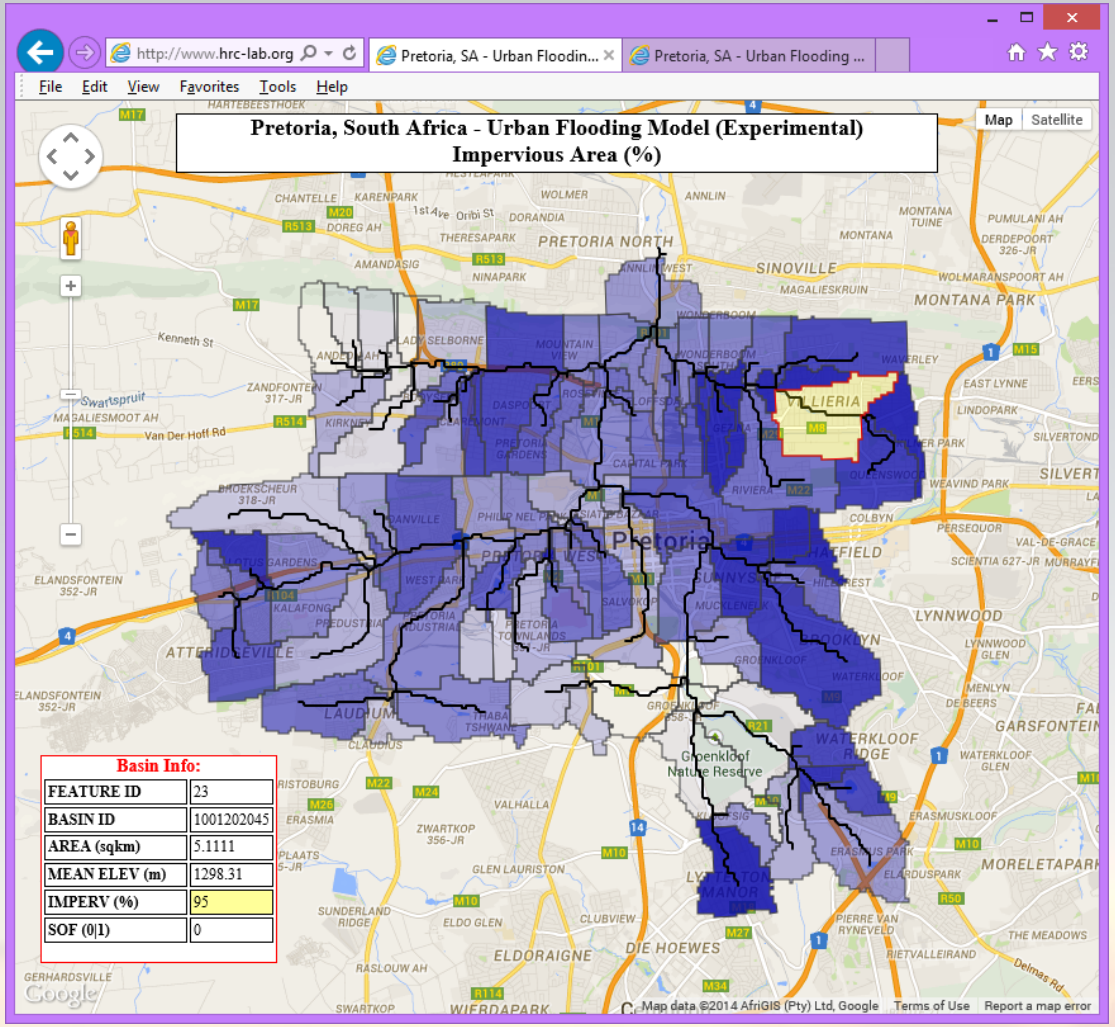
A.2 Demonstration of Feasibility (City of Pretoria)



Basin Areas: 1-5 km²

Rain Grid Area: 16 km²

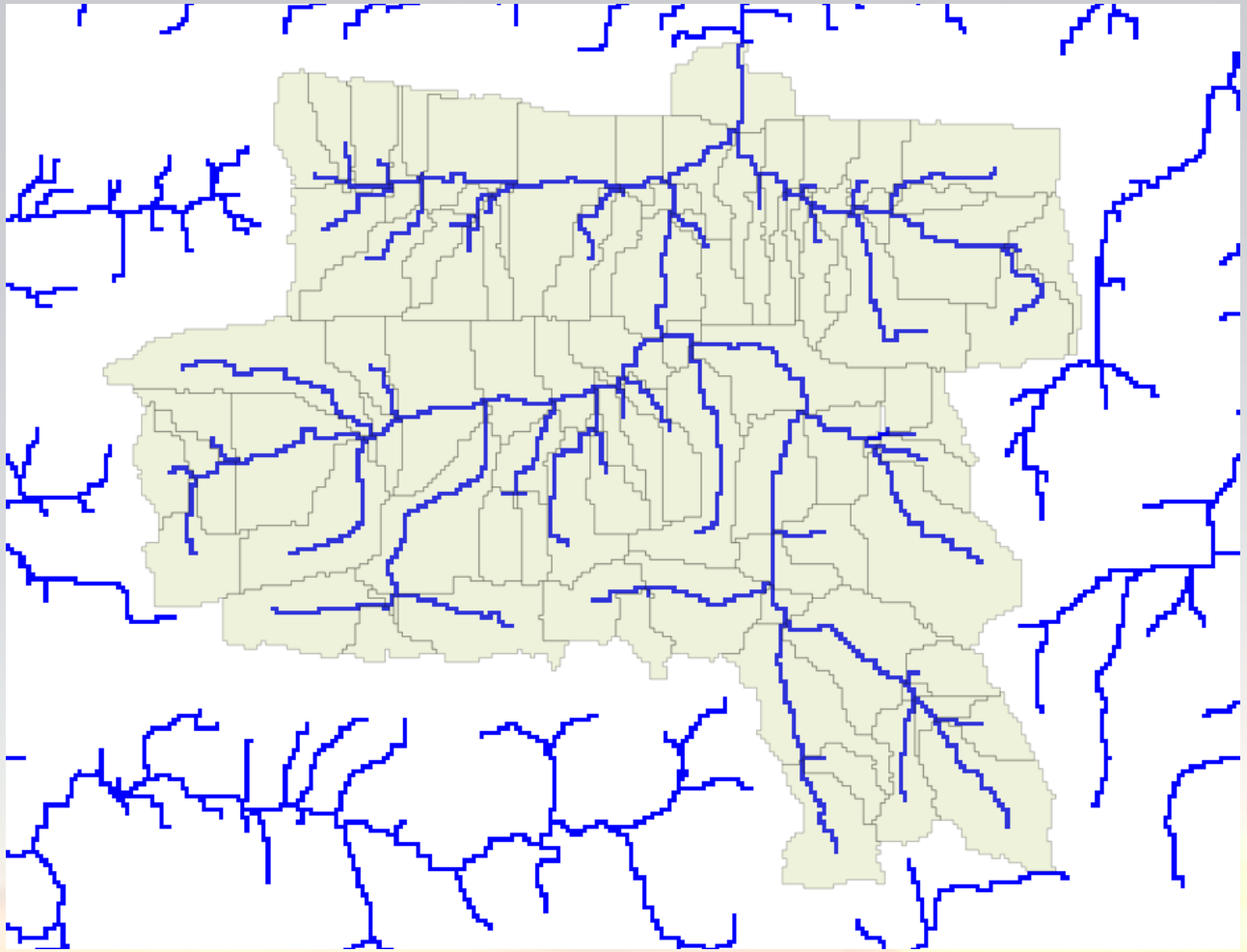
A.2 Demonstration of Feasibility (City of Pretoria)



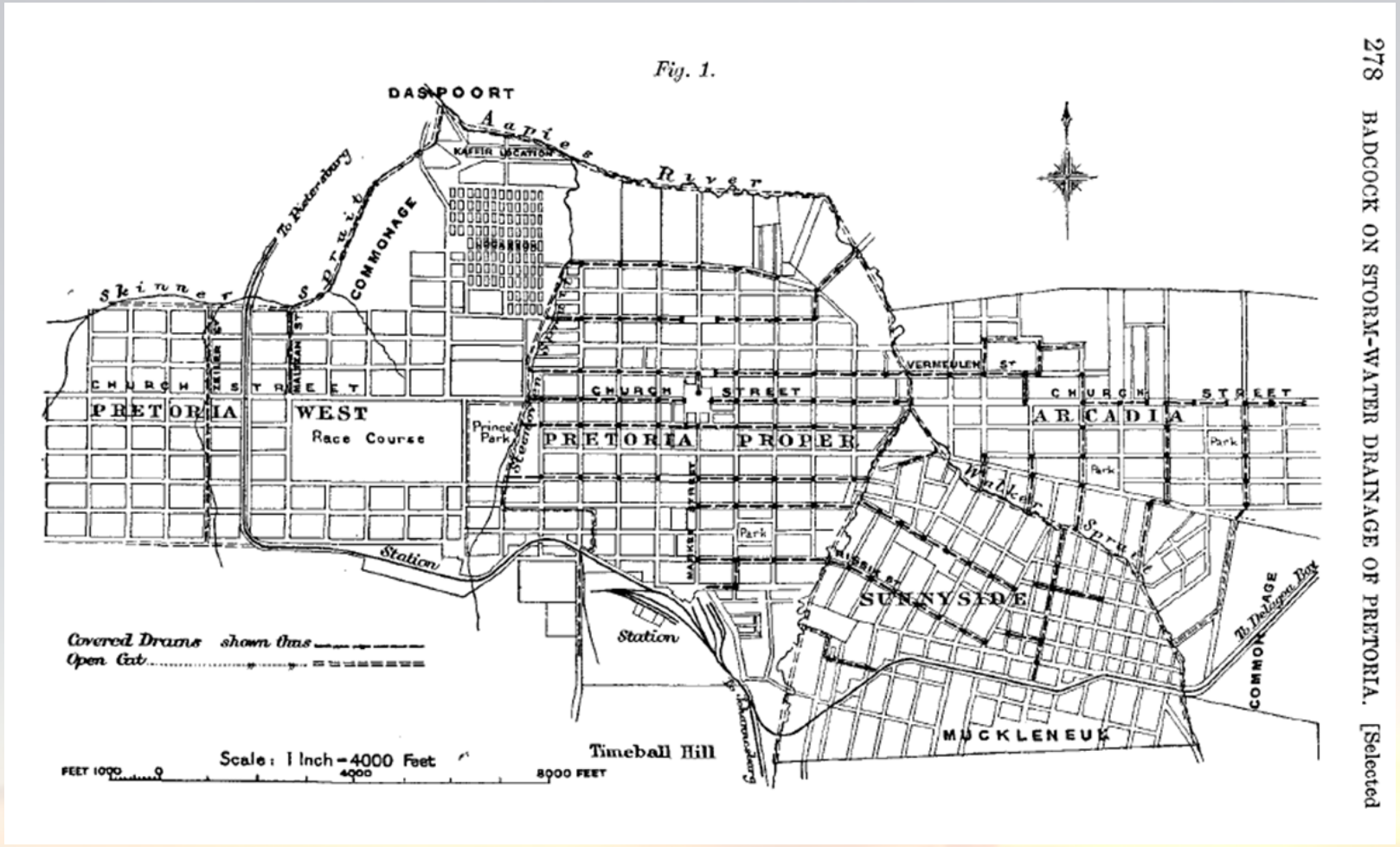
Av. Basin Area: 1-5 km^2

Rain Grid Area: 16 km^2

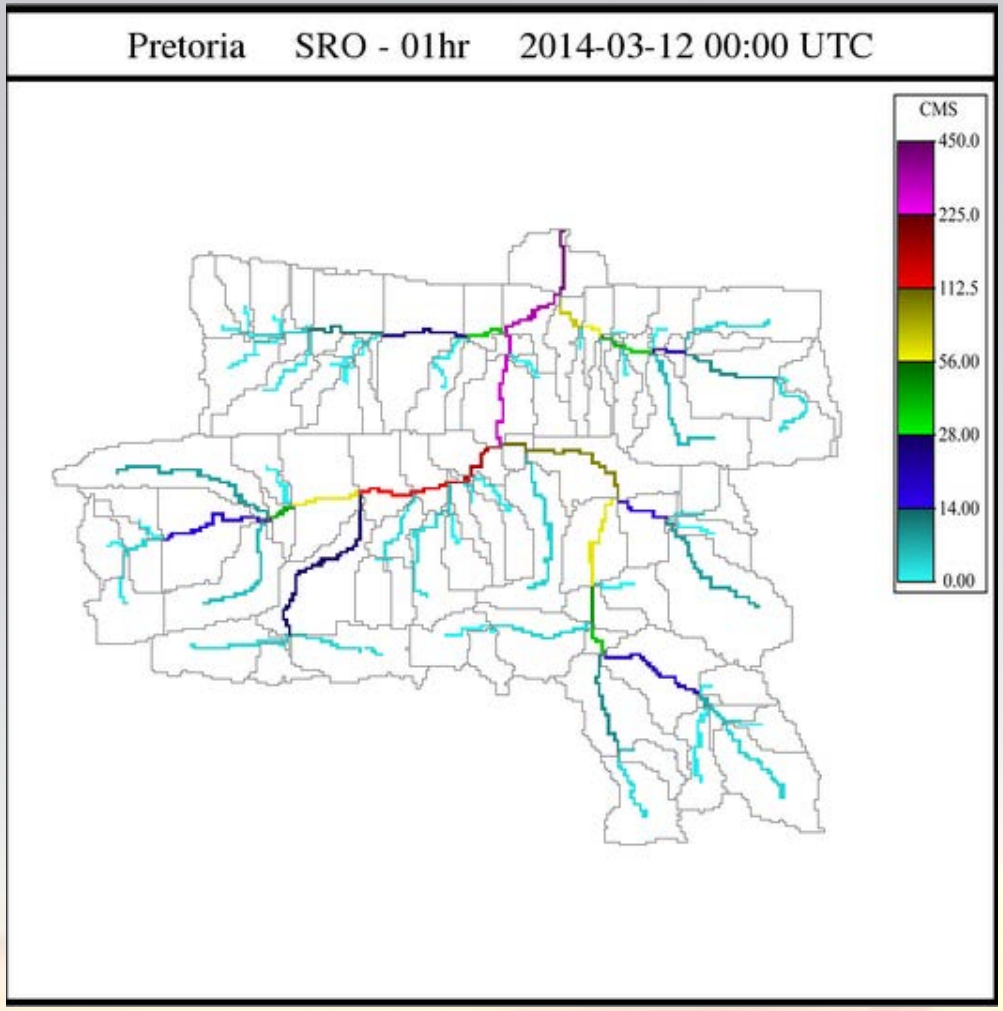
A.2 Demonstration of Feasibility (City of Pretoria)



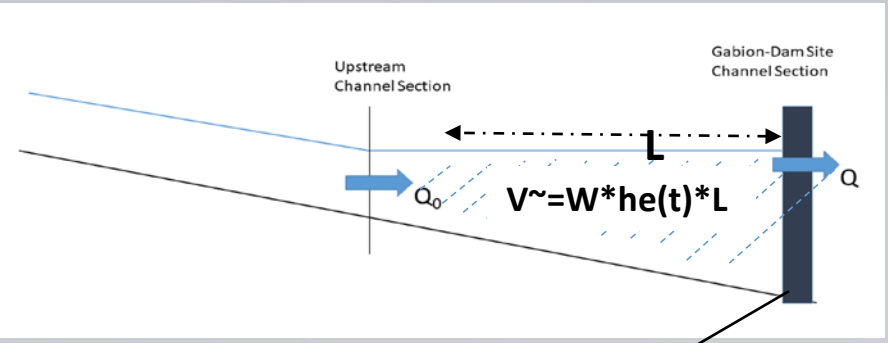
A.2 Demonstration of Feasibility (City of Pretoria)

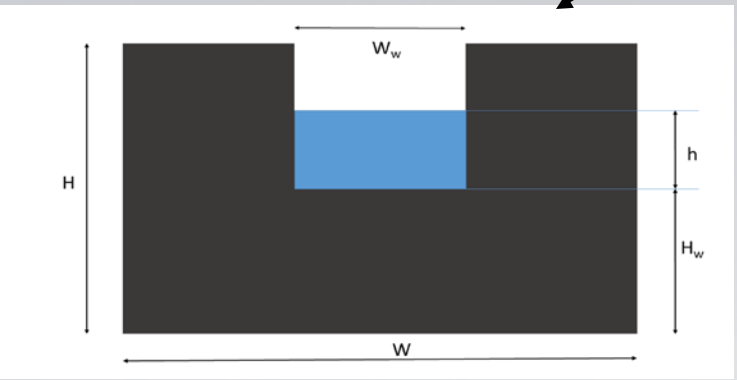


A.3 Example Surface Drainage Flow



A.4 Use for Flood Hazard Mitigation



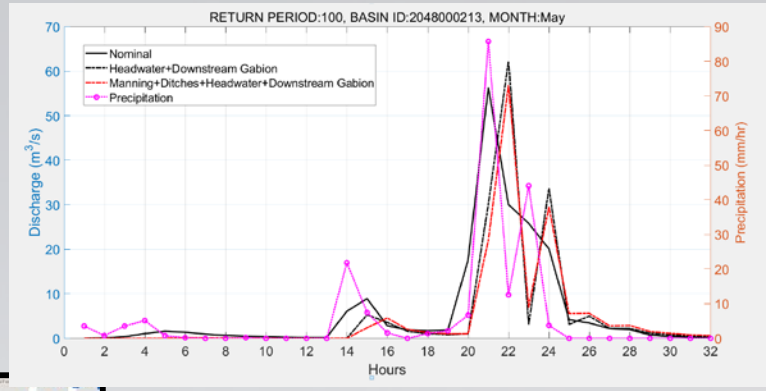


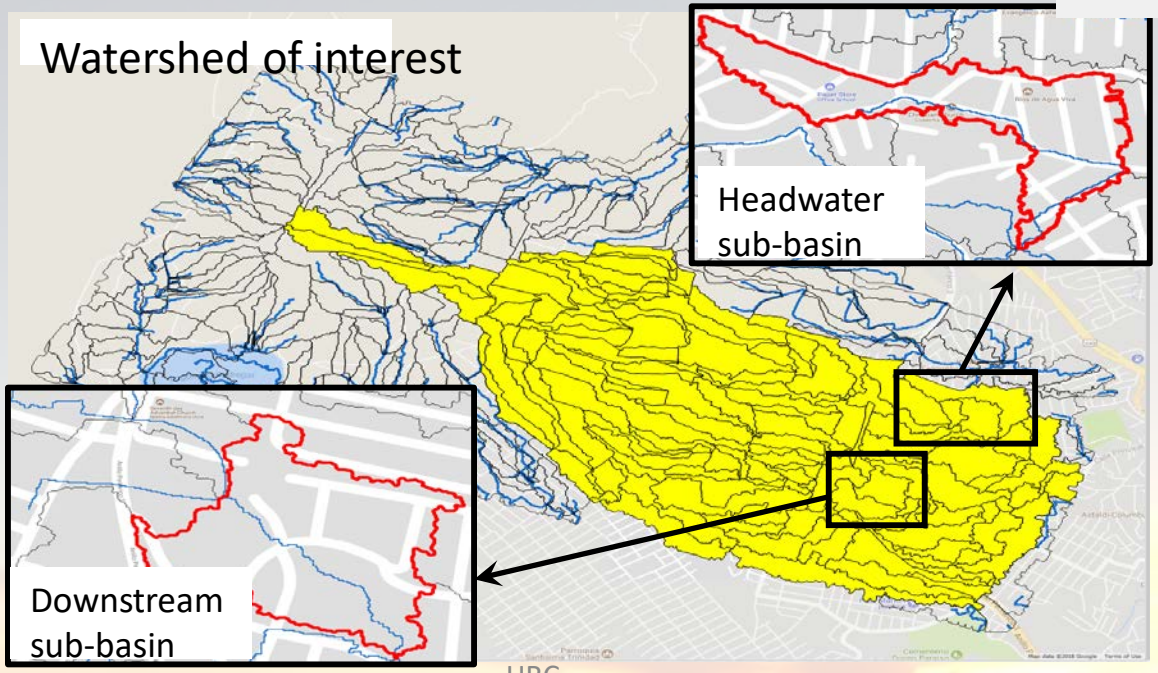
Application to Tegucigalpa, Honduras, for flood hazard mitigation

Only Surface Storm Drainage through Streams and Streets

Urban watersheds defined at a resolution of 0.01 km².

Street Ditches and Small Dams modelled



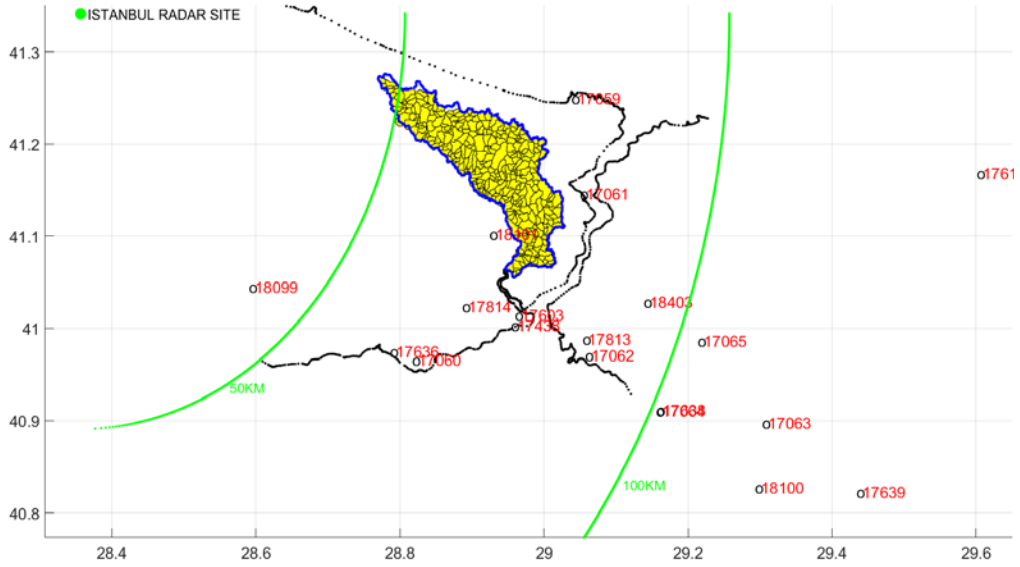


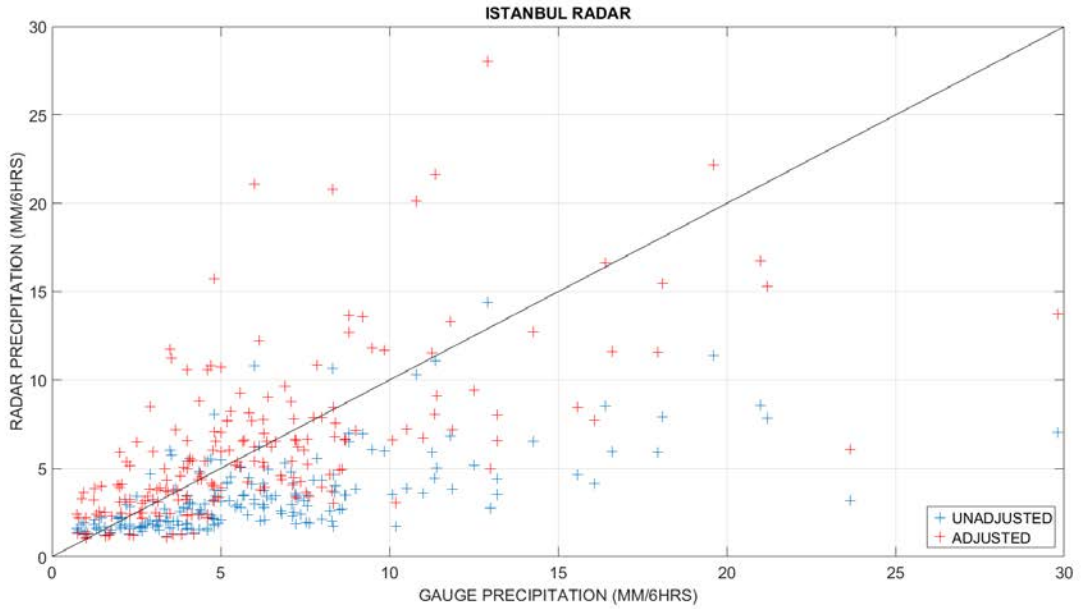
A.5 FFGS Implementation

FFGS application to Cendere Basin, Istanbul.

Only Surface Storm Drainage through Streams and Streets

Urban watersheds defined at a resolution of 0.25 km².





B. Channel Routing for FFGS

Goal:

To provide capability to forecast flow discharge at pre-specified locations along the channel network of selected river basins and to train forecasters and others on the use of information

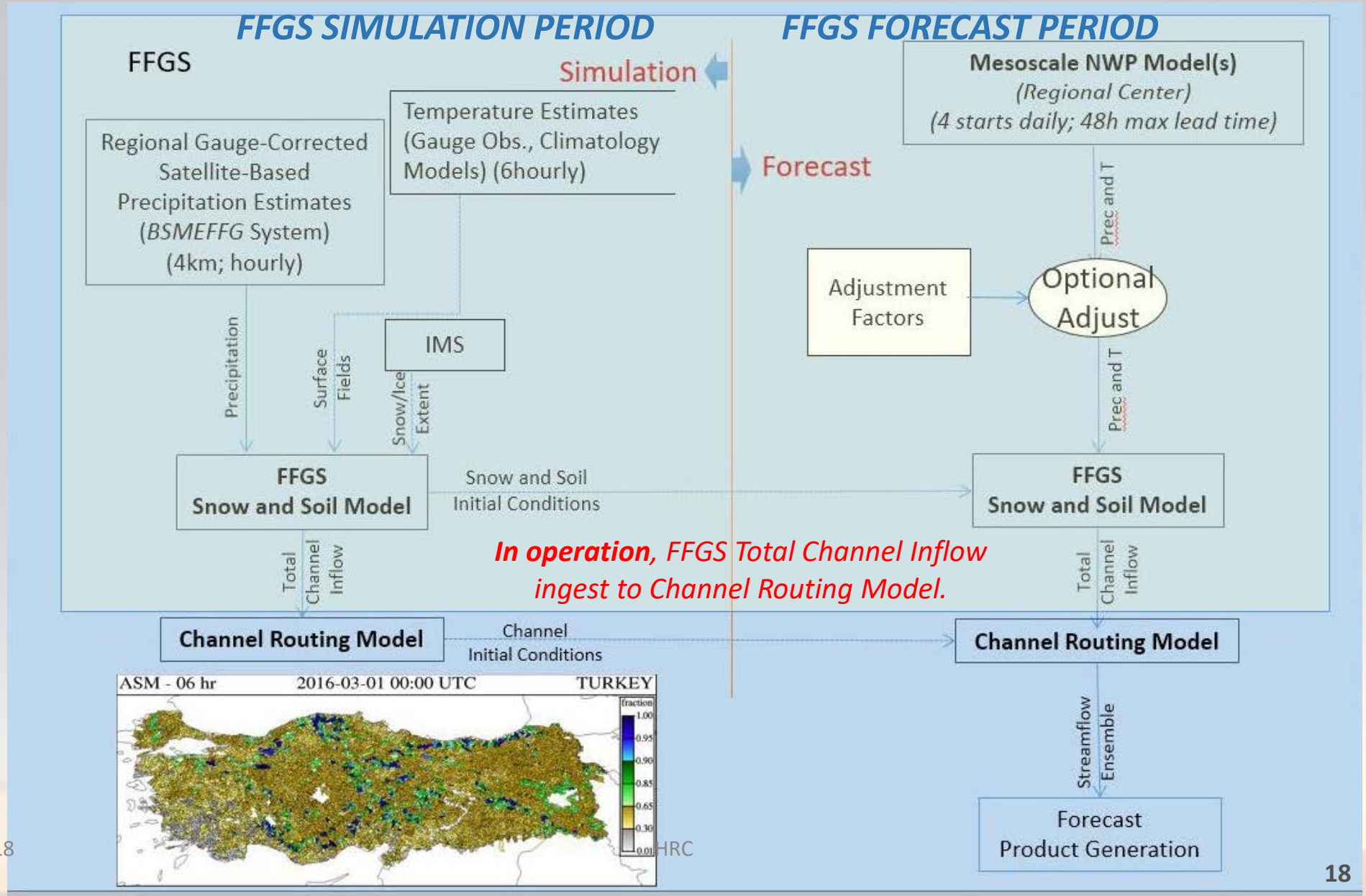
Prerequisites:

1. Mesoscale numerical weather prediction forecasts (single or ensemble forecasts) for FFGS ingest (*countries and the RC*)

2. Selection of a specific river basin and forecast points within the river basin (*countries and the RC*)

3. Information at sites of the river channel and reservoir information for those reservoirs included (*countries*)

B.1 Riverine Routing Sub-system



B.2 Type of Channel Routing

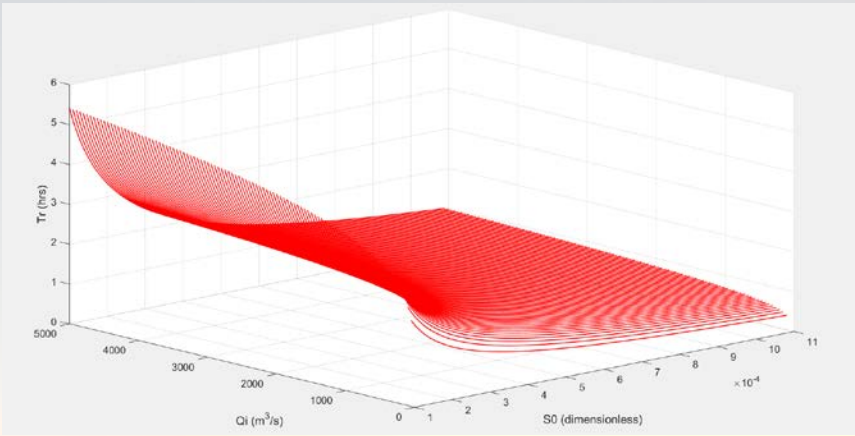
Steep slopes (> 0.01-0.001)
Kinematic routing

Mild Slopes (>0.0001)
Diffusive Routing (Muskingum-Cunge)

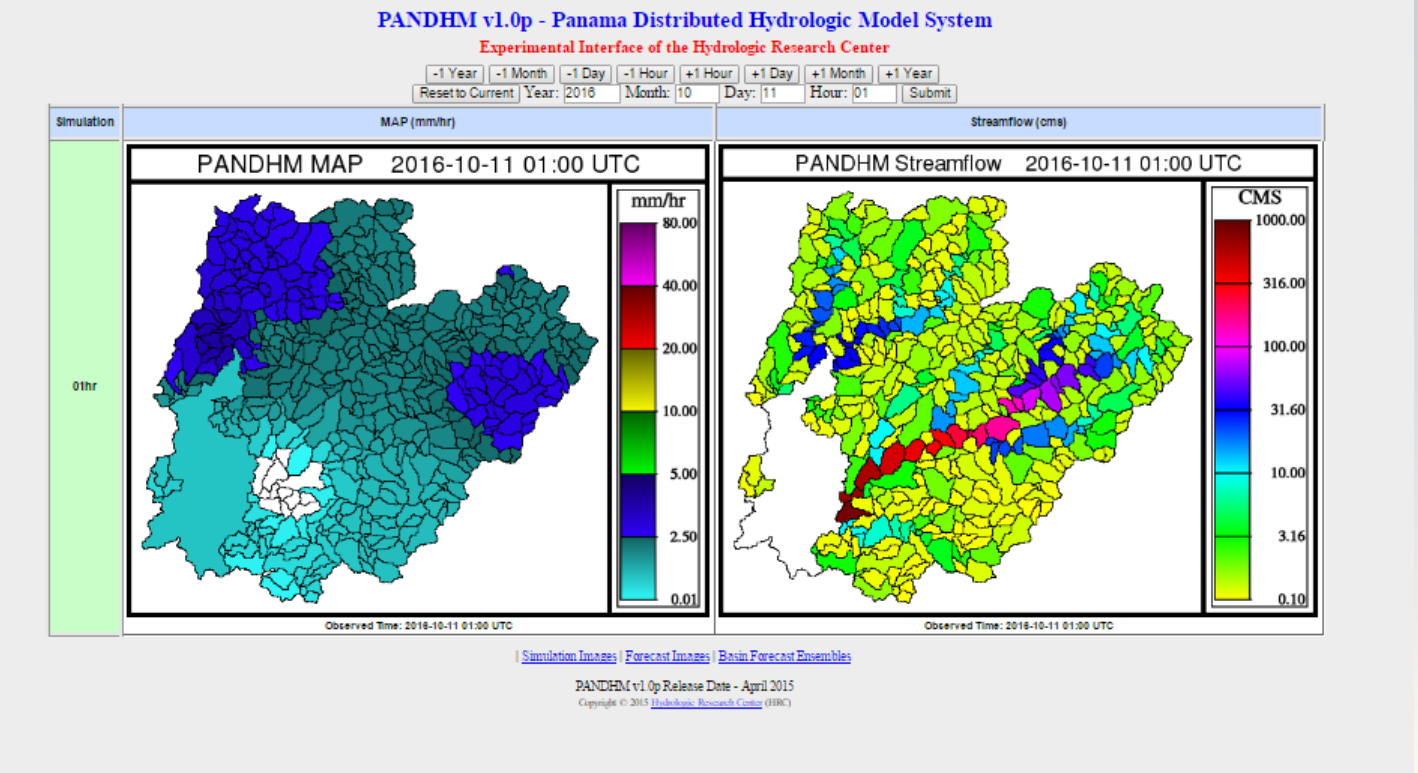
Diffusive

Kinematic

$$\frac{\partial Q}{\partial t} + \frac{\partial(\frac{Q^2}{A})}{\partial x} + gA\frac{\partial h}{\partial x} - g\,A\,s + g\,A\,S = 0$$



B.3 Type of Interface: Simulation Products



B.3 Type of Interface: Ensemble Traces and Table

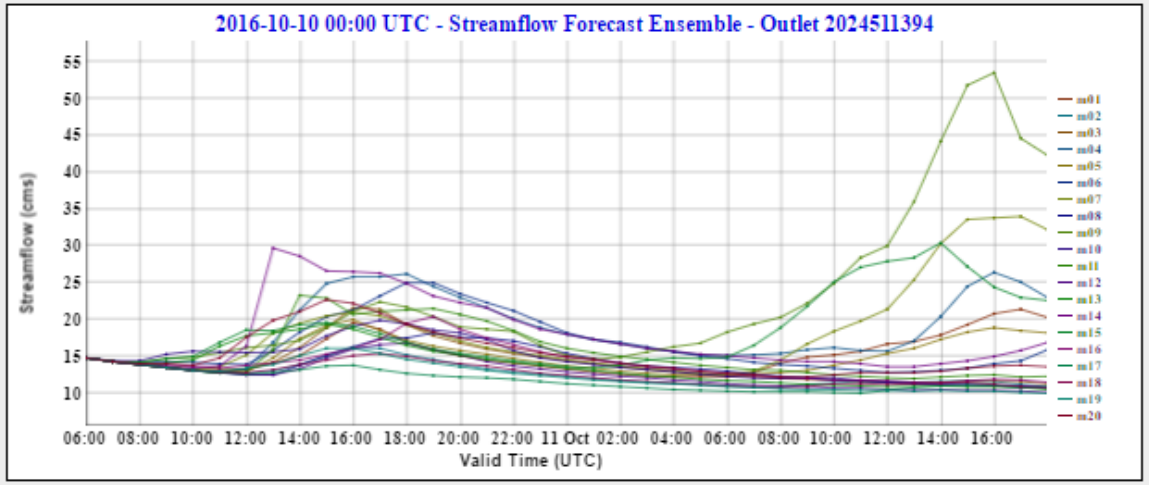
PANDHM v1.0p - Panama Distributed Hydrologic Model System

Experimental Interface of the Hydrologic Research Center

2024511394 - Candelaria

Reset to Current | Year: 2016 | Month: 10 | Day: 10 | Hour: 00 | Submit

-1 Year | -1 Month | -1 Day | -12 Hour | +12 Hour | +1 Day | +1 Month | +1 Year



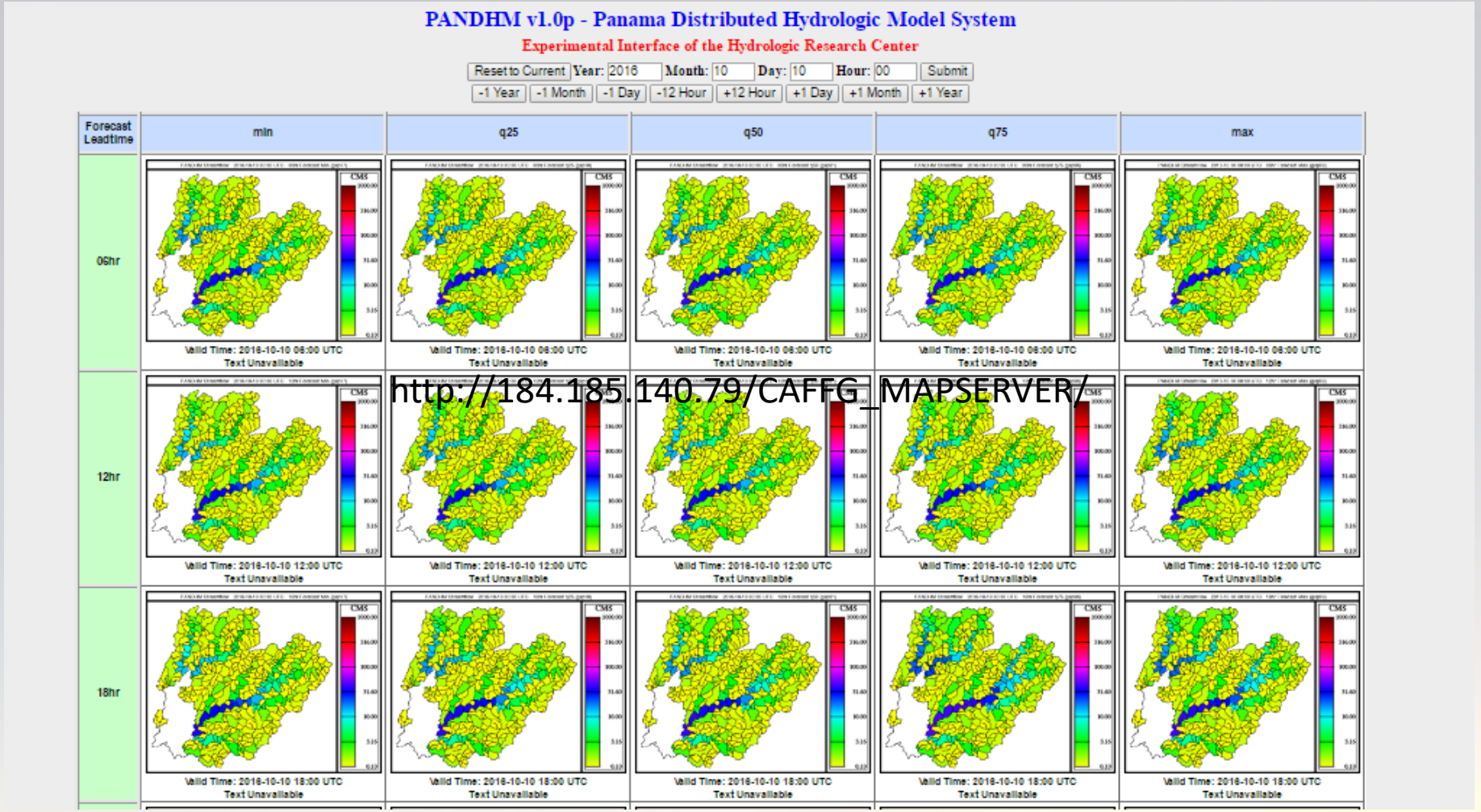
Download the CSV data file: 2016101000_2024511394_streamflow_forecast_basin_ensemble.csv

2016-10-10 00:00 UTC - Streamflow Forecast Ensemble - Outlet 2024511394

Units: cms

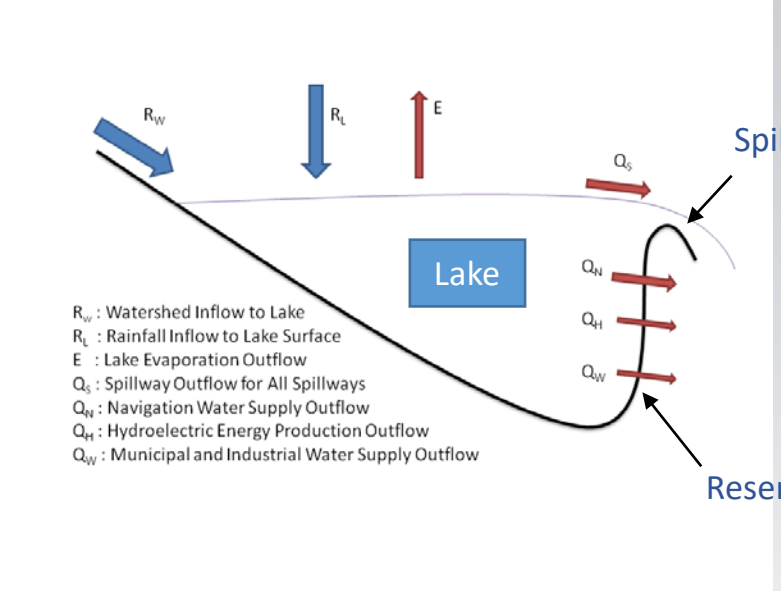
Valid Time	m01	m02	m03	m04	m05	m06	m07	m08	m09	m10	m11	m12	m13	m14	m15	m16	m17	m18	m19	m20
2016-10-10 06:00	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8
2016-10-10 07:00	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.4	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3
2016-10-10 08:00	13.9	13.9	13.9	13.9	13.9	14.2	13.9	13.9	14.2	14.4	13.9	13.9	13.9	13.9	14.2	13.9	13.9	13.9	13.9	14.0
2016-10-10 09:00	13.5	13.5	13.5	13.5	13.5	14.3	13.5	13.5	14.7	15.3	13.5	13.5	14.1	13.7	14.7	13.9	13.5	13.5	13.5	14.0
2016-10-10 10:00	13.1	13.1	13.3	13.1	13.1	14.2	13.2	13.1	14.9	15.7	13.1	13.1	14.5	13.5	15.0	13.7	13.1	13.1	13.1	13.8
2016-10-10 11:00	12.9	12.8	13.3	12.8	12.8	14.0	13.6	12.8	15.5	15.6	12.8	12.9	16.4	13.7	16.9	13.4	12.8	12.9	13.0	14.8
2016-10-10 12:00	13.2	12.7	13.3	13.3	12.9	13.9	15.2	12.5	16.2	15.5	12.9	12.5	17.8	16.4	18.6	13.8	12.6	12.8	13.4	17.6
2016-10-10 13:00	14.1	13.0	14.2	16.9	14.8	15.8	18.2	12.5	16.5	15.6	15.9	12.5	18.2	29.7	18.5	14.1	12.8	13.2	13.9	19.9
2016-10-10 14:00	15.1	13.9	16.2	21.3	17.4	18.3	19.5	13.8	17.2	16.0	23.3	13.3	18.7	28.6	19.3	14.5	13.2	13.9	15.1	21.1
2016-10-10 15:00	17.4	15.0	18.9	24.9	19.2	20.4	20.5	15.2	18.9	17.8	22.9	14.8	19.4	26.6	19.6	15.3	13.7	14.5	16.1	22.7
2016-10-10 16:00	19.6	16.2	21.6	25.8	20.0	21.3	21.0	16.3	21.1	19.1	20.7	16.0	18.7	26.5	19.1	16.1	13.8	15.1	16.1	22.2
2016-10-10 17:00	18.7	16.1	21.4	25.8	18.5	23.2	20.5	17.4	22.4	19.9	21.1	16.6	17.6	26.3	18.1	17.3	13.2	15.4	15.4	20.9
2016-10-10 18:00	16.9	15.2	19.3	26.2	17.2	25.0	19.3	17.5	21.7	19.4	21.3	16.8	16.5	24.9	16.9	19.5	12.7	15.0	14.6	19.4

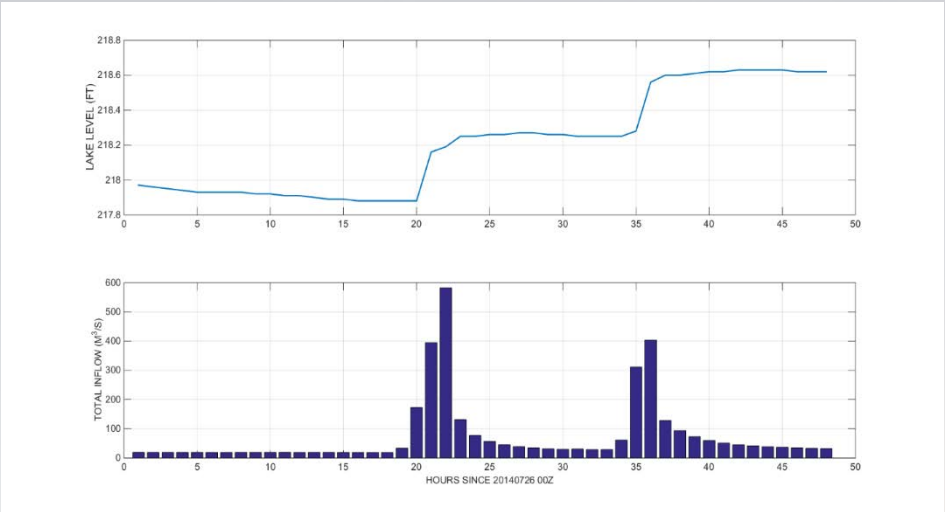
B.3 Type of Interface: Forecast Maps



B.4 Reservoirs and Lake Levels

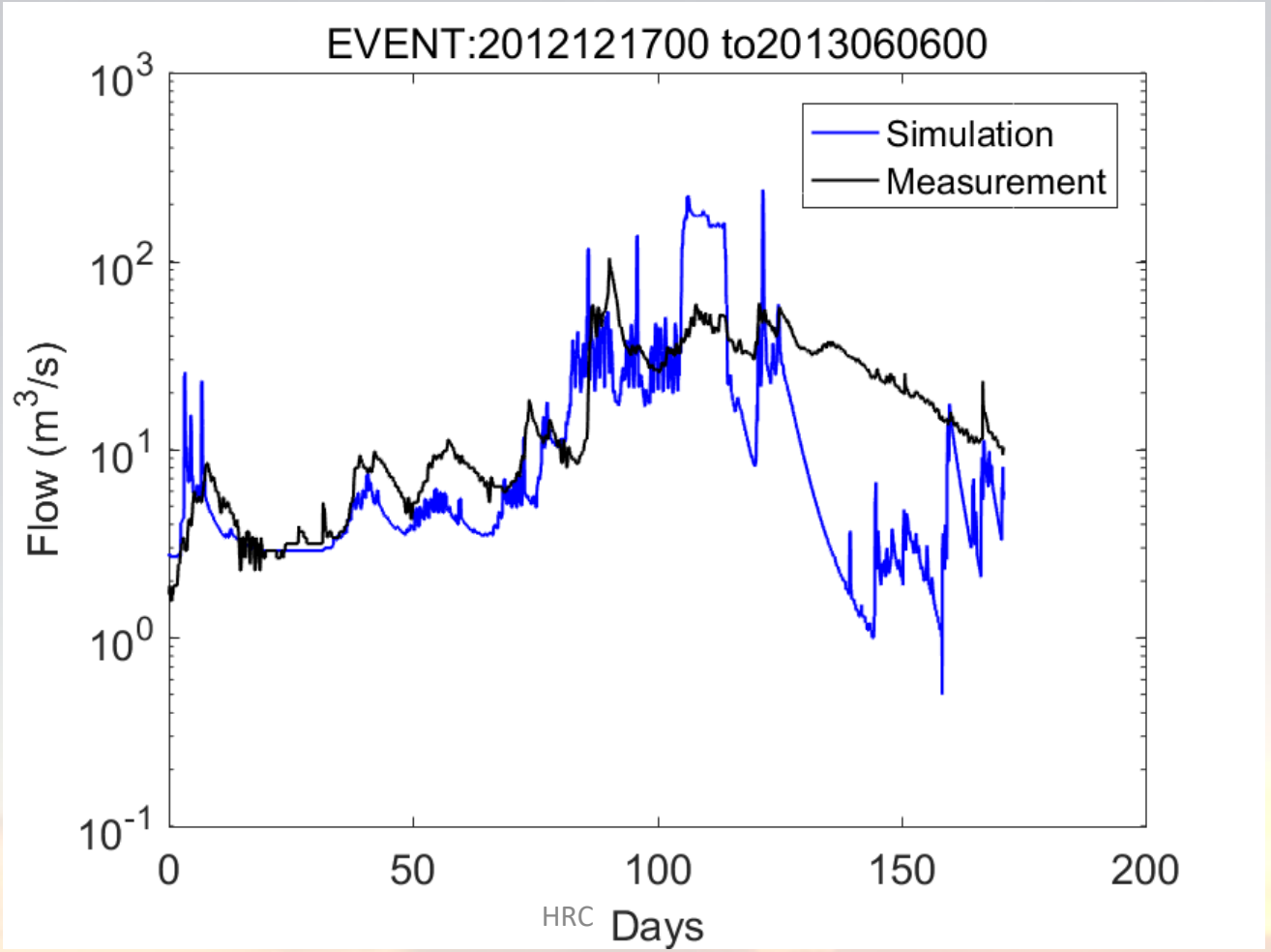
Reservoir Storage/Release Module for the Routing Component





B.5 Influence of Hydrologic Model Parameters

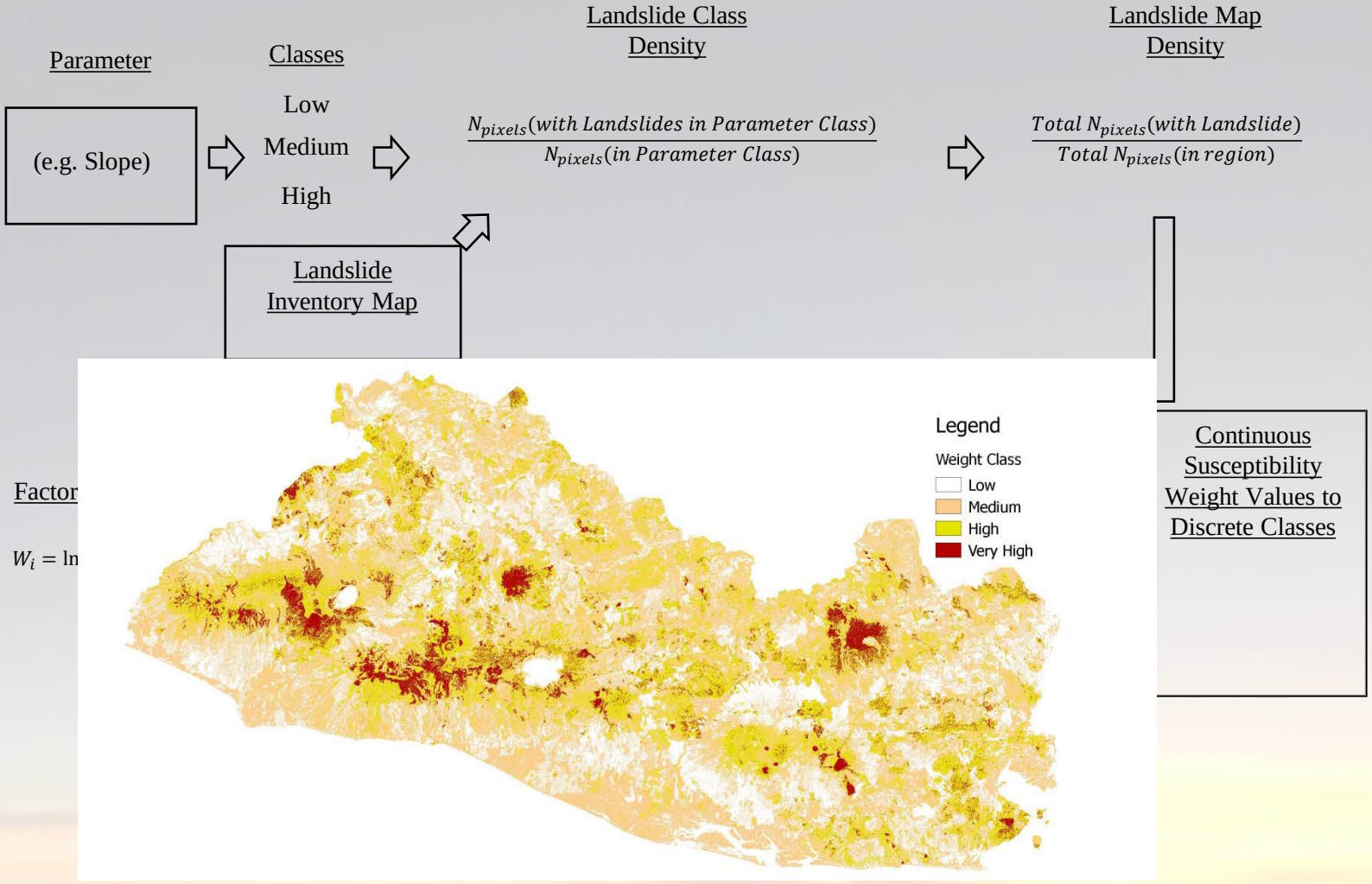
*Hourly simulation of discharge (blue line) with **unadjusted** model parameters, compared to observations (black line) – Hourly Streamflow Observations Important for Calibration*



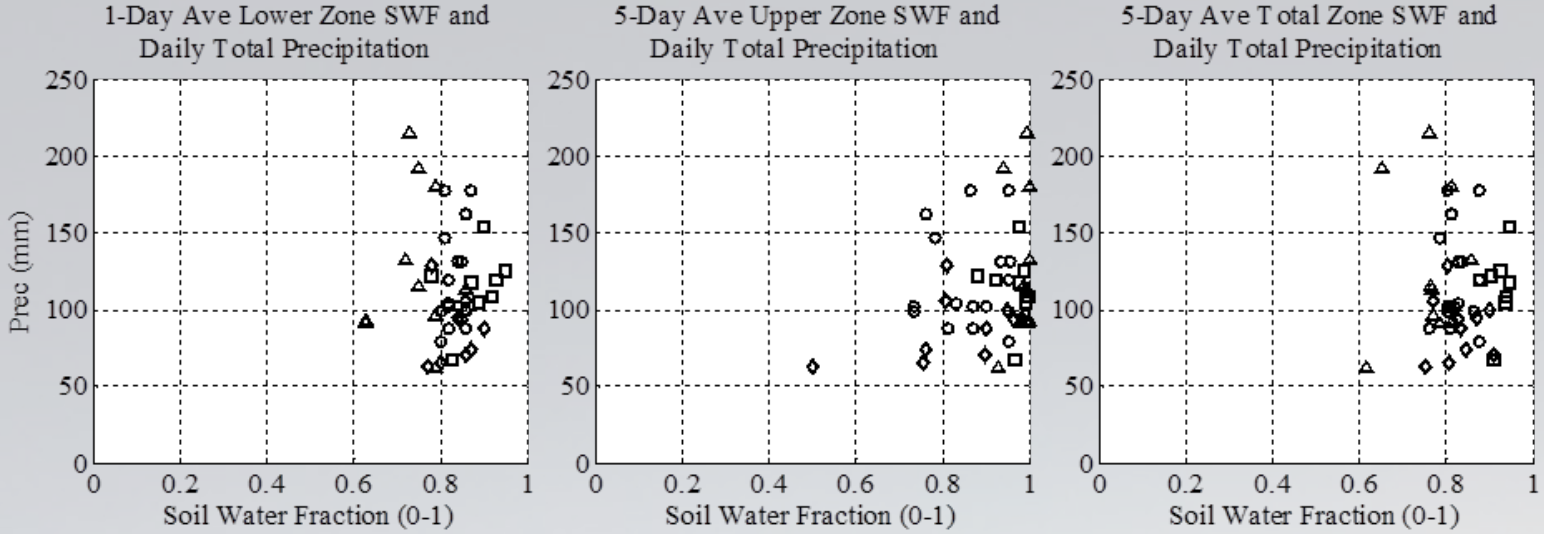
C. Landslide prediction using FFGS output

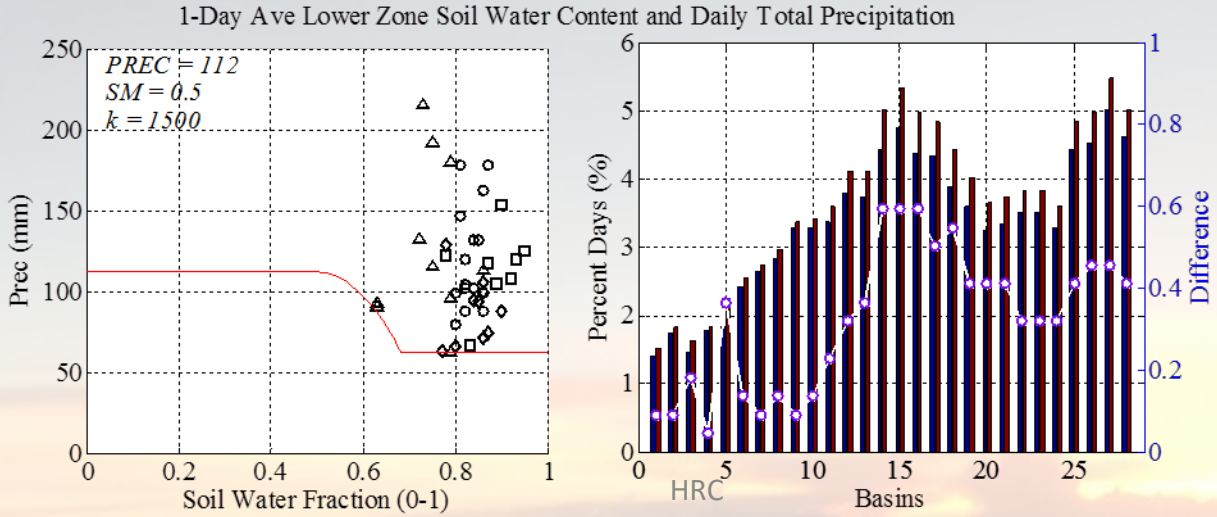
- C.1 Susceptibility map development in a region with an adequate database (El Salvador, Central America) (completed)
- C.2 Real Time landslide prediction using FFGS rainfall and soil water thresholds in El Salvador (completed)
- C.3 Generalization for Central America and implementation/demonstration in CAFFG (on going)
- C.4 FFGS Product Console for Landslide Assessment

C.1 Susceptibility Mapping

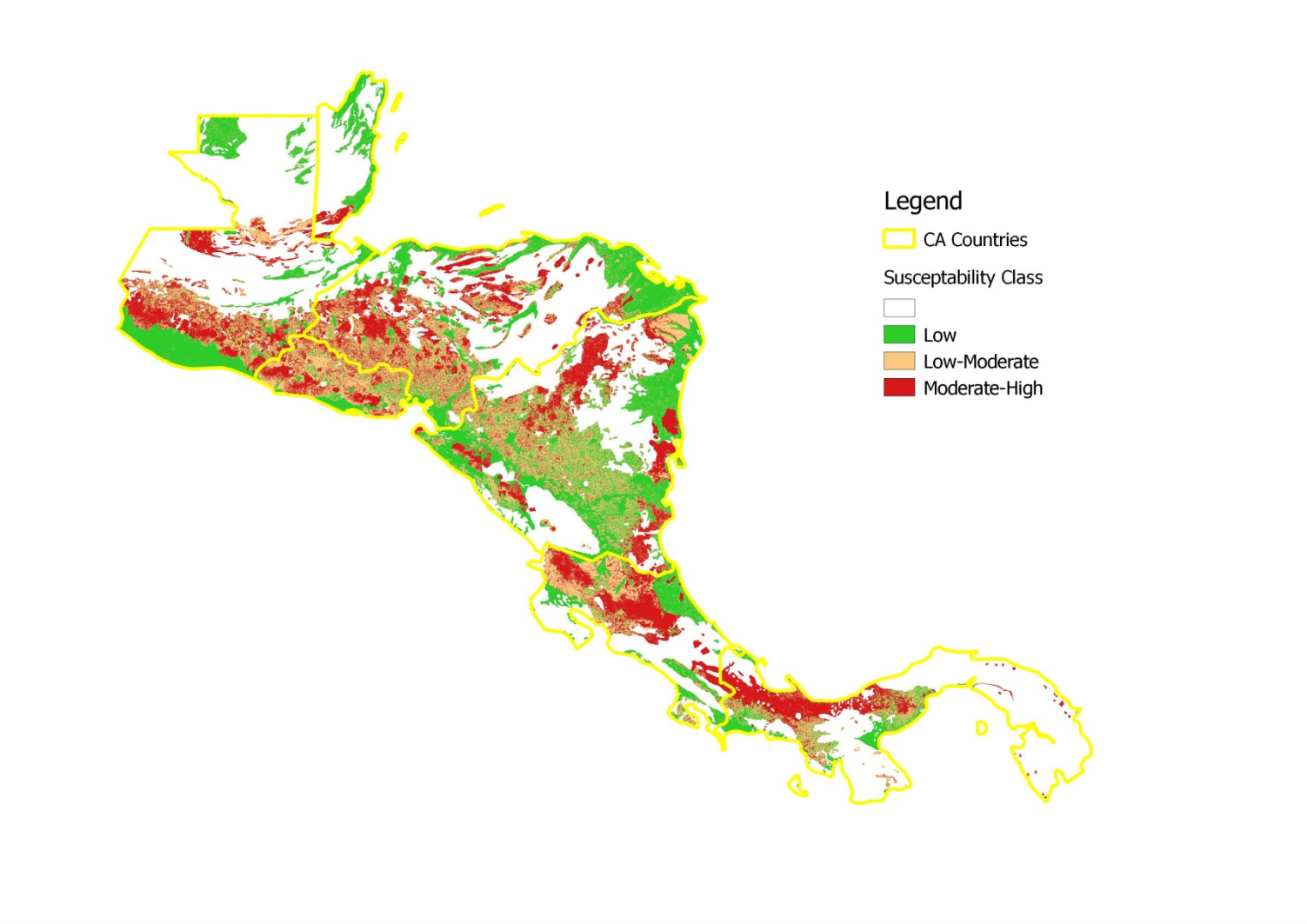


C.2 Real-time Occurrence Prediction based on FFGS Rainfall and SM





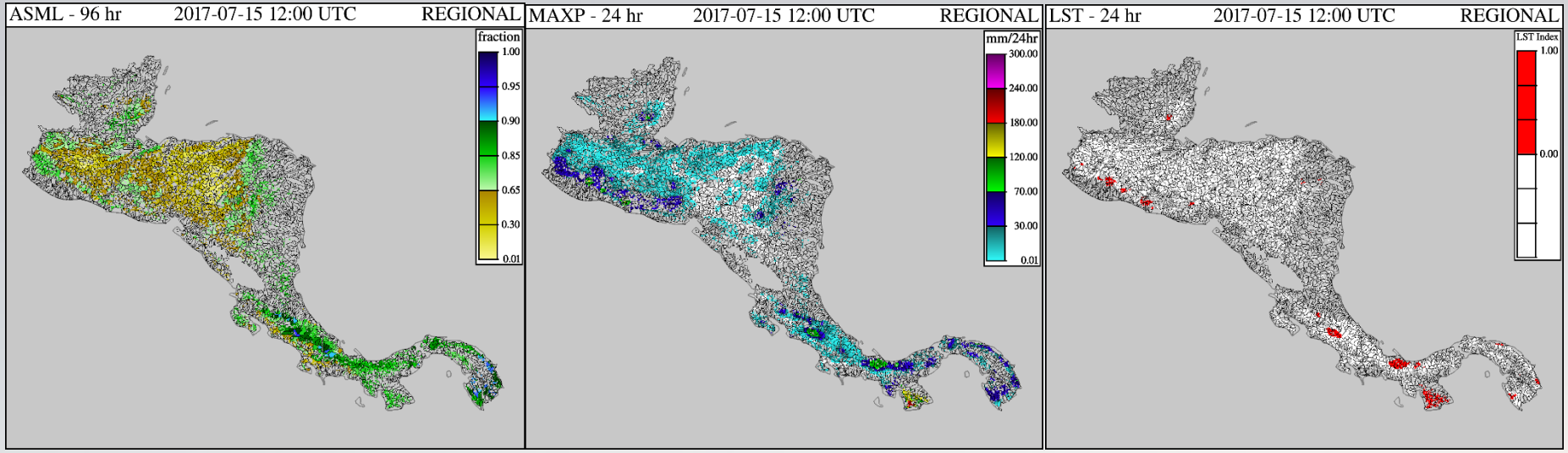
C.3 Generalization for Central America



C.4 Product Console

Design and Implementation Status of Current Advances

Landslide Module operational in CAFFG System

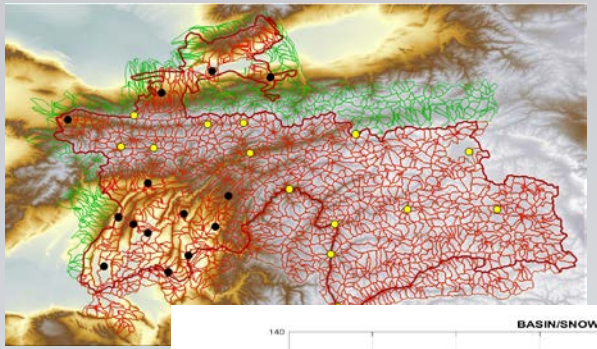


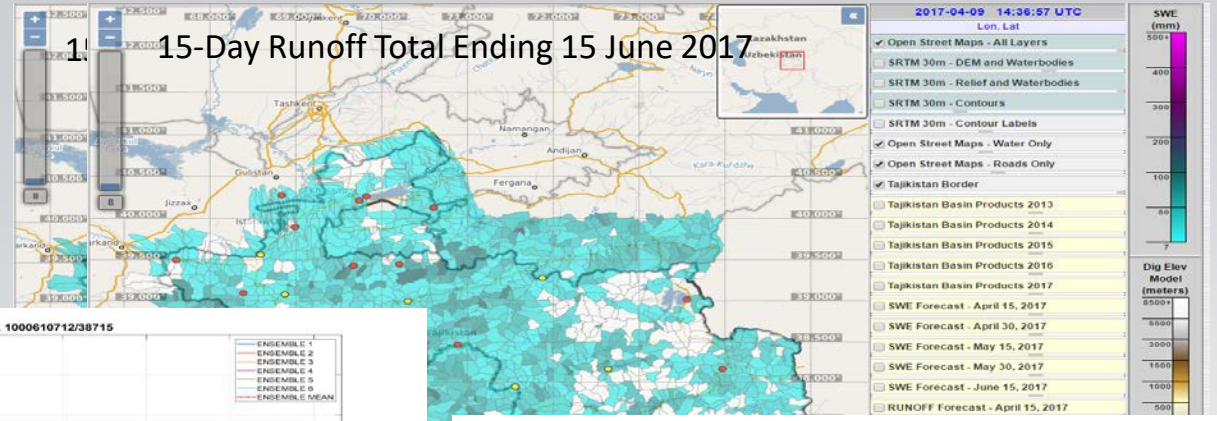
D. Seasonal to Sub-seasonal Ensemble Forecasting

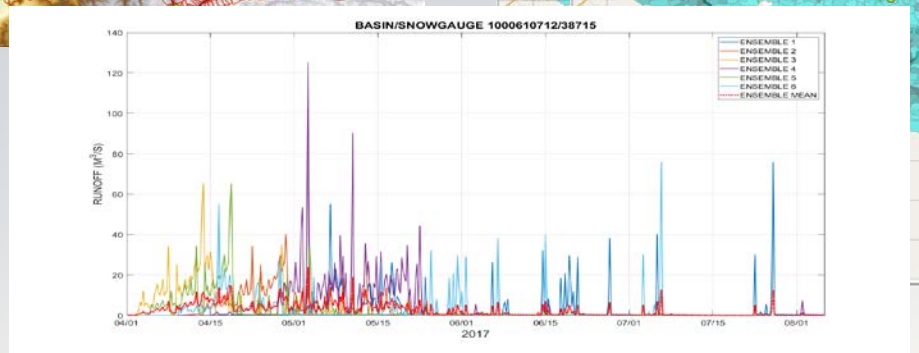
Seasonal Forecasting of Snowmelt and Rain Runoff

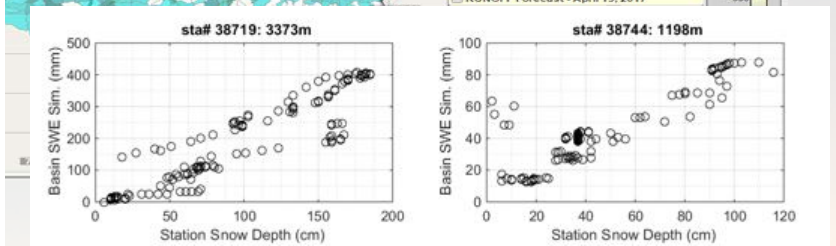
Assessment Date 1 April 2017

Tajikistan 2017 Assessments



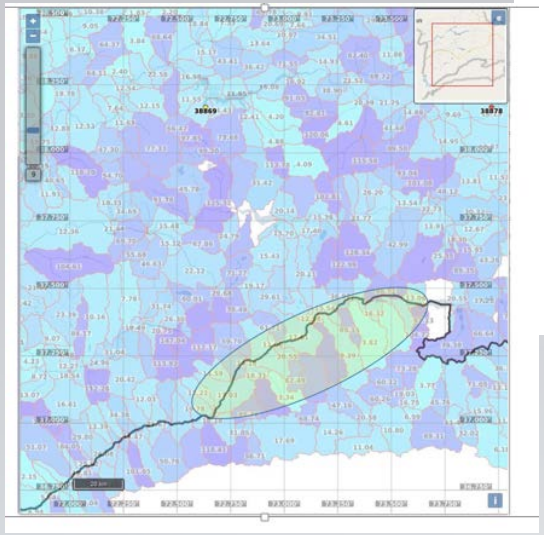




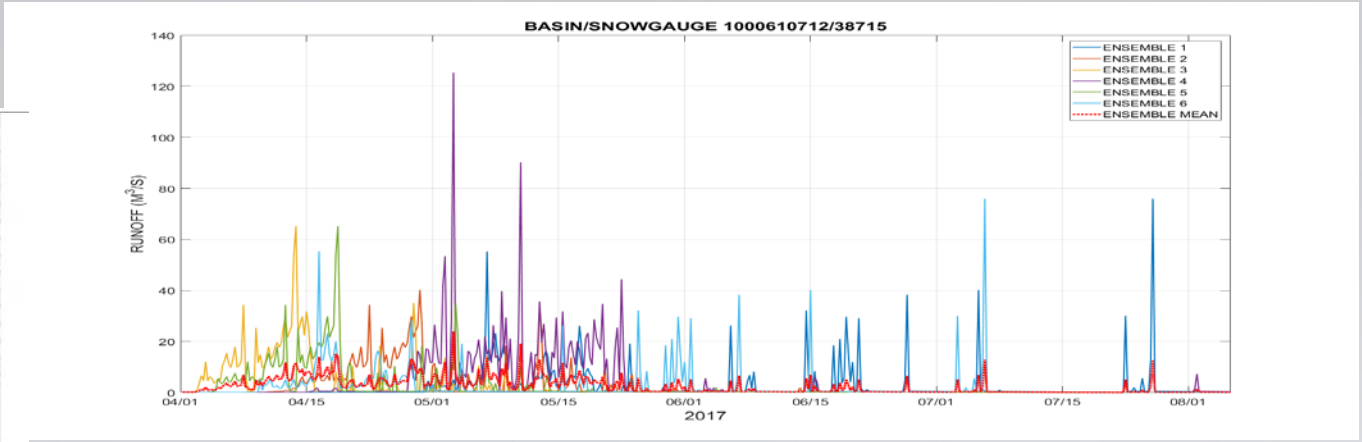


D.1 Seasonal to Sub-Seasonal Ensemble Runoff and Flow Prediction

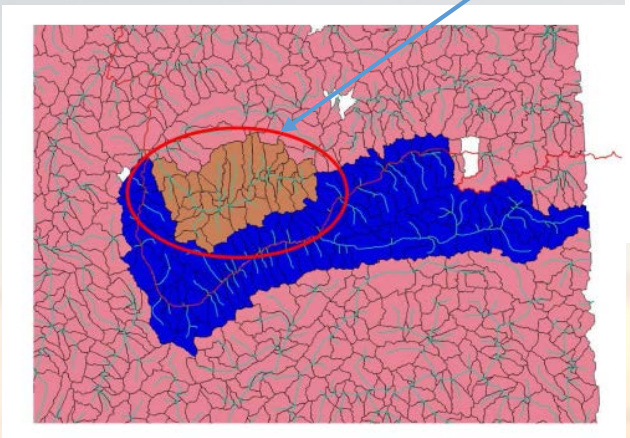
Interactive Maps for Runoff Volume

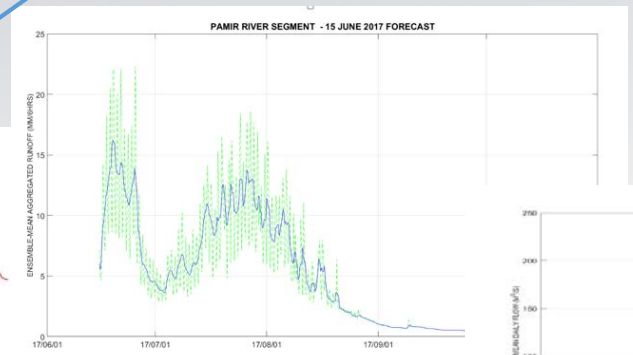


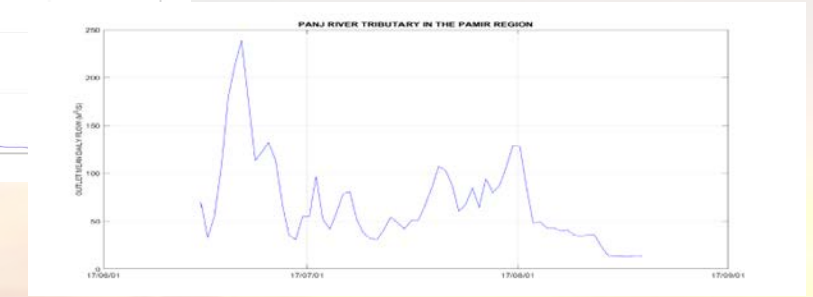
Ensemble Forecast Time Series for a 84.63-km^2 basin (1 April 2017)



Median Runoff and River Flows (South Tajikistan)







E. Inundation Mapping for SM Estimation

MRC FLASH FLOOD GUIDANCE SYSTEM - MRCFFG

In Operation Since 2009

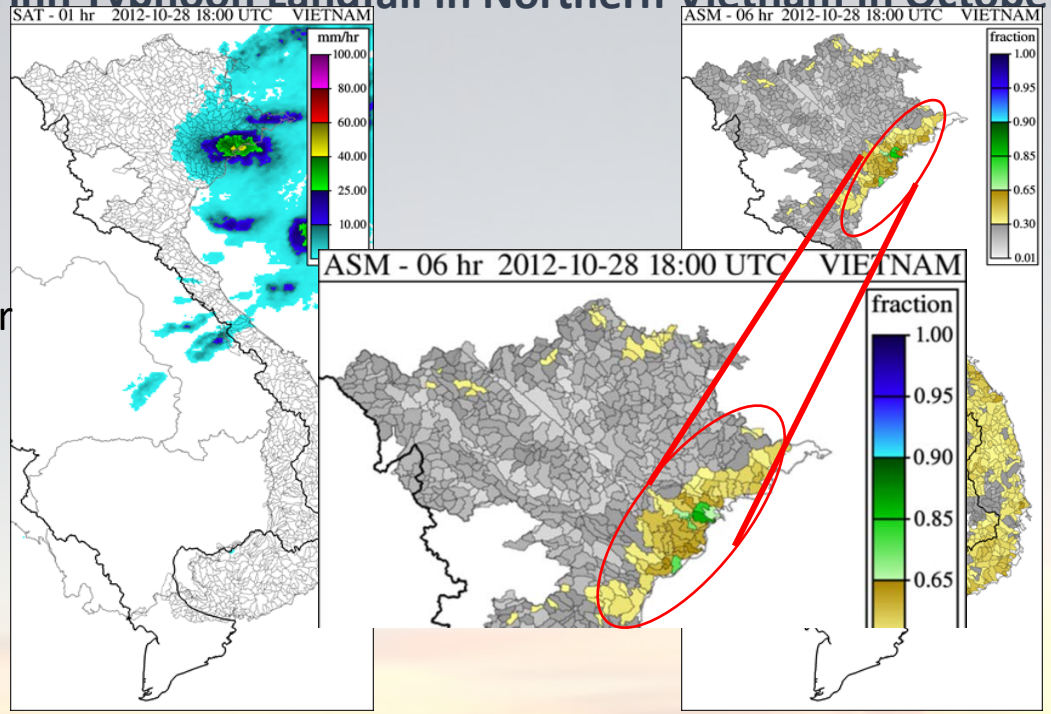
Development/Implementation/Training: Hydrologic Research Center

Purpose: Provide Regional Products with High Resolution to Forecasters in Thailand, Lao PDR, Cambodia and Vietnam to Provide Real-Time Warnings for Flash Floods

Sample Products for Flash Flood Prone Basins Delineated in Vietnam

(Son Tinh Typhoon Landfall in Northern Vietnam in October 2012)

Precipitation at Landfall from NESDIS HydroEstimator

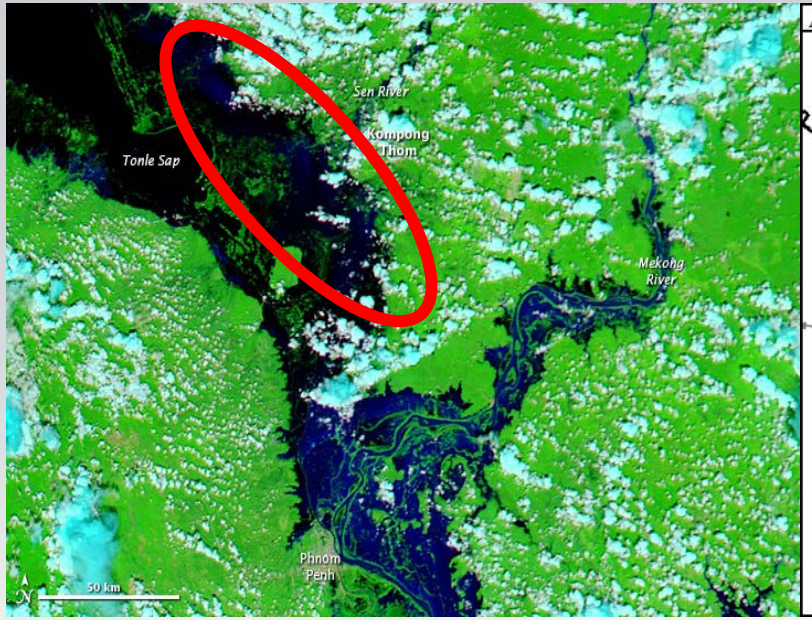


Upper-Soil Water Saturation Fraction at Landfall from operational MRCFFG (uses bias-adjusted HE pixel values)

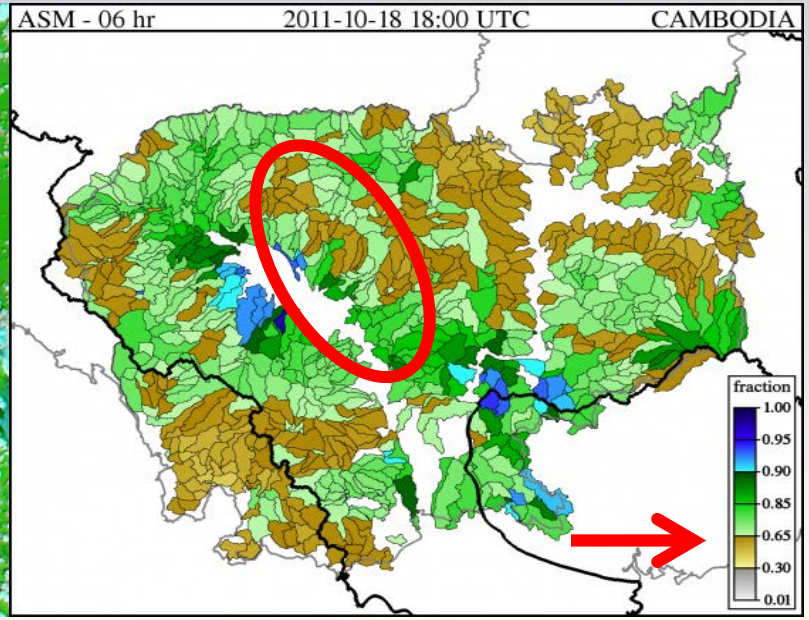
E. Inundation Mapping for SM Estimation

STANDING WATER CORRECTIONS TO MODEL SOIL WATER FROM NASA PRODUCTS

MODIS-Based
Observed Inundation Area in Cambodia

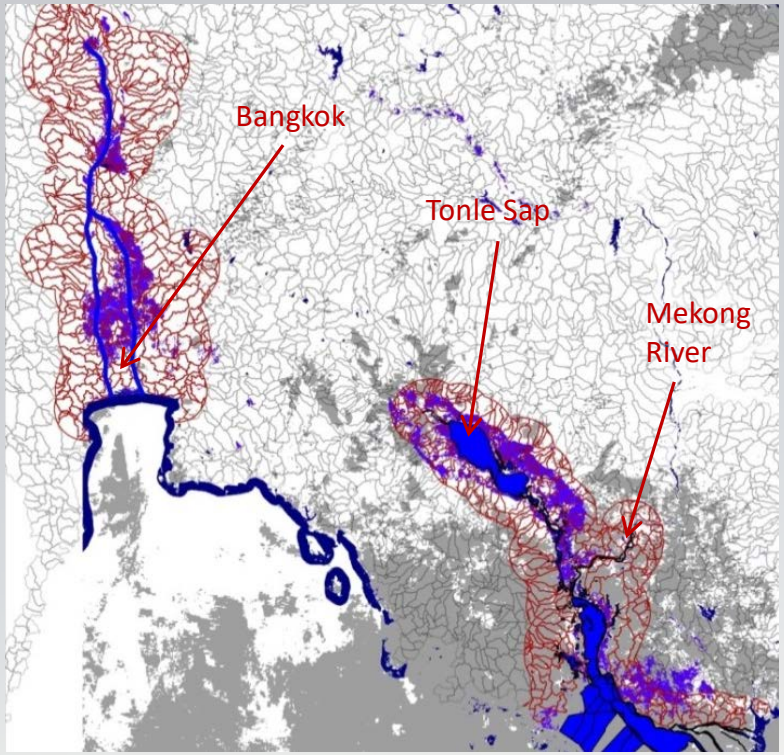


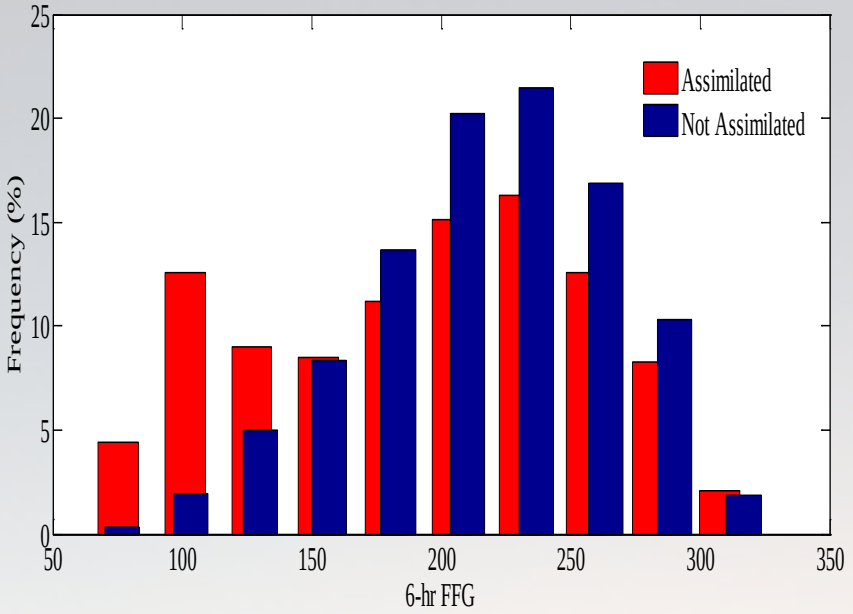
MRCFFG Modeled
Drying Surface Soil Water in Cambodia



E. Inundation Mapping for SM Estimation

Posner et al. Remote Sens. **2014**, *6*, 10835-10859 – Open Access





Method: Assimilation of saturation of upper soil in catchments with inundation greater than 85% and use of soil model to adjust lower soil water.


THANK YOU