Enhanced Engagement in Research on Kabul River Basin (EKaRB)

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Brief Overview

- A consolidated database on Indus Basin "Indus Basin Knowledge Platform (IBKP)" http//: indusbasin.org
- Kabul River Basin Geodatabase
- Kabul River Basin Decision Support Tool
- Hec-GeoHMS rainfall runoff model with climate change scenarios
- Water Evaluation and Planning Model (WEAP) for the Kabul River Basin
- A comprehensive review of relevant national, sub-national, regional and international laws on water to suggest options for future development of Kabul River Basin
- Research Uptake and new opportunities for engagement

Background

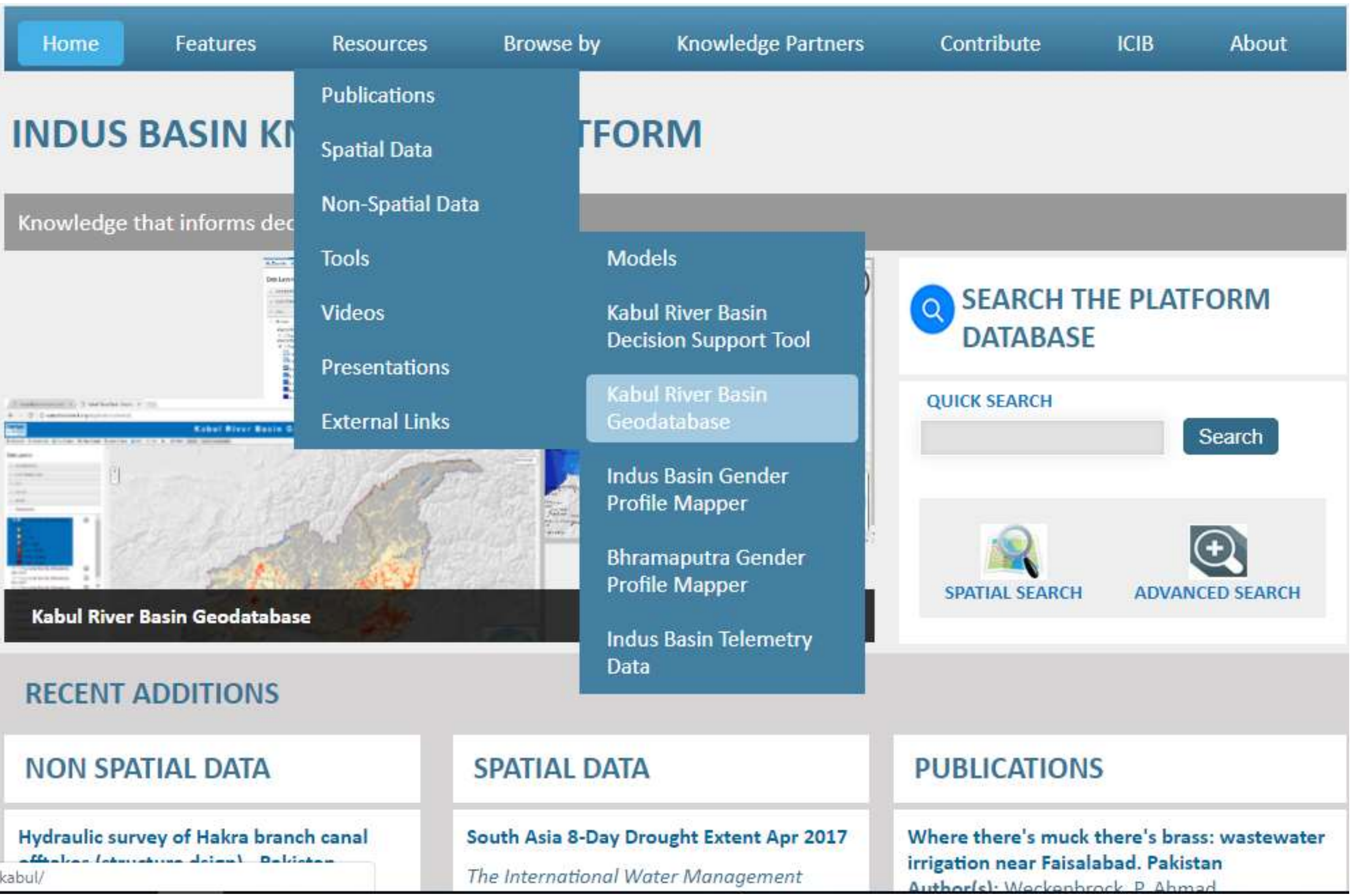
- Both Pakistan and Afghanistan share Kabul River Basin (KRB) becoming upper and lower riparian states respectively. KRB contributes a significant amount of water in the water budget of both countries. However, there has been a considerable decrease in annual flows of Kabul river system based on the historical data (1937 – 2008) which amounts from 28 to 19 MAF (IUCN 2013). The possible reasons could be climatic variability, persistent drought or enhanced use of water in Afghanistan.

- **Key Objectives of the Project**

❖Pairing climate data and historical and modern climate data to statistically create a hydrograph

❖Projected climate change impacts on flows

❖Water availability and use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kabul/

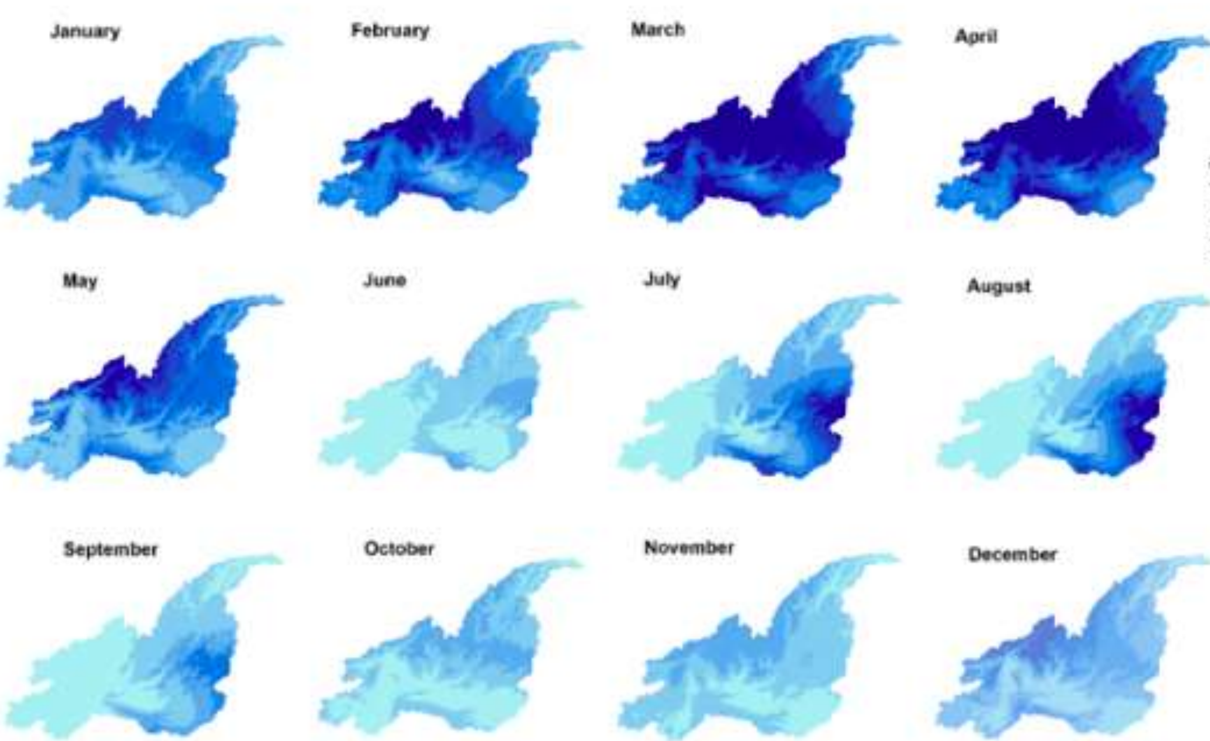
Kabul River Basin Geodatabase

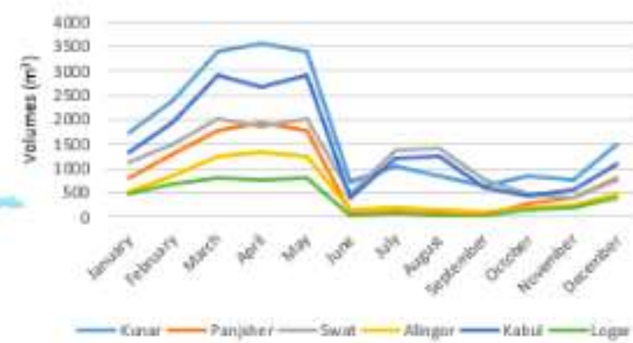
http://waterdata.iwmi.org/applications/kabul

- The geodatabase helps users to explore and analyze the biophysical and socioeconomic conditions of the basin by compiling a number of existing data (GIS, attribute, geographic features, GPS, etc.) into one platform, with each data source attributed

Geodatabase Interface

30 Years Monthly Average Precipitation (mm)



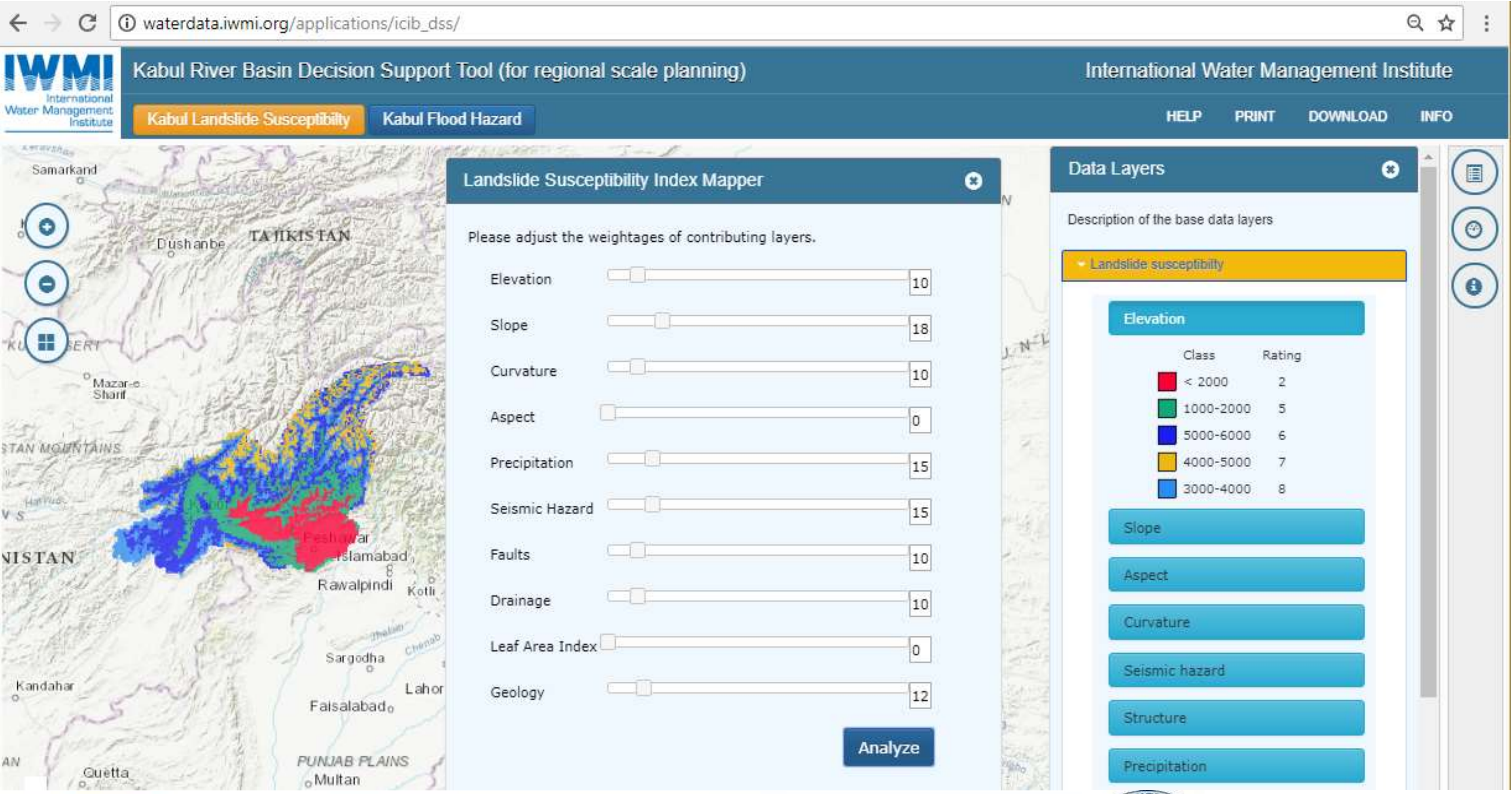


Decision Support Tool

http://waterdata.iwmi.org/applications/icib_dss/

- The decision support tool (DST) provides landslide susceptibility index maps and flood hazard index maps – vital for disaster management and for planning development activities.

DST Landslide Susceptibility Interface



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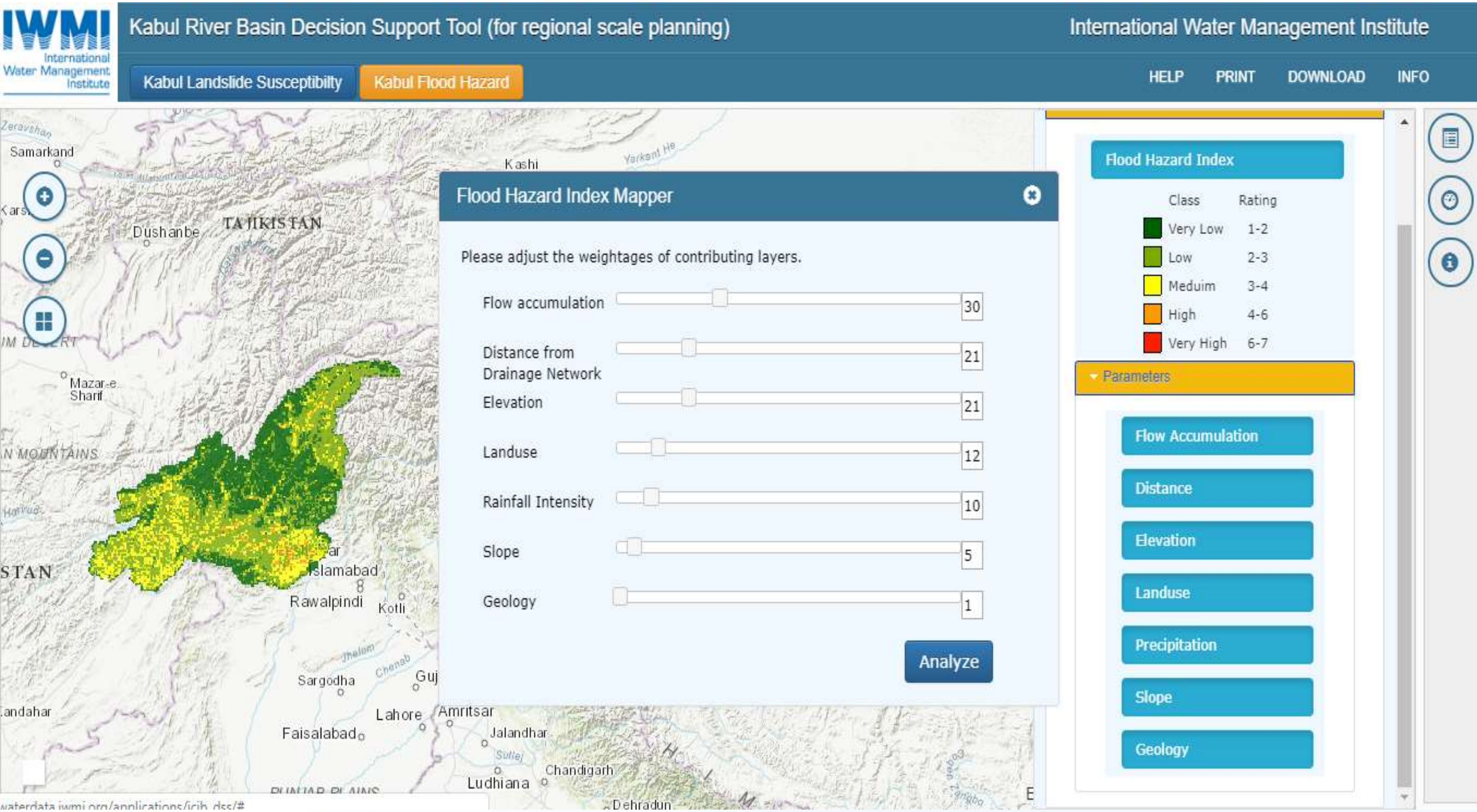
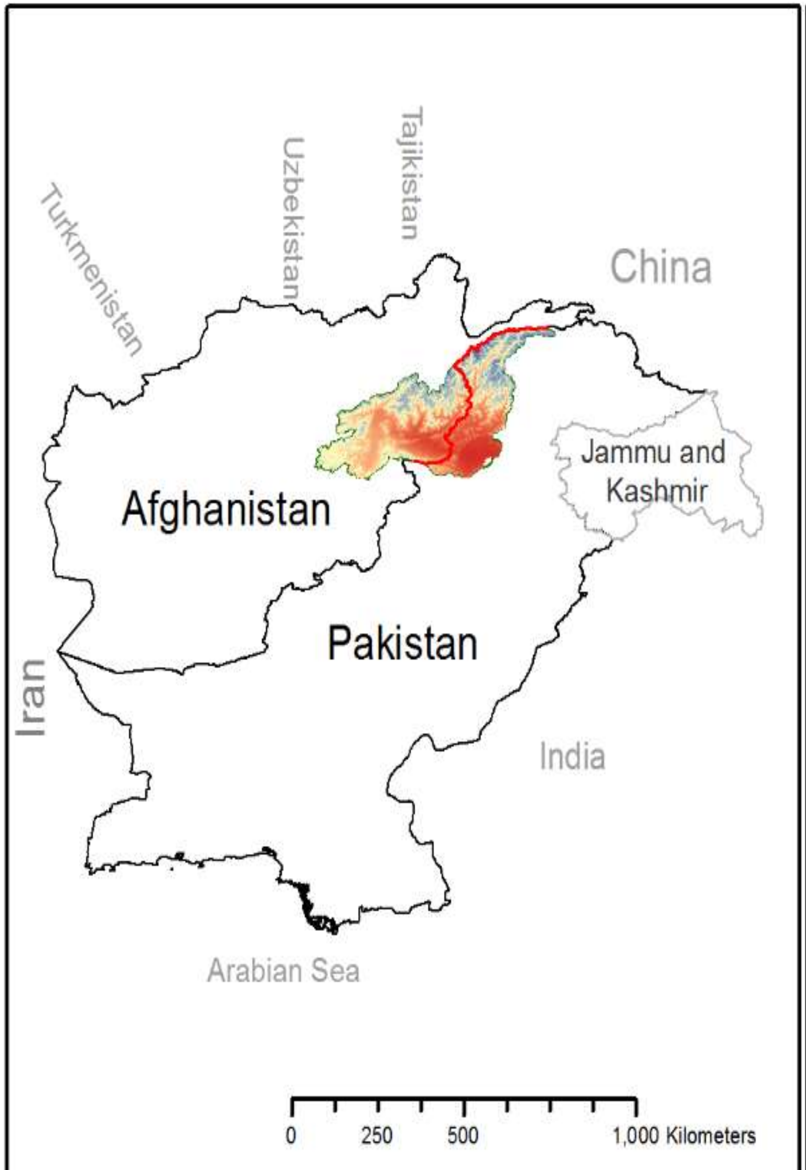
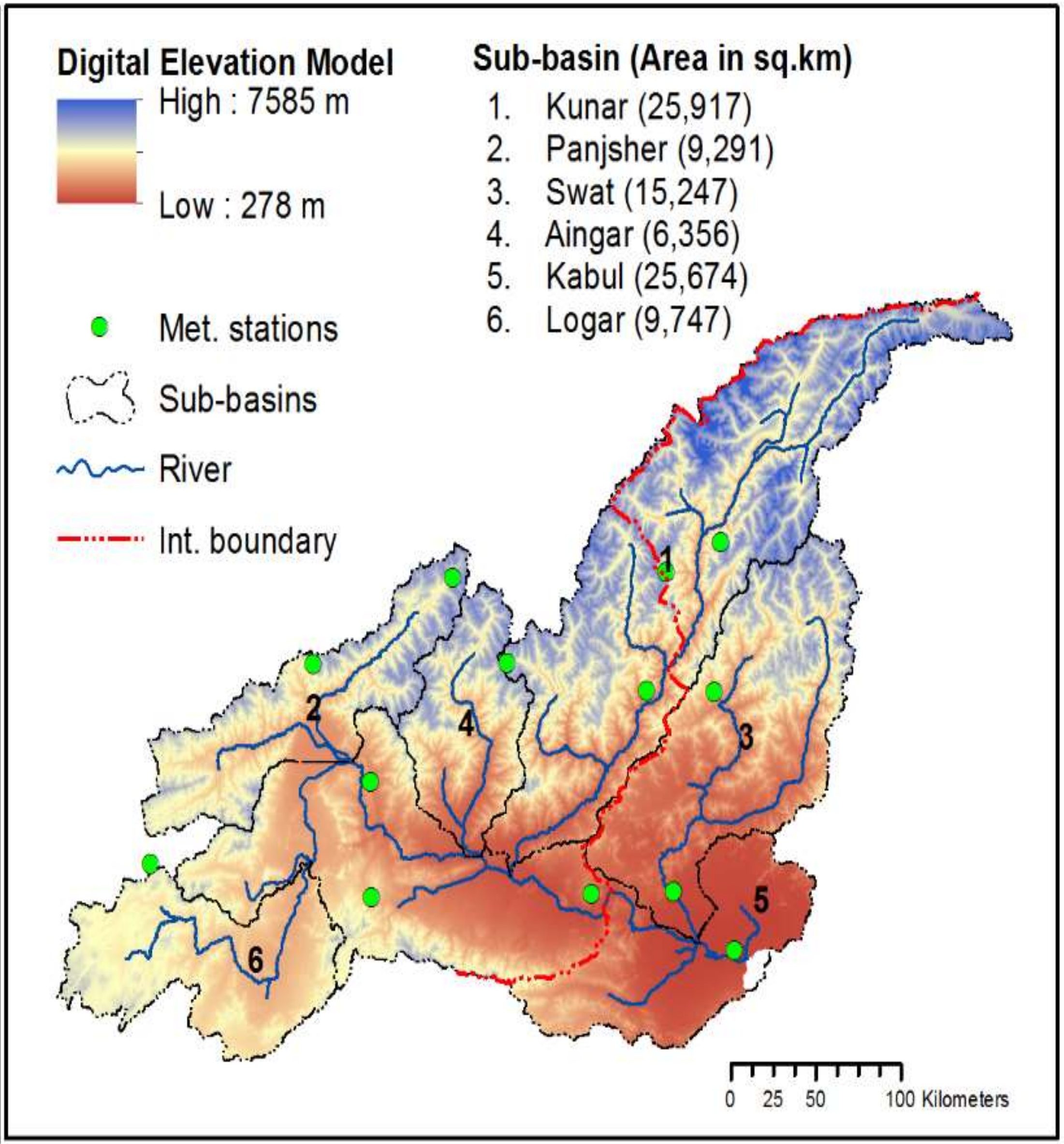
DST Flood Hazard Interface



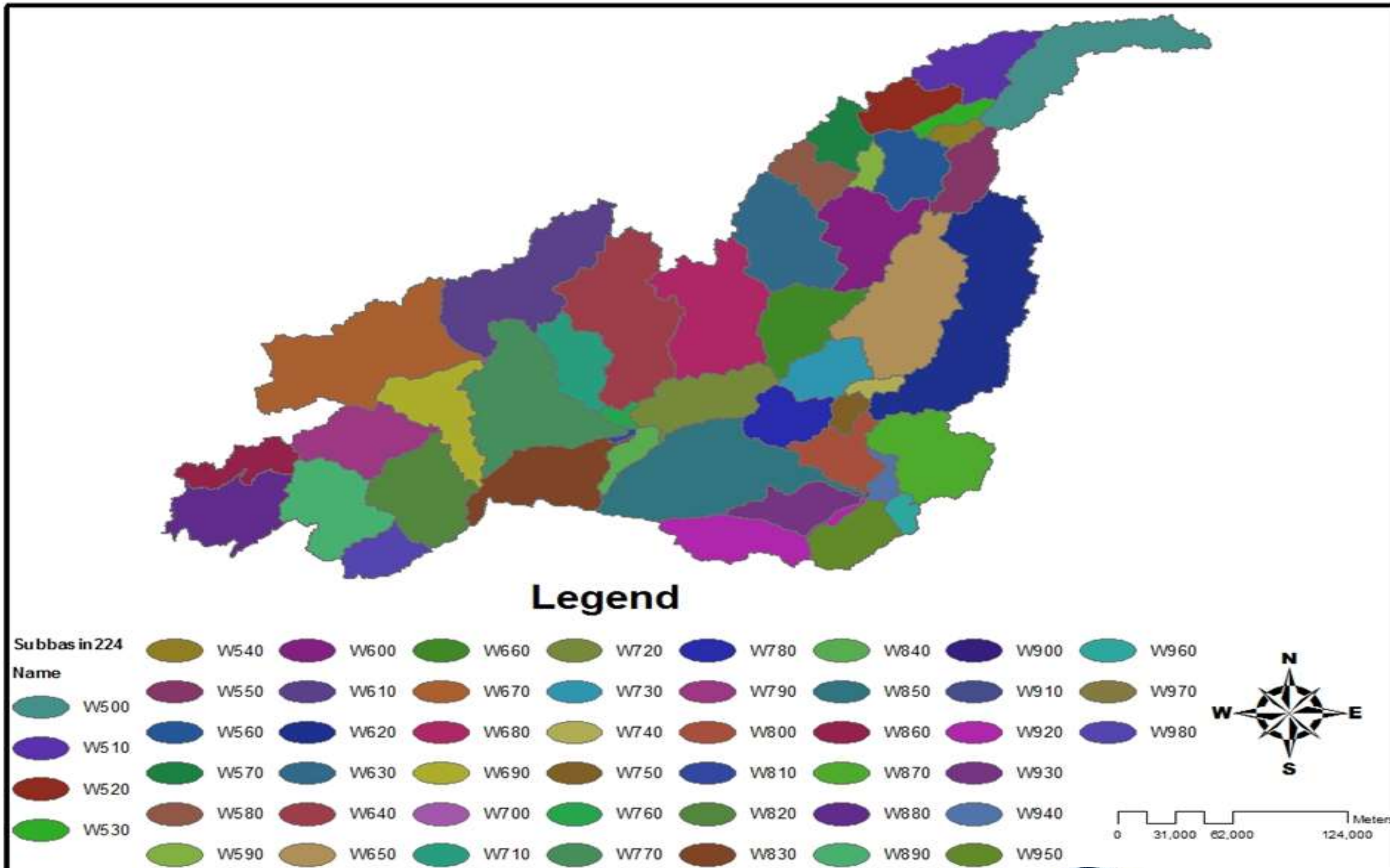
Hec GeoHMS Model for Kabul River Basin

Study Area and DEM of KRB

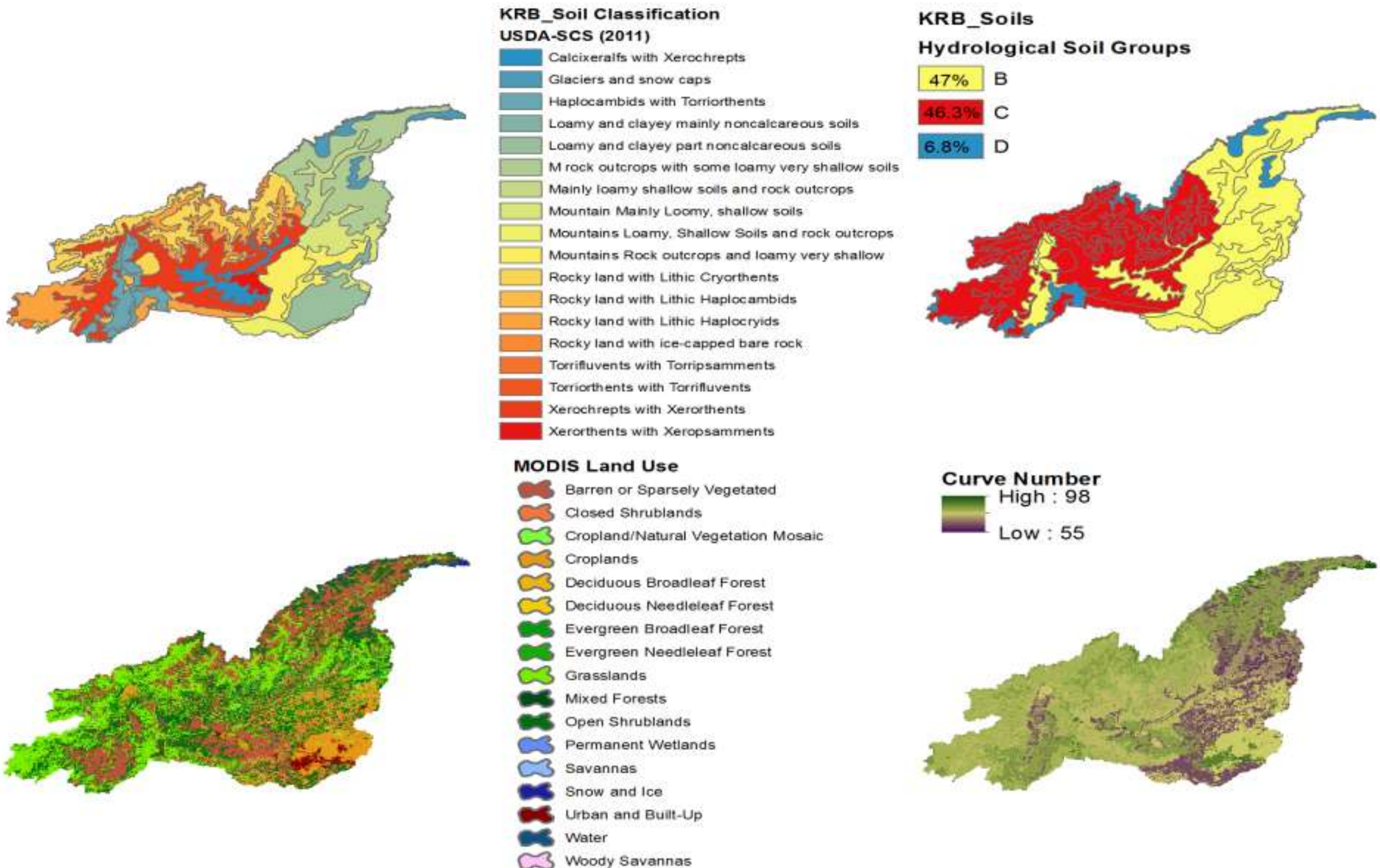




GIS and HEC-GeoHMS processing (Subbasin delineation)



GIS input to the Model



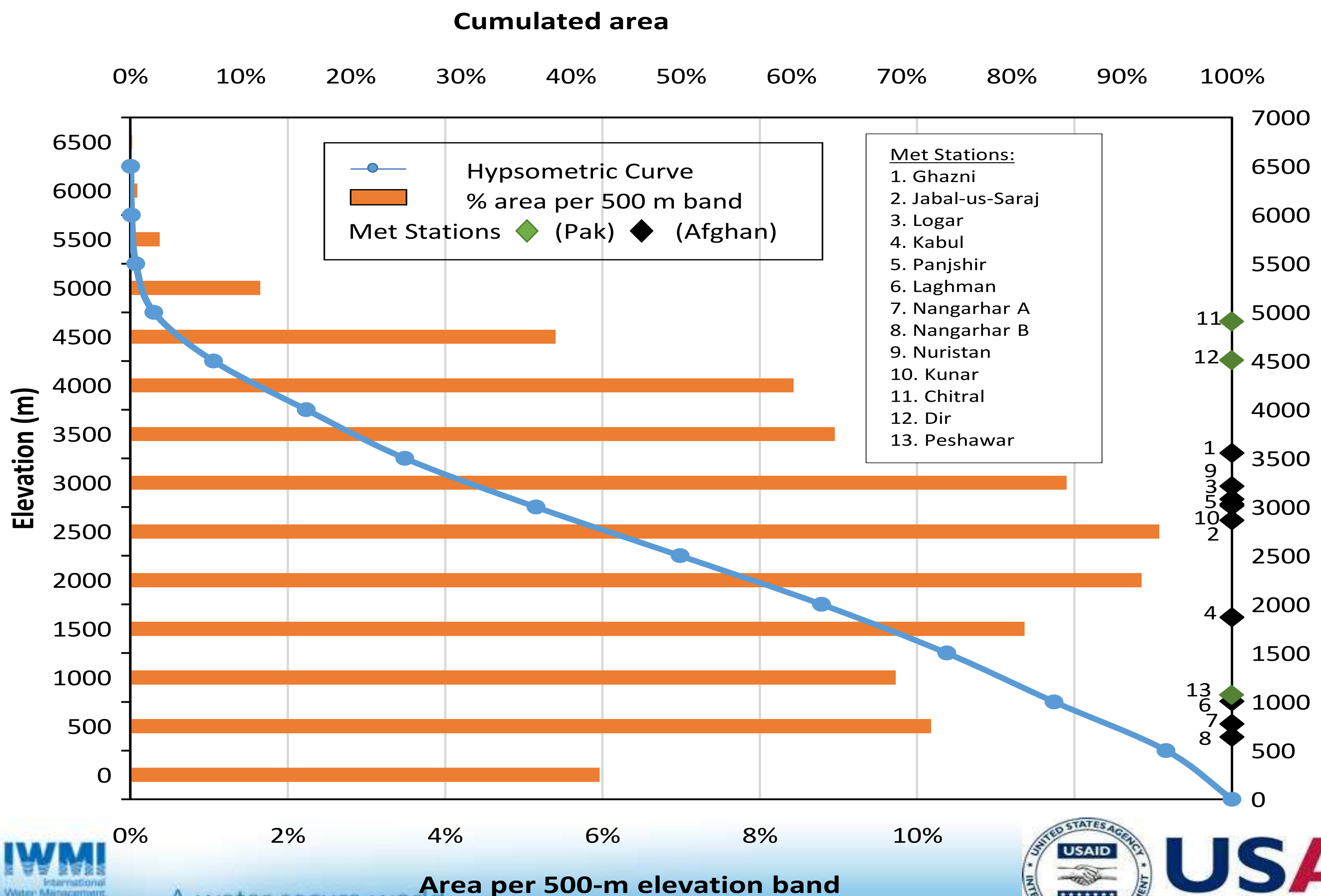
Hydrological Soil Groups

Hydrological Soil Group (HSG)	Soil Textures
A	Sandy, loamy sand, or sandy loam
B	Silt loam or loam
C	Sandy clay loam
D	Clay loam, silty clay loam, sandy clay, silty clay, or clay

Satellite data

- Digital Elevation Model (DEM) 90m data was retrieved using the Shuttle Radar Topography Mission (SRTM) (http://srtm.csi.cgiar.org/)
- Moderate Resolution Imaging Spectroradiometer (MODIS) land cover data (http://glcf.umd.edu/data/lc/).
- Soil classification within Kabul River basin was retrieved from Unites States Department of Agriculture (USDA) and soil survey of Pakistan soil maps. (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/use/worldsoils/?cid=nrcs142p2_054000)

Hypsometric curve for KRB



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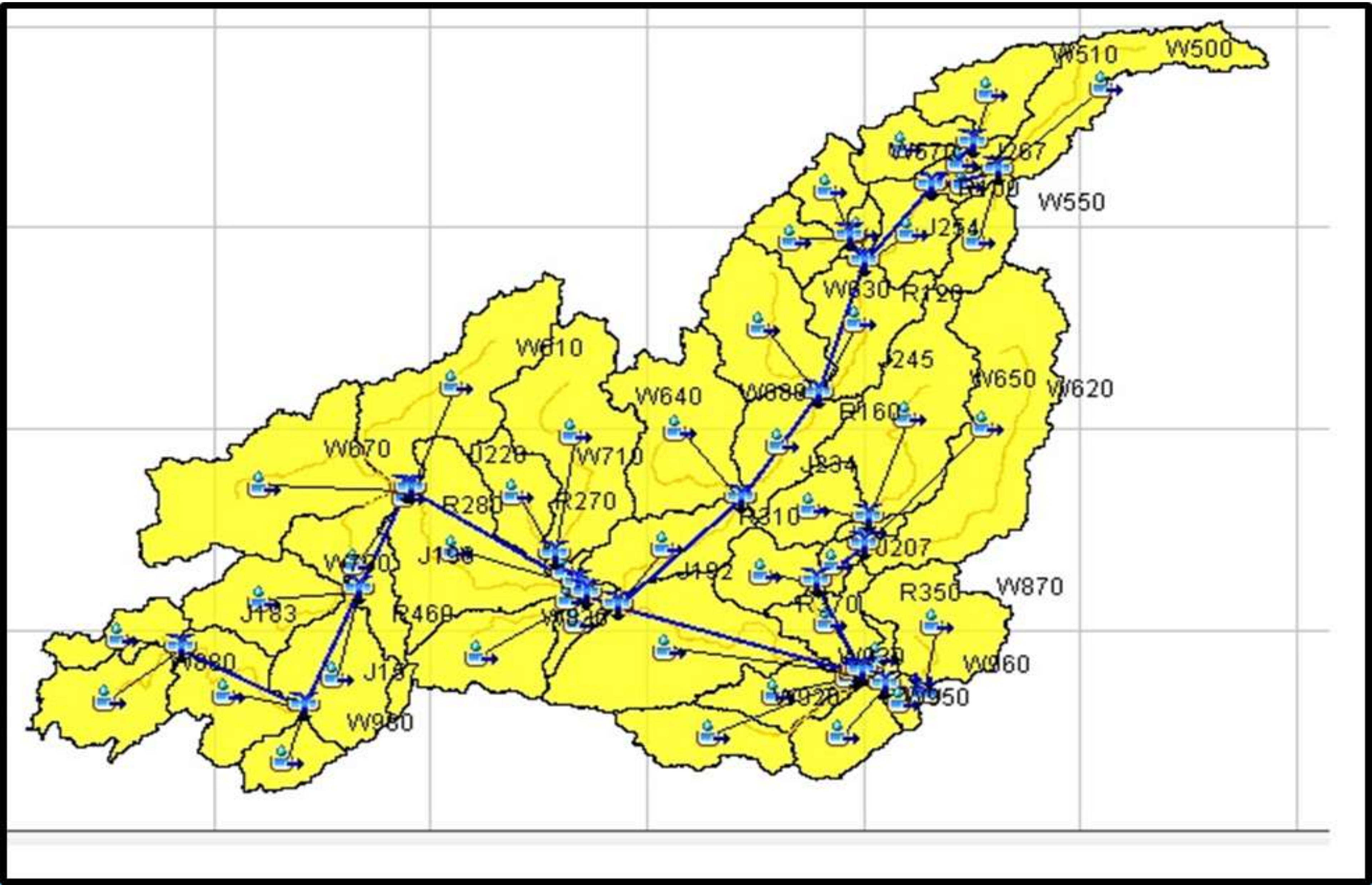
HEC-HMS Project



Hydrologic and climate data

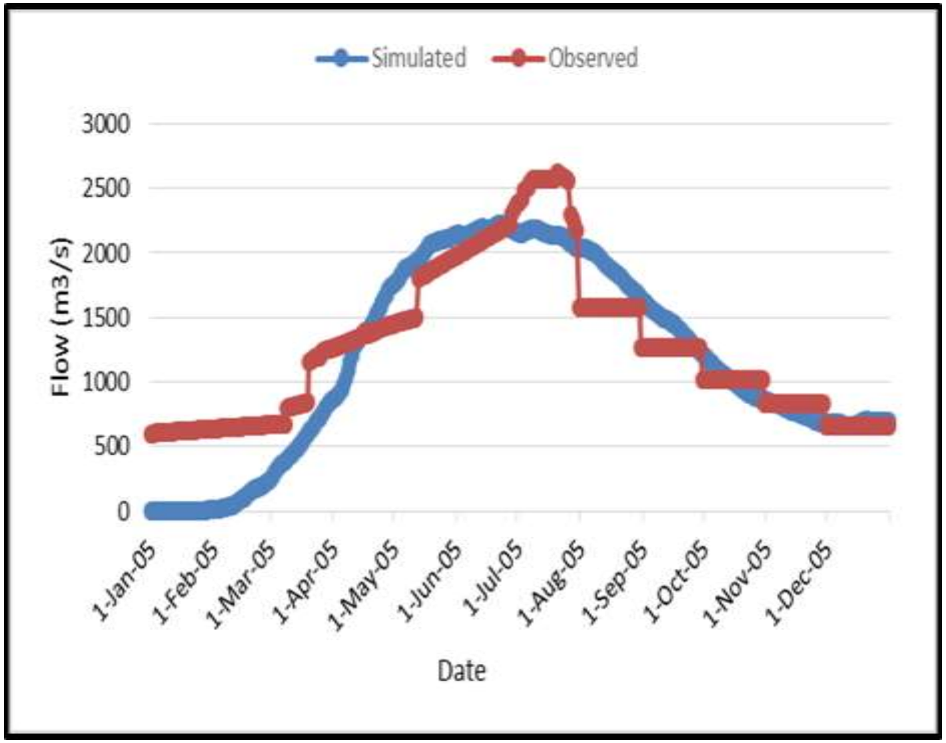
Met Stations	Period of record
Ghazni	2000-2012
Jabal-us-Saraj	2000-2012
Logar	2000-2012
Kabul	2000-2012
Panjshir	2000-2012
Laghman	2000-2012
Nangarhar A	2000-2012
Nangarhar B	2000-2012
Nuristan	2000-2012
Kunar	2000-2012
Chitral	2001-2012
Dir	2001-2012
Peshawar	2001-2012

Flow Stations	Period of Record
Noshehra	2002-2014
Warsak Dam	2004-2014

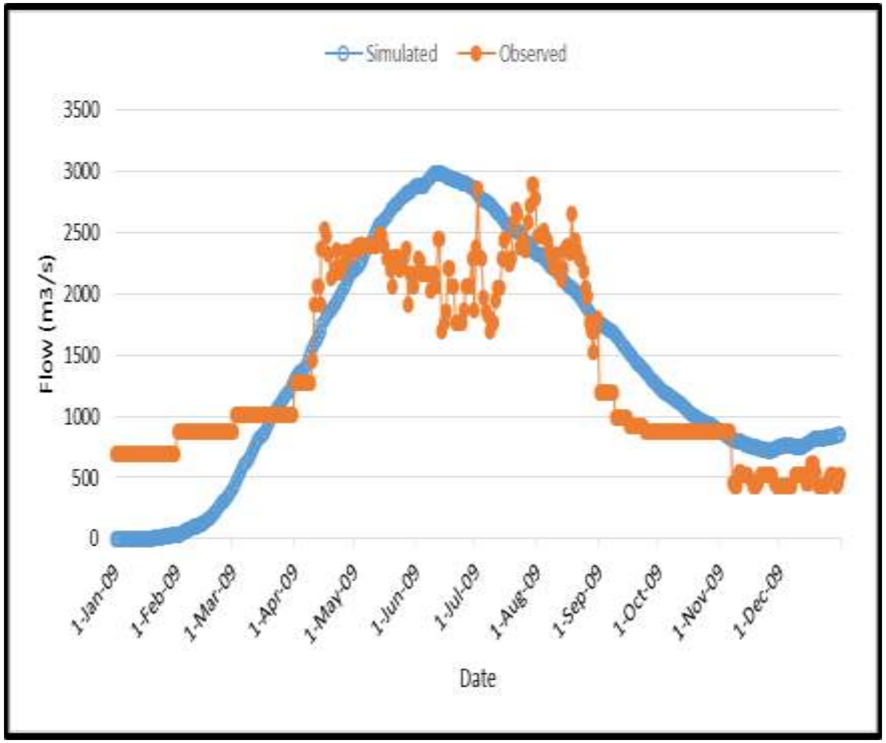
Model Calibrated and validated at downstream of Warsak Dam near Nowshehra

Model Calibration and Validation at Nowshera

- Calibration



- Validation



Model Calibration and Validation at Nowshera

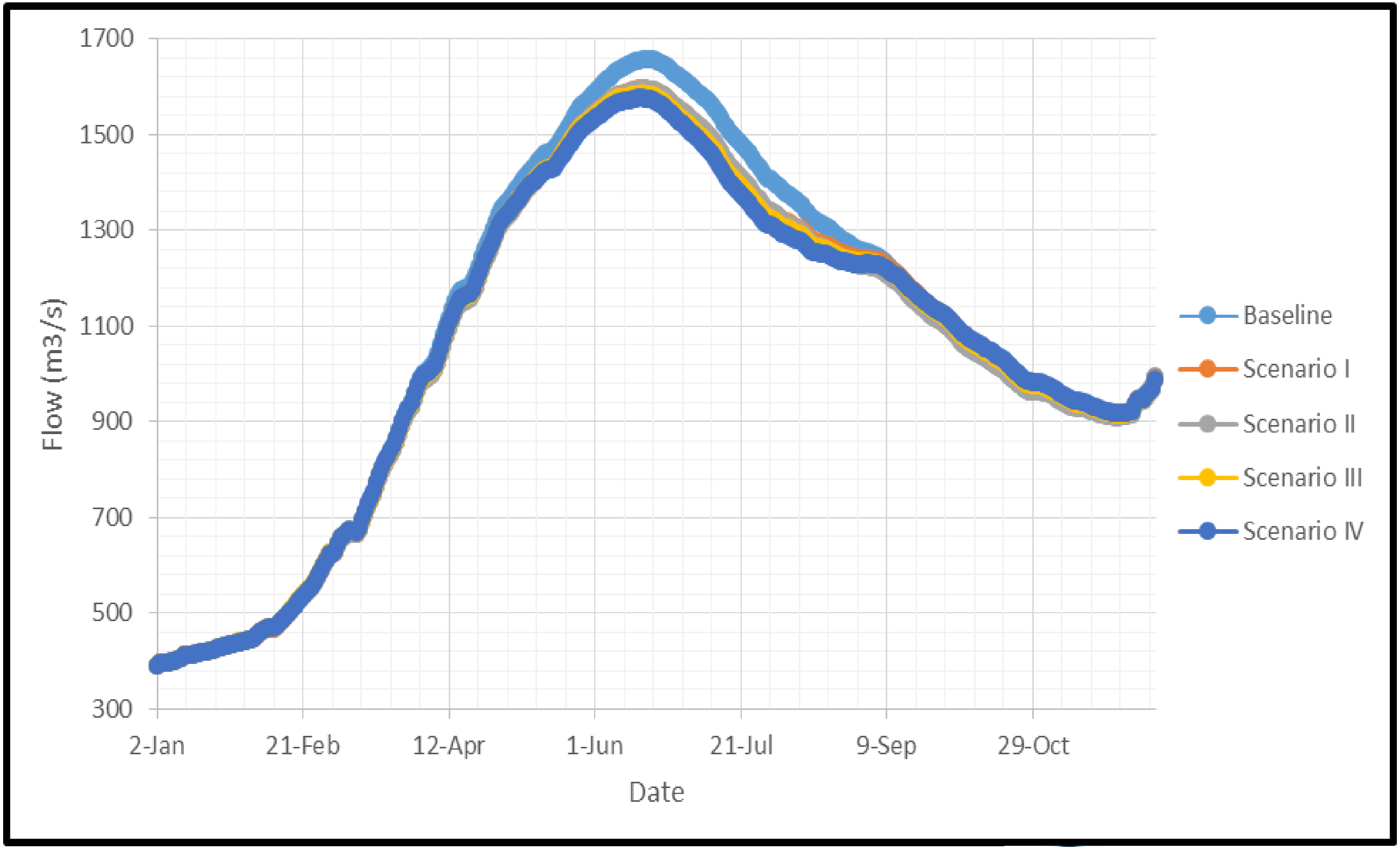
Action	Period	Peak flow			Mean flow			Total volume			R^2	NS
		Observed m^3/s	Simulated m^3/s	RE %	Observed m^3/s	Simulated m^3/s	RE %	Observed Mm^3	Simulated Mm^3	RE %		
Calibration	2005	2620	2224	**15.11**	1271	1176	**7.47**	40	37.1	**7.25**	**0.84**	**0.71**
Validation	2009	2892	2988	**-3.32**	1363	1430	**-4.92**	42.94	45	**-4.80**	**0.74**	**0.56**

Future climate change scenarios

Downscaled climatic data for KRB was used for future scenario analysis:

- Year 2002 – Baseline
- Year 2025 – Scenario I
- Year 2050 – Scenario II
- Year 2075 – Scenario III
- Year 2100 – Scenario IV

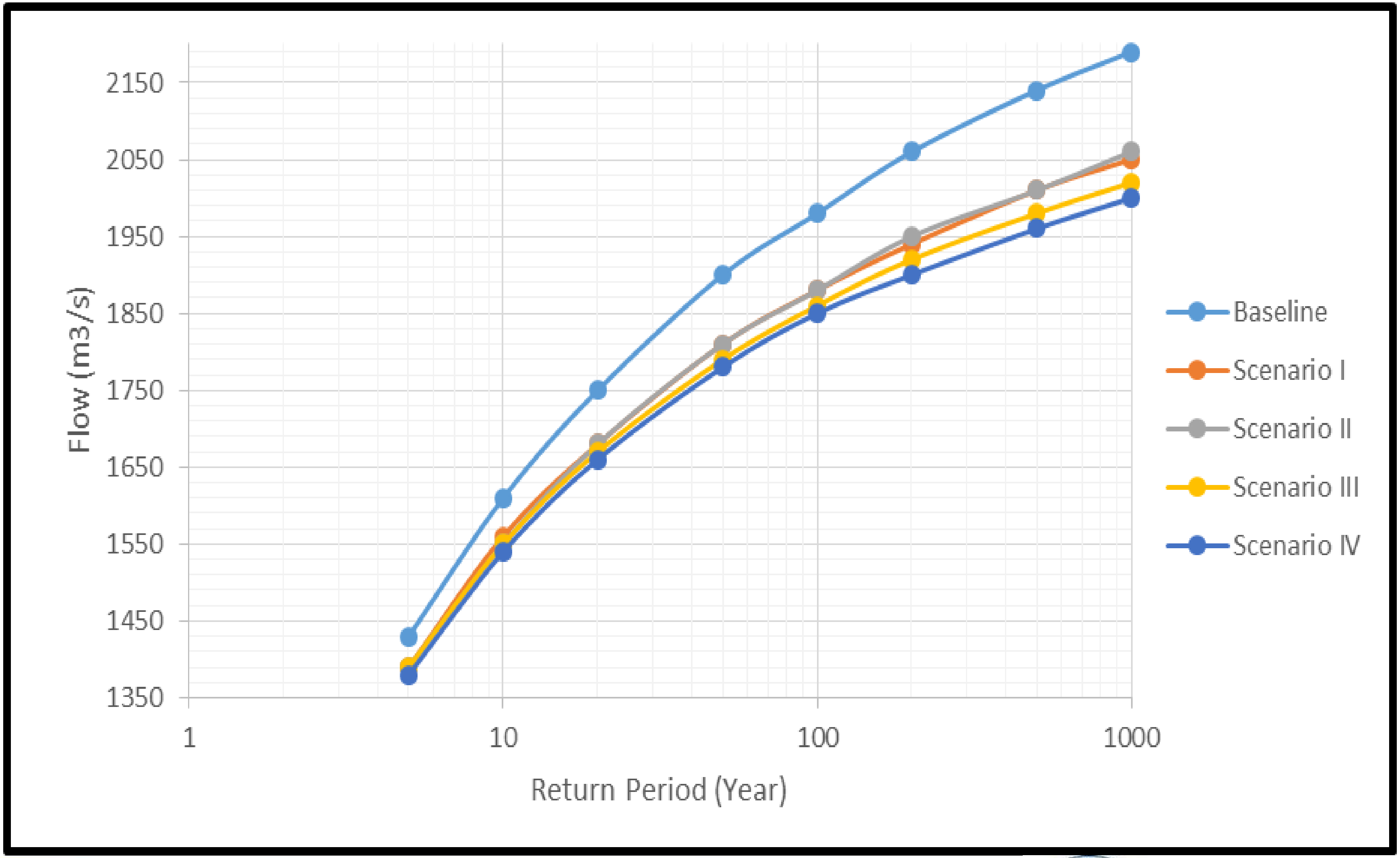
Future discharge cycle at Noshehra



Future discharge cycle at Noshehra

Scenarios	Change in mean discharge (%)	Change in peak discharge (%)
Scenario I	-1.71	-3.83
Scenario II	-2.15	-3.85
Scenario III	-2.00	-4.49
Scenario IV	-2.19	-5.12

Future flood frequency analysis



Summary

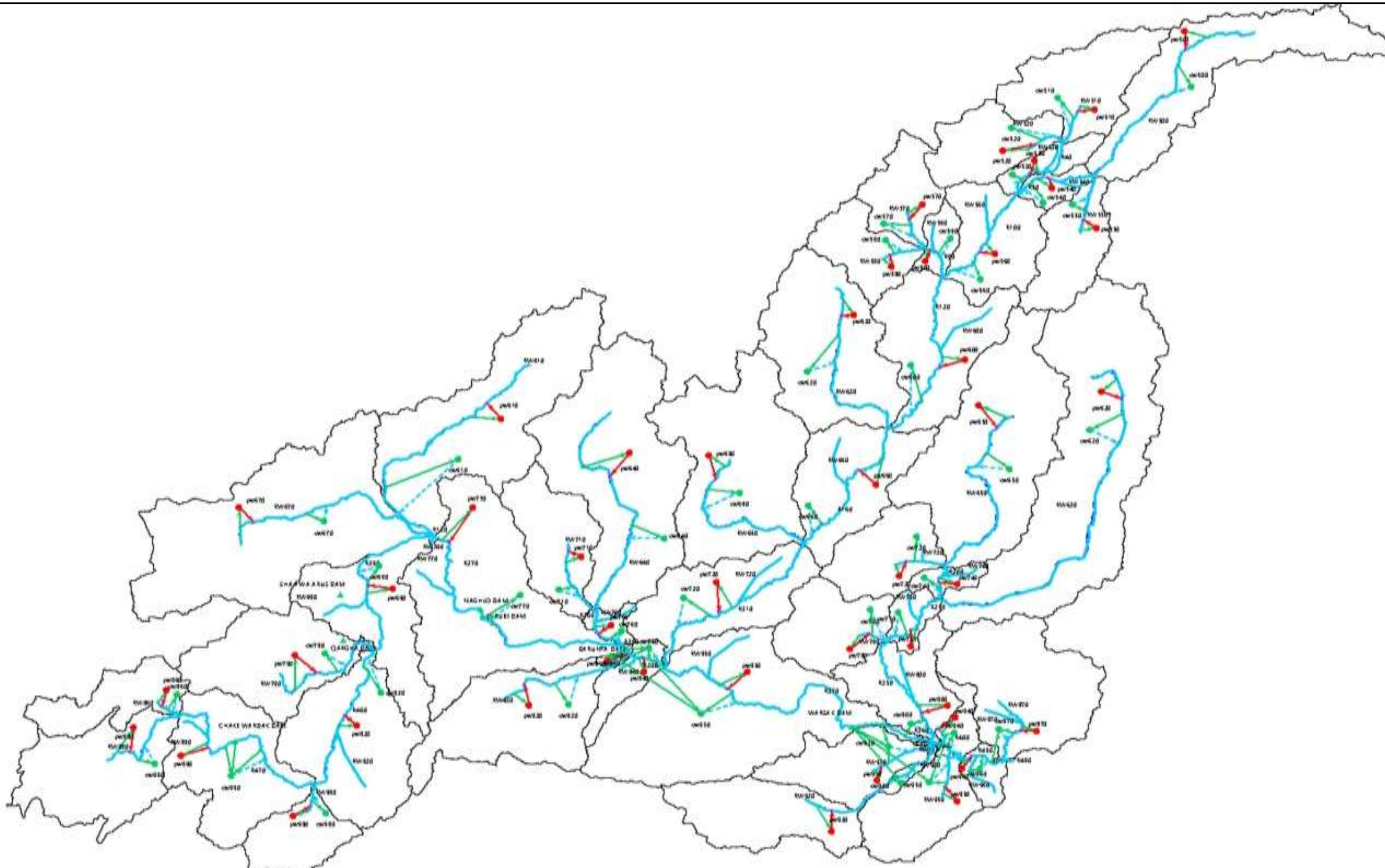
- HEC-HMS was used to examine the impacts of climate change on the flood frequencies
- GIS and HEC-GeoHMS was used to process the data in the KRB
- Observed meteorological and flow data were used to calibrate and validate the model for best set of parameters
- Future climate data were downscaled for KRB
- Climate change has nominal effect on the mean and peak flows
- Flood frequency quantiles will reduce under climate change scenarios

WEAP Model

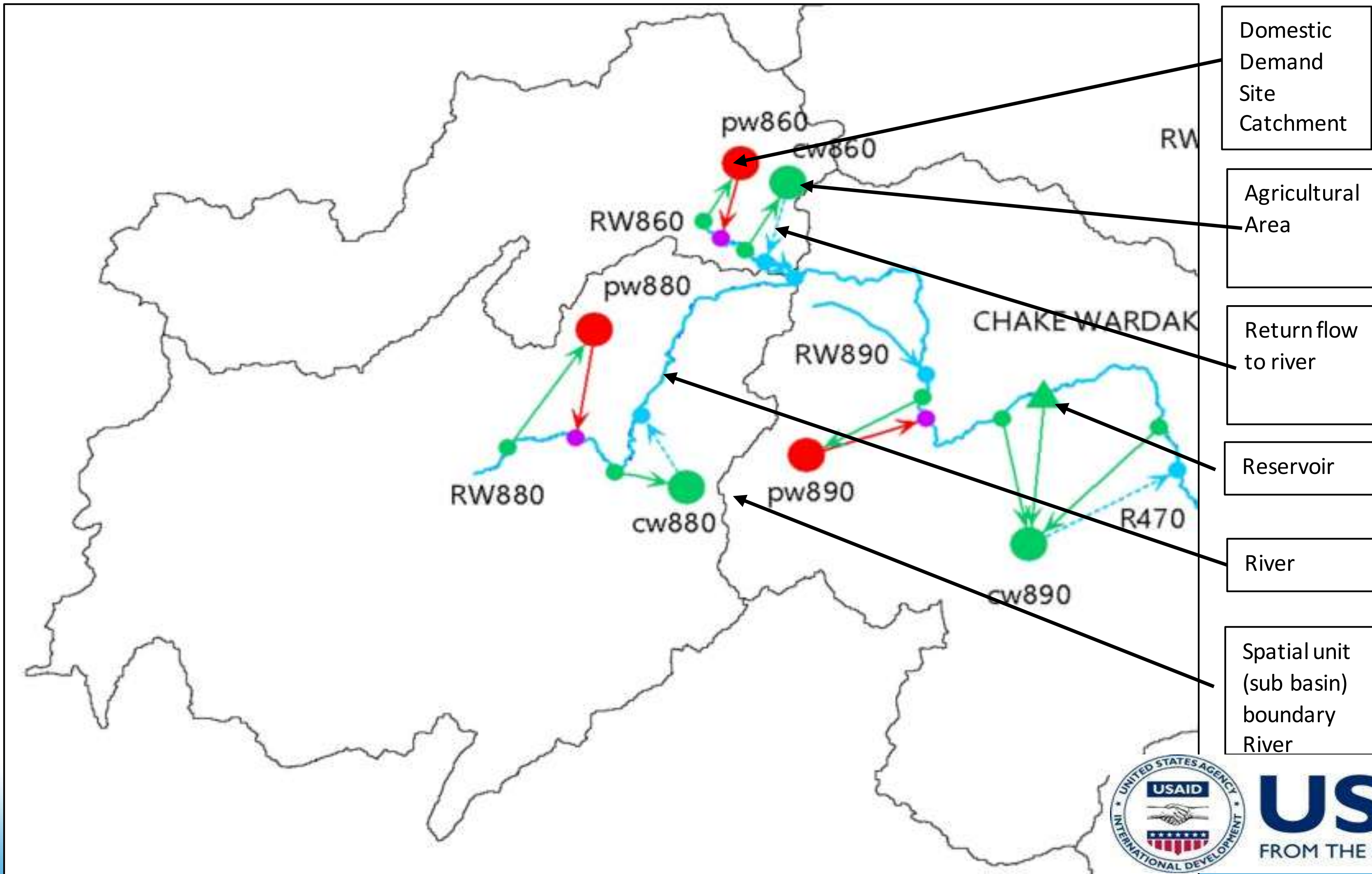
WEAP Model

- The Water Evaluation and Planning (WEAP) model is a scenario driven decision support system (DSS) designed to support water resources planning and management. It integrates the physical hydrologic processes of a system, with water infrastructure and management, and allocation of water resources to different sectors (Yates et al. 2005a, 2005b)

A screenshot of the Schematic structure of the WEAP model for the Kabul River basin



Schematic representation of the river and demand nodes within some of the spatial units (sub basins) in the Ghazni and Wardak provinces of Afghanistan



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Model Assumptions

- Only SW data included to develop scenarios
- No GW data was available. Model can incorporate GW data if available later
- Reservoir operating rules assumed as per international practice i.e.
- a. all reservoirs have an inactive zone equivalent to one third of the storage capacity
- b. Reservoir buffering starts when storage in any reservoir falls below half its storage capacity
- c. The buffer coefficient is 0.5, i.e., once the storage in the reservoir falls below half its storage capacity, only half of the volume of water available in the reservoir at any time step is released to meet demands.

Model Input Data

- 07 reservoir data included in the model
- Agricultural demand calculation based on the cropped area in each spatial unit
- $A_s = \sum_{i=1}^{n} \frac{a_i}{A_i} \times TA_i$
- Domestic Water Demand
- $D_d = PCD \times Population$

Model Input Data

The assumed crop calendars for Afghanistan and Pakistan based on the AQUASTAT database (http://www.fao.org/nr/water/aquastat/water_use_agr/index2.stm) of the Food and Agricultural Organization (FAO)

- Afghanistan
- Wheat – Nov 1 to May 31
- Barley – December 1 to May 31
- Maize – June 1 to Oct 31
- Rice – June 1 to Oct 31
- Tobacco – June 11 to September 30
-
- Pakistan
- Wheat – November 1 to May 31
- Barley – November 1 to April 30
- Maize – June 1 to Oct 31
- Rice – June 1 to Oct 31
- Tobacco – June 11 to September 30

Scenarios

1. Reference (current) scenario where the model represents the situation from January 2002 to June 2012. This scenario includes existing reservoirs (where storage capacity data are available) while all agricultural demands are met from surface water. No domestic demands are included.

2. A scenario where in addition to agricultural demands all domestic demands too are met from surface water resources.

3. A scenario where the cultivated area is doubled

4. A scenario where daily precipitation and river discharge are assumed to be 75% of their current values, representing a long drought situation.

5. A scenario where daily precipitation and river discharge are assumed to be 125% of their current values, representing a long excess rainfall situation.

Key outcomes

- The current unmet demand in the basin for irrigation supplies is only 1.3% of the total irrigation supply requirement under the assumptions considered.
- In all scenarios, the unmet demand as a percentage of the total supply requirement remains low.
- in all scenarios the percentage increase in unmet demand from the reference condition is significantly high. This means that the model is sensitive to the changes introduced in the scenarios
- If all domestic supplies are delivered from surface water, the total supply requirement from the river increases by 37.7% from its reference condition

Key outcomes

- The % change in unmet demands decreases with the introduction of new reservoirs.
- There is no significant change in the river flow to the Pakistan side of the basin and the river flow out of the basin under the currently assumed storage capacities of new reservoirs. However, again, the results may change if the storage capacities are varied

Way Forward

International Water Laws/Conventions as a Starting Point?

The Helsinki Rules on the Uses of the Waters of International Rivers, 1966

Dublin Principles (1992) - non-binding declarations for action at the local, national and international level to reduce water scarcity

Berlin Rules on Water Resources, 2004 - non-binding and applicable only to the extent no agreement exists between basin states.

Convention on the Law of Non-Navigational Uses of International Watercourses - only enforceable international law that impacts transboundary aquifers, entered into force on 17 August 2014 following it thirty-fifth ratification. The Convention is not applicable to non-signatories and does not affect the right of any watercourse state rising from any prior agreement.

Both Afghanistan and Pakistan have not yet Ratified UN Watercourse Convention – Is this a starting point?

Research Uptake

- IWMI Pakistan office recently secured a USD 7.5 Million grant for the project "**Water Management for Enhanced Productivity**" spanning over 5 years.
- The project has an Exclusive outcome/component on "**Increased Afghanistan-Pakistan collaboration on water policy, practices, and water sector challenges common to each**"
- The project will provide technical support and training to Afghan water professionals on different modeling platforms used in the EKaRB project as well as the RS/GIS-based Kabul River Basin Knowledge platform. This work will also include exchange visits of Pakistani and Afghan water professionals
- A big opportunity for the PEER recipients to collaborate and take the research forward on Kabul River Basin

THANKS