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Application of Remote Sensing in UNESCO Science Programmes

A Case Study of Pakistan Flood Management

United Nations/Pakistan/PSIPW 4th International Conference
on Space Technology for Water Management

Islamabad Serena Hotel
Islamabad, Pakistan, 26 February - 2 March 2018

Prof. Shahbaz Khan
Director/Representative, UNESCO Regional Science Bureau for Asia and the Pacific
Indonesia

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Natural Sciences Programmes and Initiatives

International Science Programmes

Intergovernmental Oceanographic Commission

+

International Hydrological Programme

Man and the Biosphere Programme

International Geoparks and Geoscience Programme

IBSP International Basic Sciences Programme

UNESCO's initiatives

Sustainability Science

For Women in Science

GLOBAL GEOPARKS NETWORK

UNESCO BIODIVERSITY INITIATIVE (UBI)

World Water Assessment Programme

engineering

LINKS

COMEST

DISASTER PREPAREDNESS AND MITIGATION

THE UNESCO Climate Change Initiative

World Heritage Convention

INTERNATIONAL BIOETHICS COMMITTEE (IBC)

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International Hydrological Programme

UNESCO's Intergovernmental Scientific Cooperative Programme in Hydrology and Water Resources since 1975

The **International Hydrological Programme** (IHP) is the only intergovernmental programme of the UN system devoted to water research, water resources management, and education and capacity building.

UNESCO INTERNATIONAL HYDROLOGICAL PROGRAMME EIGHT PHASE (2014-2021)

UNESCO-IHP-VIII: "WATER SECURITY Responses to Local, Regional, and Global Challenges"

***"Water security** is defined as the capacity of a population to safeguard access to adequate quantities of water of acceptable quality for sustaining human and ecosystem health on a watershed basis, and to ensure efficient protection of life and property against water related hazards -- floods, landslides, land subsidence,) and droughts."*

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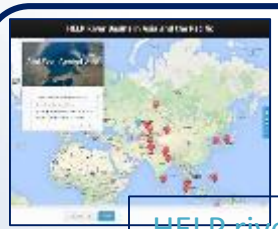
International Hydrological Programme

UNESCO-IHP in the Asia Pacific Region

- 27 IHP National Committees
- 6 UNESCO Water Centres among 15 Science Centres
- 6 UNESCO Water Chairs among 28 Science Chairs in the Asia Pacific Region.
- **Regional Steering Committee for Asia and the Pacific (Nov 2017)**.
- International Flood Initiative Secretariat
- International Drought Initiative Secretariat

Ecohydrology

Regulation of biota by altering hydrology and regulation of hydrology by shaping biota (Zawleski approach)



HELP river basins

RESEARCH **POLICY ADVICE** **CAPACITY BUILDING**

IHP Nagoya/Kyoto Training Course

-The International Hydrological Programme (IHP) Training Course -
ユネスコ・アジア太平洋地域国際水文学計画トレーニングコース

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Examples of Application of Remote Sensing in UNESCO Programmes

1 INTERNATIONAL FLOOD INITIATIVE

ICHARM

2 INTERNATIONAL DROUGHT INITIATIVE

RCUWM TEHRAN

3

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HIST

International Centre on Space Technologies for
Natural and Cultural Heritage
under the auspices of UNESCO

INTERNATIONAL FLOOD INITIATIVE

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IFI Strategic Structure

Integrated Water Resources Management (IWRM)

Sendai Framework

SDGs

Paris Agreement

Integrated Flood Management (IFM)

Minimizing social, environmental and economic risks

Maximizing net benefits from the use of flood plains

supporting tools

- *science & technology*
- *capacity building*
- *database*
- *local, national, regional initiatives*
- *financial mechanisms*

Focus Areas

- *Hazard Assessment*
- *Vulnerability assessment and capacity building*
- *Synthesis*
- *Monitoring*
- *Exposure Assessment*
- *Finance and investment*
- *Communication and engagement*

Expected Stakeholders

- IFI promoters
- Academic Society
- Government
- Funding Agencies
- DB operational supporters
- Project investors & ownersz

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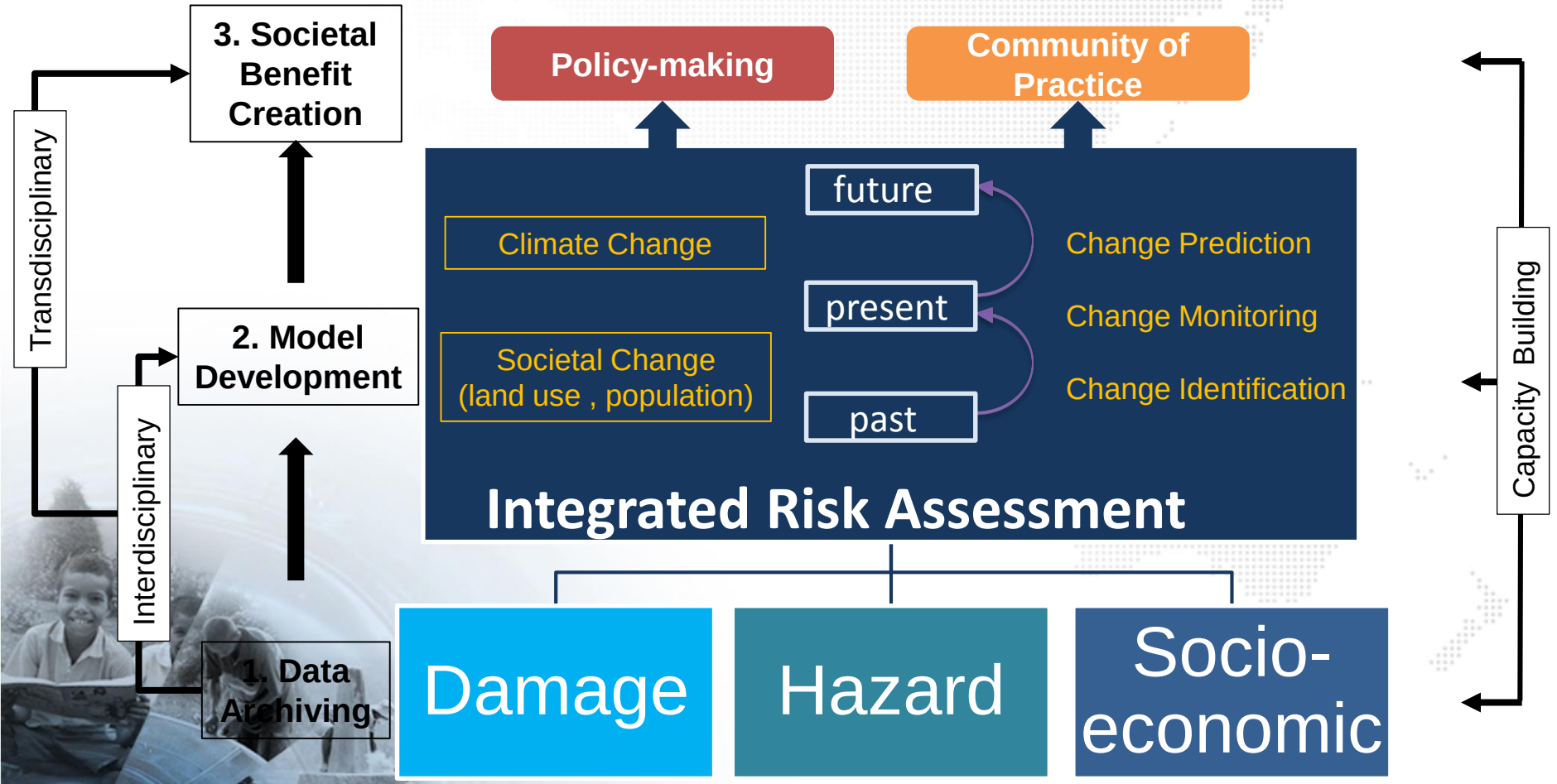
ICHARM

Implementation Framework of the Platform on Water and Disaster



INTERNATIONAL FLOOD INITIATIVE

Flood Early Warning

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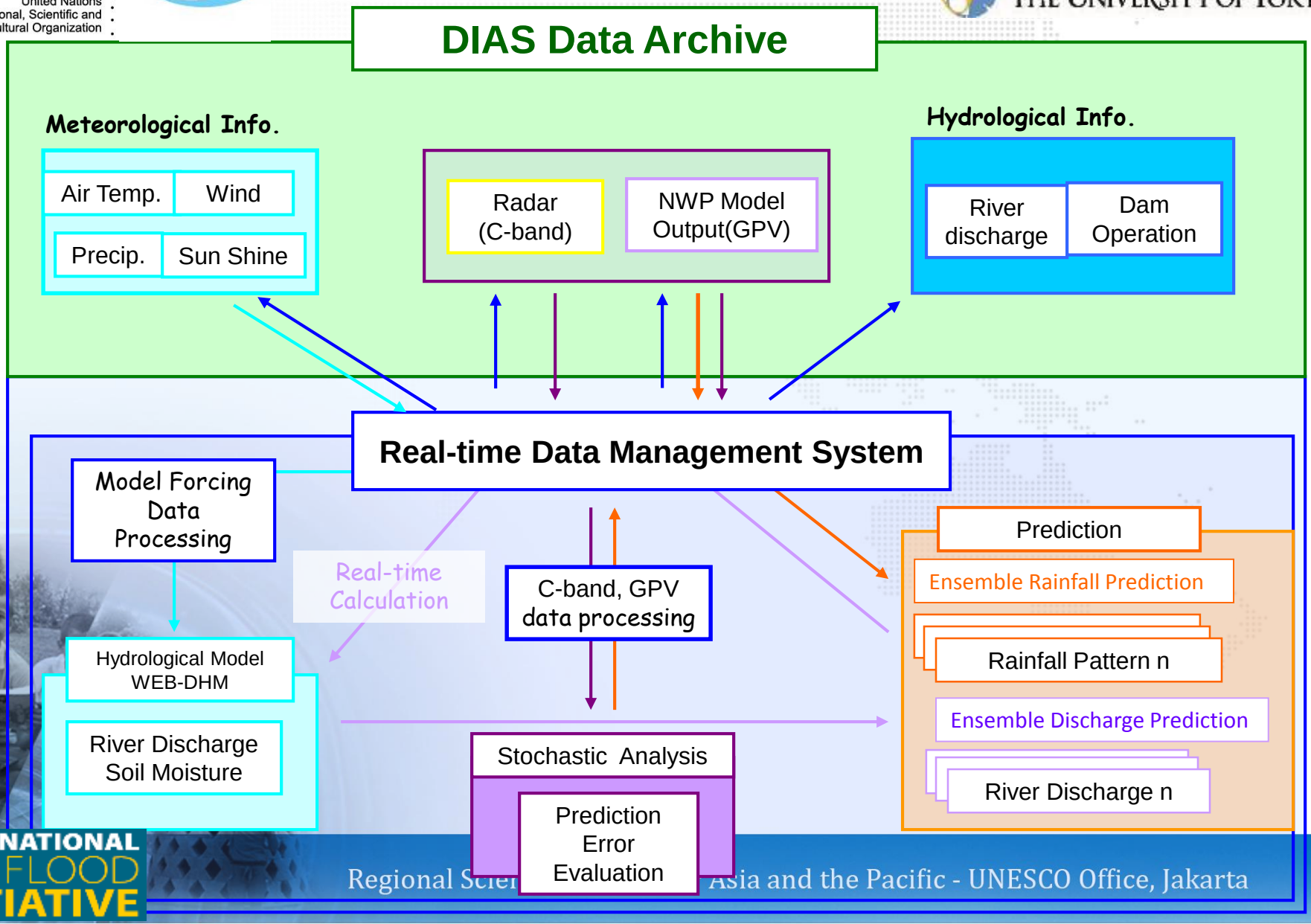
ICHARM

DIAS

THE UNIVERSITY OF TOKYO



Drought Monitoring and Prediction

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DIAS Archives

Hydromet—Agromet Data
- NASA GLDAS
- JMA Reanalysis
- NCDC Global Met
- Crop Data
- Irrigation Data

Satellite
- AMSR2
- MODIS

Seasonal Forecast
- GFDL
- APCC

Global CLVDAS Outputs
- Optimized LDAS Parameters
- Optimized RTM Parameters
- LDAS Reanalysis Statistics

Real Time Data Management System

Satellite-based Land Data Assimilation (CLVDAS)

Water-Energy Budget Hydrological Model (WEB-DHM)

River Discharge
Soil Moisture
Ground Water
Dam Storage
Crop Production

Prediction Accuracy Evaluation
Bias Correction
Weighting

Prediction

Ensemble Rainfall Prediction
- Rainfall Pattern 1
- Rainfall Pattern 2
- Rainfall Pattern n

Ensemble Drought Prediction
- River Discharge
- Soil Moisture, Ground Water
- Dam Storage
- Crop Production

Development of a National Water Security Atlas to Support Sustainable Water Governance in Iran

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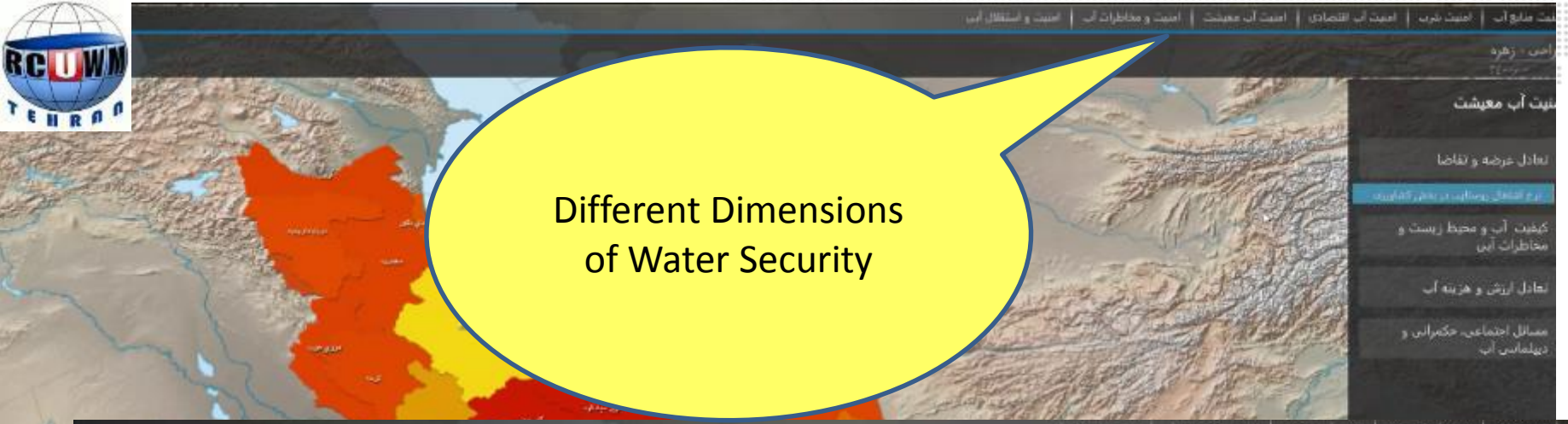
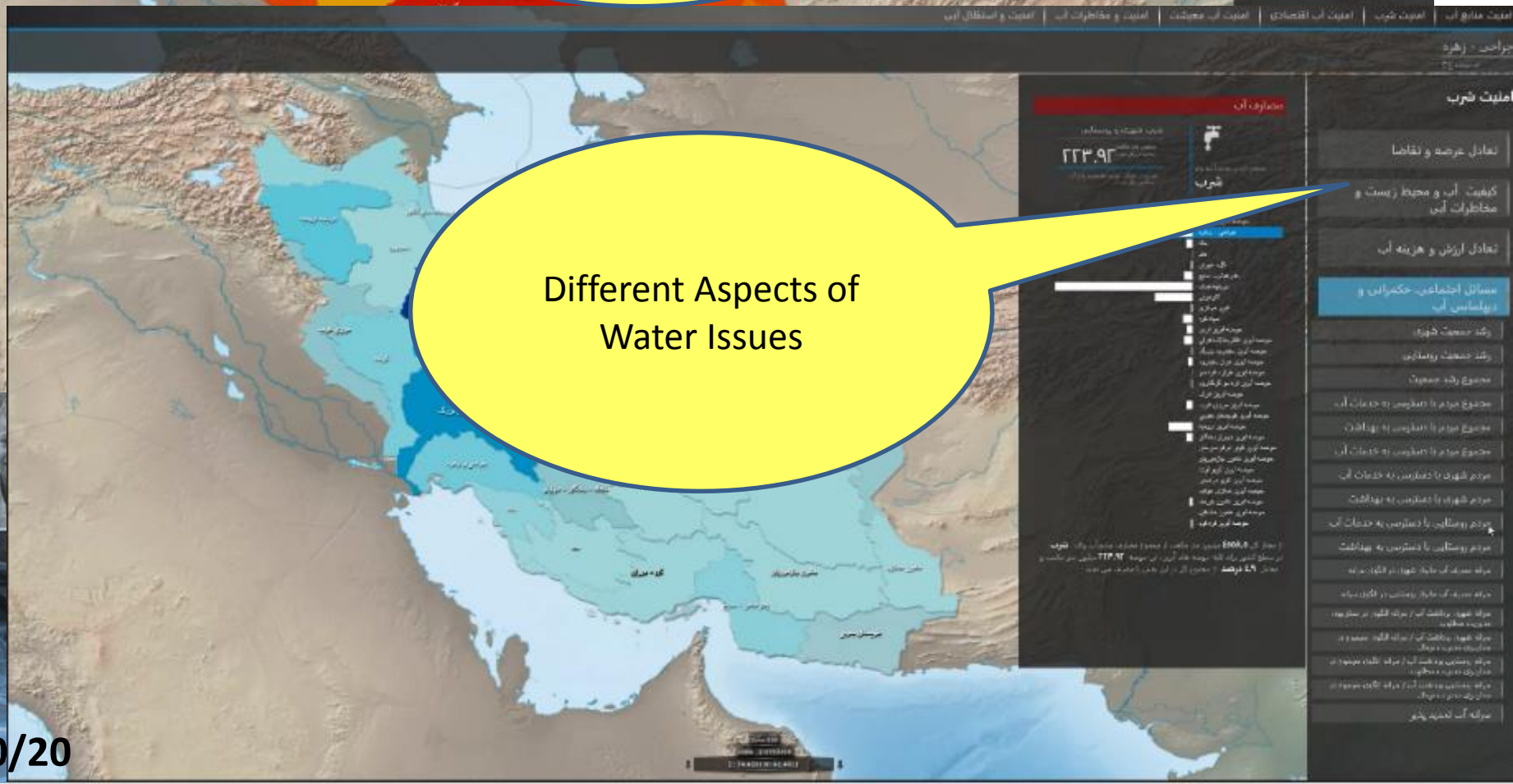
- Agricultural Water Productivity
- Precipitation
- Economic Value of Water
- Air Temperature
- Livelihood-Dependent Agriculture
- Population
- Irrigation Development
- Agricultural Development
- Percent of Water Reuse
- Per Capita Urban Water Use


Different Dimensions
of Water Security


Different Aspects of
Water Issues

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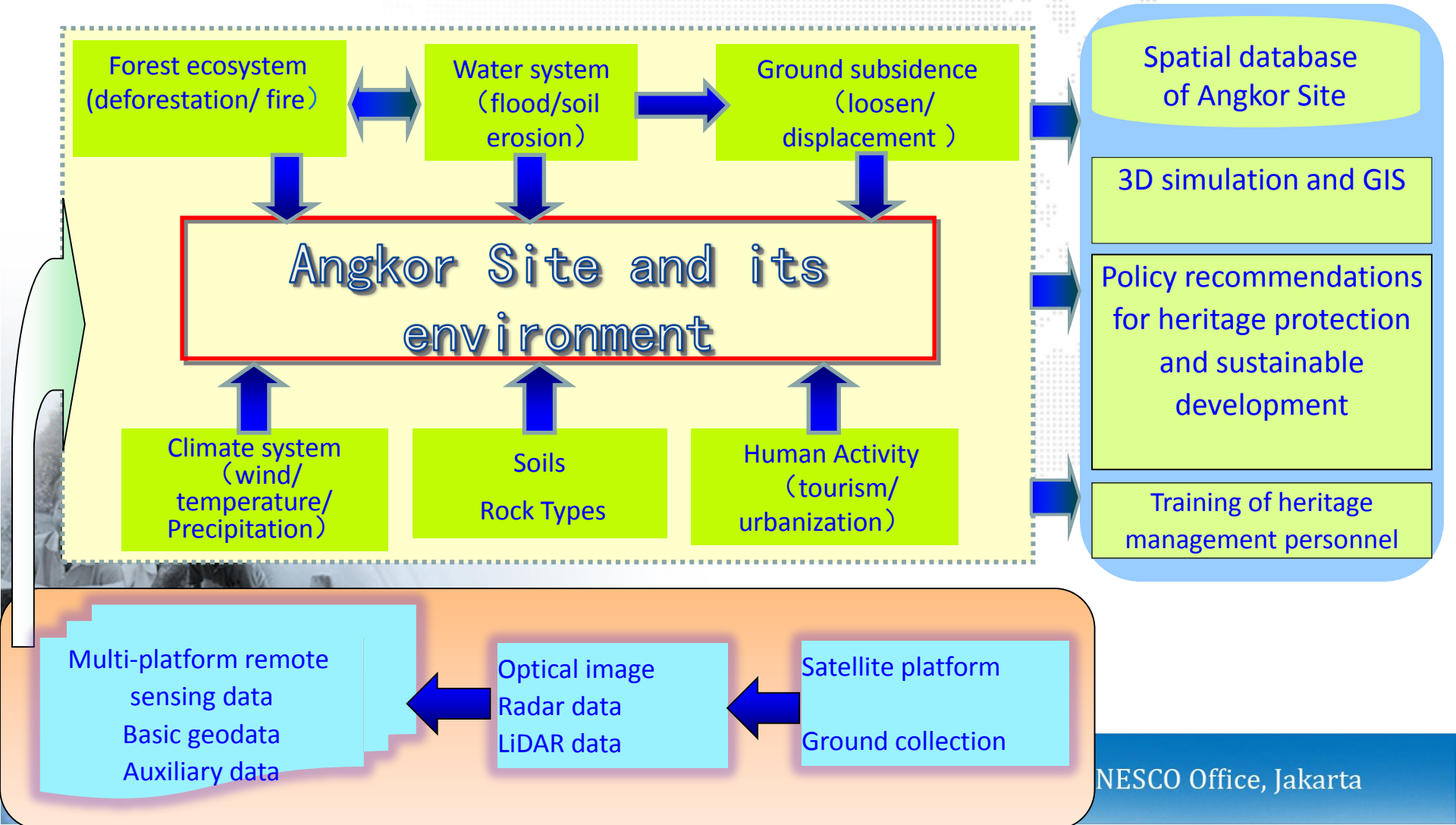
International Centre on Space Technologies for Natural and Cultural Heritage under the auspices of UNESCO

APSARA

Remote Sensing for Environment of Angkor Site (2013-2015)

REAS
Remote Sensing for Environment of Angkor Site



NESCO Office, Jakarta

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APSARA

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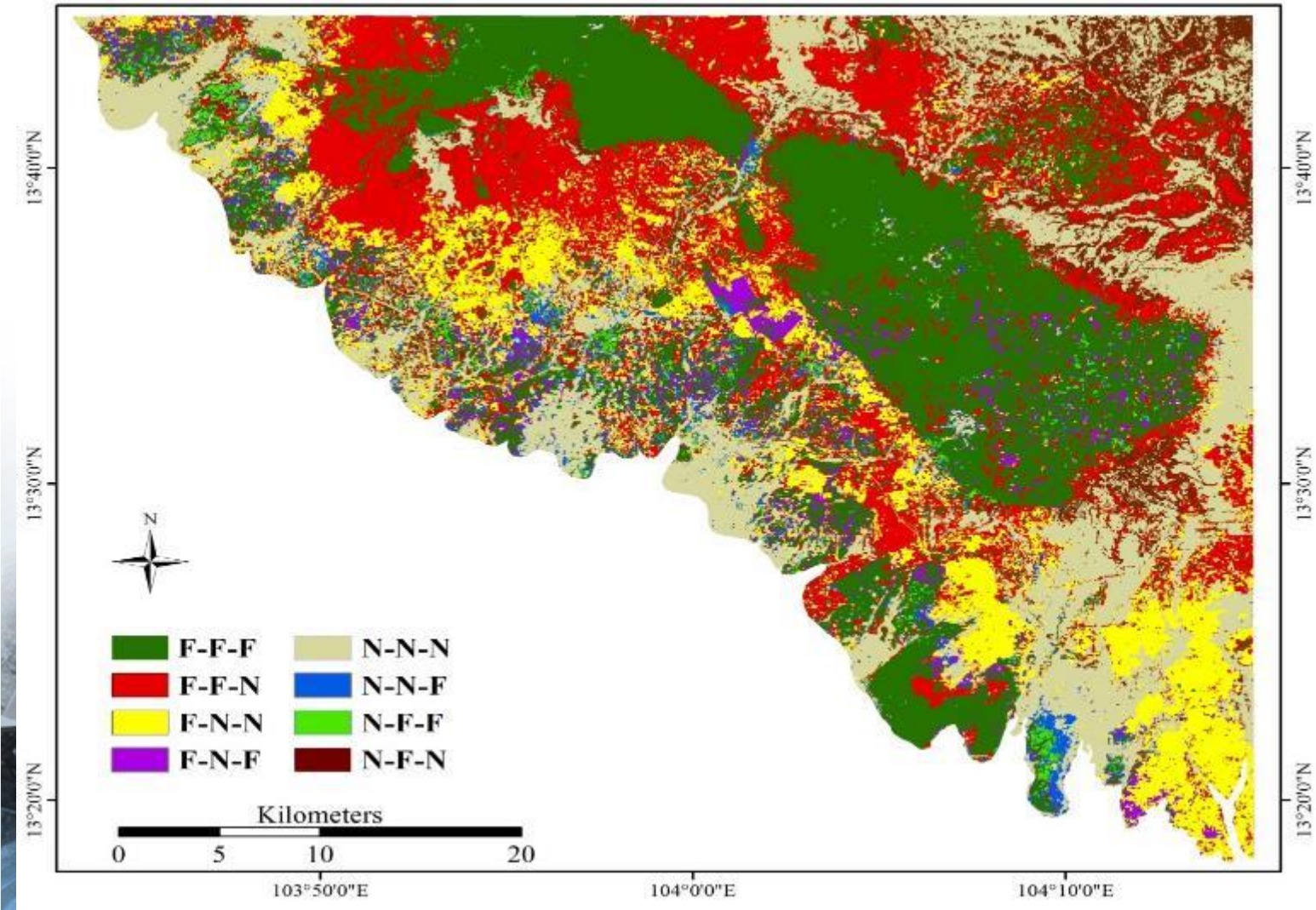
Map of Forest cover change in Kulen Mountains. F refers to forested areas and N to non-forest areas, respectively. The total area mapped and analyzed in the southern slopes of Mt. Kulen is about 1663 sq.km.



Note：Kulen Mountain was defined in our study as the area with 40 m a.s.l.

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Flood Forecasting and Management
Case Study of Pakistan

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Shahbaz Khan

April 10 at 9:58am ·

A 200-Year Drought Doomed Indus Valley Civilization - water has always been the essence of Indus Valley Civilization. Evidence from dry river beds in central Punjab and Lower Indus revealed a long history of irrigation stretching back more than 4000 years to the Mohenjodaro and Harappa urban civilizations. Frequent floods and droughts and land salinization destroyed these settlements. One of longest droughts in the history of Indus Valley Civilization lasted for 200 years (between 4,200 and 4,000 years ago) when precipitation dramatically decreased and regular summer monsoons stopped for some 200 years. People needed to leave their cities and emigrate eastwards as water and agriculture systems could not cope anymore with their life needs. We are facing similar threats again, what are the solutions to avoid water catastrophe?

Reference - Nature 2014 https://www.scientificamerican.com/…/200-year-drought-doom…/

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UNESCO Post 2010 Floods Actions in Pakistan

1. UNESCO DG sent a team of flood management experts to Pakistan on 22nd August 2010.
2. Based on the mission to Pakistan, UNESCO prepared response project with the Pakistani authorities to reinforce the country's capacity in:
   - Integrated flood and watershed management
     - Groundwater resources for emergency situations
     - Landslides and ground instability especially for relocation of affected population.

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Problem revealed by the flood 2010 and counter measures taken in this project

Upper Indus

There was limited or no flood forecasting ability for the areas severely damaged by the floods

→

Flood forecasting including upper-Indus was introduced by a new system utilizing satellite data（A1)

Lower Indus

The flood devastated the areas where had no inundation experience in the past

→

Updated flood hazard maps in lower Indus to cover the new inundated areas（A2)

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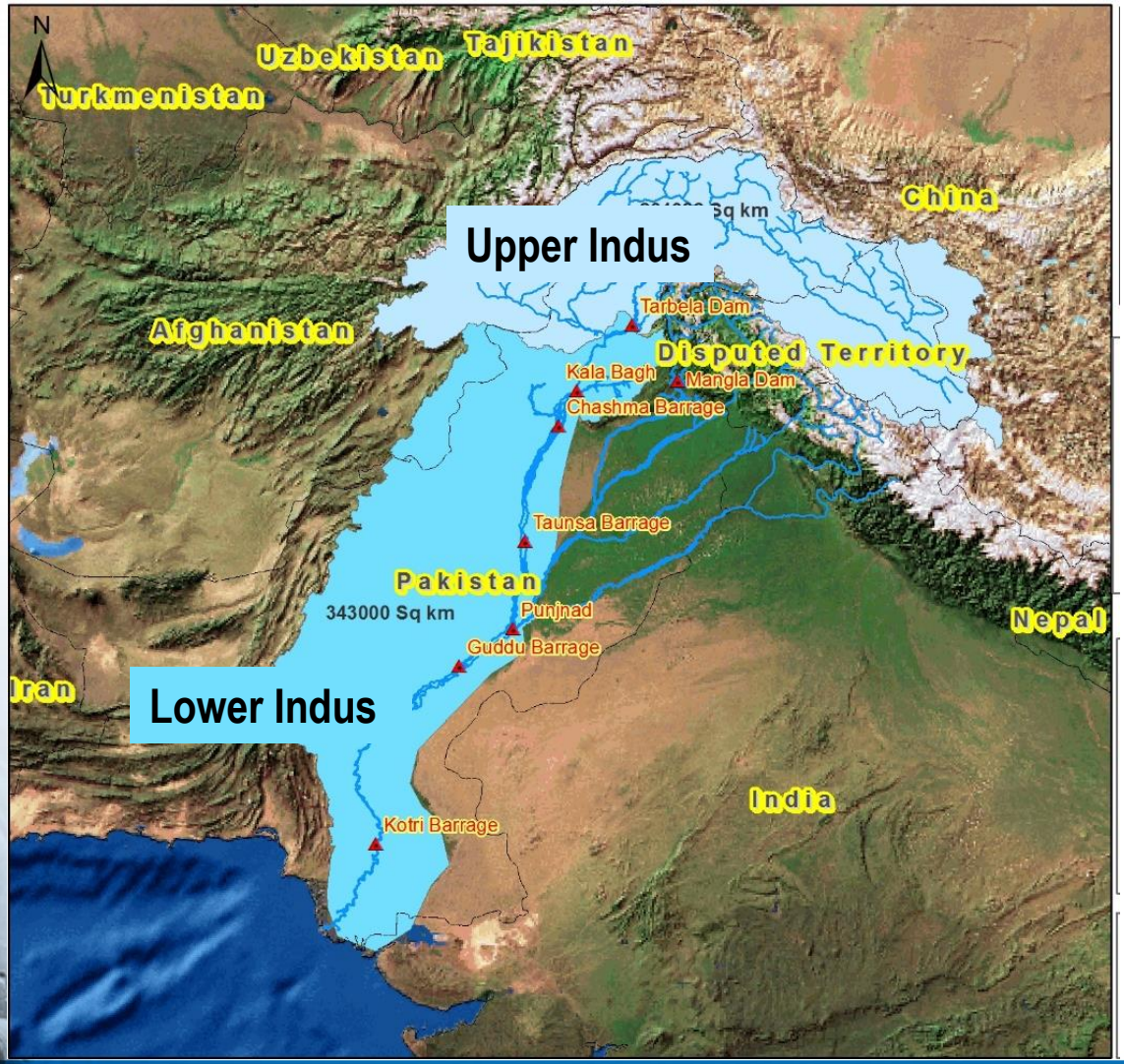
Target Area for Phase-1 Flood Project



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Component of the Pakistan Flood Project (Phase-1)

A. Strategic Augmenting of Flood Forecasting and Hazard Mapping Capacity

A-1 Development of Indus IFAS
A-2 Floodplain and Hazard Mapping of Lower Indus

B. Knowledge Platforms for Sharing Transboundary and Community Data

B-1 International Networking for Sharing of Transboundary Data
B-2 Knowledge platform for timely national, provincial and district level data sharing

C. Capacity Development for Flood Forecasting and Hazard Mapping

- *Master degree training course for the Pakistan government staff*
- *Short training courses for the senior water managers*
- *Training workshops on use of flood forecasting models and flood hazard maps*

Implementation Framework

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Pakistan Authorities

PMD
Development of Flood Forecasting System Component: A1

Data support

PCRWR
Soils and Hydrological data
Component: A1

SUPARCO
Flood Risk Hazard Mapping
Component: A2

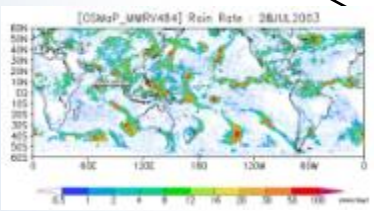
NDMA (Including NIDM)
National Policy and Flood Management at National, Province, District level
Component: B2, C

FFC
Coordination for flood management at provincial level Component: B2

Indus River Commission
Transboundary Data sharing
Component:B1

- Flood forecasting and early warning system
- Hazard mapping

- GSMAP Local Calibration
*Satellite based rainfall



UNESCO

Project Implementation

International Partners

UNESCO International Network

Experts
UNESCO Network
Component: A1, A2

UNESCO Water Center

ICHARM
International Centre for Water Hazard and Risk Management under the auspices of UNESCO
Component: A1, C

JAXA
Japan Aerospace Exploration Agency
Component: A1, A2

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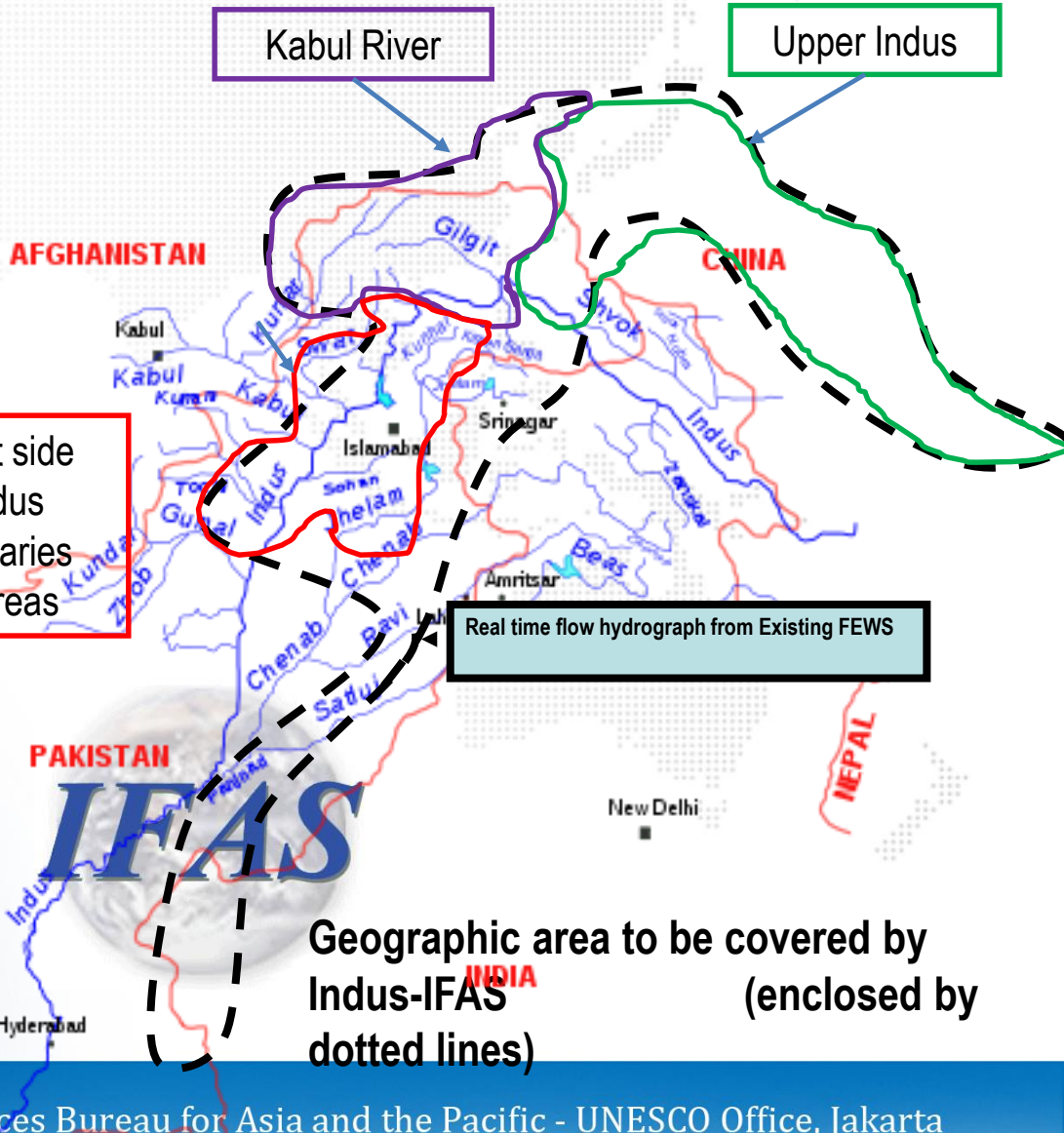
Integrated Flood Analysis

- Indus-IFAS has been developed in collaboration with UNESCO & ICHARM
- Test operation in 2012
- Validation and update in 2013*

*The result was published through FFD/PMD website

- Models have been made operational toward flood season in 2014



Integrated Flood Analysis System (IFAS)

Flood forecasting system using satellite data

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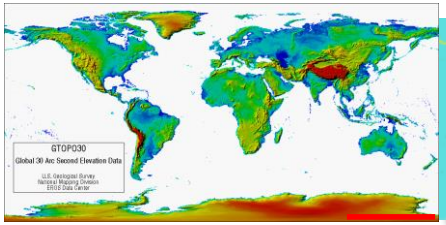
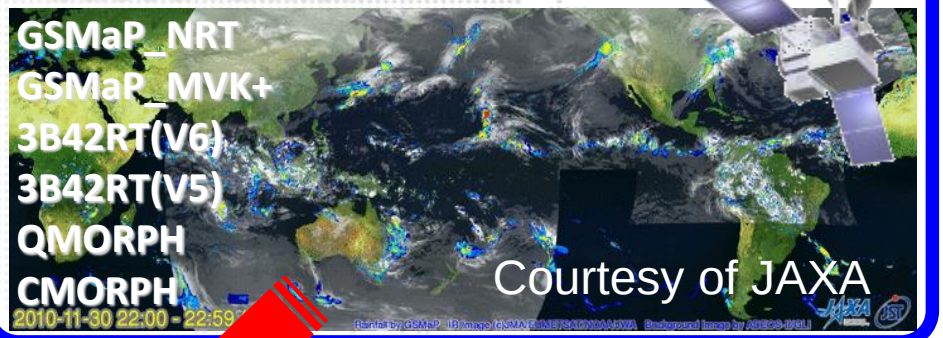
Global Geological data for modeling Elevation data, Land use data, etc.



Ground rainfall and Satellite-based rainfall



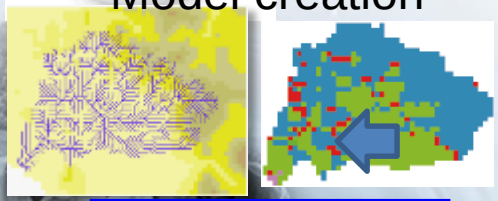
input

input

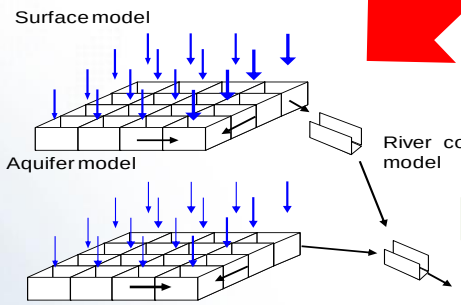
IFAS

Integrated Flood Analysis System

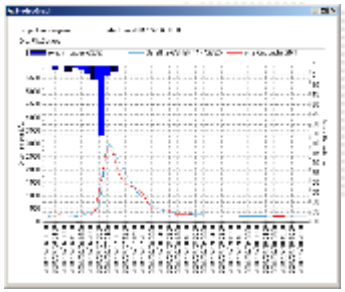
Model creation

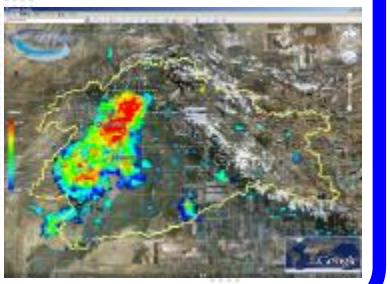


Run-off analysis



River discharge, Water level, Rainfall distribution





Calculation

Flow/water level

Flood forecasting/warning

Promoting safe evacuation

Reduce/Prevent flood damage

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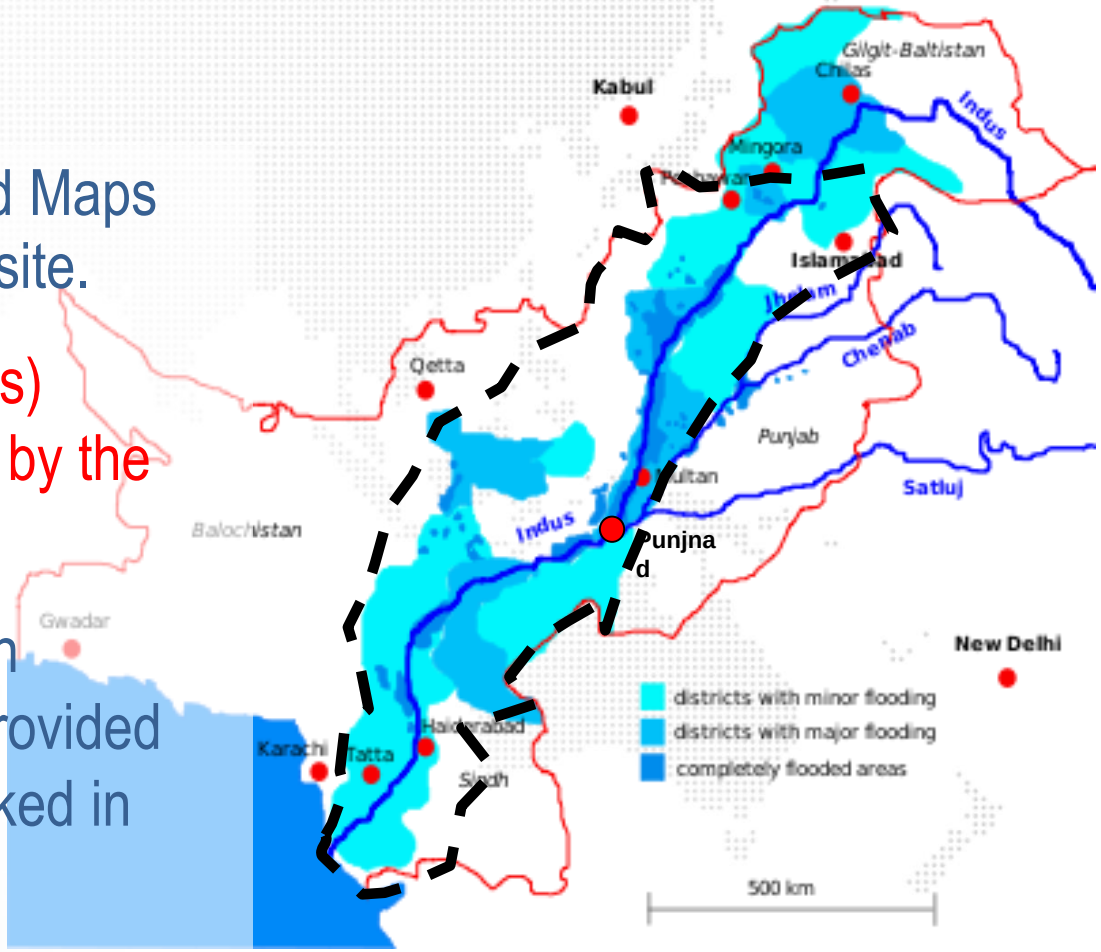
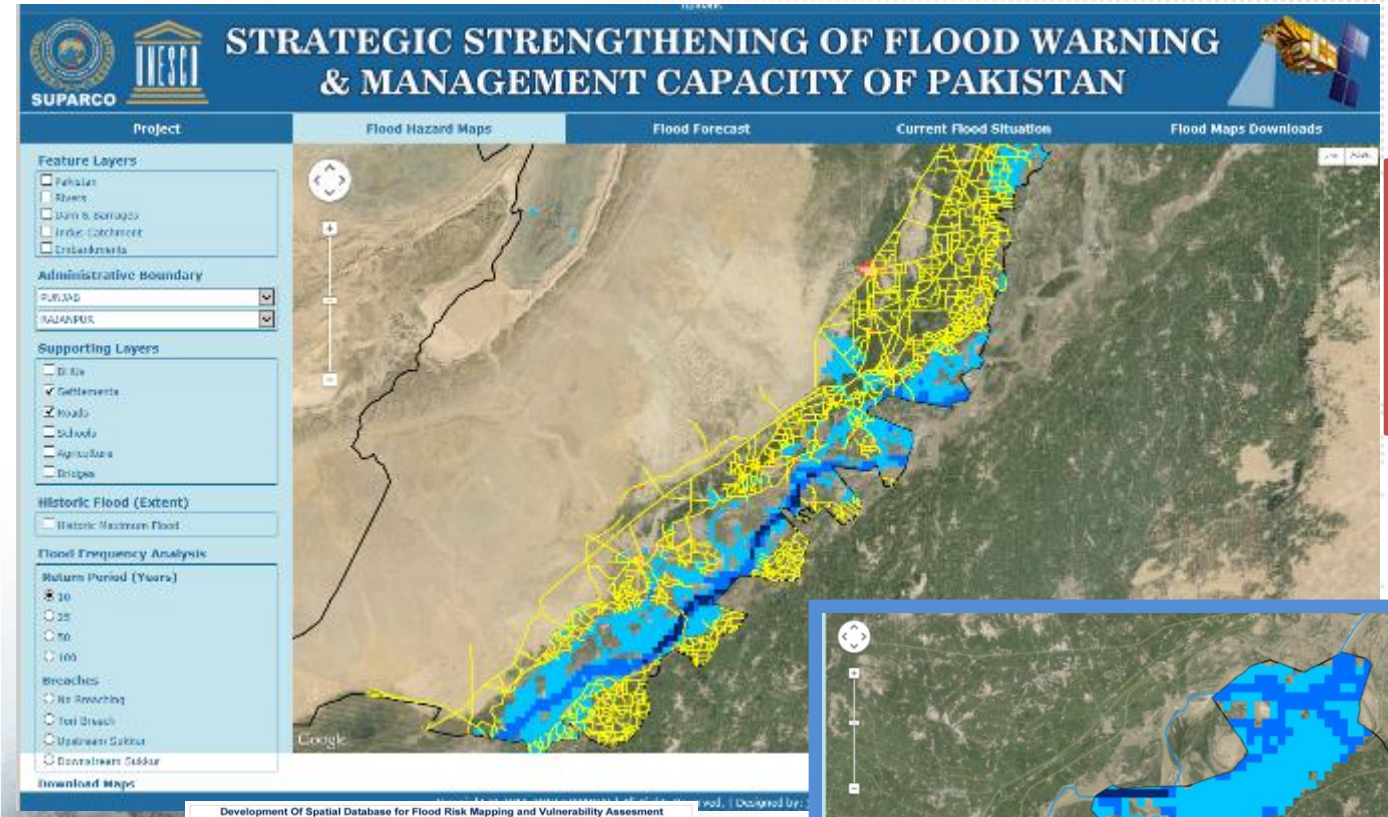
Flood Hazard Mapping

- Updated and simulated Hazard Maps are available through the web site.
- Coverd lower Indus (32 districts) including newly affected areas by the flood 2010
- Real time inundation simulation model(RRI model) has been provided and its accuracy is being checked in current flood season.

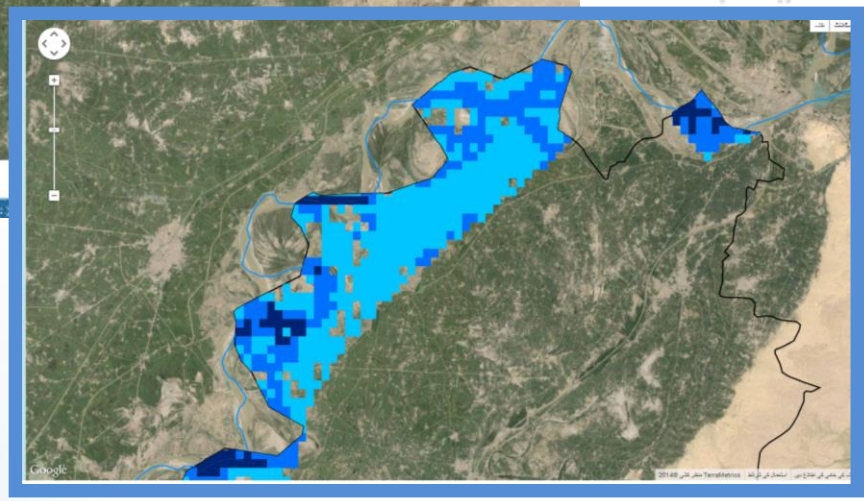


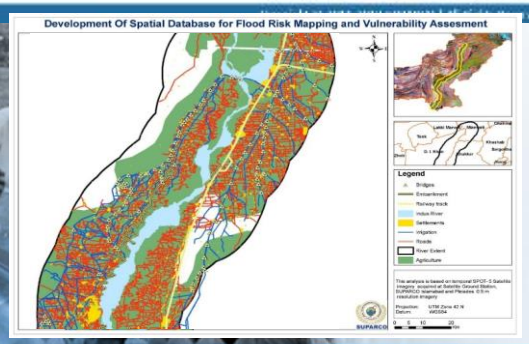
Flood Hazard Mapping Area (enclosed by dotted lines)

Integration of Models with GIS and RS



BHUs, Settlements, Roads, Schools, Agriculture and Bridges with layers





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Platform for Transboundary and Domestic Data Sharing

- International dialogue for transboundary data sharing/flood management has been started with neighboring countries through the the international forum/conference with using UNESCO water network.

- The Hydro-meteorological data sharing information system, called PIFMIS, has been provided to FFD/PMD.
- This system is expected to provide a common platform for all flood-related stakeholders in flood management (PMD, SUAPRCO, IRSA, FFC, WAPDA, IWC, provincial irrigation departments, etc.)
- PFIMIS enables hydro-meteorological data entry, analysis, and display of flood related information in a user-friendly way and enhances inter-organizational coordination, while sharing precipitation, stage, and discharge data in near real-time.

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Hardware Facilities for Dissemination

- A media centre equipped with advanced devices was newly established in PMD-FFD in Lahore within the framework of the project and it enables to directly provide the real time flood forecasting and warning to the public.

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Human Capacity Development

Master Degree Course training

Flood fighting drill & Flood forecasting/
operation room observation
(short term training)

- 6 Pakistan professionals**(PMD, SUPARCO, Irrigation departments)** have graduated and obtained Master's Degrees through ICHARM training course in Japan.
- Intensive short term trainings were conducted for senior managers in Japan and 11 experts have received trainings on flood forecasting and management in Japan.

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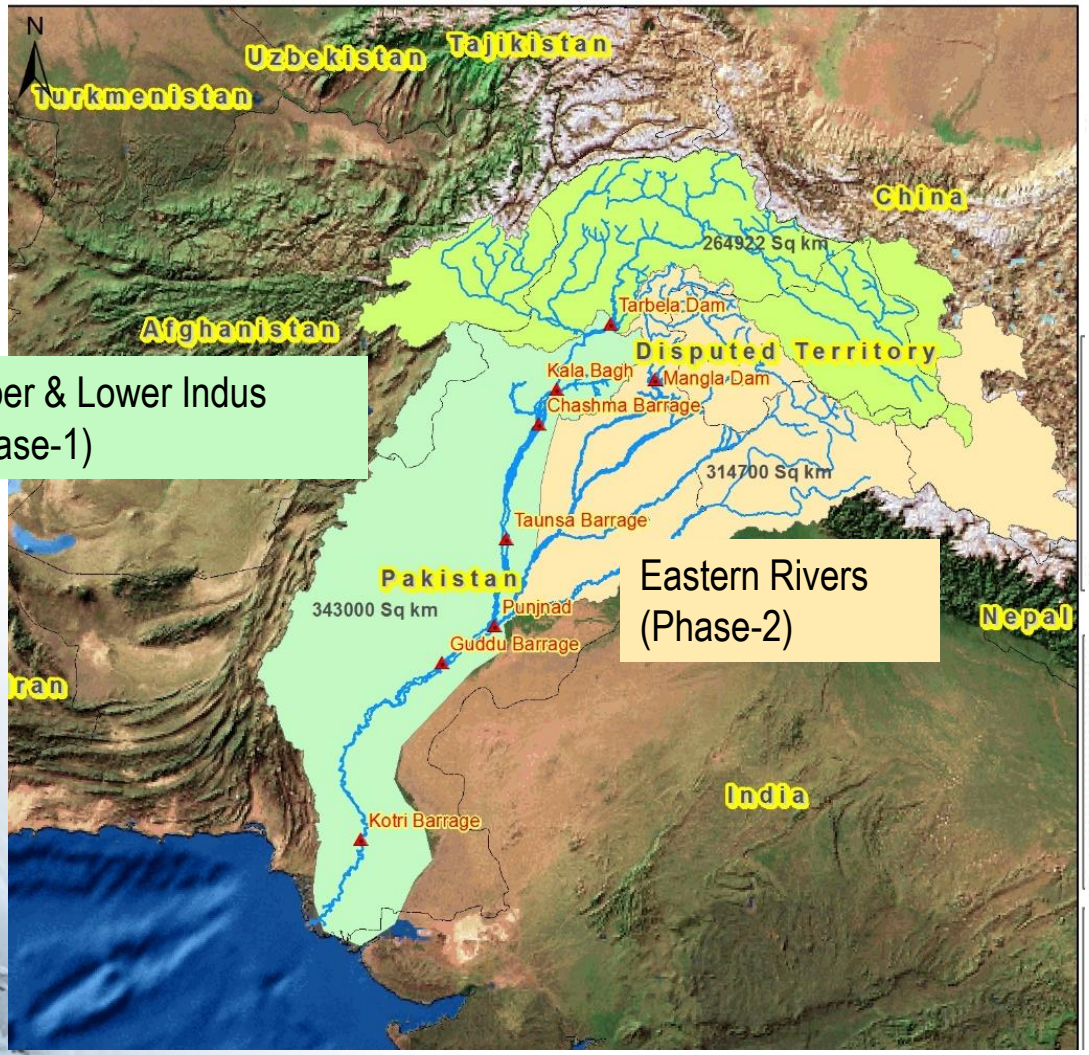
Target Area of Phase-2



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Components of the Pakistan Flood Project (Phase-2)

A. Establishment of the technical foundation for sustainable capacity development on the flood management, forecasting, early warning and flood hazard analysis in Pakistan agencies

A-1 Technical studies on the improvement of the accuracy of flood forecasting and early warning system in Pakistan
A-2 Strengthening the flood forecasting and warning capacity in Eastern Rivers (Jhelum, Chenab, Ravi and Sutlej rivers)
A-3 Strategic and continuous enhancement of the flood management capacity in Pakistan

B. Technical studies to promote strengthening of cooperation with Indus river basin countries for transboundary flood management and transboundary data sharing

B-1 Technical studies on strengthening of the transboundary flood management capacity of the Indus river basin countries
B-2 Reinforcement of the relationship within the Indus river basin countries for transboundary flood management and data sharing

C. Capacity building and education to community on flood management for proper utilization of flood hazard information and tools

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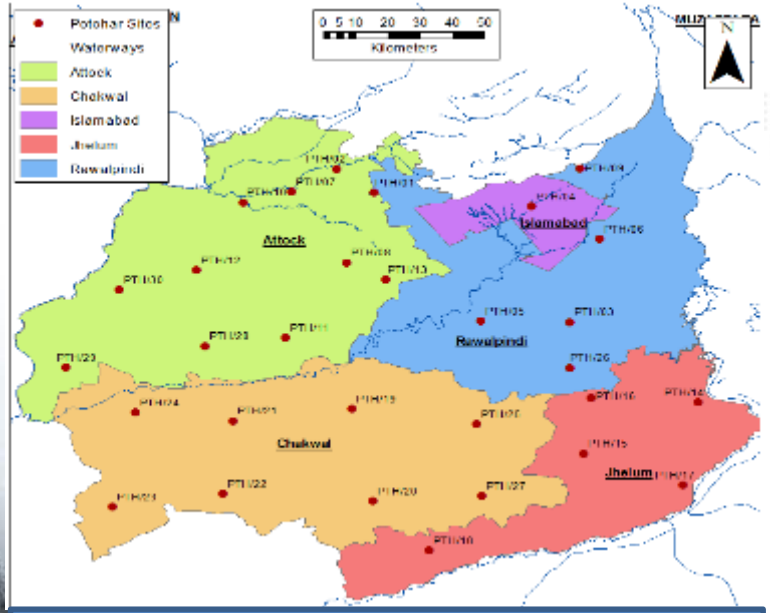
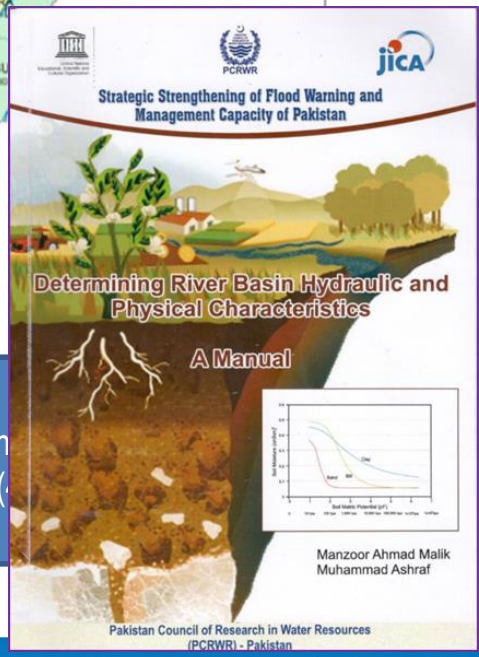
Establishment of Technical Foundation for Localized Data Collection and Acquisition

- Soil hydraulic characteristics of active flood plains and within doabs are carried by PCRWR



Pothwar:
Geographical area = 22,254 km²
Coverage per site = 855 km² (30 km X 30 km grid)
Achieved: 30 sites

Doabas:
Geographical area = 113,085 km
Coverage per site = 1713 km2 (
Achieved: 66 sites



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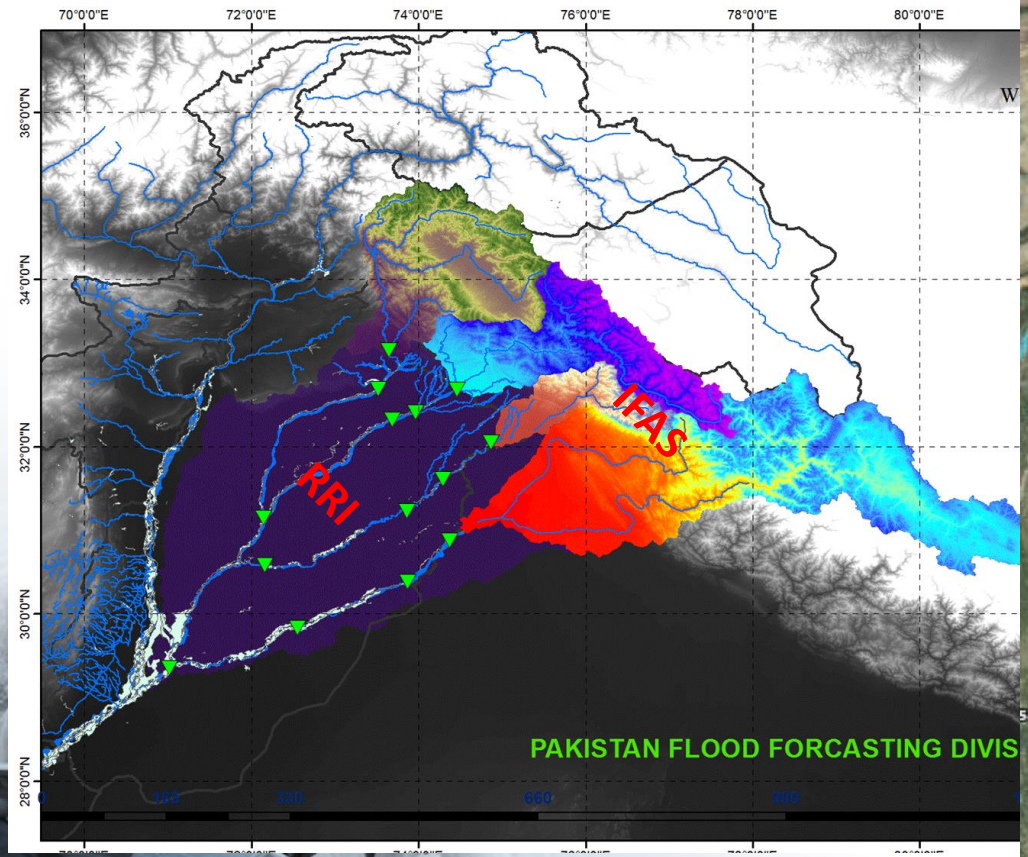
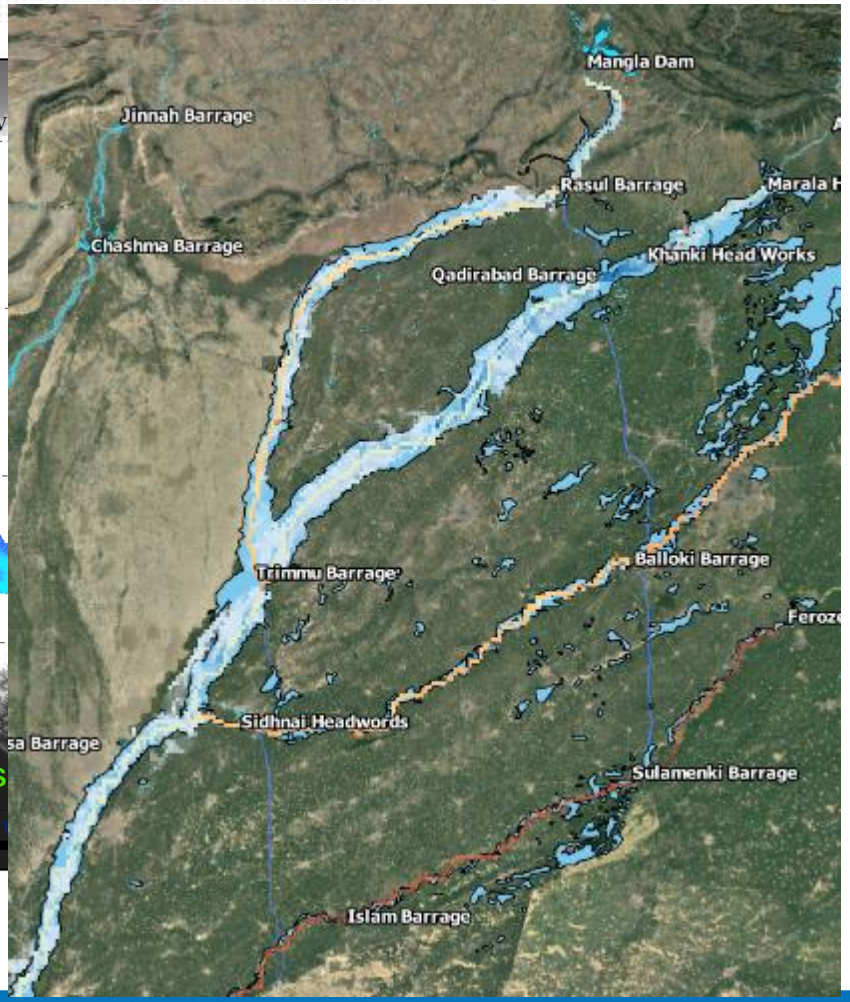
Strengthening of Flood Forecasting of Eastern Rivers- RRI Models





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Several National and International Workshops

2days workshop with Embassy of Japan, JICA, PMD, SUPARCO, NDMA, Regional Irrigation Departments, ICHARM, JAXA and Pakistani universities (NUST, UET-Lahore), co-hosted by PMD and UNESCO

Presentation by Prof Toshio Koike, Director of ICHARM

Opening remarks
(Left: H.E. Mr. Abid Sher Ali, Minister of State for Water and Power
Centre: Ms. Vibeke Jensen, Director, UNESCO Islamabad
Right: Dr. Ghulam Rasul, DG of PMD)

Young engineers of PMD with their in house developed Automated Weather Station (AWS) (more than 35% lower than international standard price)

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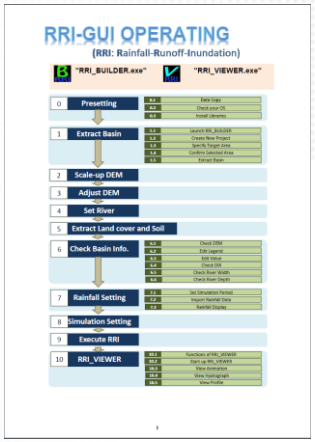
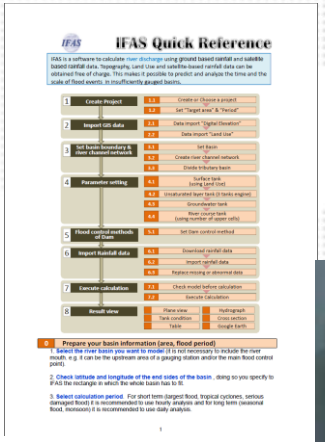
Pakistan-Afghanistan Joint Capacity Building

13 participants (incl. 2 Afghan officers from ANDMA and MEW, FFD, NUST and UET with 4 women) received a 4 days intensive training delivered by ICHARM on IFAS and RRI in FFD.





RRI-Graphic User Interphase and IFAS Quick Reference manuals

Introduction of Mr Aziz Aimaq, director ANDMA and Mr Farhad Nayyer, Modeller MEW to Mr Riaz, Chief Meteorologist, FFD in presence of ICHARM (Mr Iwami, Dr Tsuda)

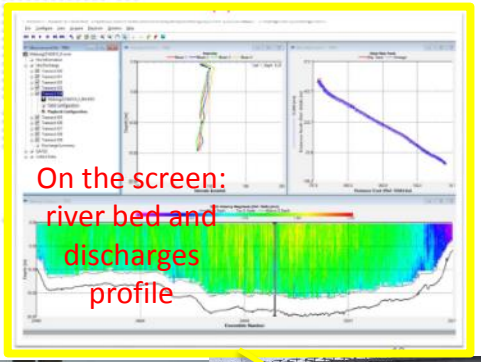
Dr Amara, lecturer at UET Lahore receiving IFAS/RRI training certificate.

Mr Aziz (top right) and Mr Farhad (down) receiving their IFAS/RRI training certificates from Prof Shahbaz (UNESCO)

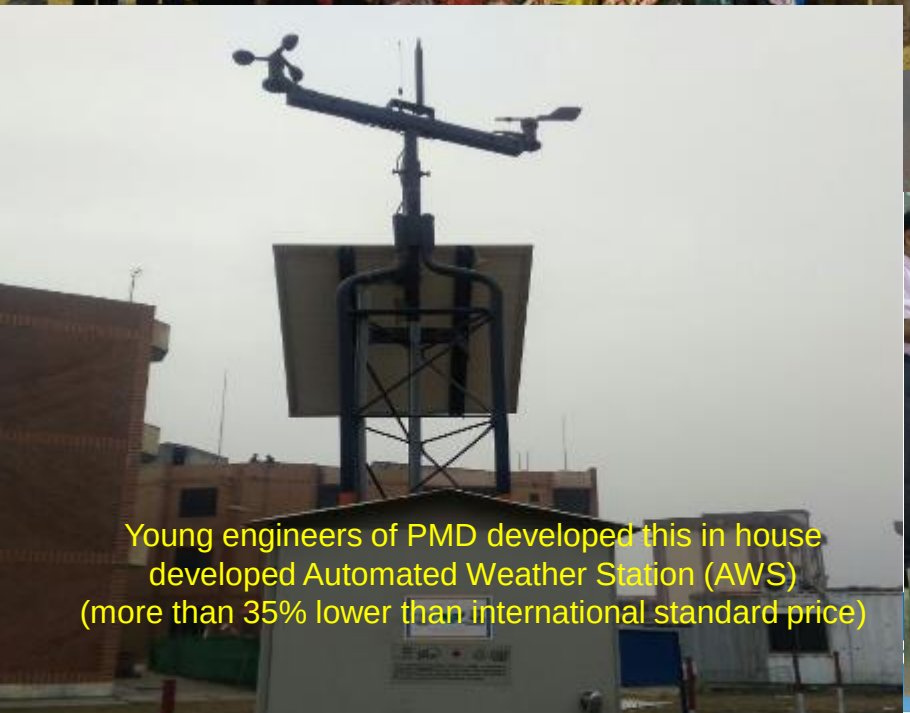
ADCP, Auto Weather Stations and Community Training

United Nations Educational, Scientific and

Training provided to PCRWR, four Provincial Irrigation Department, WAPDA and PMD (21 trainees)



River Transect measurements on Jhelum river 5-6 August 2017



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Further update on activities

Shahbaz Khan UNESCO