FFGS Advanced Functionalities

Hydrologic Research Center

21 February 2016

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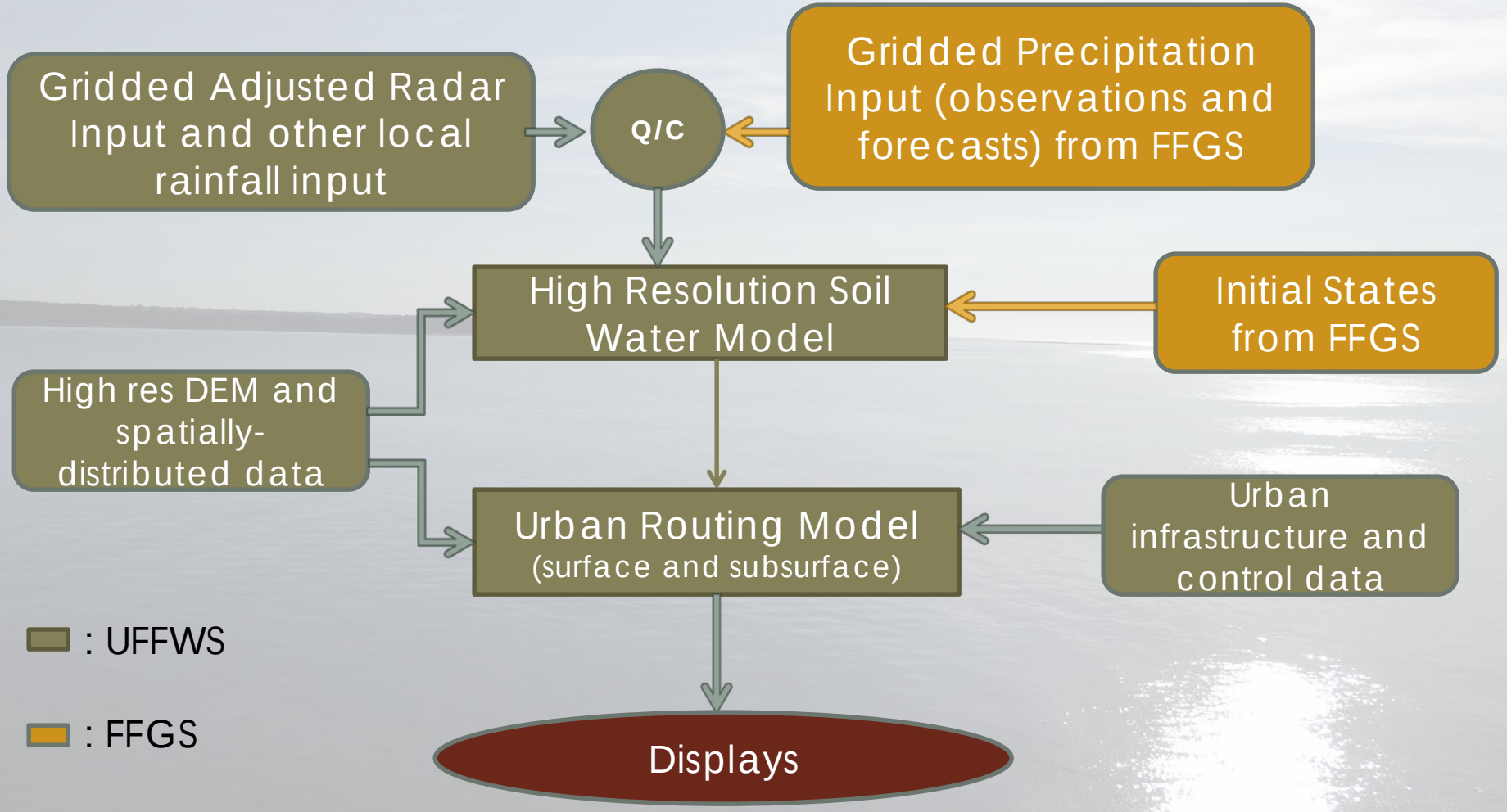
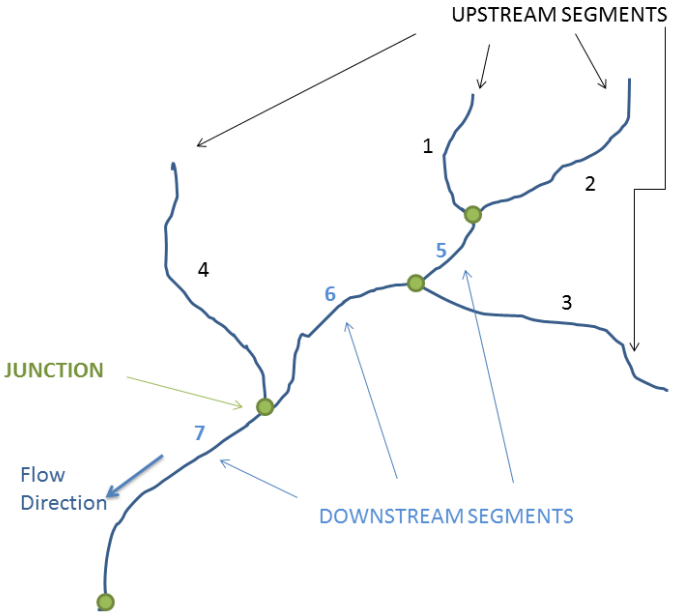
Advanced Functionalities

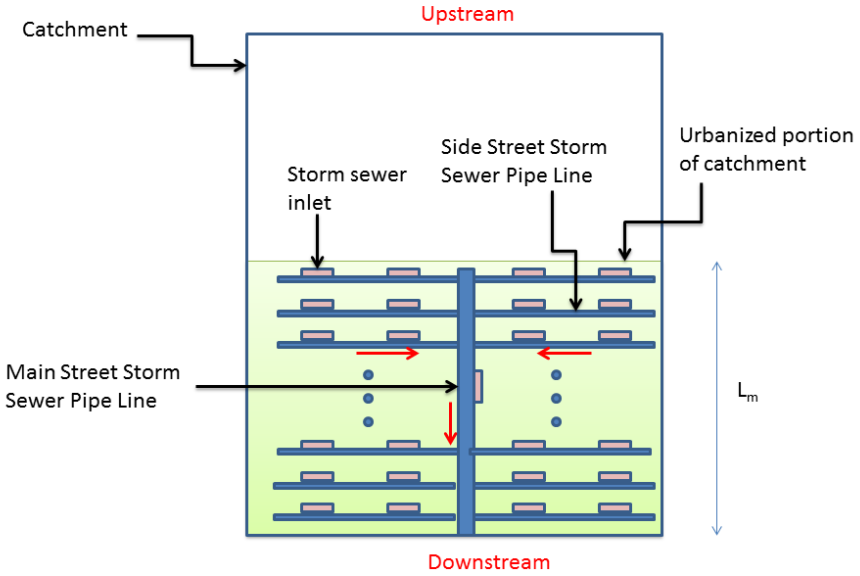
- A. Urban Flash Flood Warning
- B. Riverine Routing
- C. Landslide Occurrence Prediction
- D. Seasonal to Sub-seasonal Runoff and Flow Forecasting

A. Urban Flash Flood Warning



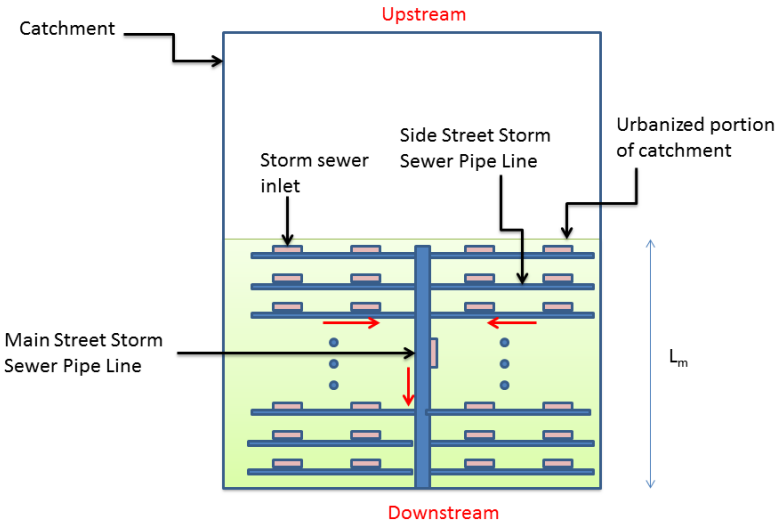
A.1 Basic Technical Elements UFFWS

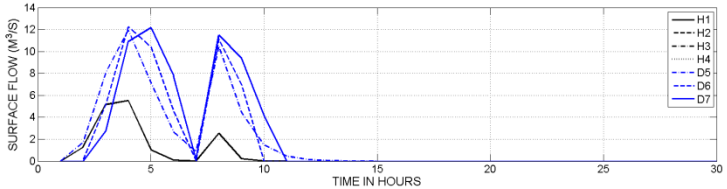


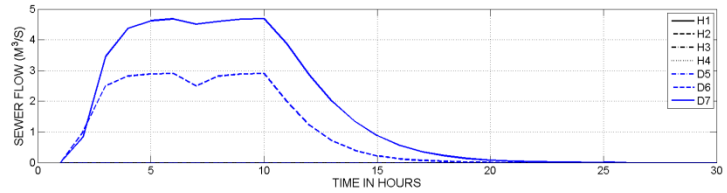


$$\partial y/\partial t + \partial(vy)/\partial x = 2q_L/B - f \qquad S_f = S_0 - \partial y/\partial x$$

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:

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

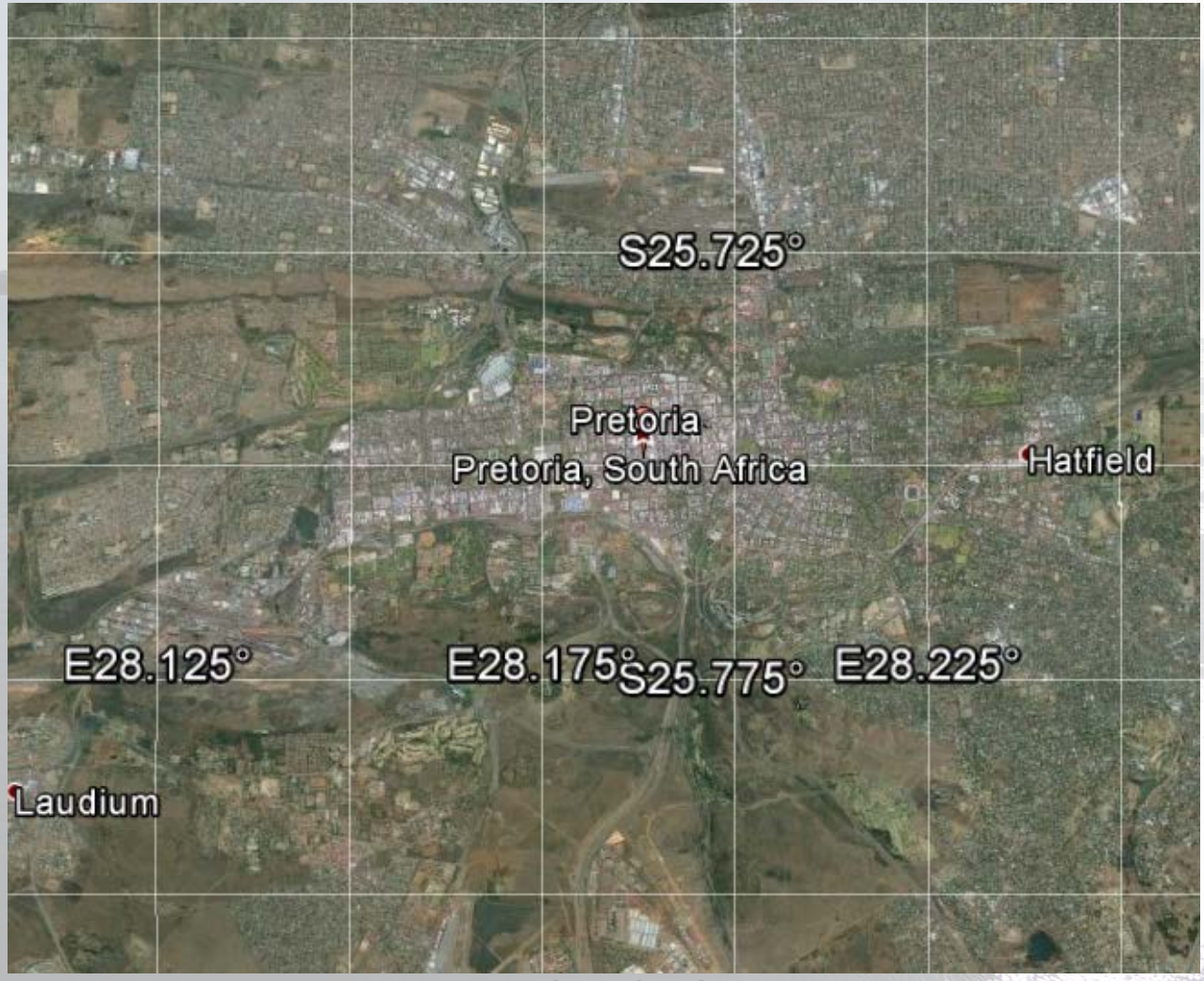
Time to Strom Sewer Overflow:

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

Scaling of Bankfull Q and Bankfull v:

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

A.2 Demonstration of Feasibility (City of Pretoria)



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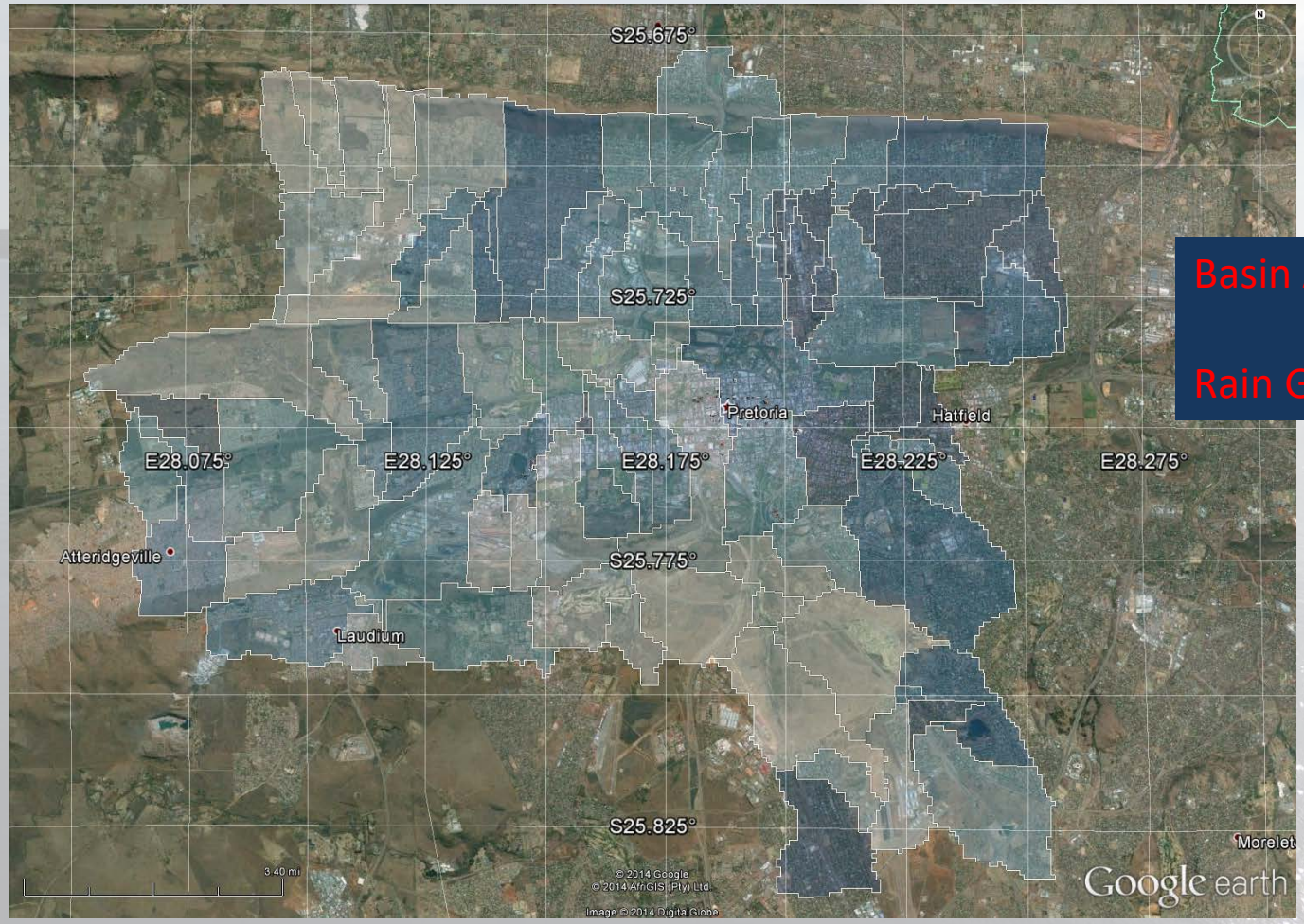

Basin Areas: 1-5 km²

Rain Grid Area: 16 km²

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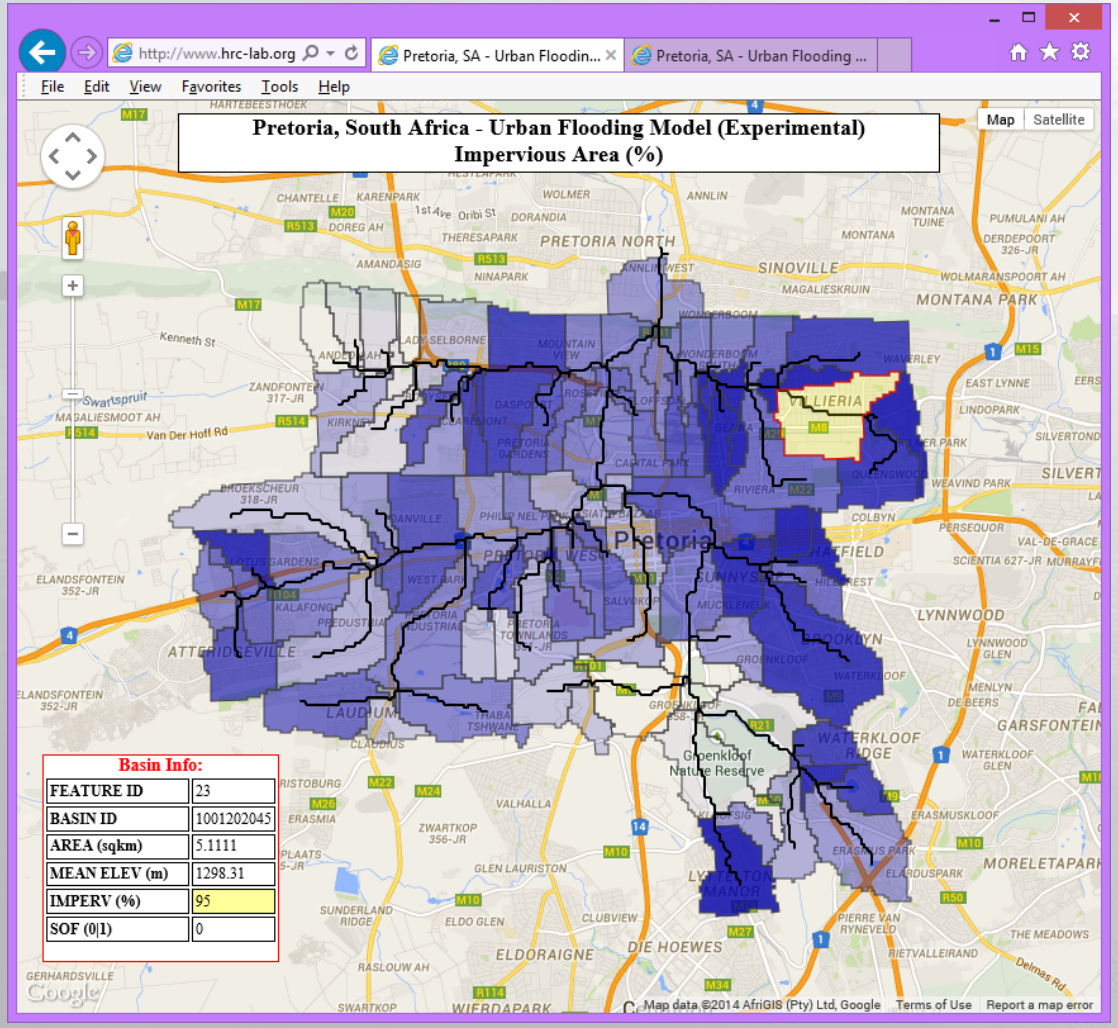

Av. Basin Area: 1-5 km^2

Rain Grid Area: 16 km^2

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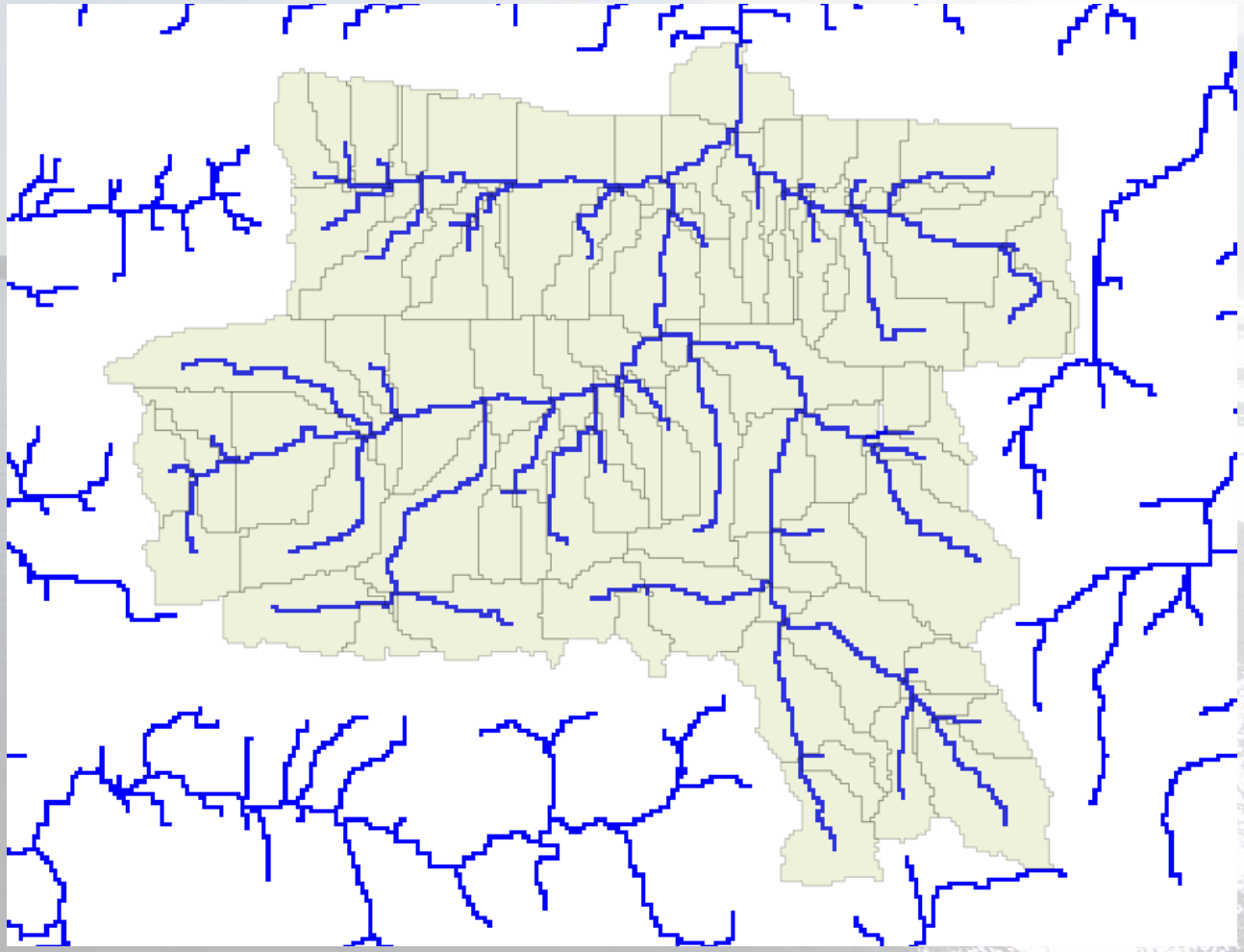

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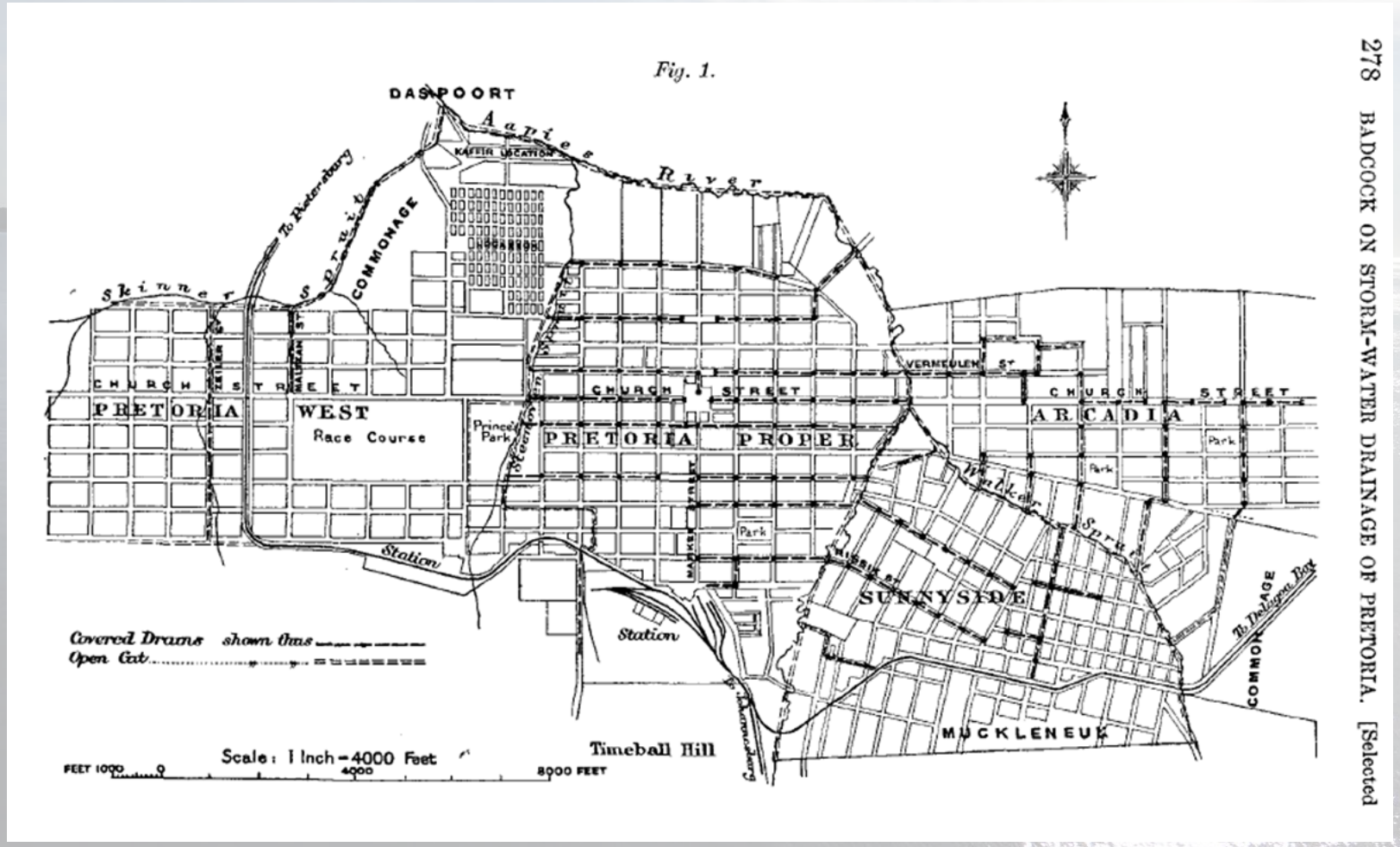
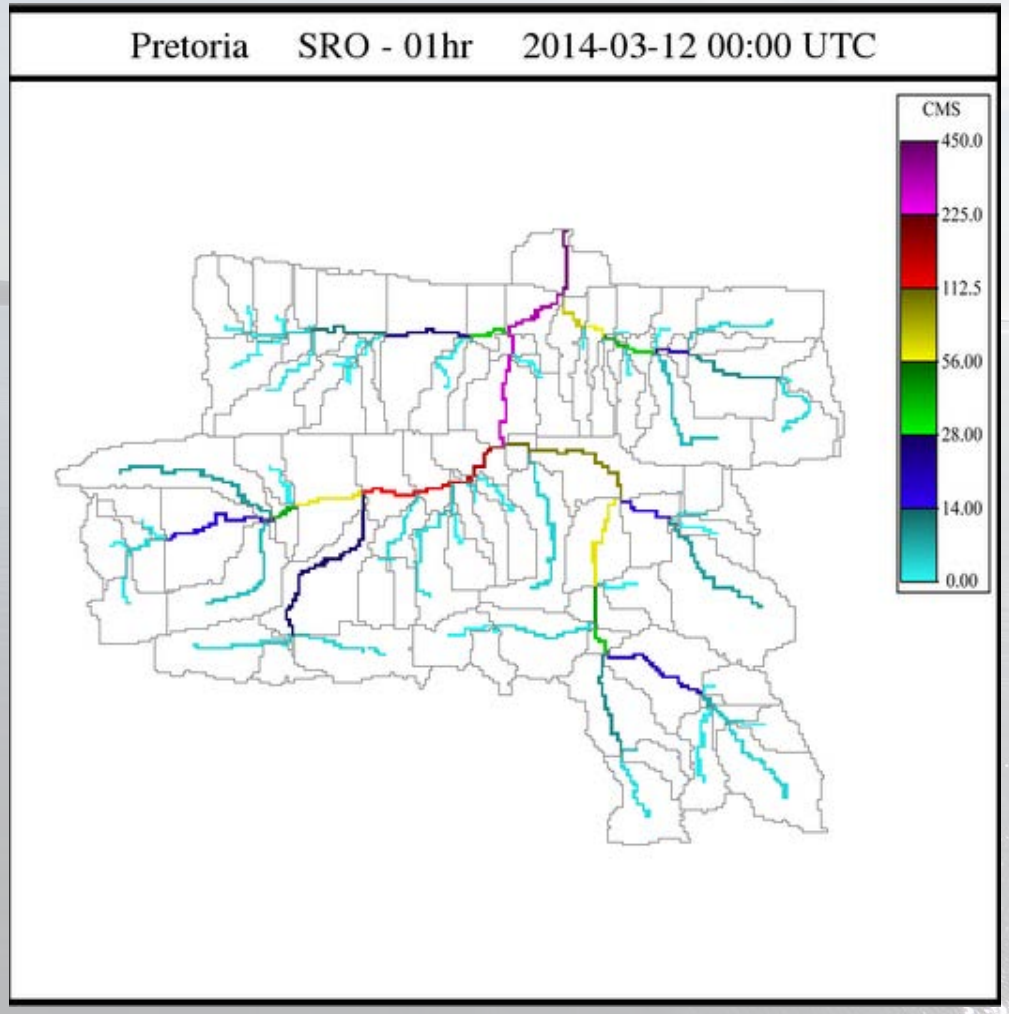


A.3 Example Surface Drainage Flow



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

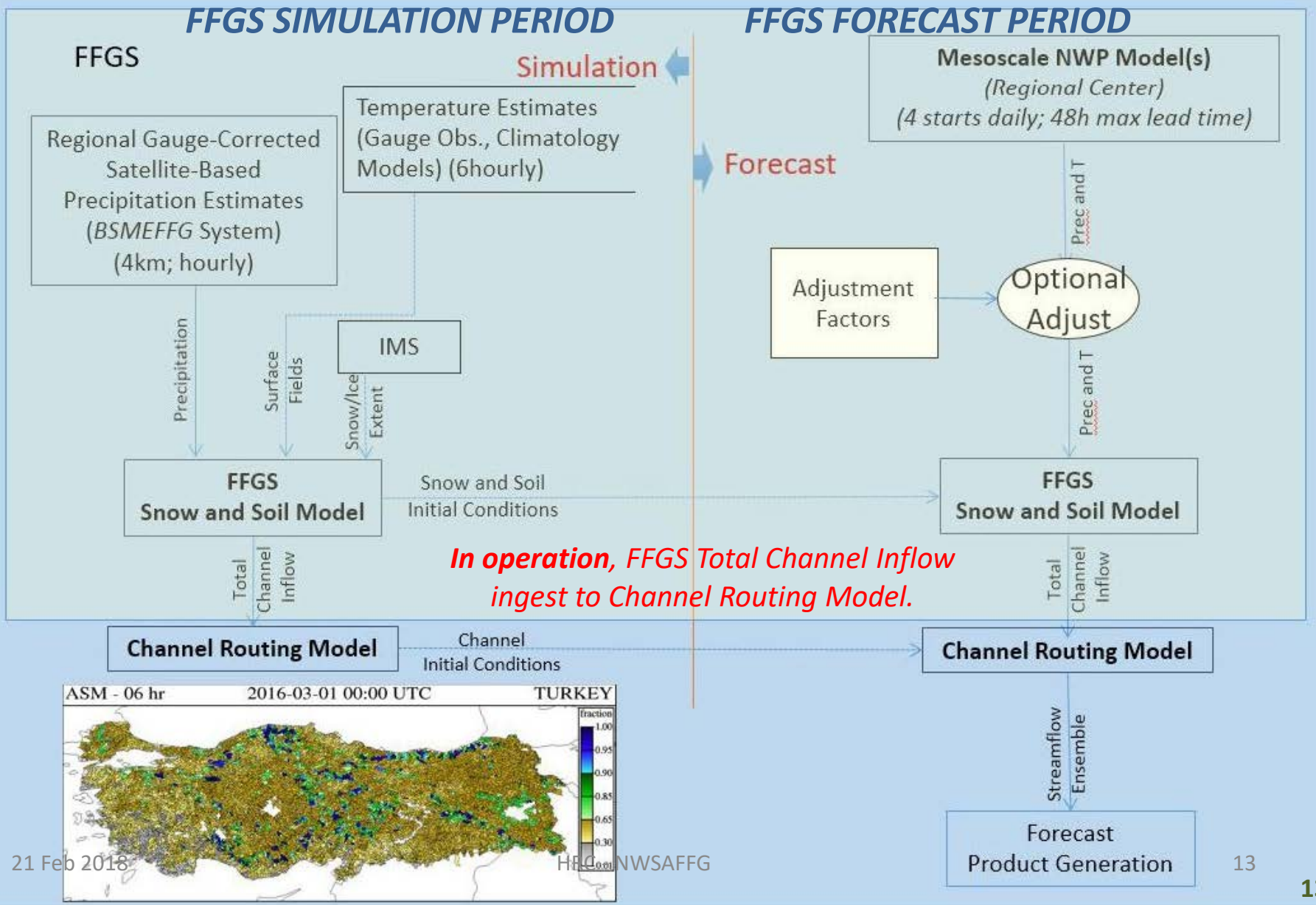
Prerequisites:

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

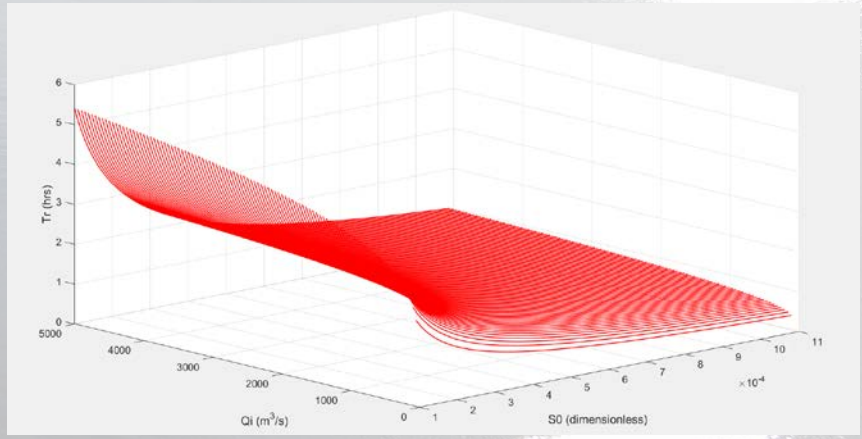
Steep slopes (> 0.01-0.001)
Kinematic routing

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

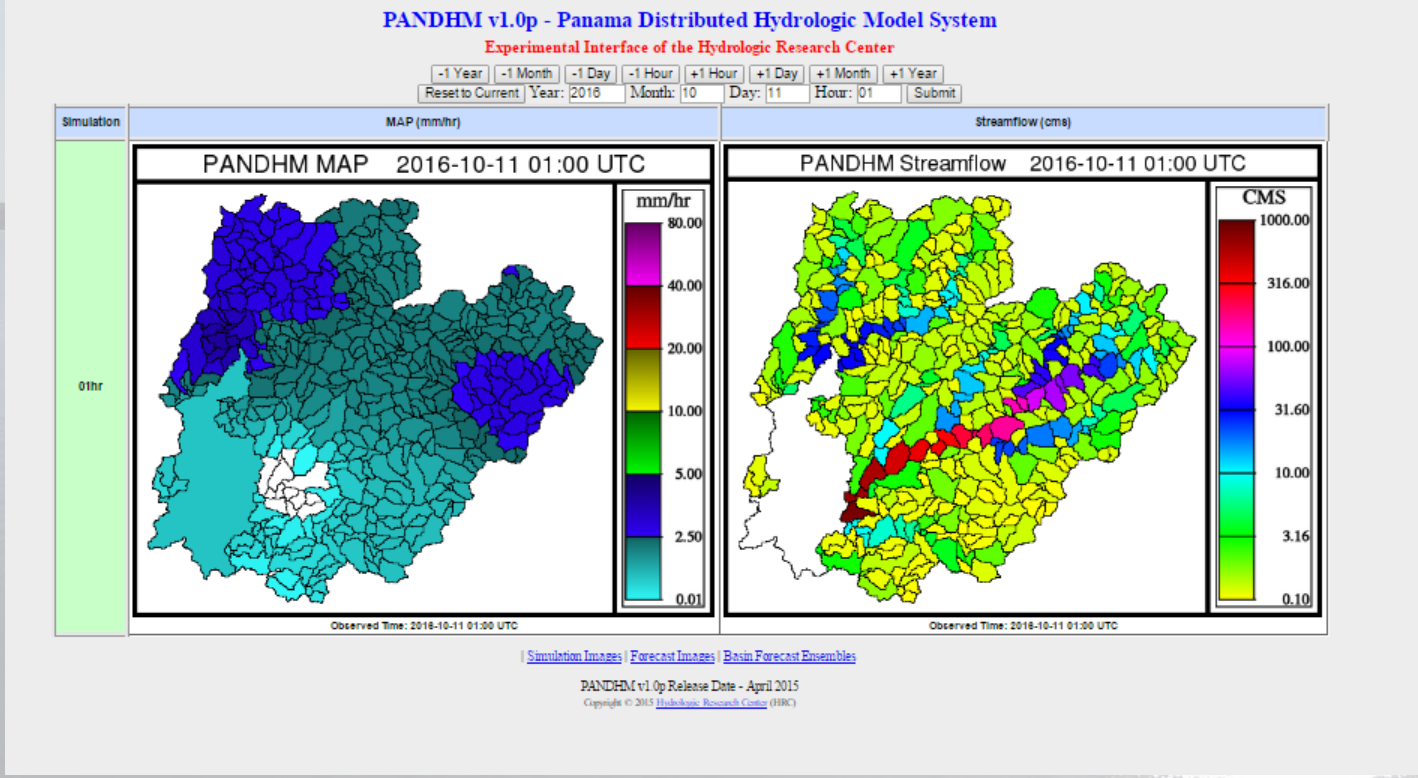
Diffusive

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

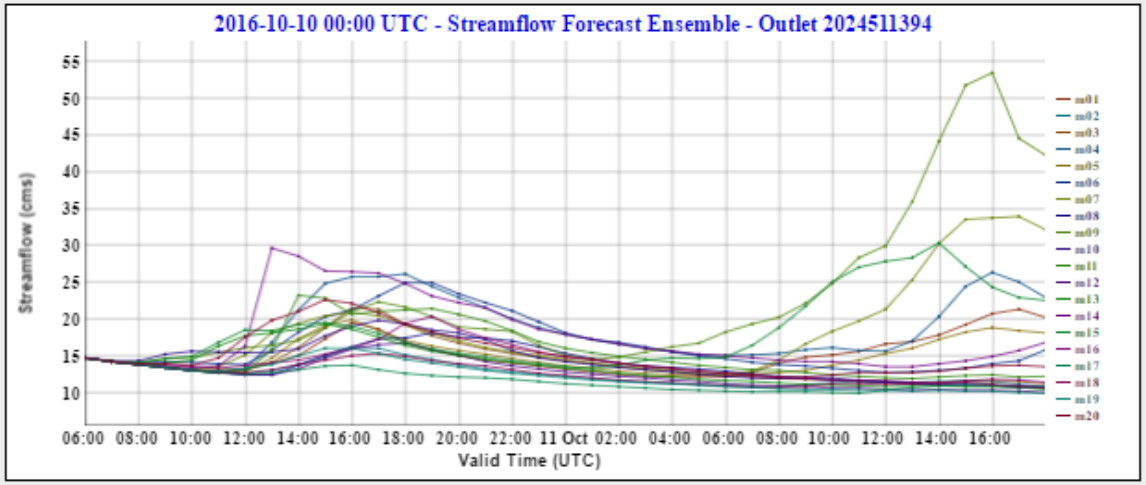
PANDHM v1.0p - Panama Distributed Hydrologic Model System

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



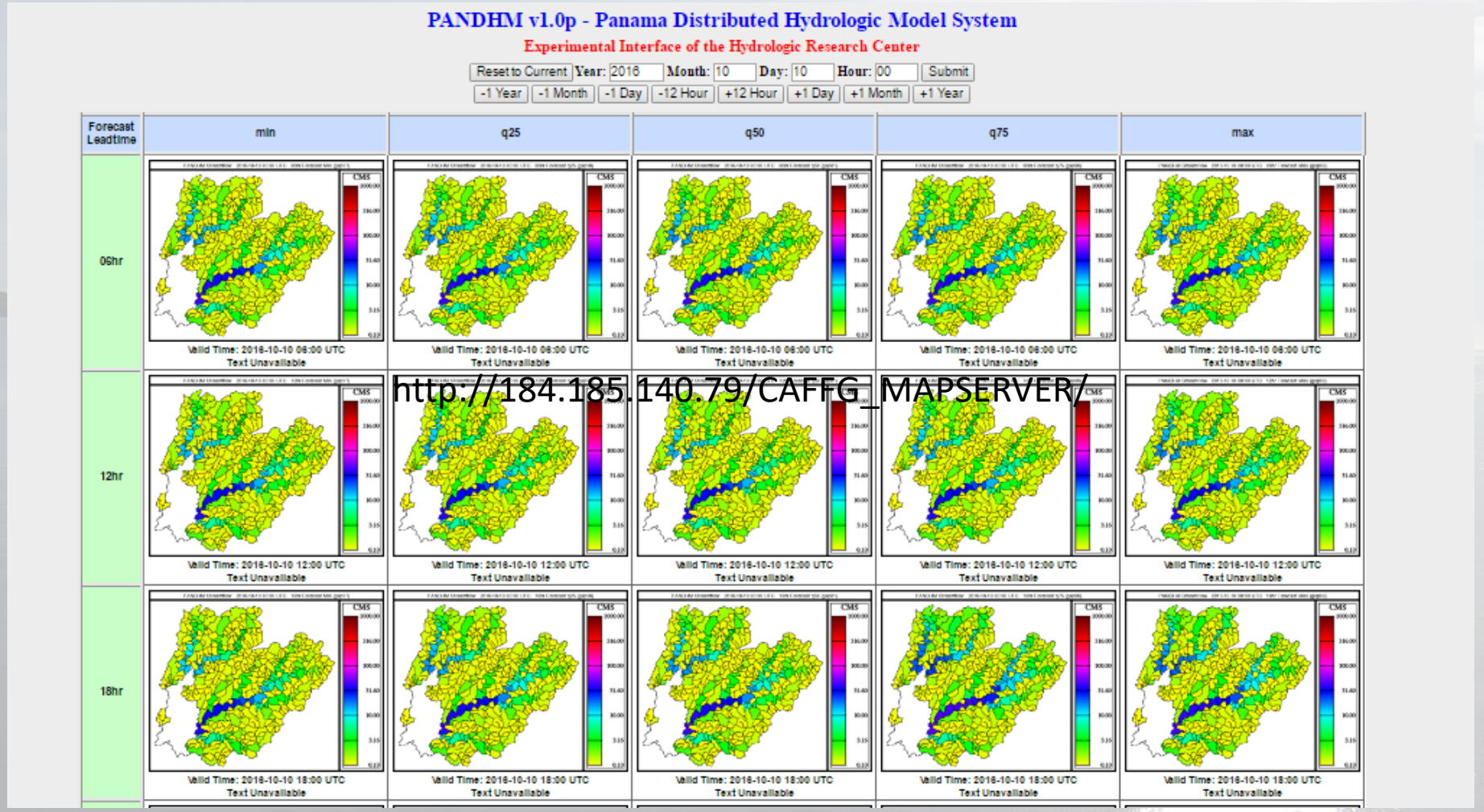
Download the CSV data file: 2016101000_2024511394_streamflow_forecast_basin_ensemble.csv

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

Units: cms

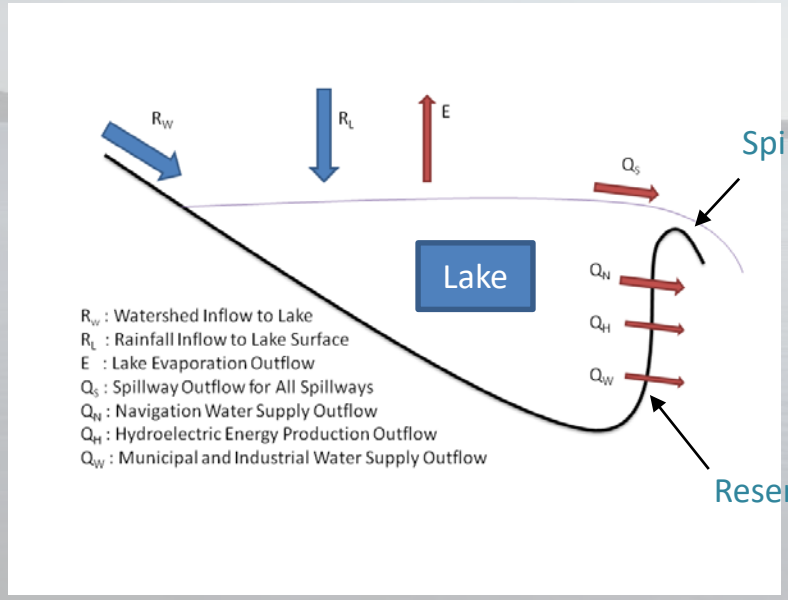
Valid Time	m01	m02	m03	m04	m05	m06	m07	m08	m09	m10	m11	m12	m13	m14	m15	m16	m17	m18	m19	m20
2016-10-10 06:00	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8	14.8
2016-10-10 07:00	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.4	14.3	14.3	14.3	14.3	14.3	14.3	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	14.5	19.4

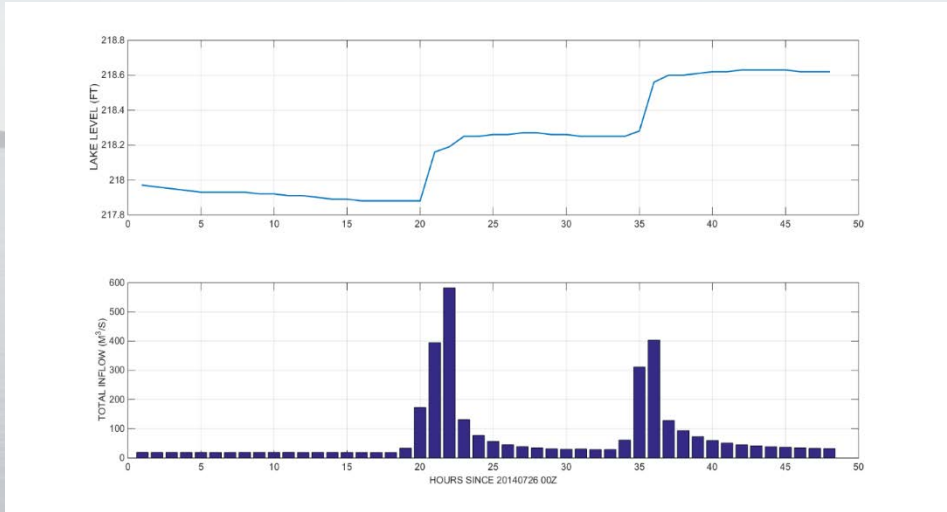
B.3 Type of Interface: Forecast Maps



B.4 Reservoirs and Lake Levels

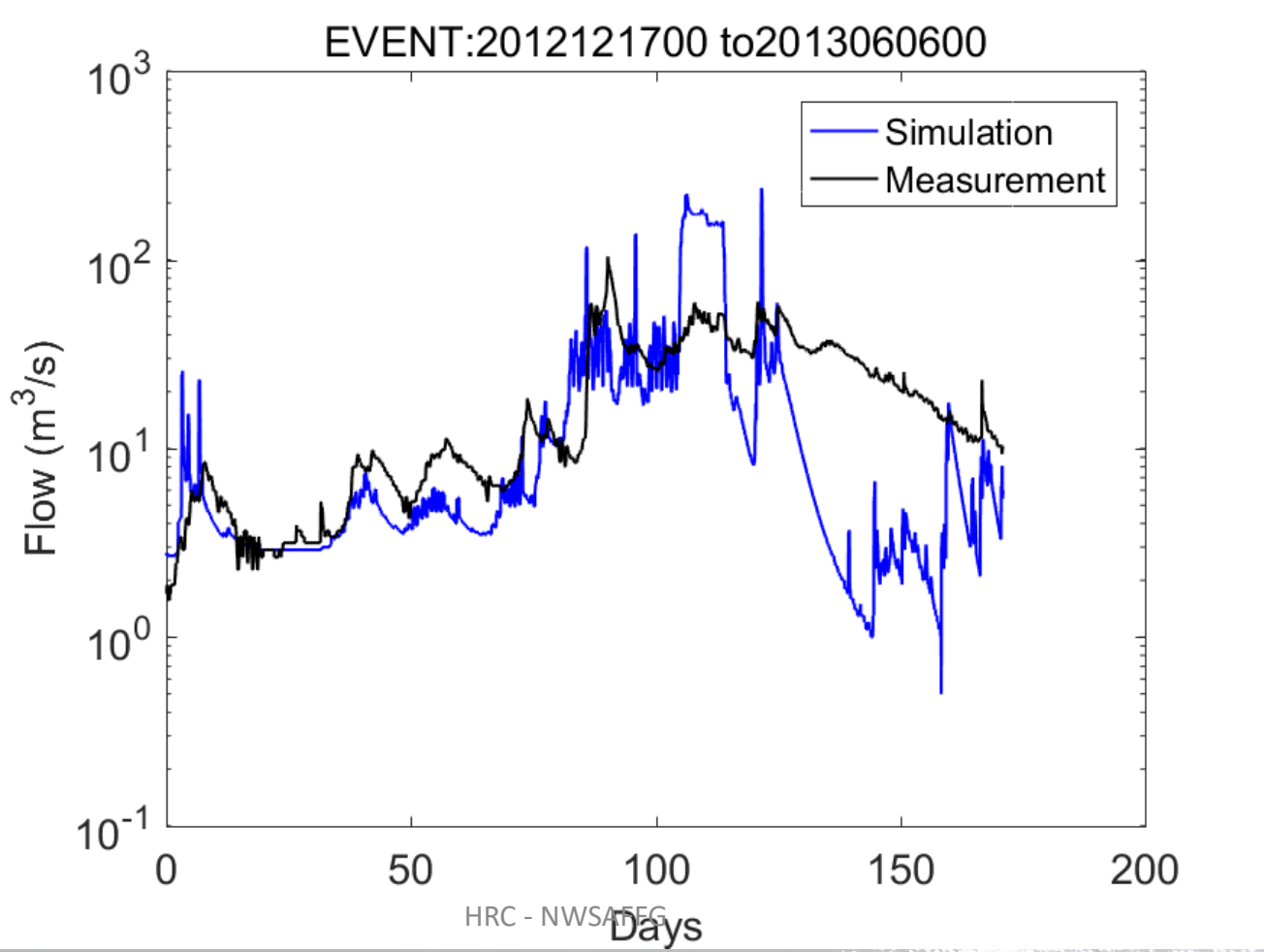
Reservoir Storage/Release Module for the Routing Component





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

Parameter

(e.g. Slope)

Classes

Low

Medium

High

Landslide Class Density

$$\frac{N_{pixels}(with\ Landslides\ in\ Parameter\ Class)}{N_{pixels}(in\ Parameter\ Class)}$$

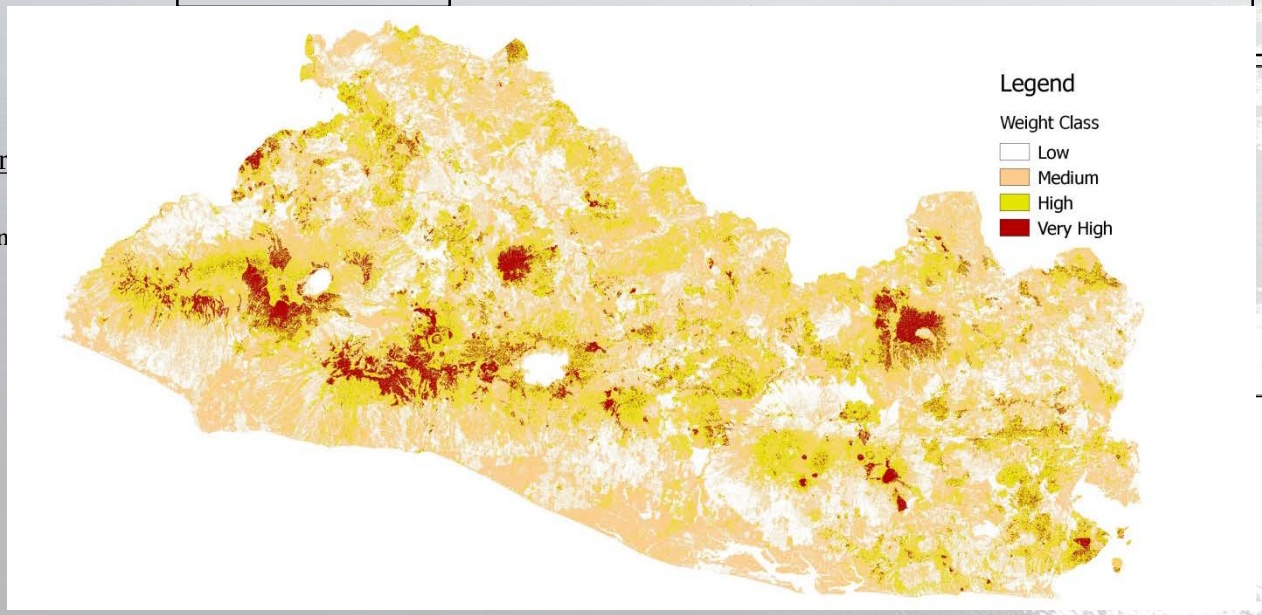
Landslide Map Density

$$\frac{Total\ N_{pixels}(with\ Landslide)}{Total\ N_{pixels}(in\ region)}$$

Landslide Inventory Map

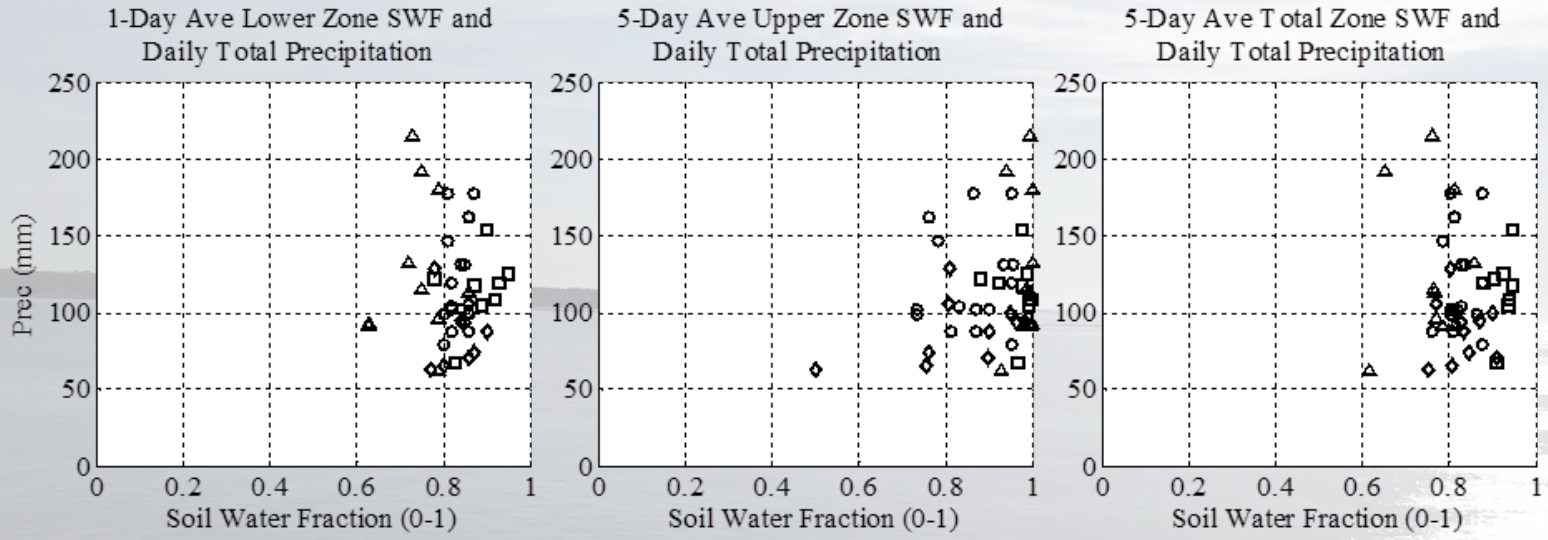
Factor

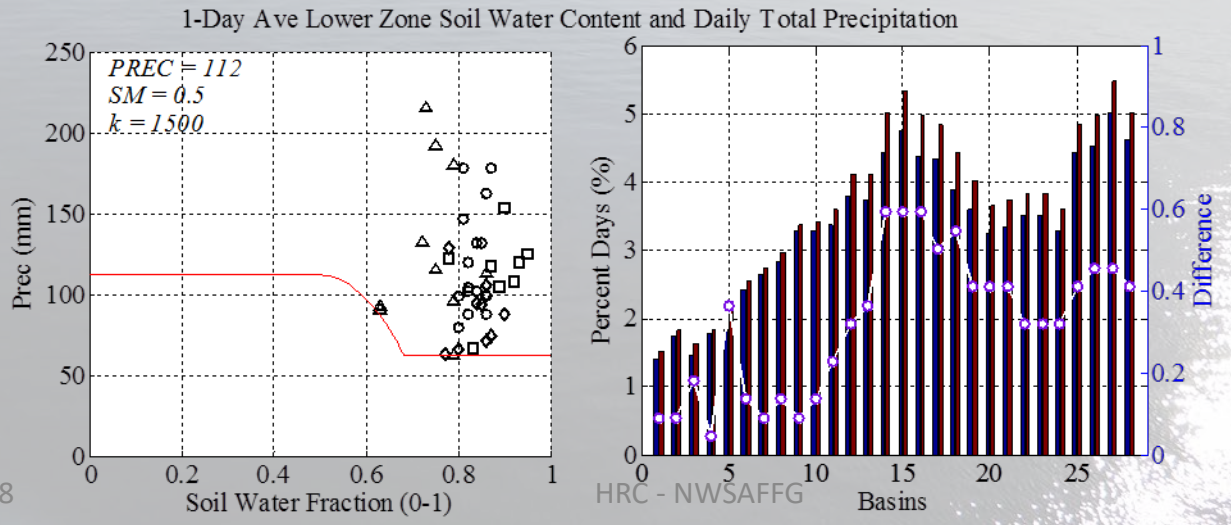
$W_i = \ln$



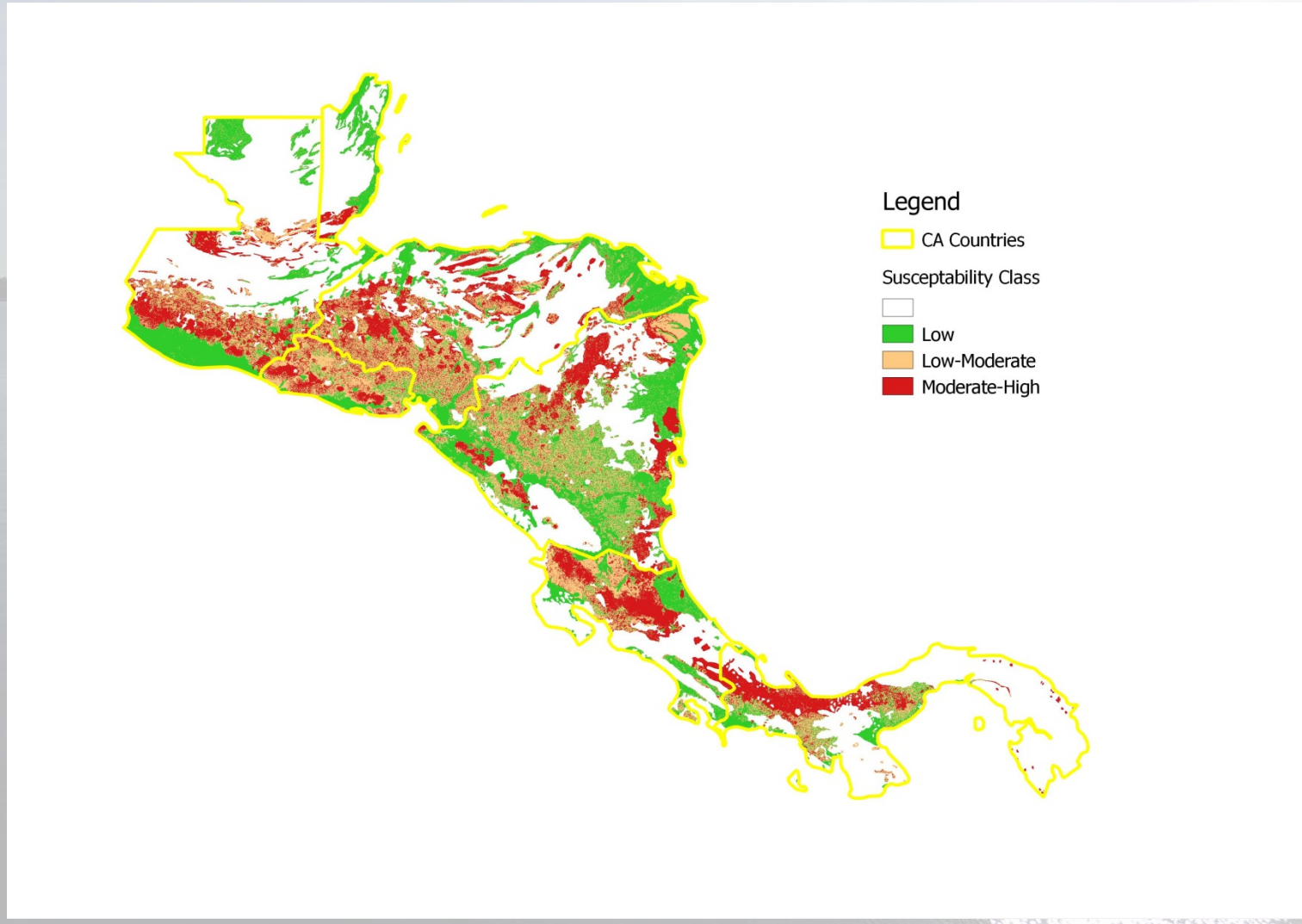
Continuous Susceptibility Weight Values to Discrete Classes

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





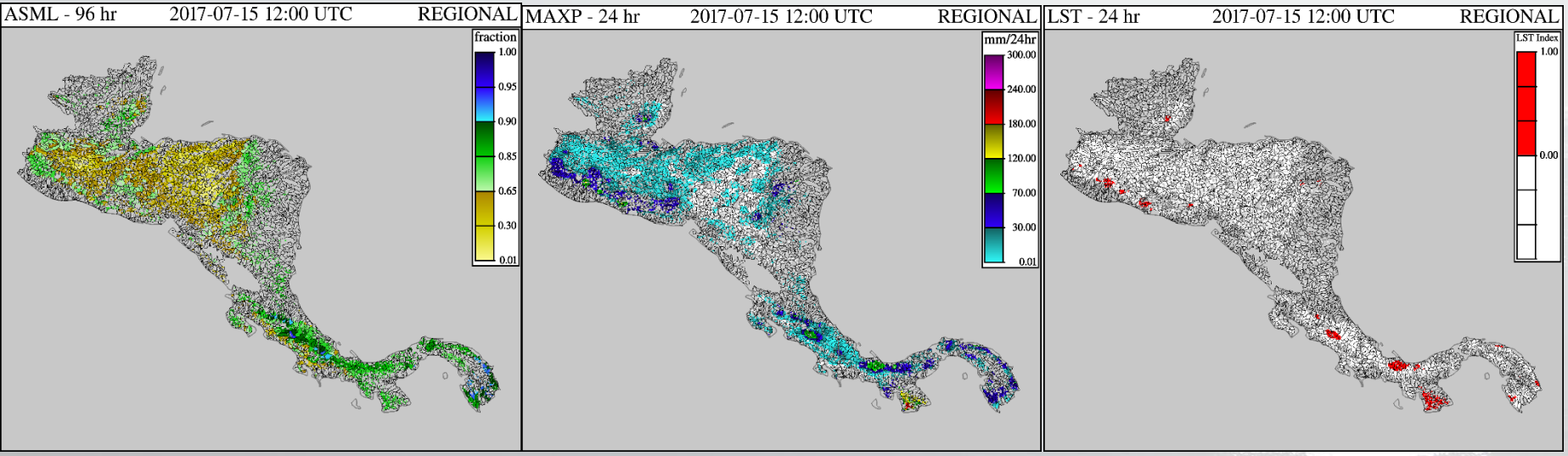
C.3 Generalization for Central America



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