UN/IRAN WORKSHOP

PROBABILISTIC FLOOD HAZARD ASSESSMENT

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AGENDA

- About UN-SPIDER, Pak-RSO
- Background
- Flood Frequency Assessment
- Flood Modeling, Calibration and Validation
- Conclusion

SPACE APPLICATION CENTRE FOR RESPONSE IN EMERGENCY AND DISASTERS (SACRED)

UN-SPIDER PAK-RSO

- THE CENTRE PROVIDES SPACE BASED INFORMATION TO NATIONAL / PROVINCIAL DISASTER MANAGEMENT AGENCIES TO RAPIDLY ASSESS THE EXTENT OF NATURAL DISASTERS AND DAMAGES TO HUMAN LIVES, PROPERTY AND INFRASTRUCTURE.
- THE CENTRE ALSO PROVIDES ASSISTANCE TO REGIONAL COUNTRIES IN CASE OF NATURAL DISASTERS.

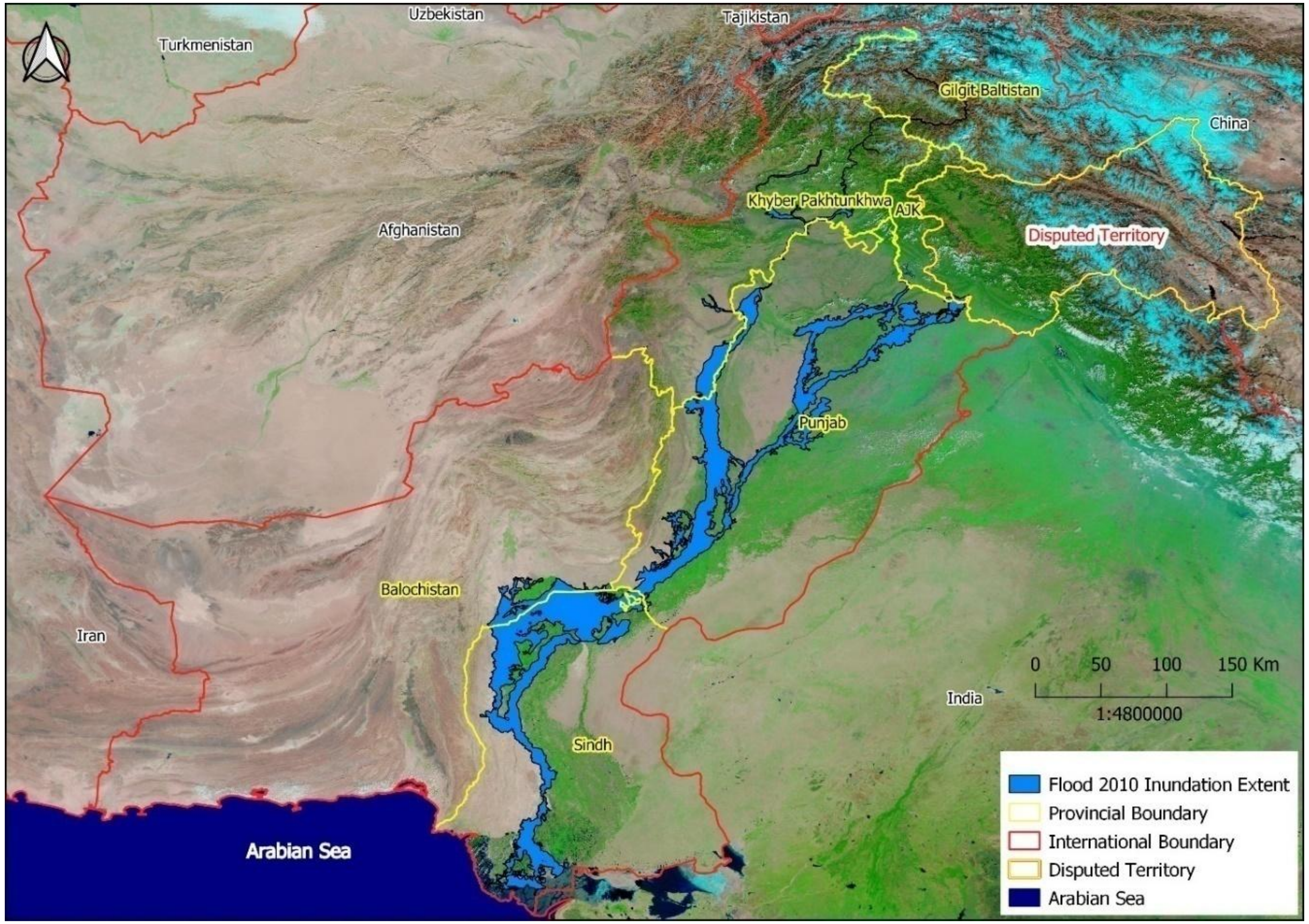
EMAIL: SACRED@SUPARCO.GOV.PK   WEB: DISASTERWATCH.SGS-SUPARCO.GOV.PK

DISASTER MONITORING – PAST EXPERIENCE

During Natural Disasters, SUPARCO provided technical support to various national Organizations NDMA, PDMAs and International Agencies ICIMOD, UN-FAO etc

Background

BACKGROUND - FLOOD 2010



Cumulative Flood Extent

Swat Valley

BACKGROUND

Shifting of focus from Reactive to Proactive Approach

- Sendai Framework for Disaster Risk Reduction 2015-2030 Priorities for action

  1. Understanding disaster risk;

  2. Strengthening disaster risk governance to manage disaster risk;

  3. Investing in disaster risk reduction for resilience;

  4. Enhancing disaster preparedness for effective response, and to "Build Back Better" in recovery, rehabilitation and reconstruction.

- Climate Change Agreement (COP21) – **Article 8**

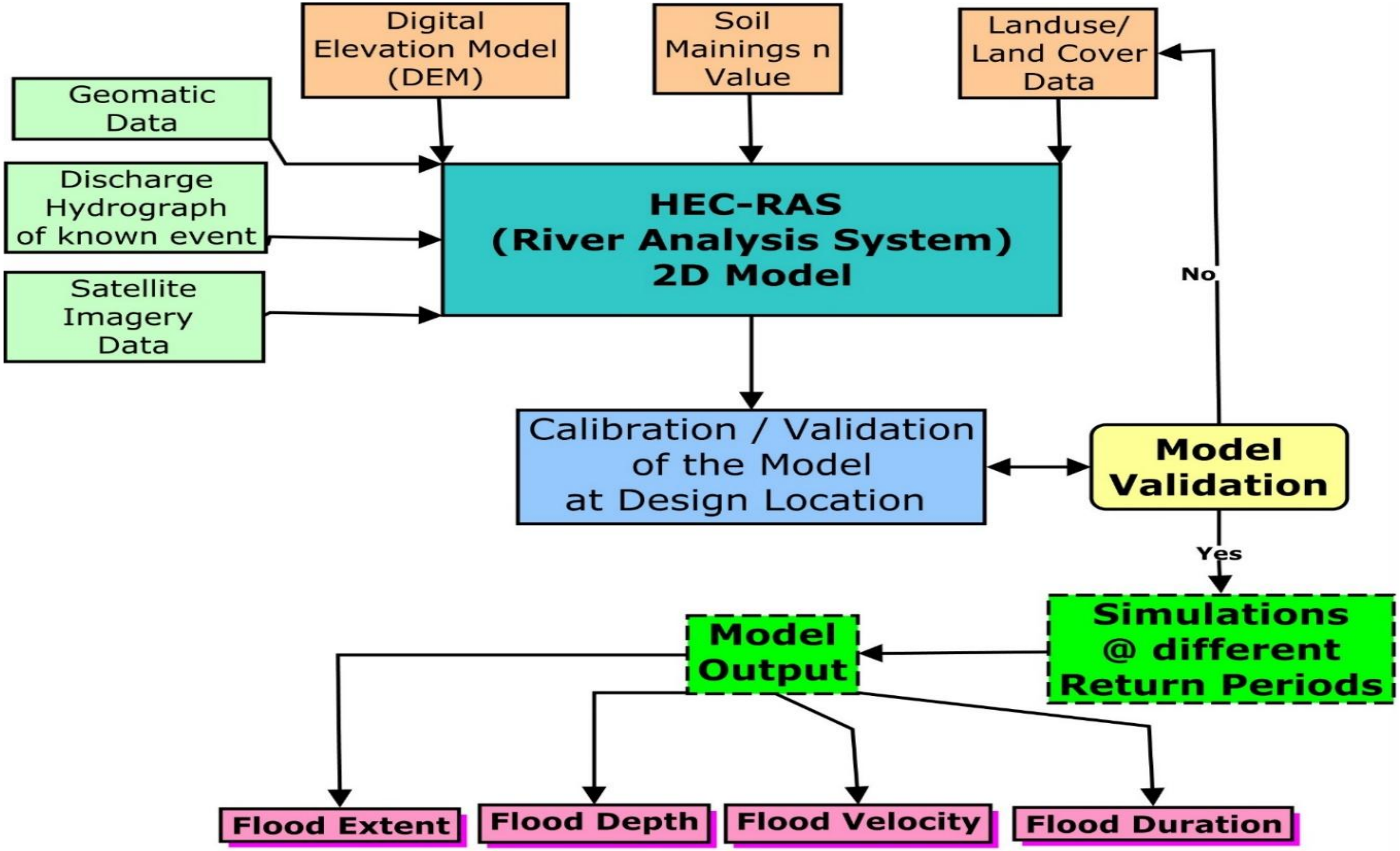
- Sustainable Development Goals (SDGs) 2015-30 – **SDGs 13**

  SDG13: TAKE URGENT ACTION TO COMBAT CLIMATE CHANGE AND ITS IMPACTS

- National Disaster Management Plan (NDMP) Implementation Roadmap 2015-30

Probabilistic Flood Case Study

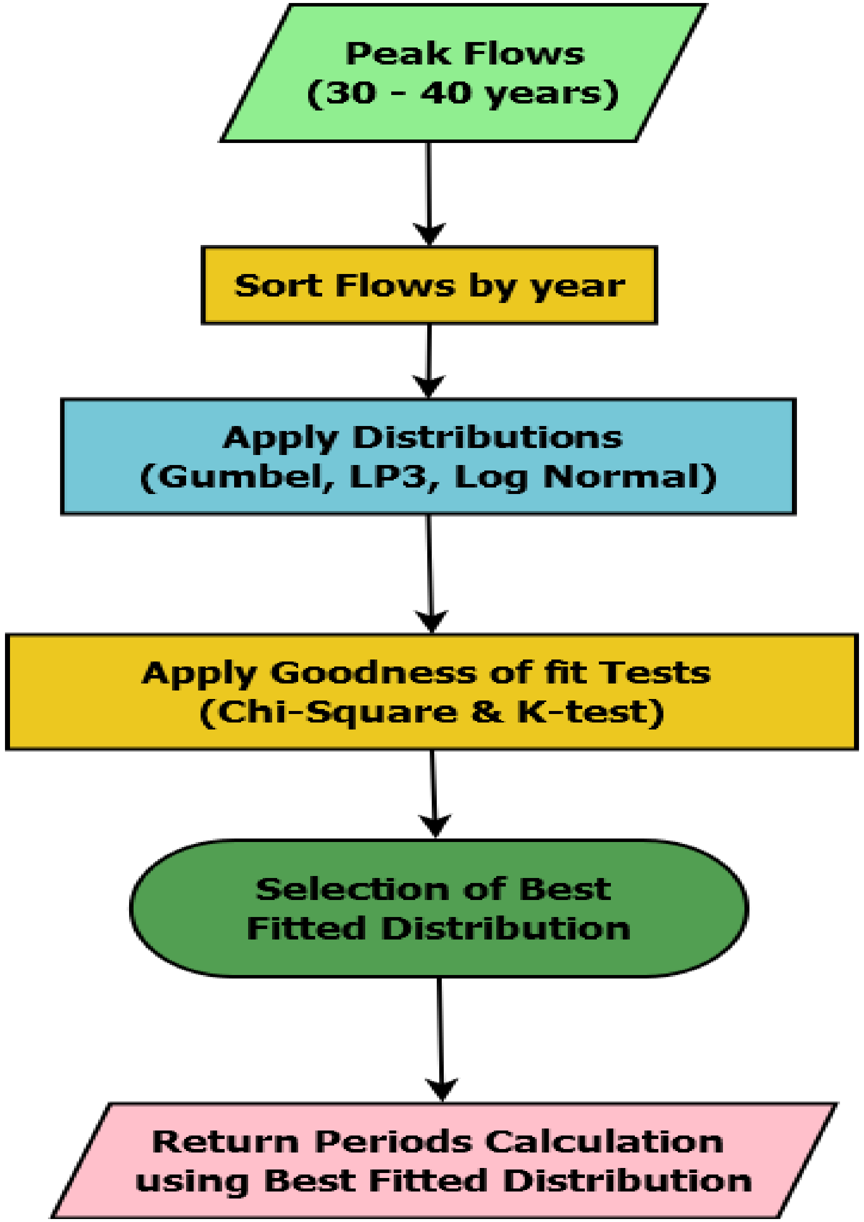
FLOOD HAZARD ASSESSMENT - OVERALL APPROACH



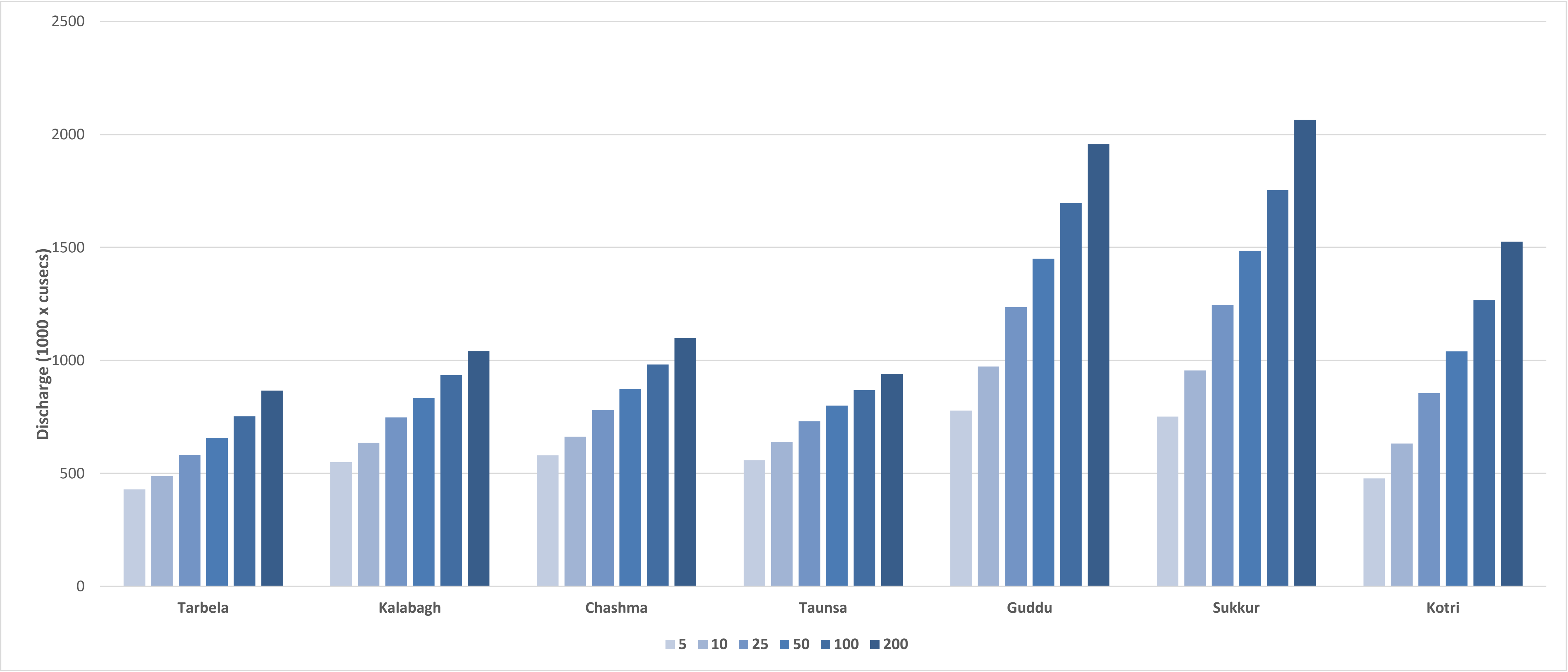
FLOOD FREQUENCY ASSESSMENT

- **Hydrological Data**
  - Long-term (preferably 30-40 years) Annual Peak Discharge data recorded at gauges stations location in the study area are required for the estimation of the flood return periods.

- **Tools**
  - HEC-SSP
  - EasyFit
  - Excel based Log Pearson-3 calculator
  - Online LP-3, GEV calculator



Return Periods – Indus River

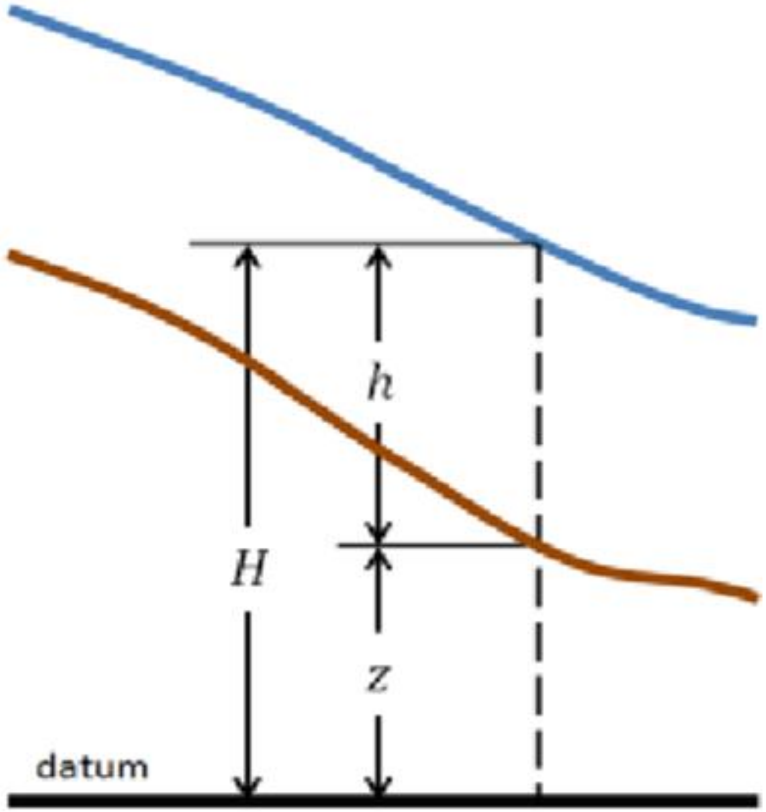


Flood Models

- **1D Model**
  - 1D model can solve flood problem in river flow direction only and does not have capability to model later flows
  - Examples: HEC-RAS 1D, MIKE11 etc
- **2D Model**
  - 2D model can solve flood problem 2 dimension i.e. along the river and lateral flows
  - Examples: HEC-RAS 2D, MIKE21, SOBEK, RRI etc
- **1D/2D Model**
  - 1D for River while 2D for overland flow
  - Examples: HEC-RAS 1D/2D, MIKE21, SOBEK etc

HEC-RAS 2D Flood Model

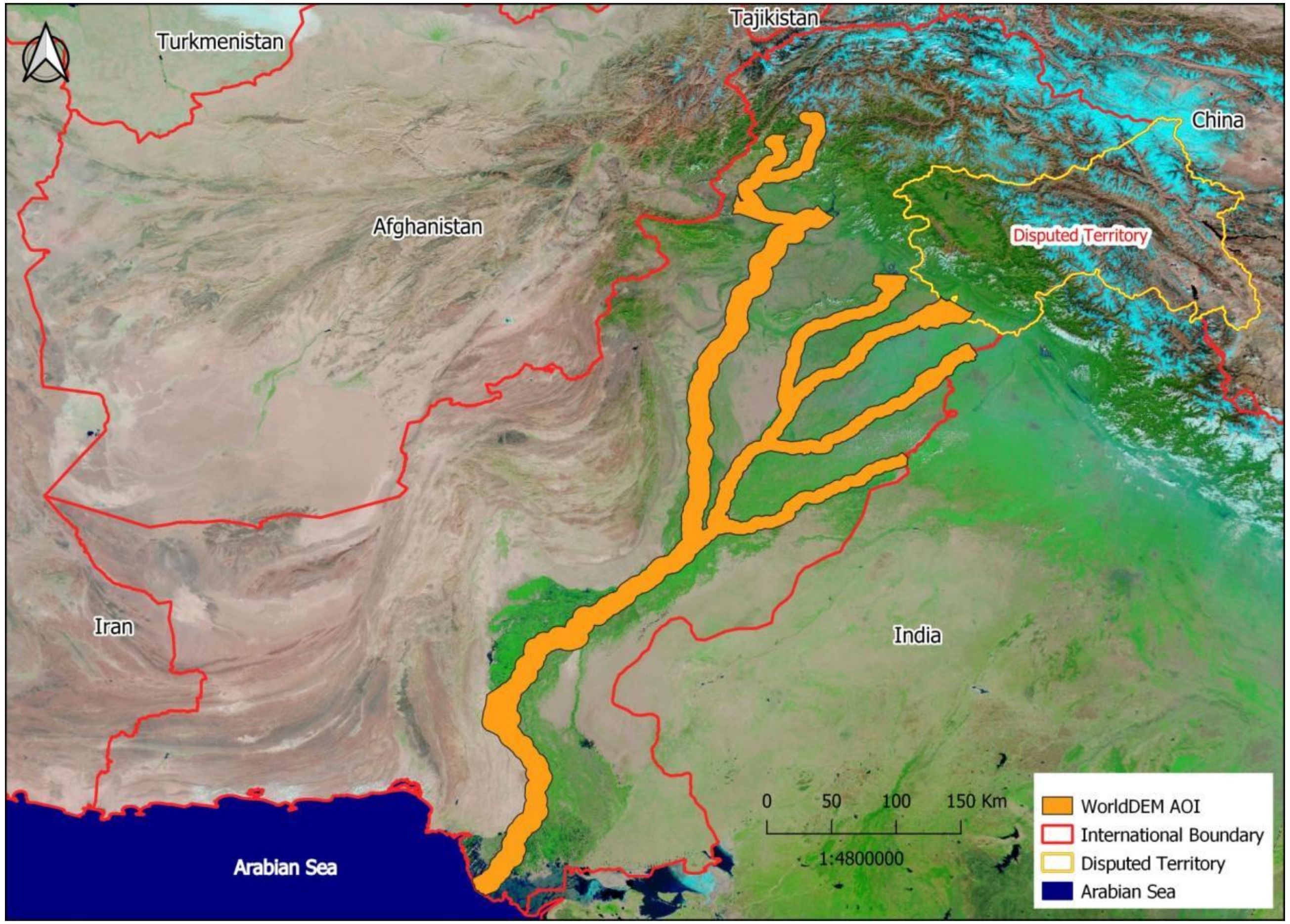
- HEC-RAS model has the capability to perform ID, 2D and combined 1D/2D unsteady flow routing.
- 2D flow modelling is achieved by including a 2D flow area component into the flood model.
- HEC-RAS flood model uses the 2D Saint Venant equations and the 2D Diffusive Wave equations for flood simulation.



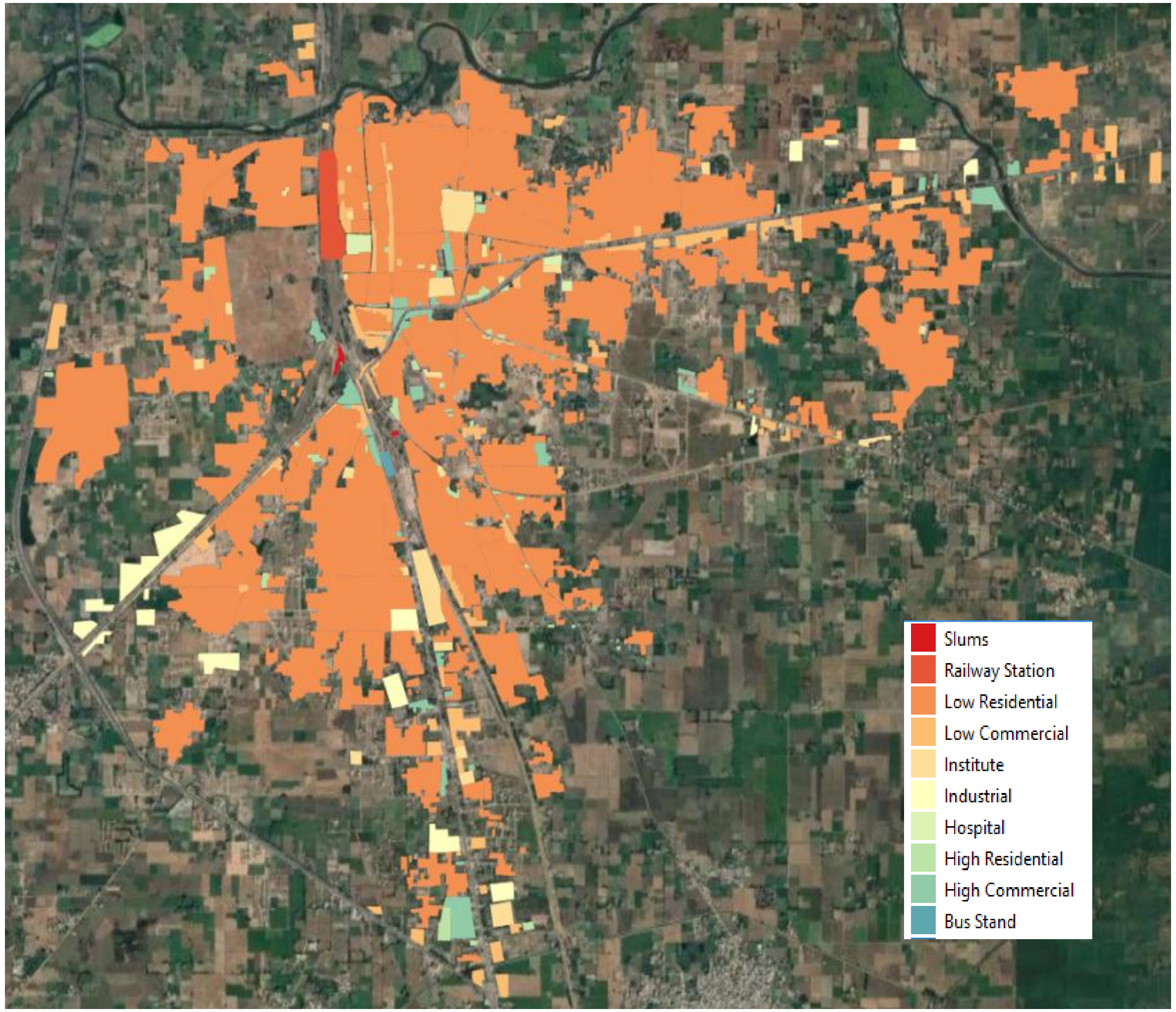
Water Surface Elevation in HEC-RAS

Flood Hazard Modelling - Datasets

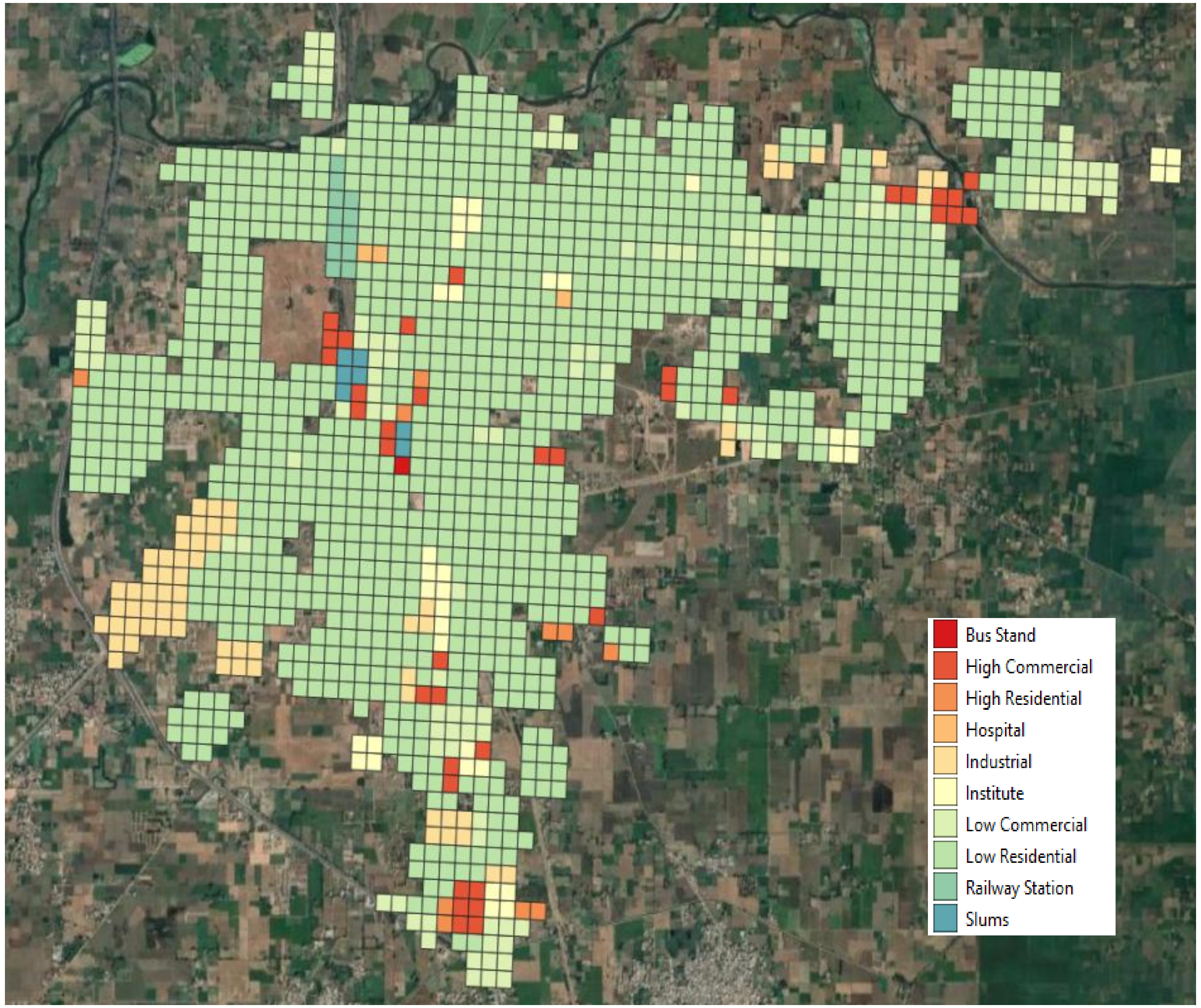
- WorldDEM DSM 12m + SRTM
- Satellite Imagery
- Landcover
- Chow, 1959 Manning's n constants
- Embankments
- Flood discharge hydrographs
- Historical flood extents



EXPOSURE DATASETS – LANDCOVER/LANDUSE

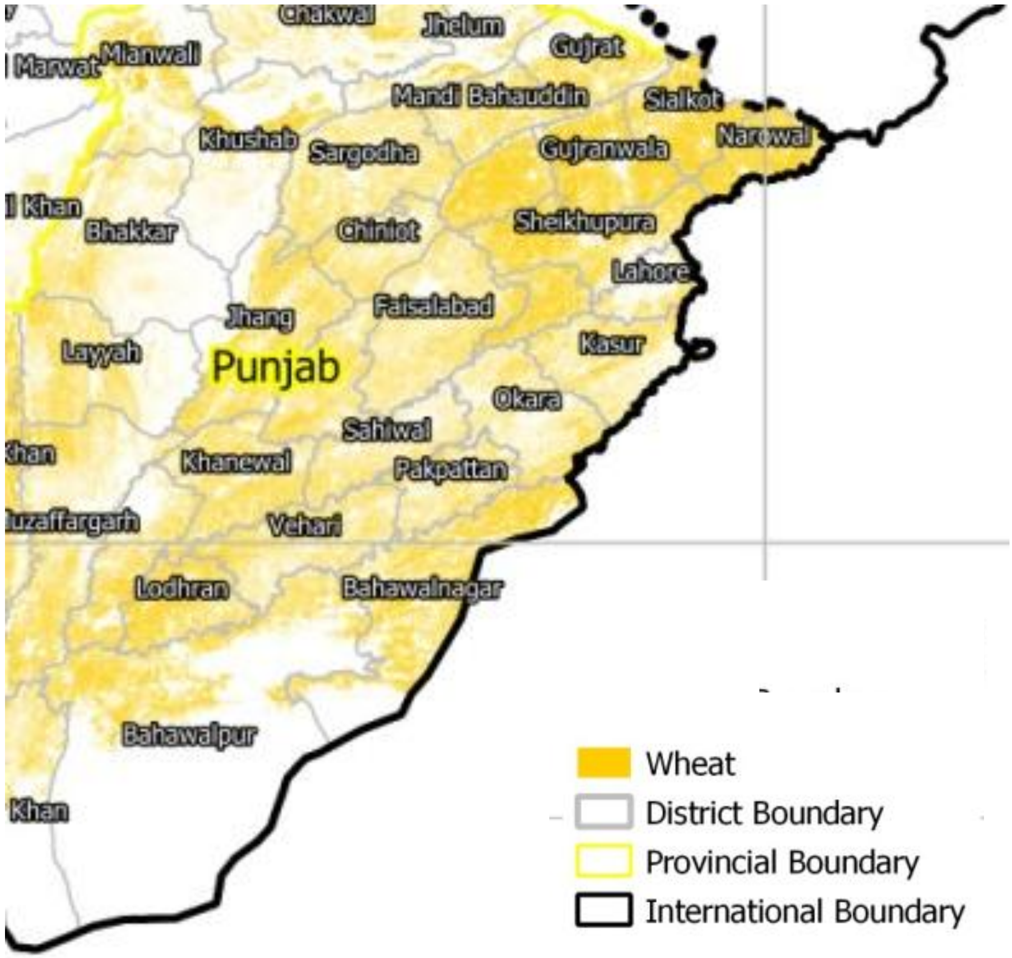


Landuse in Wazirabad city

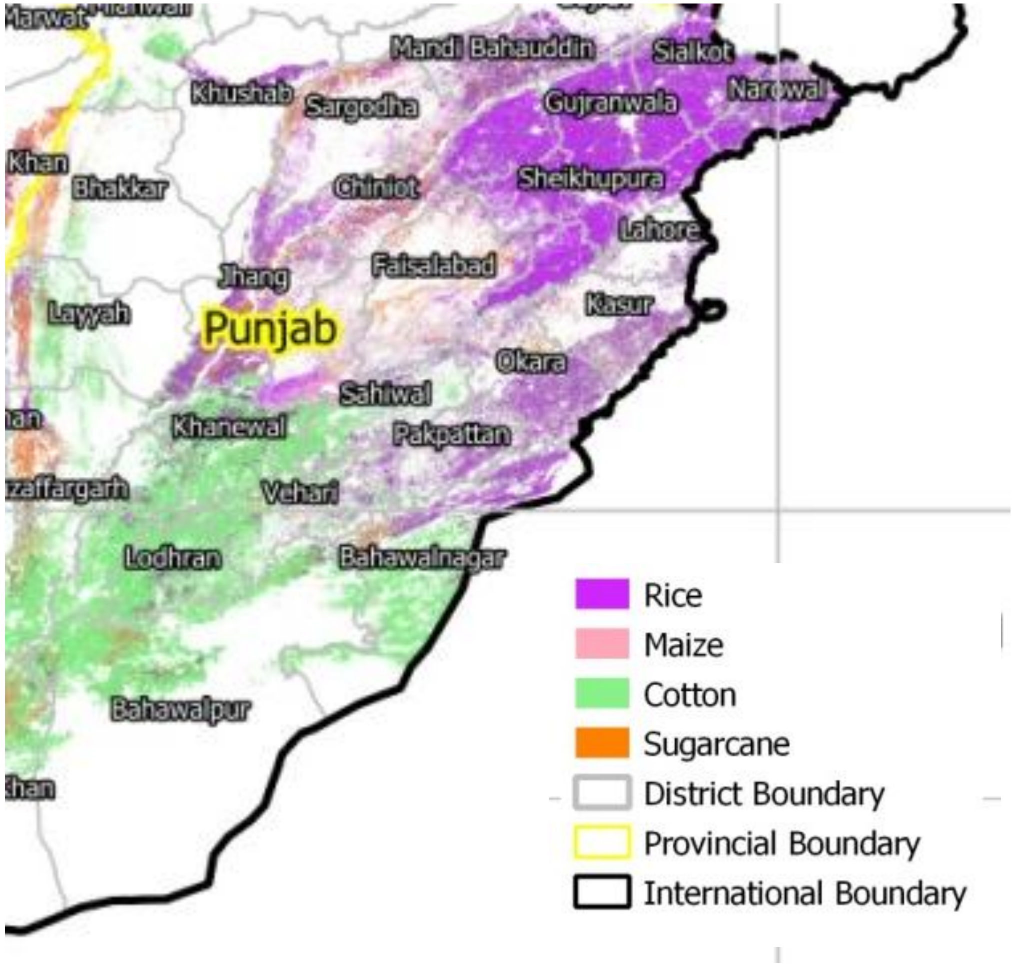


Wazirabad city Landuse - 100mX100m Grid

Exposure Datasets – Crop Mask

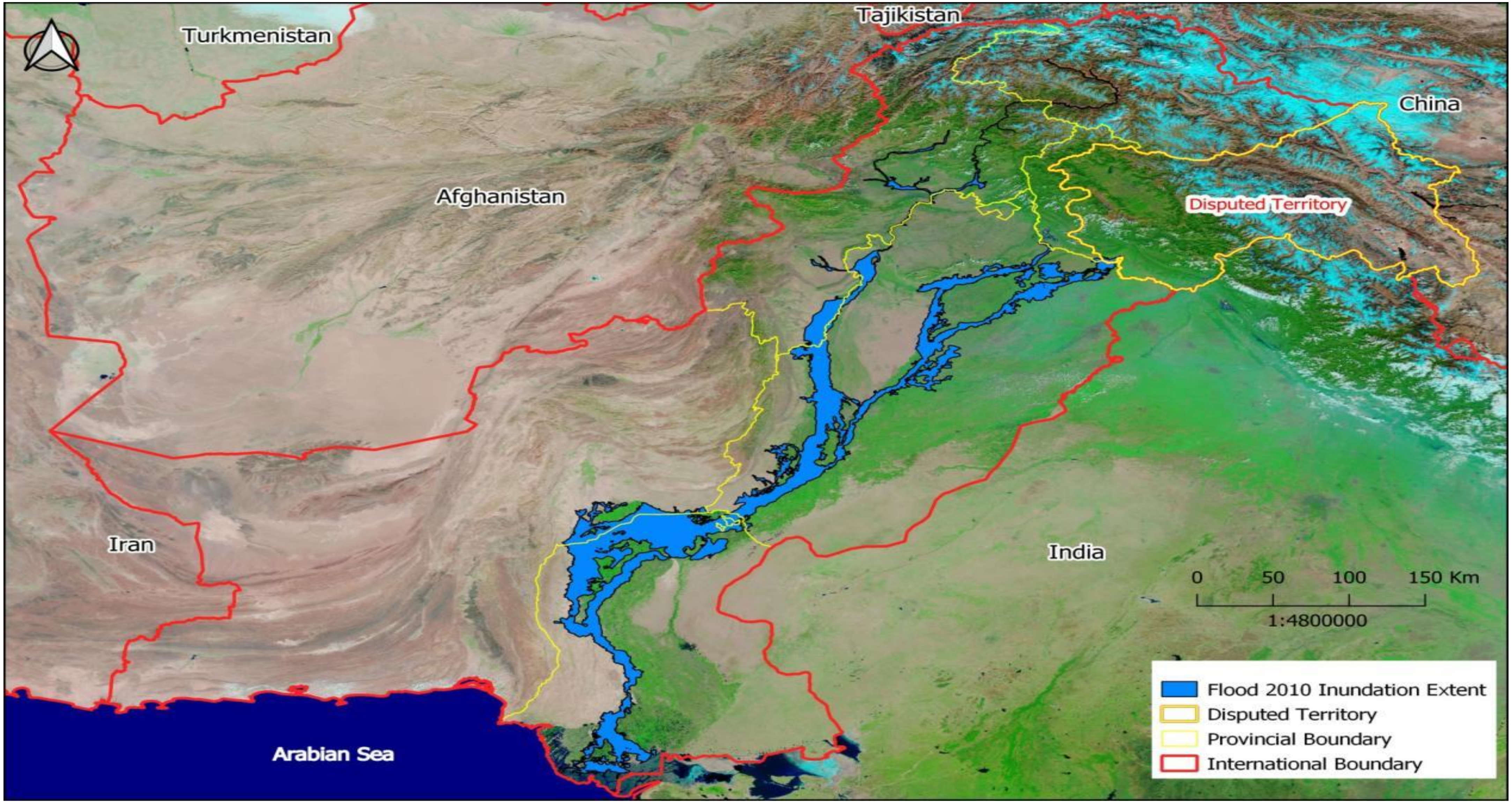


Rabi Crop



Kharif Crop

HISTORICAL MAXMUM FLOOD EXTENTS (2010)



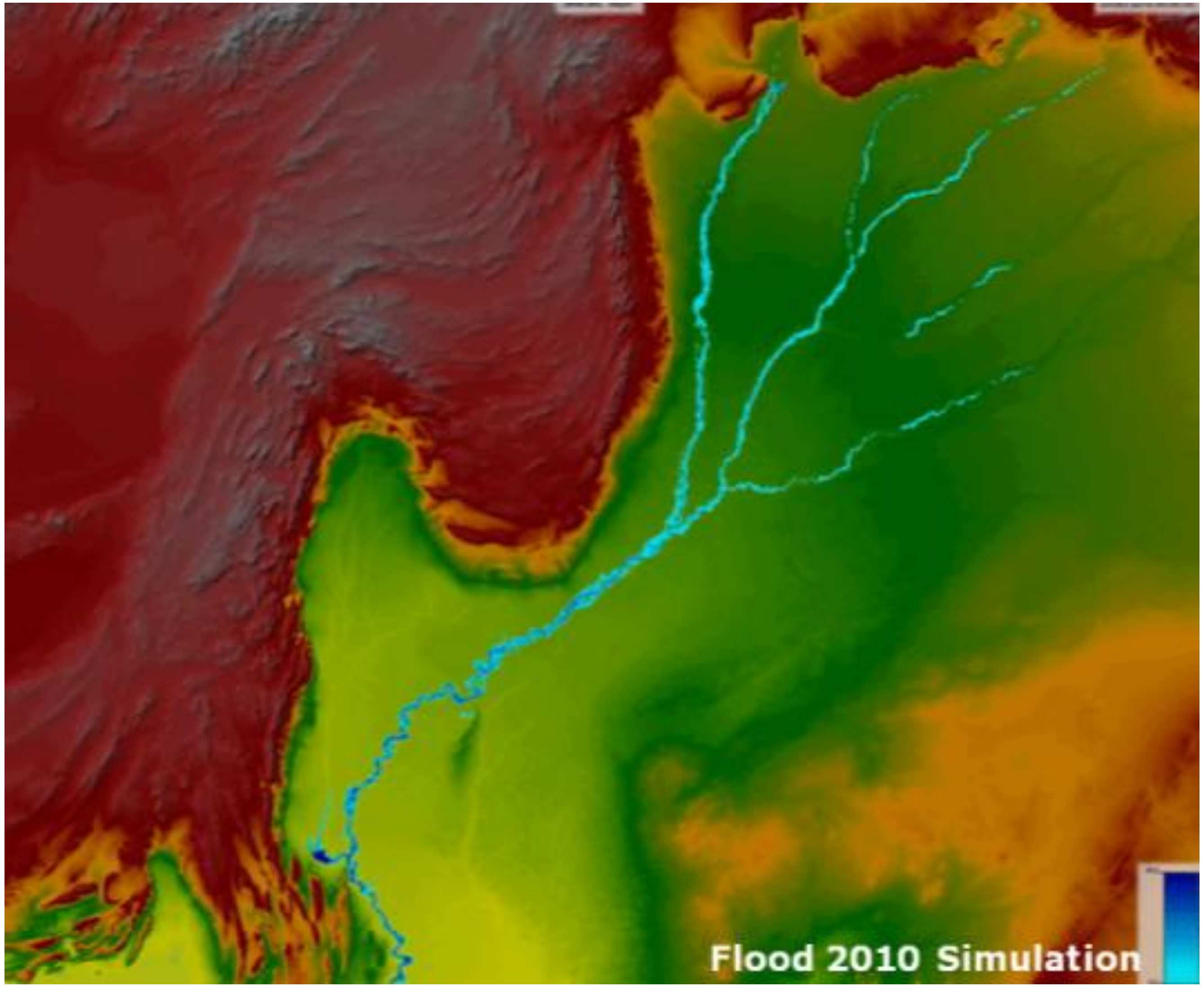
Model Calibration and Validation - Manning's n

Manning's n layer is required to account for infiltration component of water channel, floodplain and its surrounding landcover/landuse types in flood model. Manning's n values are taken from Chow 1959, Manning's n table.

Landcover Class	Values Range
Built-up	0.020-0.040
Bare Areas	0.020-0.040
Crops/Vegetation	0.030-0.050
Forests/Orchards	0.050-0.080
Snow & Glaciers	0.030-0.040
Wet Areas	0.030-0.040

Flood Model Simulation

Probabilistic Flood Assessment against 5, 10, 25, 50, 100 and 200 years return periods

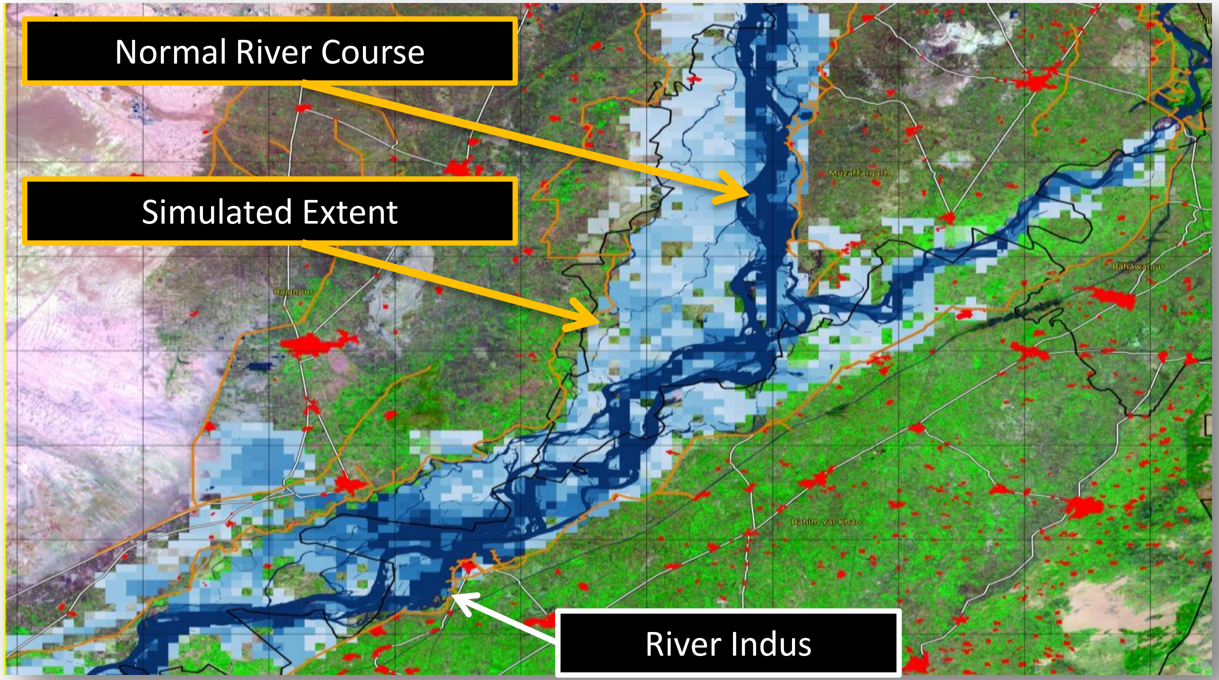


Model Outputs

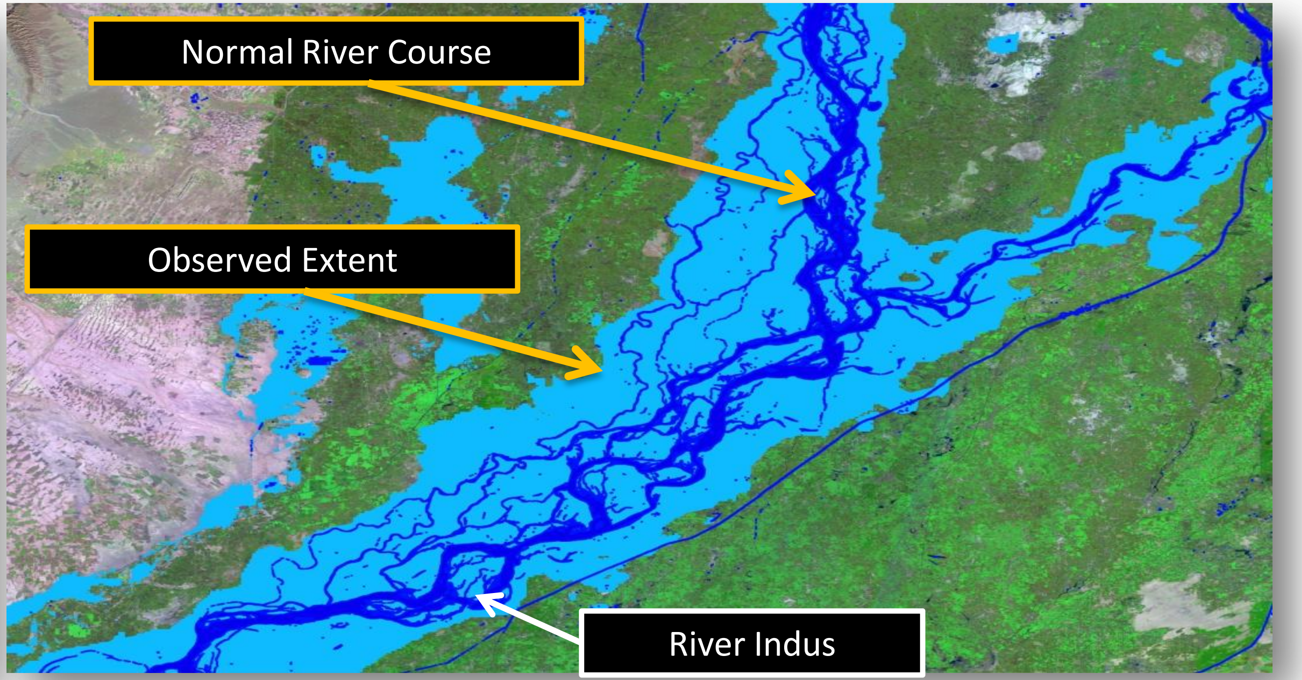
- Flood Extent
- Flood Depth
- Flood Velocity
- Flood Duration

MODEL CALIBRATION AND VALIDATION - OBSERVED VS SIMULATED FLOOD

Panjnad Downstream – 2015

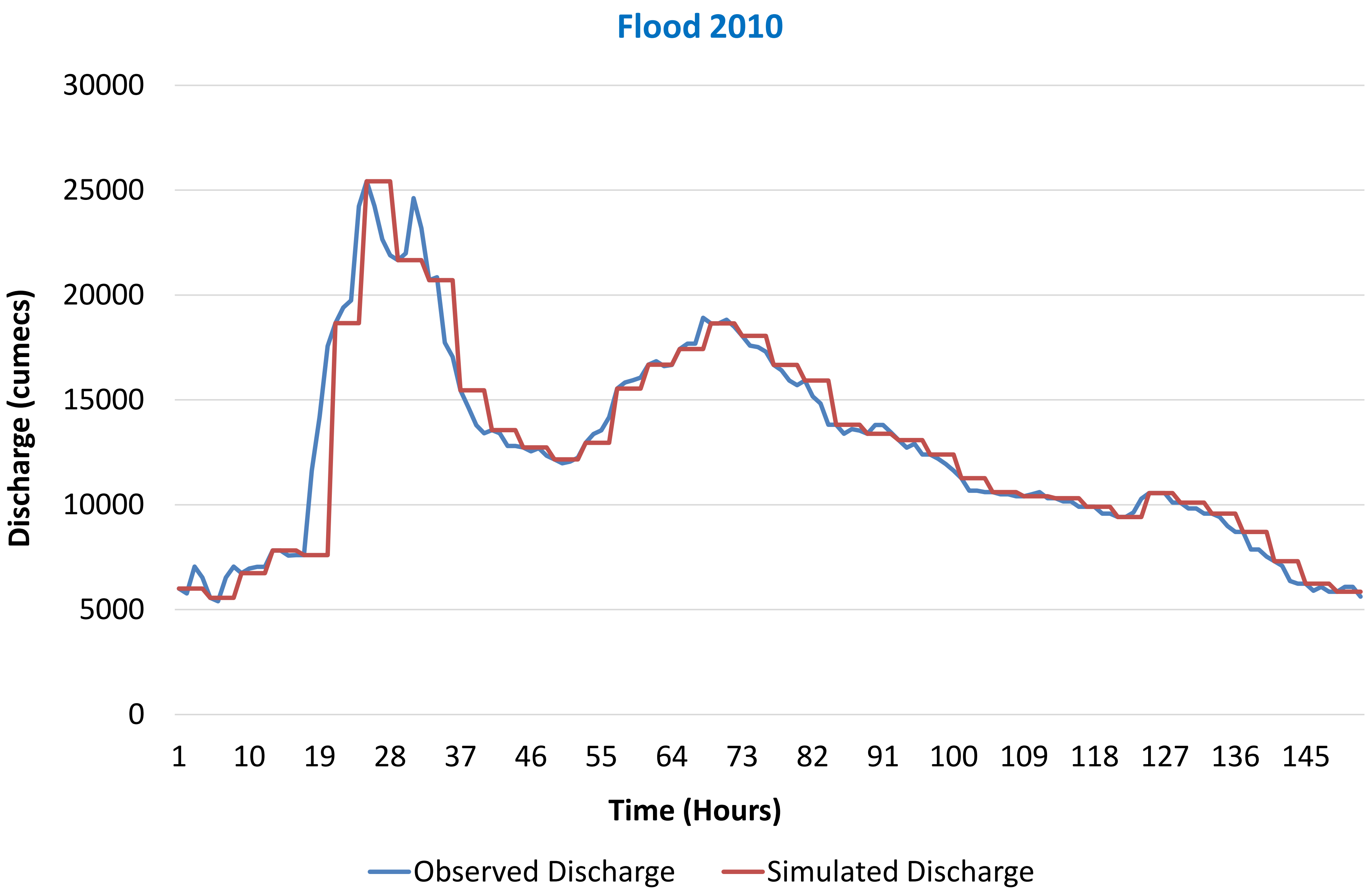


Maximum simulated inundation

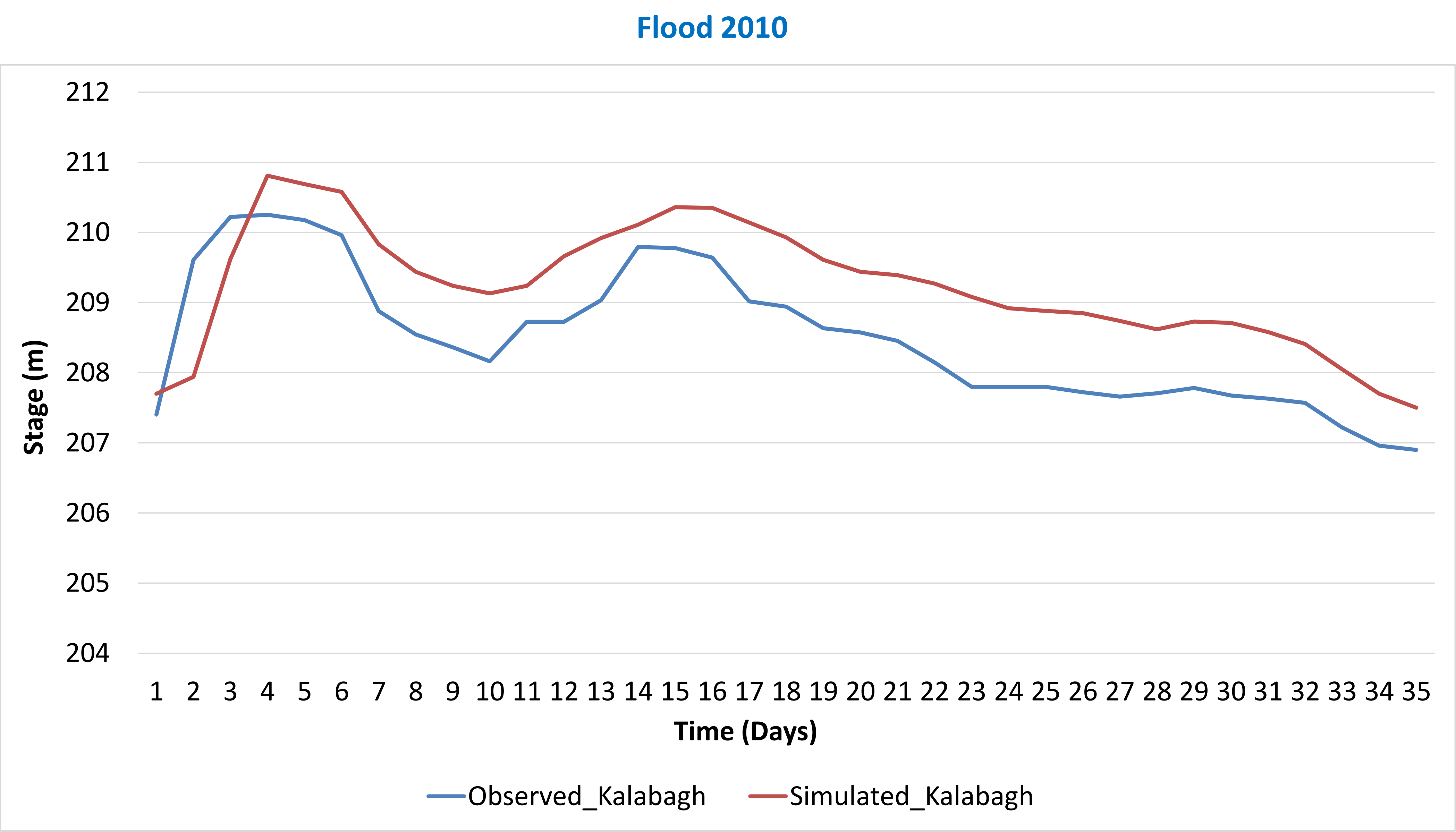


Cumulative observed inundation

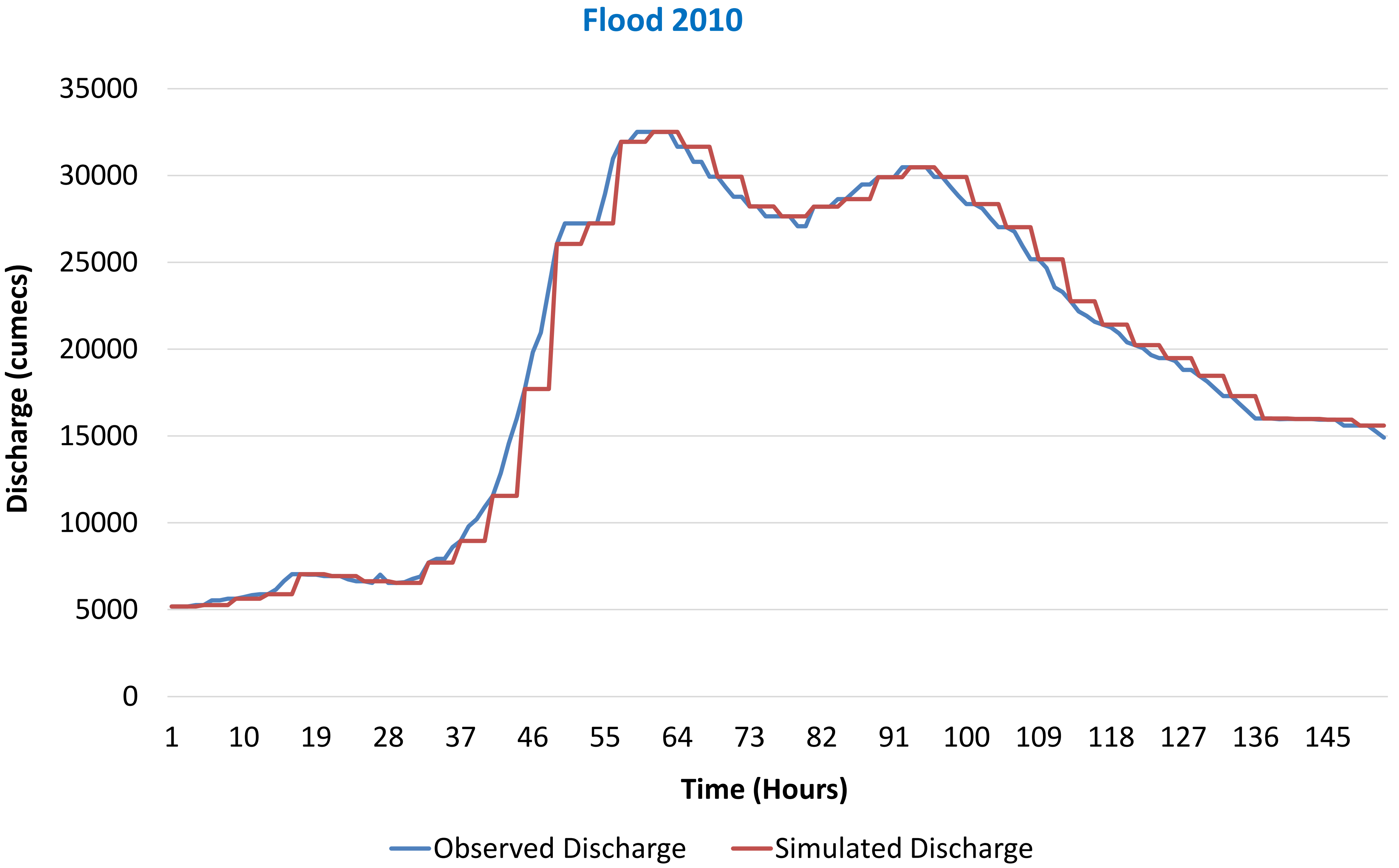
Observed vs Simulated Discharge hydrographs - Kalabagh Headwork



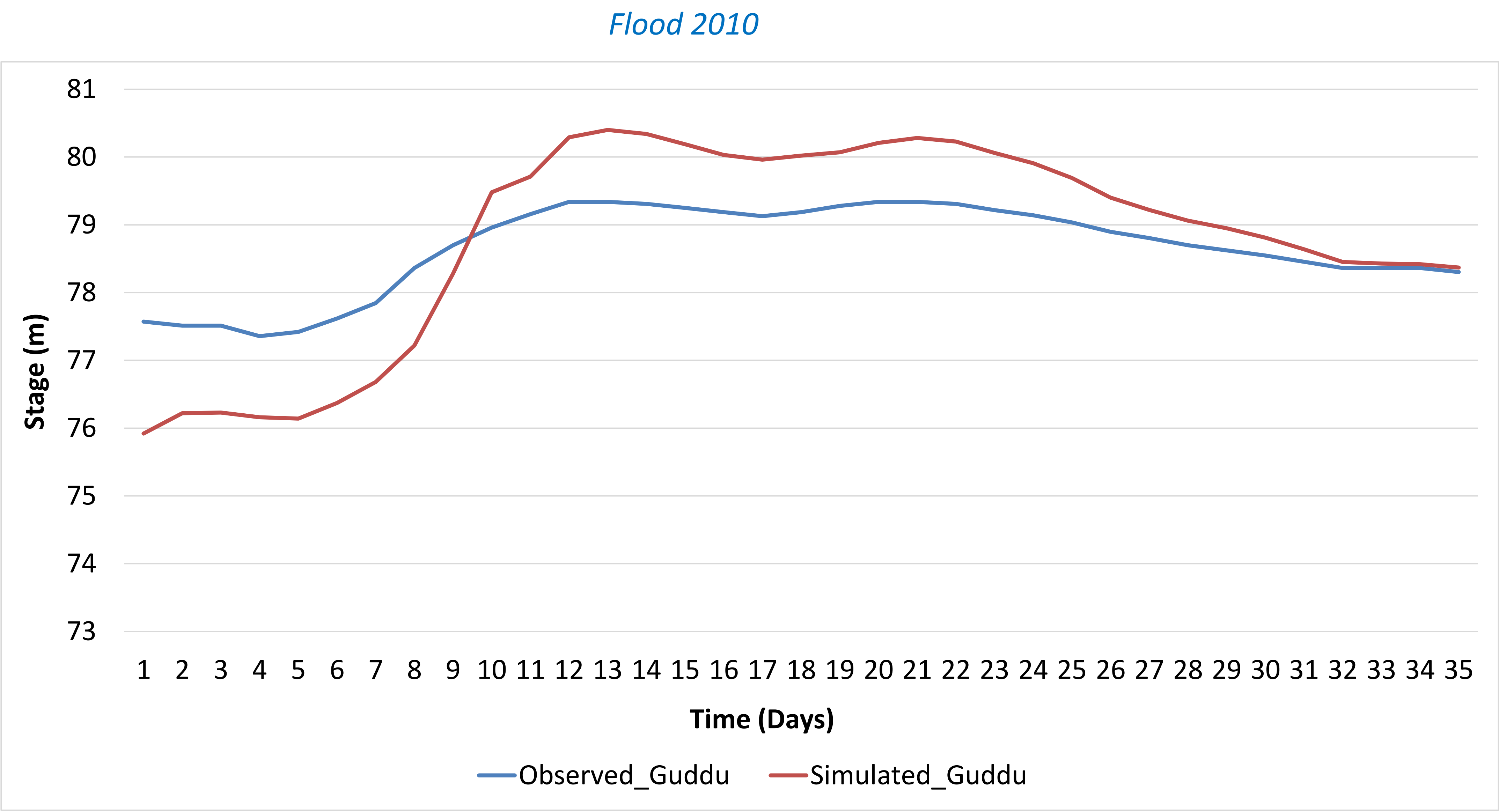
Observed vs Simulated Stage - Kalabagh Headwork



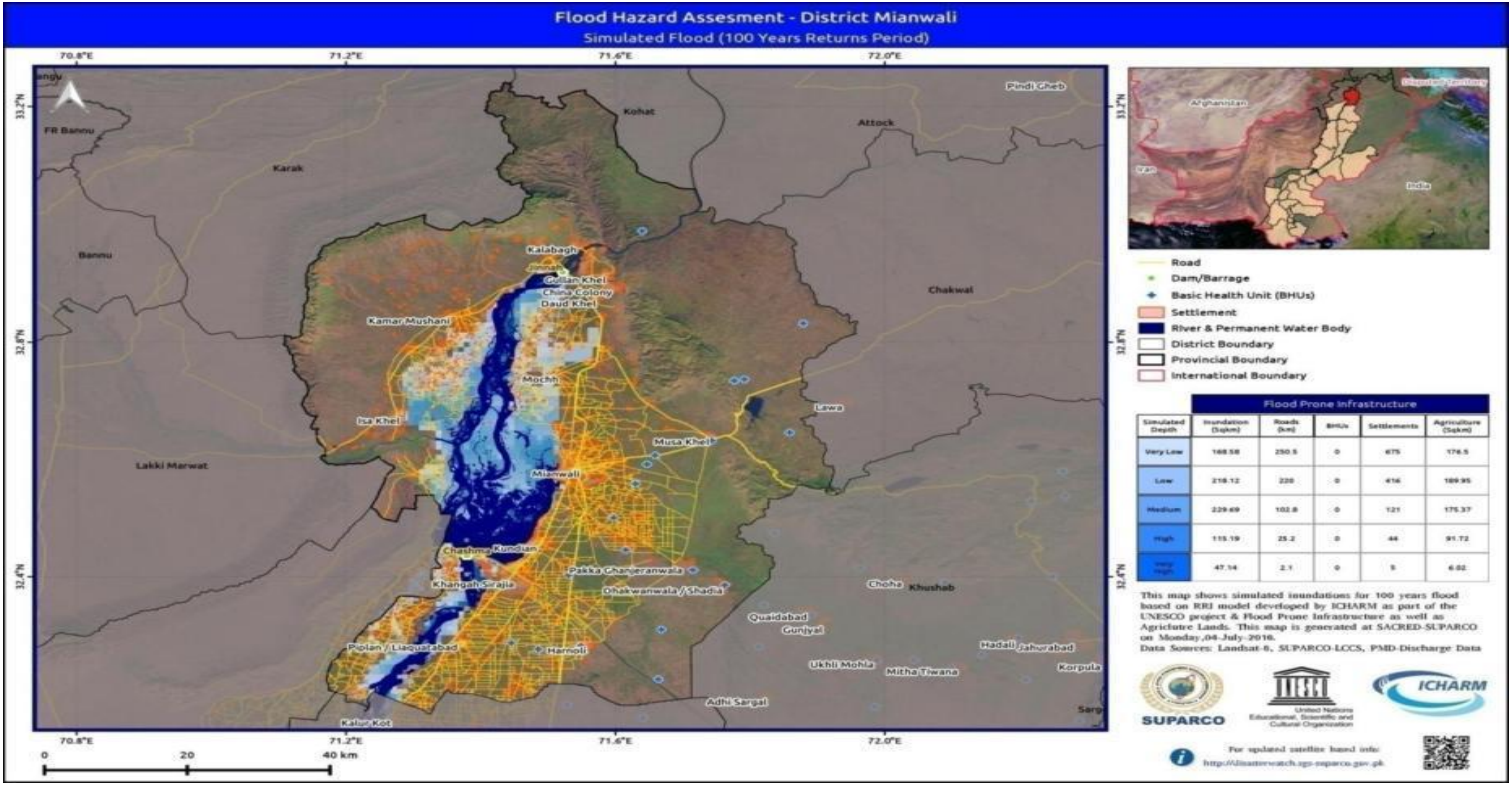
Observed vs Simulated Discharge hydrographs - Guddu Barrage



Observed vs Simulated Stage - Guddu Barrage

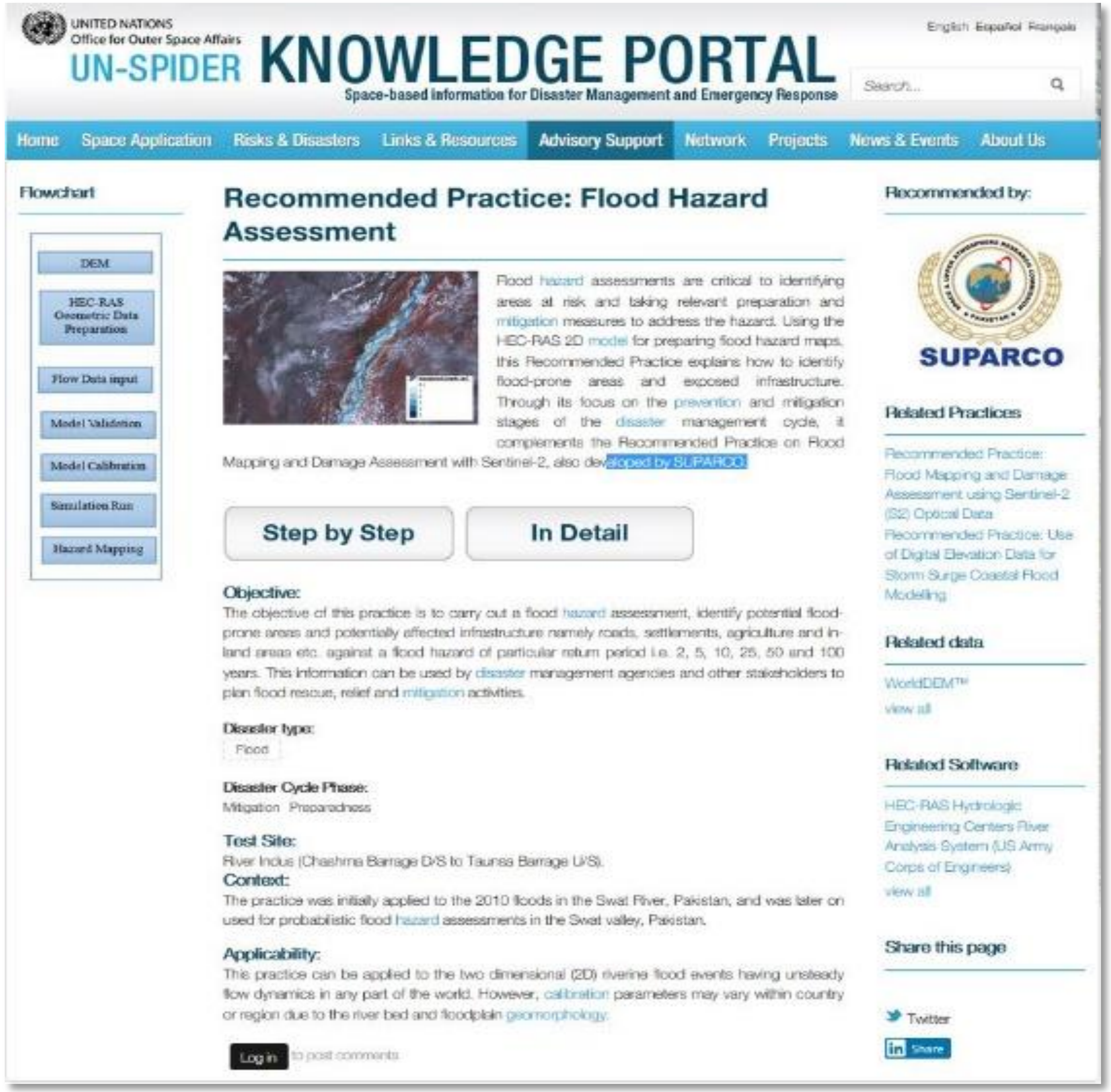


Flood Hazard Maps



Simulated Depth	Inundation (Sqkm)	Roads (km)	BHUs	Settlements	Agriculture (Sqkm)
Very Low	168.58	250.5	0	675	176.5
Low	218.12	220	0	416	189.95
Medium	229.69	102.8	0	121	175.37
High	115.19	25.2	0	44	91.72
Very High	47.14	2.1	0	5	6.02

Recommended Practices for UN-SPIDER Knowledge Portal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Flowchart

DEM
HEC-RAS Geometric Data Preparation
Flow Data input
Model Validation
Model Calibration
Simulation Run
Hazard Mapping

Recommended Practice: Flood Hazard Assessment

Flood hazard assessments are critical to identifying areas at risk and taking relevant preparation and mitigation measures to address the hazard. Using the HEC-RAS 2D model for preparing flood hazard maps, this Recommended Practice explains how to identify flood-prone areas and exposed infrastructure. Through its focus on the prevention and mitigation stages of the disaster management cycle, it complements the Recommended Practice on Flood Mapping and Damage Assessment with Sentinel-2, also developed by SUPARCO.

Step by Step | In Detail

Objective:
The objective of this practice is to carry out a flood hazard assessment, identify potential flood-prone areas and potentially affected infrastructure namely roads, settlements, agriculture and in-land areas etc. against a flood hazard of particular return period i.e. 2, 5, 10, 25, 50 and 100 years. This information can be used by disaster management agencies and other stakeholders to plan flood rescue, relief and mitigation activities.

Disaster type:
Flood

Disaster Cycle Phase:
Mitigation Preparedness

Test Site:
River Indus (Chashma Barrage D/S to Taunsa Barrage U/S).

Context:
The practice was initially applied to the 2010 floods in the Swat River, Pakistan, and was later on used for probabilistic flood hazard assessments in the Swat valley, Pakistan.

Applicability:
This practice can be applied to the two dimensional (2D) riverine flood events having unsteady flow dynamics in any part of the world. However, calibration parameters may vary within country or region due to the river bed and floodplain geomorphology.

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Recommended by:

SUPARCO

Related Practices

Recommended Practice: Flood Mapping and Damage Assessment using Sentinel-2 (S2) Optical Data
Recommended Practice: Use of Digital Elevation Data for Storm Surge Coastal Flood Modelling

Related data

WorldDEM™
view all

Related Software

HEC-RAS Hydrologic Engineering Centers River Analysis System (US Army Corps of Engineers)
view all

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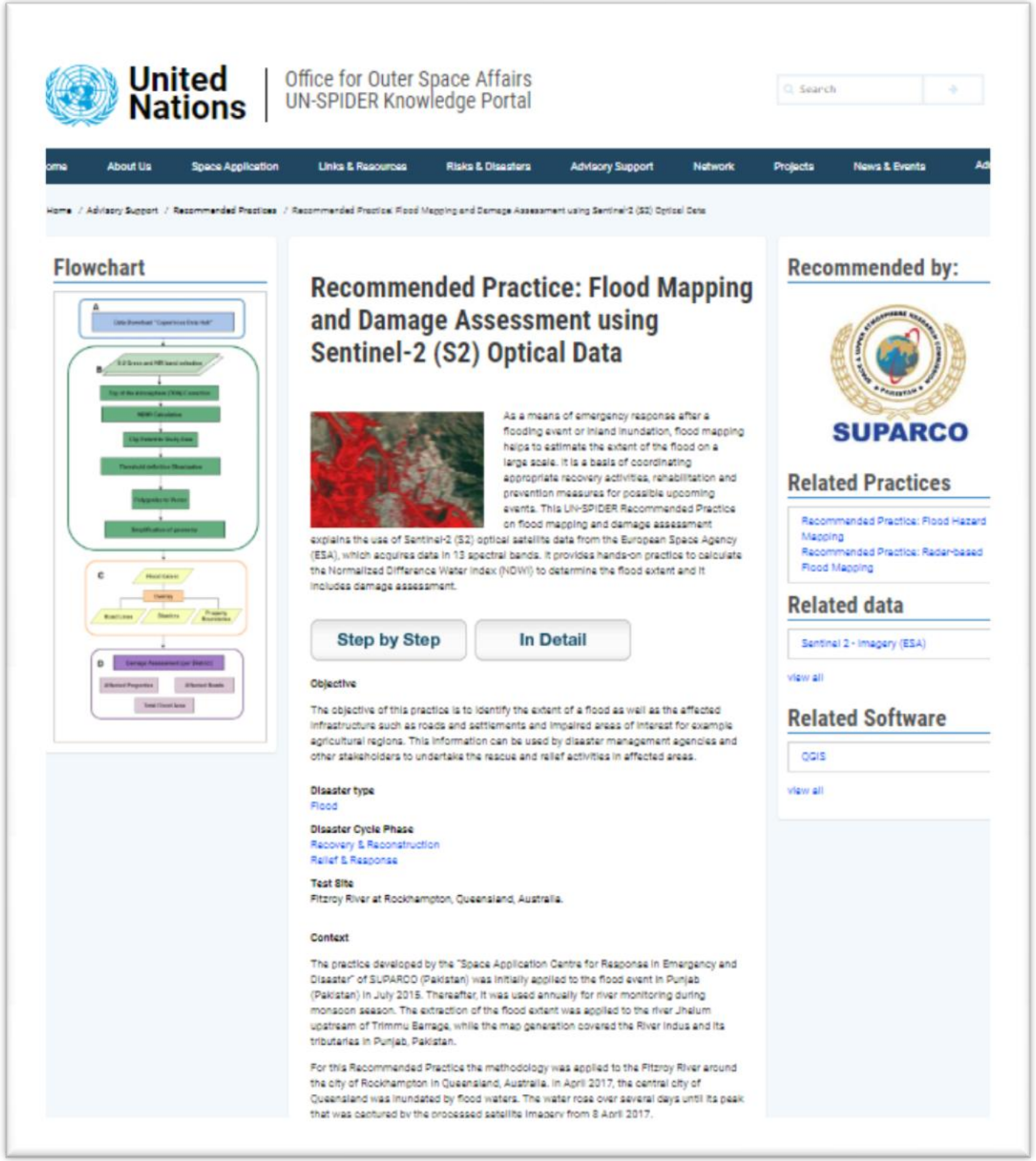
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Flowchart

Recommended Practice: Flood Mapping and Damage Assessment using Sentinel-2 (S2) Optical Data

As a means of emergency response after a flooding event or inland inundation, flood mapping helps to estimate the extent of the flood on a large scale. It is a basis of coordinating appropriate recovery activities, rehabilitation and prevention measures for possible upcoming events. This UN-SPIDER Recommended Practice on flood mapping and damage assessment explains the use of Sentinel-2 (S2) optical satellite data from the European Space Agency (ESA), which acquires data in 13 spectral bands. It provides hands-on practice to calculate the Normalized Difference Water Index (NDWI) to determine the flood extent and it includes damage assessment.

Step by Step | In Detail

Objective
The objective of this practice is to identify the extent of a flood as well as the affected infrastructure such as roads and settlements and impaired areas of interest for example agricultural regions. This information can be used by disaster management agencies and other stakeholders to undertake the rescue and relief activities in affected areas.

Disaster type
Flood

Disaster Cycle Phase
Recovery & Reconstruction
Relief & Response

Test Site
Fitzroy River at Rockhampton, Queensland, Australia.

Context
The practice developed by the "Space Application Centre for Response in Emergency and Disaster" of SUPARCO (Pakistan) was initially applied to the flood event in Punjab (Pakistan) in July 2015. Thereafter, it was used annually for river monitoring during monsoon season. The extraction of the flood extent was applied to the river Jhelum upstream of Trimmu Barrage, while the map generation covered the River Indus and its tributaries in Punjab, Pakistan.

For this Recommended Practice the methodology was applied to the Fitzroy River around the city of Rockhampton in Queensland, Australia. In April 2017, the central city of Queensland was inundated by flood waters. The water rose over several days until its peak that was captured by the processed satellite imagery from 8 April 2017.

Recommended by:

SUPARCO

Related Practices

Recommended Practice: Flood Hazard Mapping
Recommended Practice: Radar-based Flood Mapping

Related data

Sentinel 2 - Imagery (ESA)
view all

Related Software

QGIS
view all

Conclusion

- Probabilistic Flood Hazard Assessment helps in identification of vulnerable communities against flood of varying magnitude and intensity
- Probabilistic flood hazard assessment estimate potential losses (physical) against flood of varying magnitude and intensity
- Probabilistic flood hazard assessment help Decision maker in prioritizing flood mitigation projects
- Probabilistic flood hazard assessment provides base data for insurance industry

Thank You

BACKGROUND

Shifting of focus from Reactive to Proactive Approach

SDGS 13: TAKE URGENT ACTION TO COMBAT CLIMATE CHANGE AND ITS IMPACTS

Every country in the world is seeing the drastic effects of climate change, some more than others. On average, the annual losses just from earthquakes, tsunamis, tropical cyclones and flooding count in the hundreds of billions of dollars. We can reduce the loss of life and property by helping more vulnerable regions—such as land-locked countries and island states—become more resilient. It is still possible, with the political will and technological measures, to limit the increase in global mean temperature to two degrees Celsius above pre-industrial levels—and thus avoid the worst effects of climate change. The Sustainable Development Goals lay out a way for countries to work together to meet this urgent challenge.

Background

Shifting of focus from Reactive to Proactive Approach

COP21 Article 8: Parties recognize the importance of averting, minimizing and addressing loss and damage associated with the adverse effects of climate change, including extreme weather events and slow onset events, and the role of sustainable development in reducing the risk of loss and damage. Accordingly, areas of cooperation and facilitation to enhance understanding, action and support may include:

(a) Early warning systems;
(b) Emergency preparedness;
(c) Slow onset events;
(d) Events that may involve irreversible and permanent loss and damage;
(e) Comprehensive risk assessment and management;
(f) Risk insurance facilities, climate risk pooling and other insurance solutions;
(g) Non-economic losses; and
(h) Resilience of communities, livelihoods and ecosystems.