HI-AWARE

Himalayan Adaptation, Water and Resilience Research on Glacier and Snowpack Dependent River Basins for Improving Livelihoods

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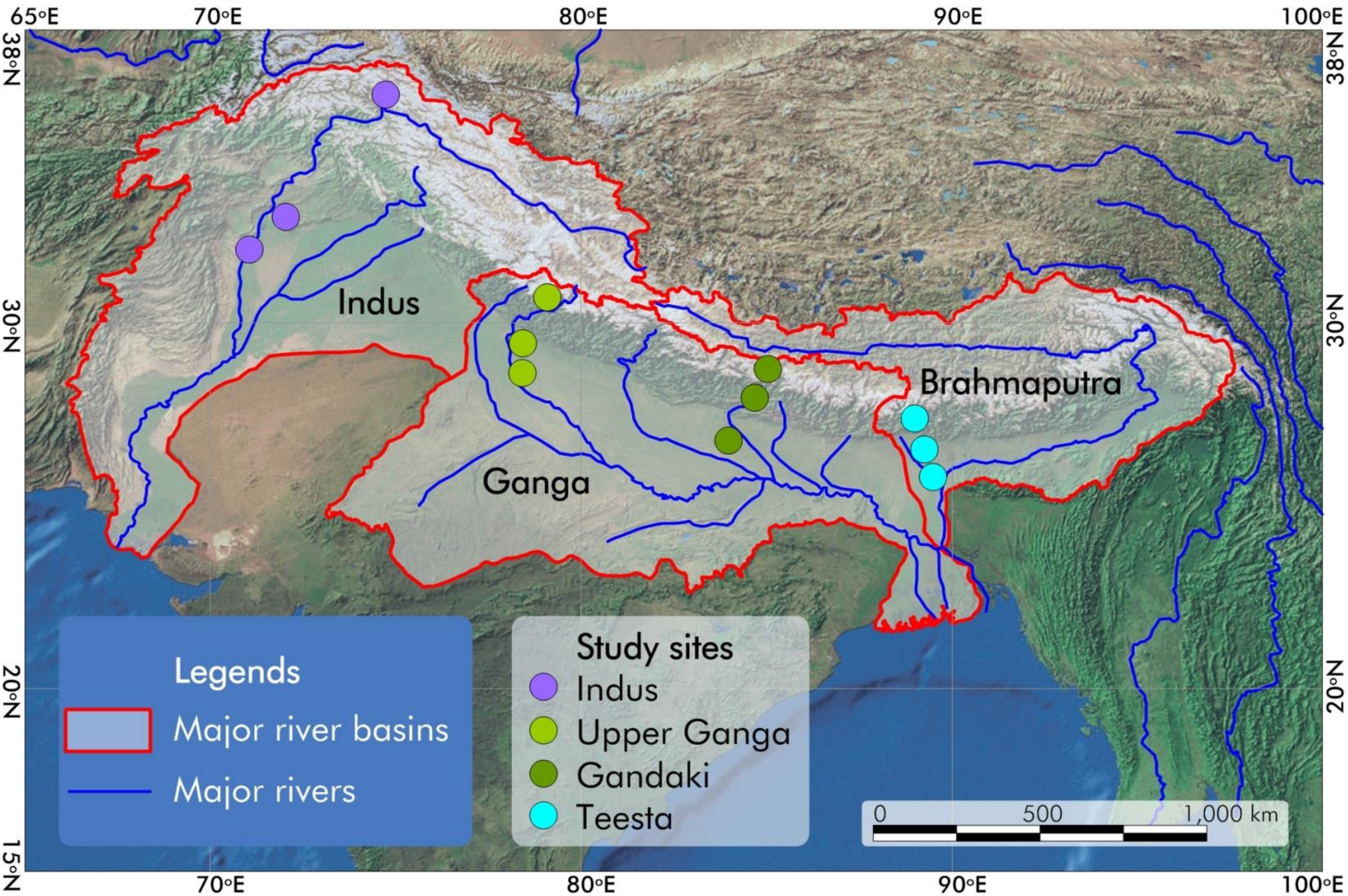
Pakistan Agricultural Research Council Islamabad

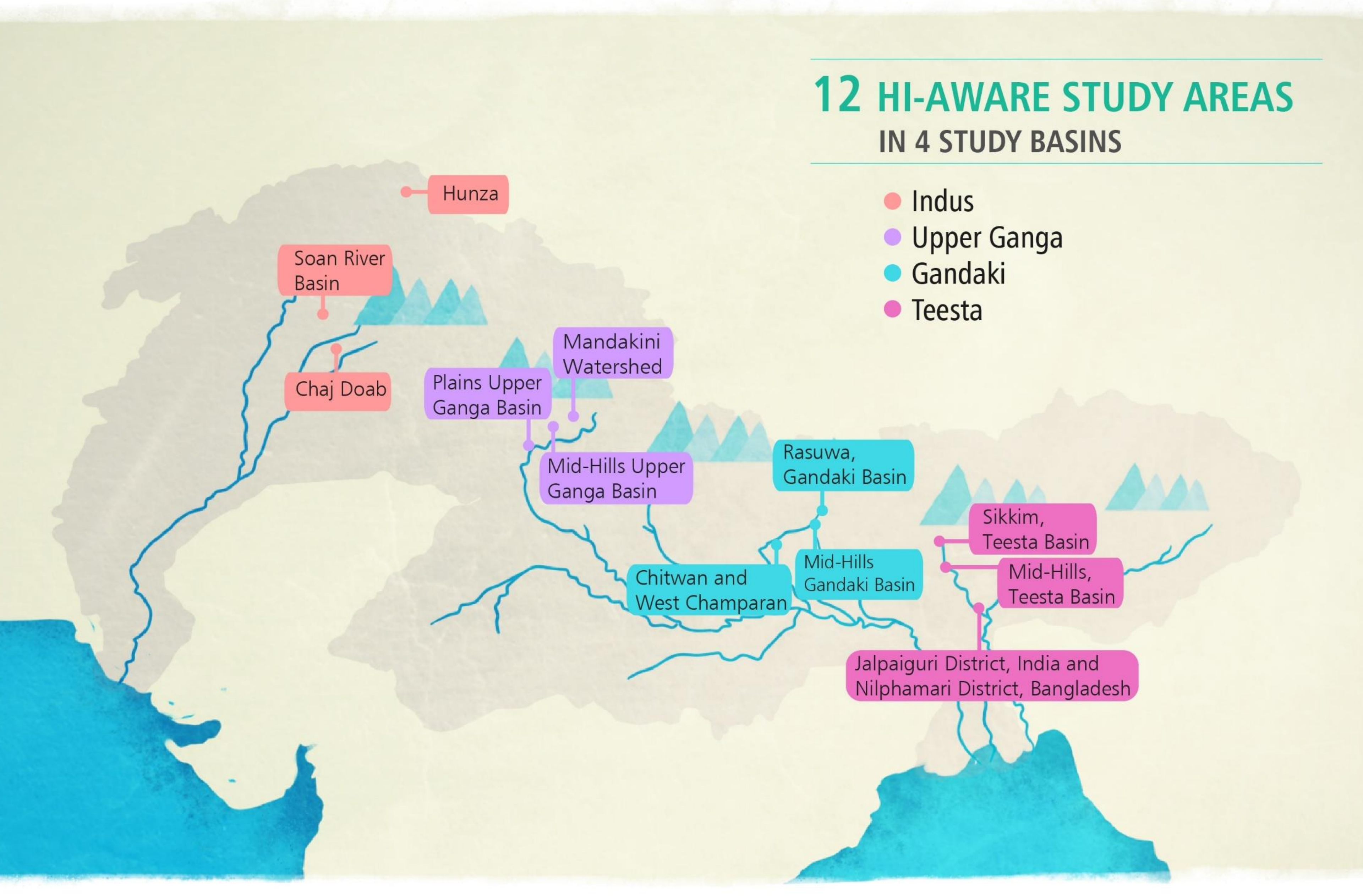


Himalayan Adaptation, Water and Resilience Research

HI-WARE Focus:

HI-AWARE
Himalayan Adaptation, Water and Resilience Research

- HI-AWARE – is a regional initiative in South Asia
- Single methodology for region
- ICIMOD is regional partner for coordination
- Prominent researchers of Wageningen University-Netherland, Future Water and Osburg University Germany, Colorado University USA are knowledge partner
- Based on intensive field monitoring, piloting, demonstration & scenario modelling
- Synergies between science base knowledge and community adaptation practices
- Addressing food/agriculture, water, energy, health, urban habitat sectors
- Economic of adaptation/Climate Action
- Focus on Climate Communication from community-practitioners to policy makers



12 HI-AWARE STUDY AREAS
IN 4 STUDY BASINS
Indus
Upper Ganga
Gandaki
Teesta
Hunza
Soan River Basin
Chaj Doab
Mandakini Watershed
Plains Upper Ganga Basin
Mid-Hills Upper Ganga Basin
Rasuwa, Gandaki Basin
Chitwan and West Champaran
Mid-Hills Gandaki Basin
Sikkim, Teesta Basin
Mid-Hills, Teesta Basin
Jalpaiguri District, India and Nilphamari District, Bangladesh

Consortium Members

- Bangladesh Centre for Advanced Studies (BCAS)
- International Centre for Integrated Mountain Development (ICIMOD), based in Nepal
- Pakistan Agricultural Research Council (PARC)
- The Energy and Resources Institute (TERI), based in India
- Wageningen University and Research, based in the Netherlands

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Strategic Partners

- Centre for Ecology Development and Research (CEDAR)
- FutureWater
- LEAD – Pakistan
- Megh Pyne Abhiyan (MPA)
- Practical Action Nepal
- The Mountain Institute (TMI) India

Implementing Partners

Pakistan Meteorological Department (PMD)

WAPDA

NUST, Karakorum University Gilgit, GC University Faisalabad

OFWM, Punjab

Research Question

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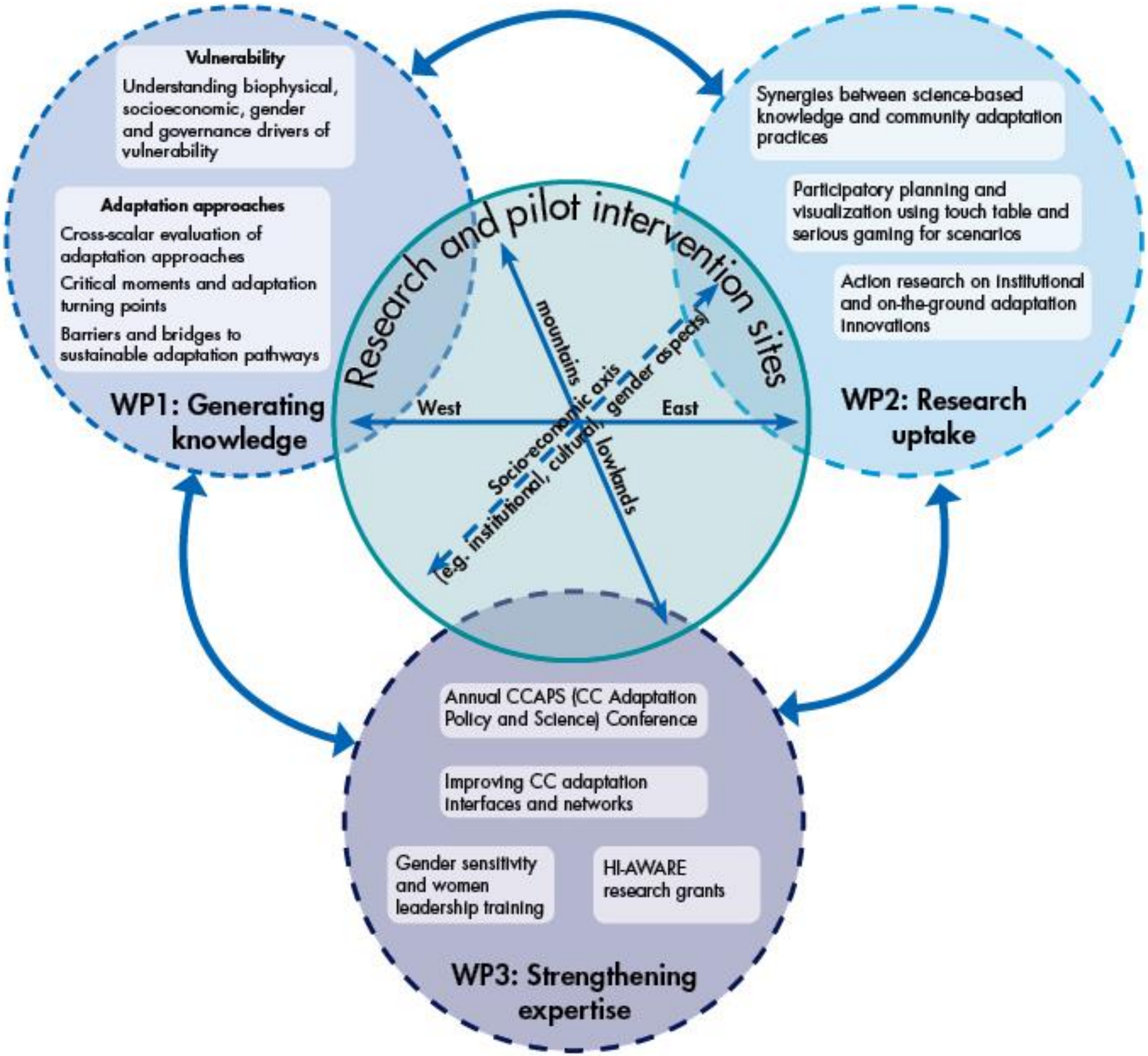
How to develop timely adaptation measures and approaches

to respond to rising temperatures, seasonal shifts in glacier and snowmelt induced runoff, and increased frequency of extreme events

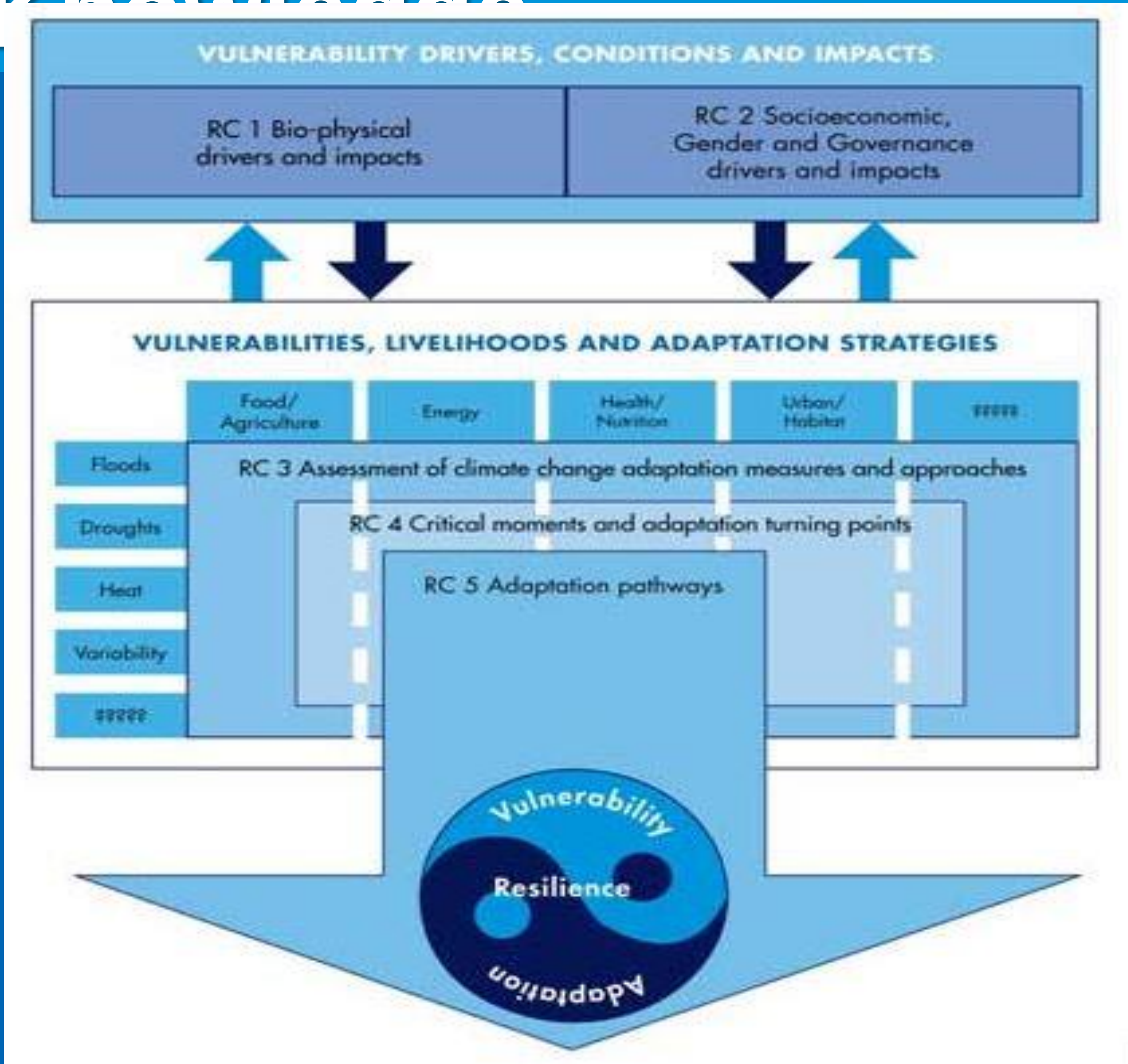
in the HKH mountains and floodplains

in order to improve the resilience of livelihoods of the poor and vulnerable?

Methodology



Generation of Knowledge



RC-1 Biophysical drivers and Impacts

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- developing detailed mountain-specific and basin-scale climate change scenarios;
- improving cryosphere-hydrological modelling to assess significant shifts in river-flow regimes, with an aim to develop water-demand and supply scenarios as well as to improve and apply water-food impact models
- helping researchers better understand climate change's impacts on extreme events (heat waves, floods, droughts), and quantify these extremes from climate models and, subsequently, impact models.

RC-1 Biophysical drivers and Impacts

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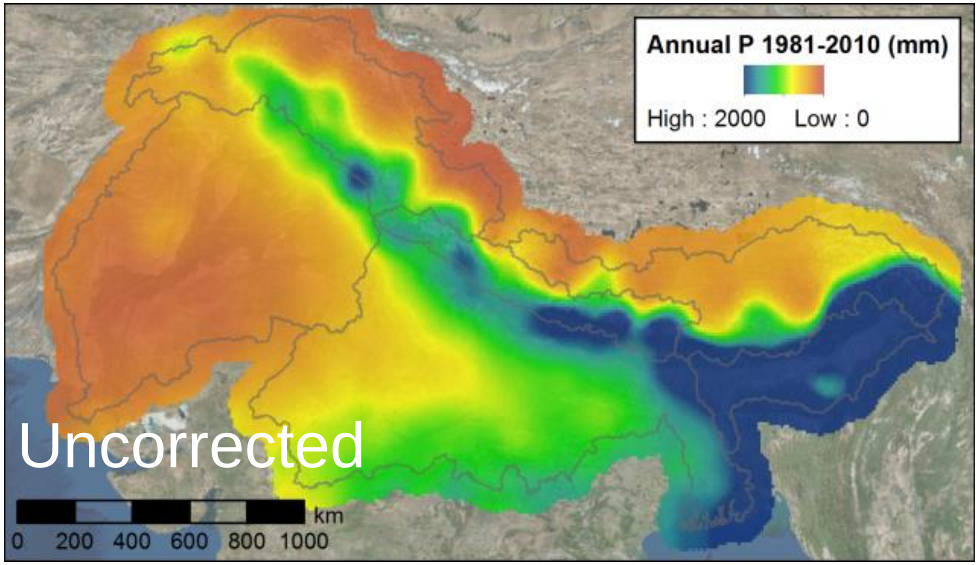
Climate Modelling

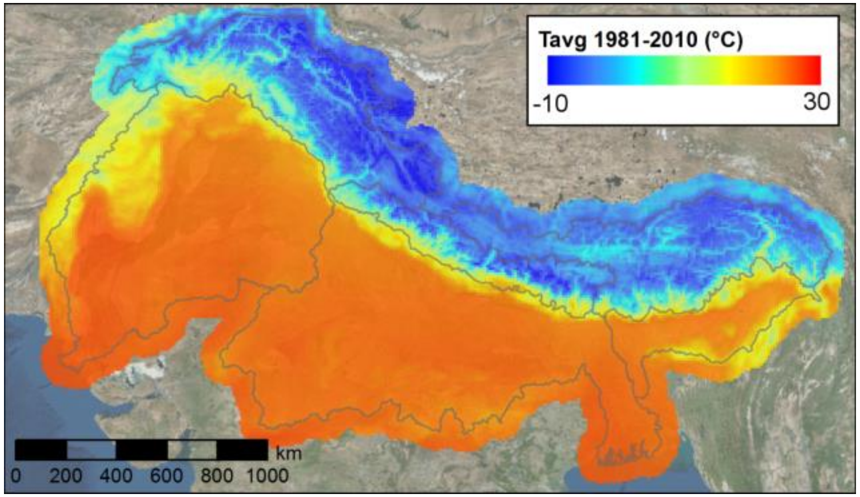
- Historical climate data sets (1981-2010) of P, T
- Development of Future scenarios (2010-2100) based on Daily,
  - Precipitation, T, ETref
  - Entire IGB at 10x10 km resolution
  - Upstream IGB at 5x5 km resolution
- 2 RCPs x 4 GCMs = 8 scenarios, covering broad range of projected changes in climate
  - RCP4.5: T increase of 1.7 to 3.5 oC (2071 to 2100 vs 1971 to 2000)
  - RCP8.5: temp increase of 3.6 to 6.3 oC (2071 to 2100 vs 1971 to 2000)

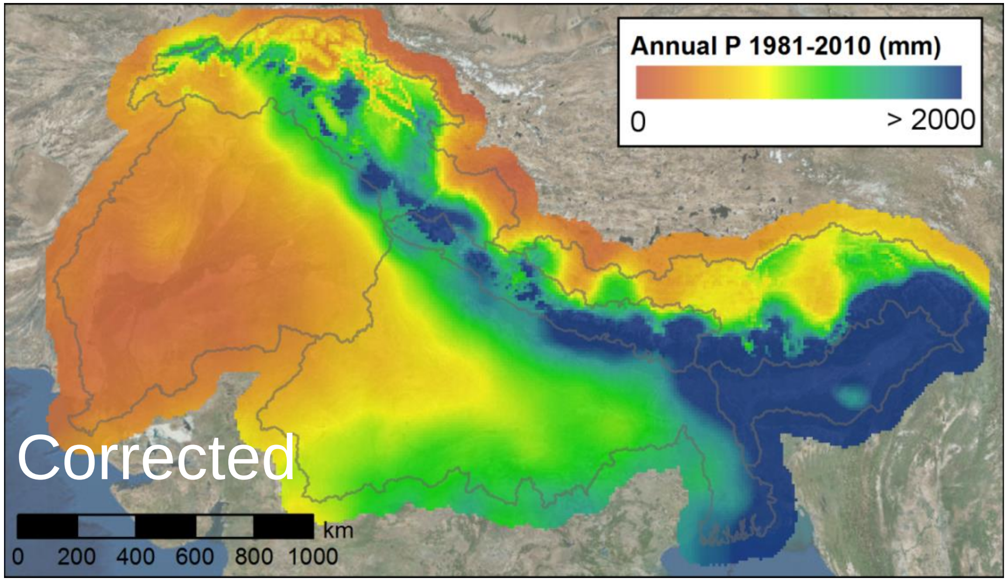
High-resolution historical climate dataset

Dataset properties

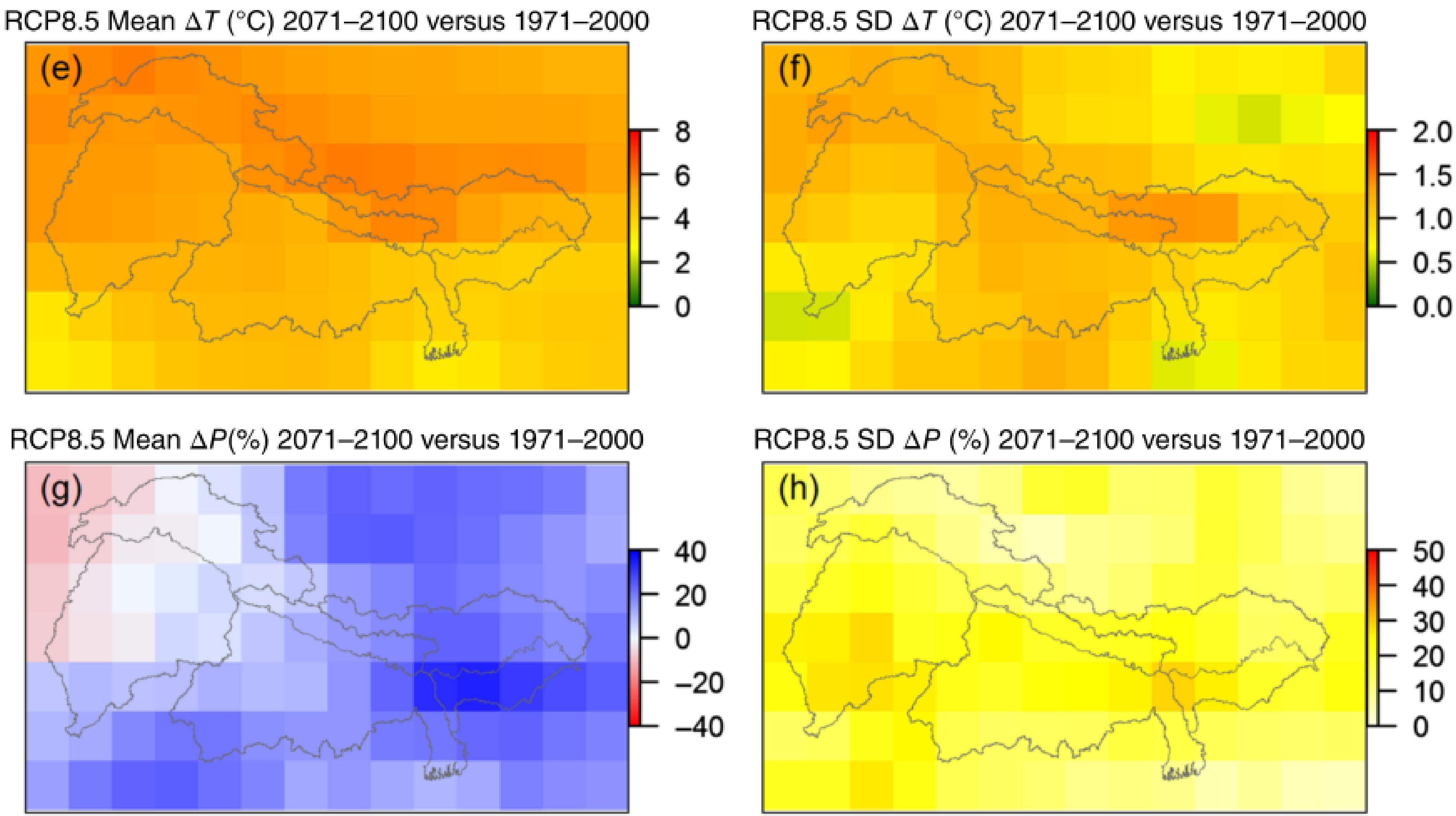
- 1981-2010, daily P, Tavg, Tmax, Tmin, ETref
- 5x5 km for upstream IGB
- 10x10 km for total IGB



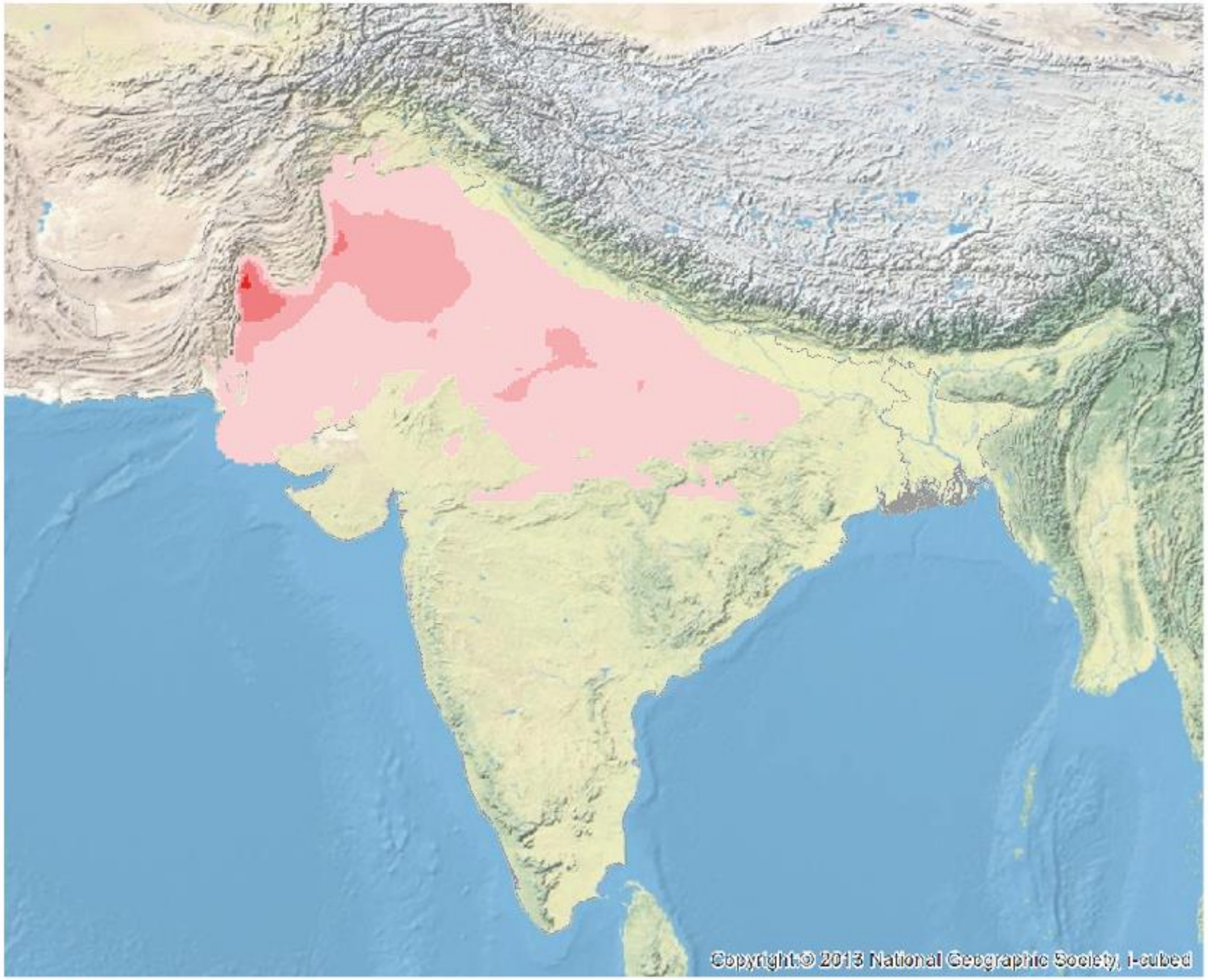




Climate modeling



Floods | Drought | Heat



Number of days with minimum temperature > 30 °C

< 1	10 - 20	30 - 45	> 60
1 - 10	20 - 30	45 - 60	

Food | Energy | Housing | Health

Background

Background map

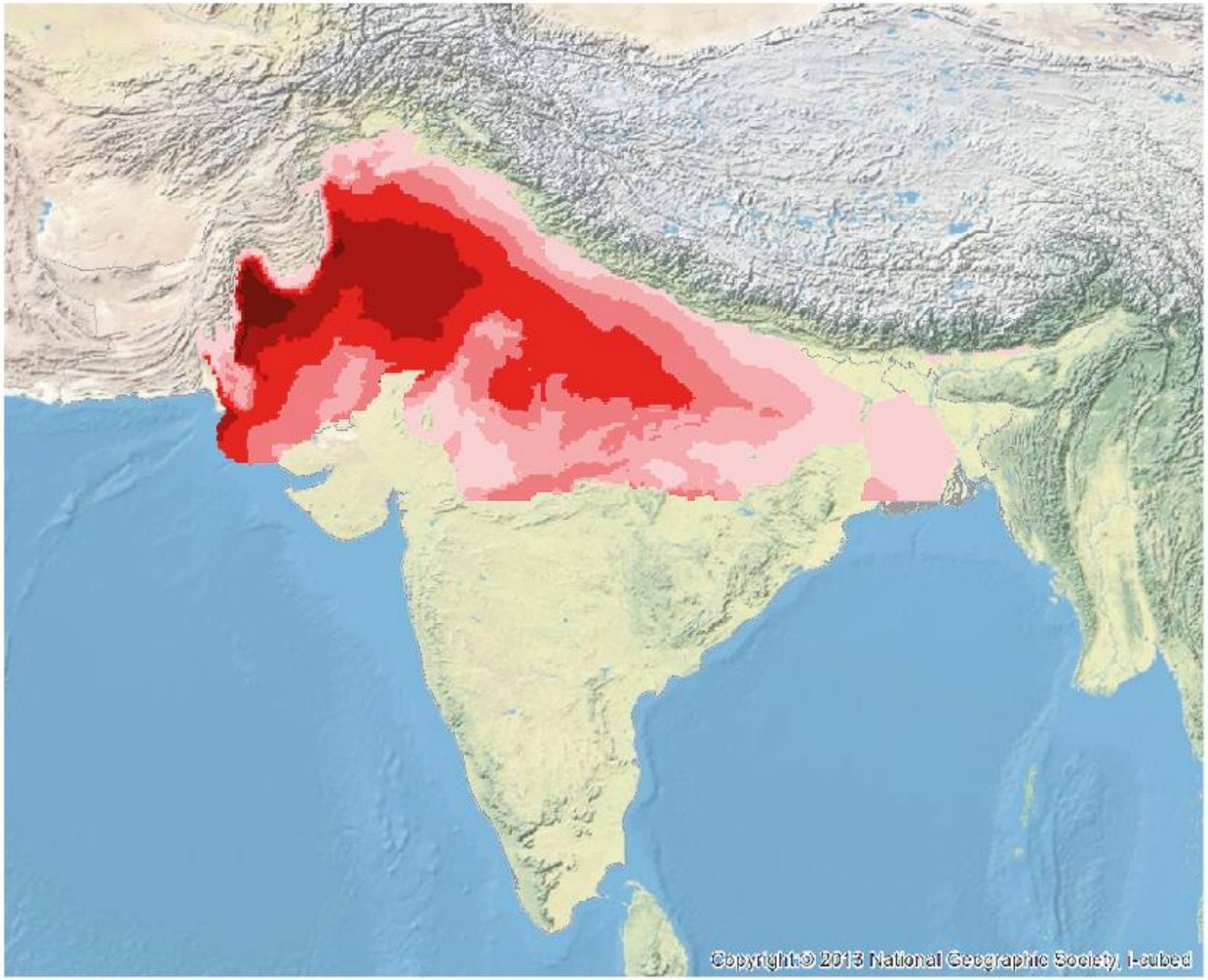
Country borders

Number of days with minimum temperature > 30 °C

Current climate | RCP 4.5 2050 | RCP 8.5 2050

Number of days with maximum temperature > 45 °C

Floods | Drought | **Heat** | Food | Energy | Housing | **Health**



Number of days with minimum temperature > 30 °C

- < 1
- 1 - 10
- 10 - 20
- 20 - 30
- 30 - 45
- 45 - 60
- > 60

Background

Background map

Country borders

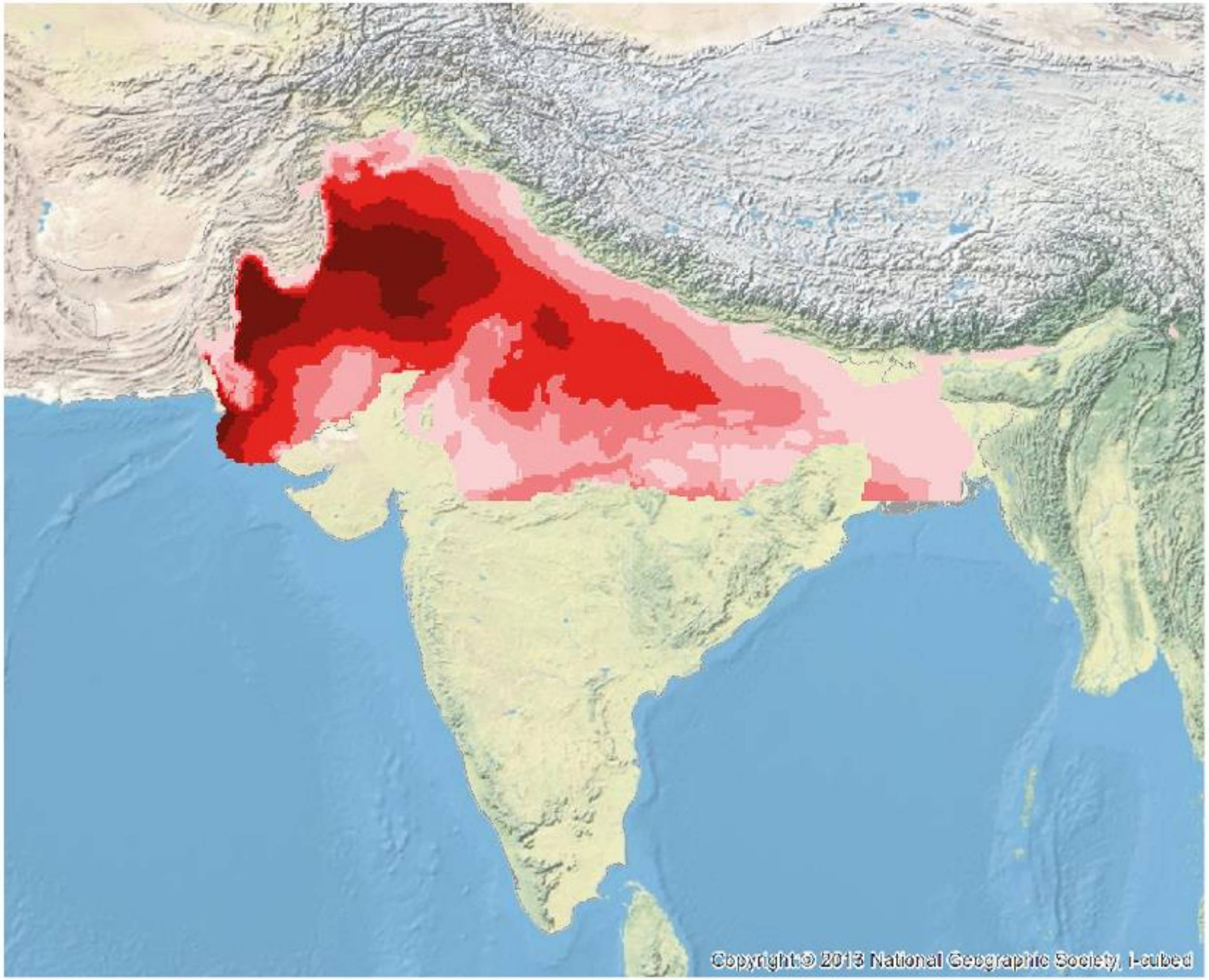
Number of days with minimum temperature > 30 °C

Current climate | RCP 4.5 2050 | RCP 8.5 2050

Number of days with maximum temperature > 45 °C

Floods | Drought | **Heat**

Food | Energy | Housing | **Health**



Number of days with minimum temperature > 30 °C

- < 1
- 1 - 10
- 10 - 20
- 20 - 30
- 30 - 45
- 45 - 60
- > 60

Background

Background map

Country borders

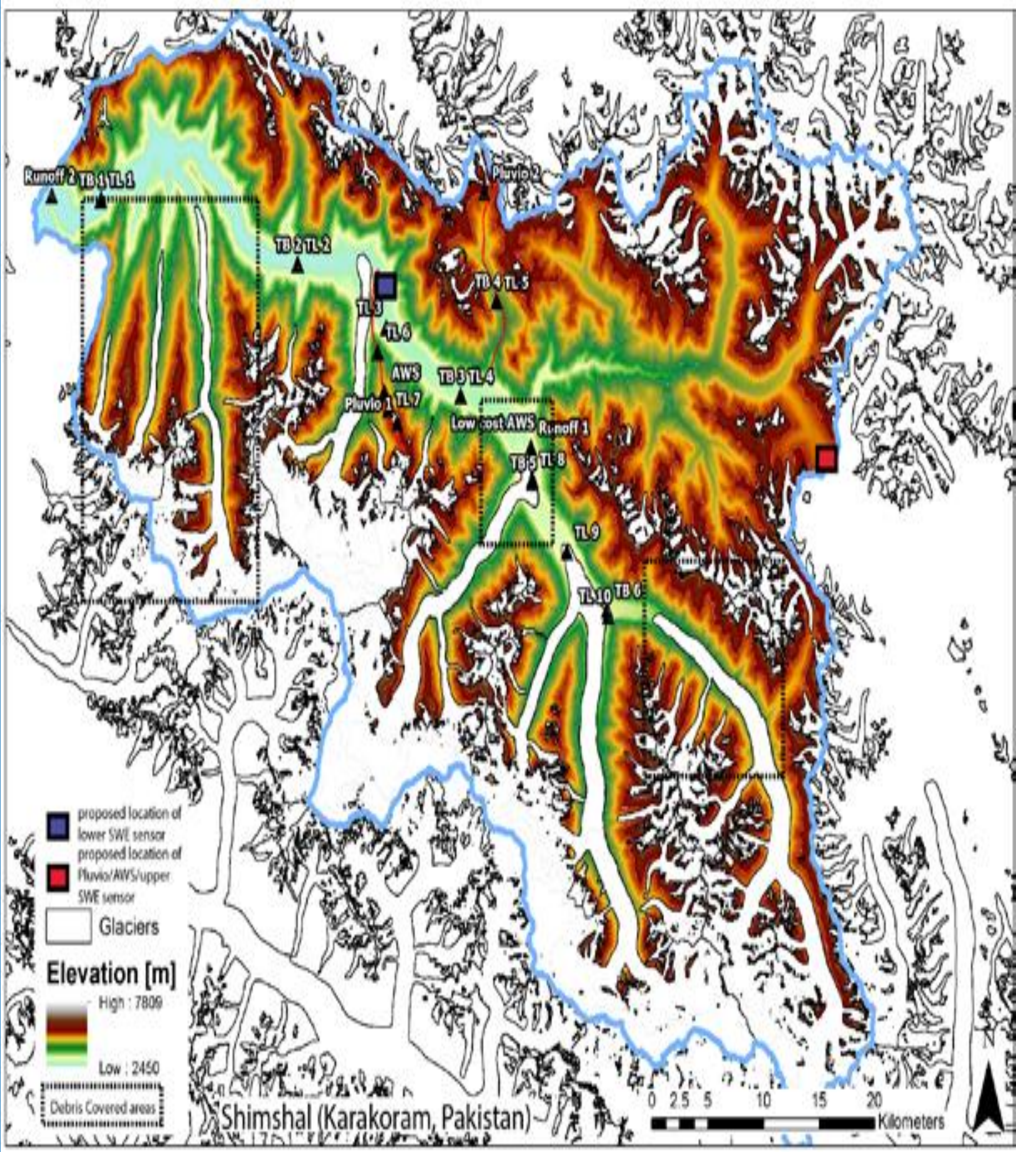
Number of days with minimum temperature > 30 °C

Current climate | RCP 4.5 2050 | RCP 8.5 2050

Number of days with maximum temperature > 45 °C

Cryosphere Monitoring Network (Hydro-meteorological equipment) in Shimshal Valley to address Karakoram Anomaly

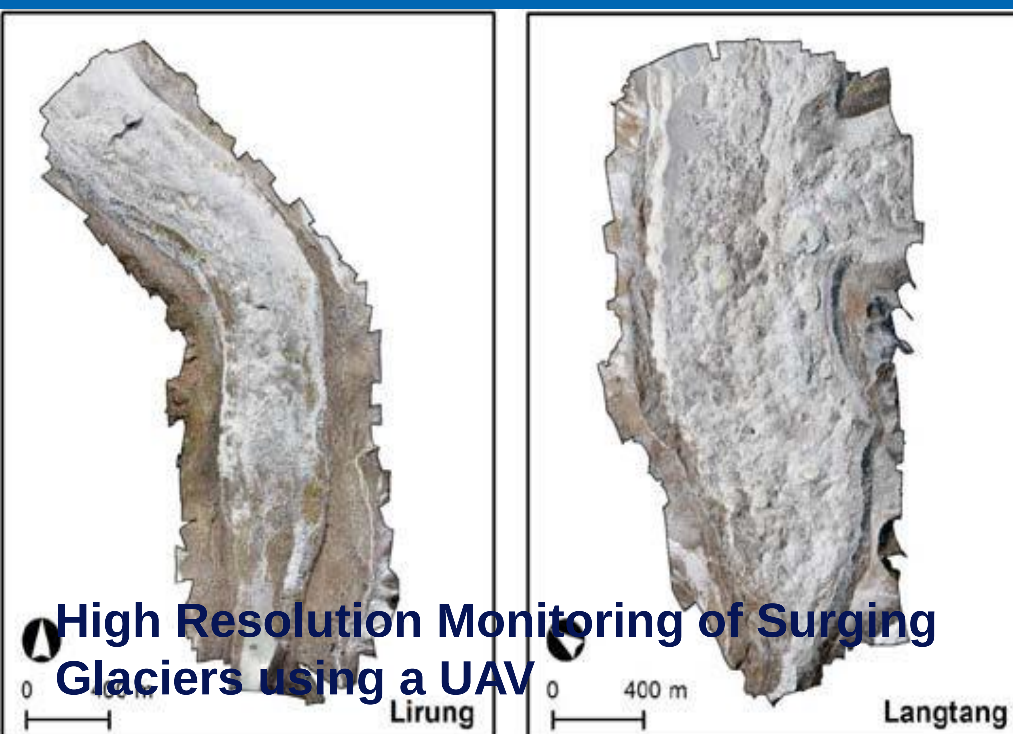
- **Automatic Weather Station (AWS) above 5000 m.a.s.l. (04 No.)**
- **Pluvio Rain Gauge System (10 NOS.)**
- **Temperature Loggers (20 NOS.)**
- **Tipping Bucket Rain Gauges (06 NOS.)**
- **Water Level Sensors (04 NOS.)**



PARC, PMD, ICIMOD, Future Water

Pluvio Meter for a High Altitude Site

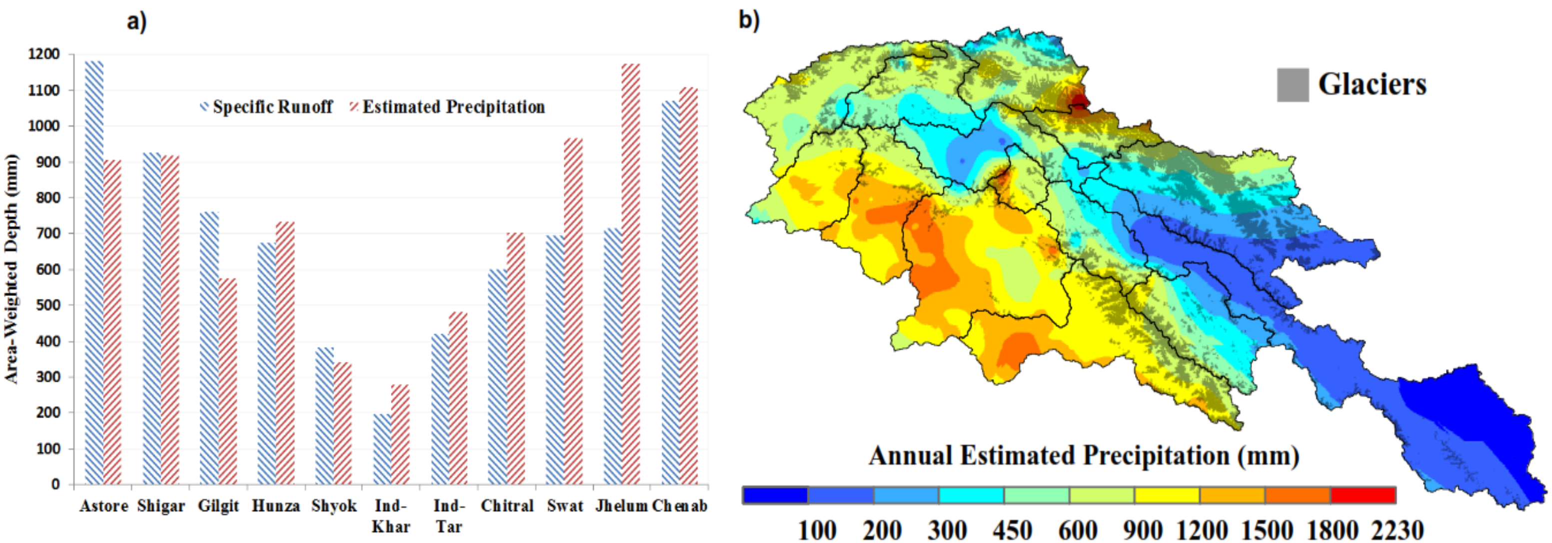
Automatic Weather Station



High Resolution Monitoring of Surging Glaciers using a UAV

Snow Water Equivalent Sensors

Correction of precipitation distribution in the high-altitude catchments of the Indus basin



To analyze altitudinal dependency of precipitation in the high-altitude Indus, basin (KED) interpolation scheme with elevation as a predictor to appraise spatiotemporal distribution of mean monthly, seasonal and annual precipitation for the period of 1998–2012 has been used

Validation of Kriging with External Drift (KED) interpolation scheme based estimated precipitation a) with specific runoff, b) with glacier cover

Zakir, Bashir & Edyy (2016). Journal of Science of the Total Environment. Impact factor 5.9

An appraisal of precipitation distribution in the high-altitude catchments of the Indus basin

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River Basin	Pre-monsoon				Monsoon				Winter				Annual			
	ERAI	WEI	TRM	APH	ERAI	WEI	TRM	APH	ERAI	WEI	TRM	APH	ERAI	WEI	TRM	APH
Indus-U	0.21	0.37	0.52	0.86	0.36	0.57	0.63	0.96	0.47	0.35	0.59	1.05	0.32	0.45	0.59	0.95
Zanskar	0.33	0.89	1.01	1.70	0.61	0.84	0.83	1.80	0.66	1.53	1.72	2.81	0.59	1.23	1.30	2.41
Shingo	0.46	1.18	1.11	1.84	0.53	0.79	0.80	1.67	0.60	1.53	1.97	3.02	0.56	1.26	1.35	2.41
Indus-Khar	0.27	0.60	0.71	1.19	0.44	0.66	0.70	1.25	0.53	0.78	1.04	1.72	0.42	0.74	0.86	1.49
Shyok	0.49	1.22	1.35	1.73	0.84	8.74	1.45	2.32	1.08	1.03	2.38	2.61	0.82	1.53	1.75	2.41
Shigar	1.12	2.55	3.29	2.57	1.38	7.67	1.56	3.35	1.81	2.61	4.52	6.30	1.53	2.93	3.17	4.23
Hunza	0.77	2.06	2.27	2.77	1.07	9.75	1.62	3.87	1.12	1.60	2.33	5.49	1.04	2.29	2.11	4.23
Gilgit	0.42	1.16	1.58	1.22	0.74	2.11	1.46	2.72	0.48	0.88	2.23	3.23	0.52	1.17	1.79	2.22
Astore	0.65	1.85	1.82	1.75	0.57	1.26	1.17	2.37	0.84	2.08	3.22	4.11	0.74	1.86	2.07	2.82
Indus-M	0.45	1.24	1.70	1.33	0.42	1.05	0.92	1.93	0.38	0.85	1.82	2.21	0.40	0.99	1.43	1.73
Indus-L	0.77	1.09	1.32	1.11	0.51	1.03	1.01	1.11	0.92	1.51	2.01	1.80	0.71	1.27	1.47	1.37
Indus-Tar	0.47	1.09	1.30	1.50	0.64	3.43	1.07	1.94	0.76	1.08	1.84	2.60	0.63	1.24	1.43	2.09
Chitral	0.50	1.03	1.73	1.27	0.96	1.42	1.56	2.47	0.72	1.09	4.44	2.98	0.69	1.10	1.88	2.14
Swat	0.70	1.03	1.28	1.11	0.39	0.88	0.93	1.02	0.86	1.38	1.43	1.36	0.62	1.18	1.27	1.22
Jhelum	0.91	1.56	1.32	1.54	0.68	0.98	0.96	1.41	0.87	1.90	1.51	1.80	0.82	1.51	1.27	1.63
Chenab	0.84	1.70	1.47	1.83	0.80	1.05	0.76	1.35	0.87	2.58	1.75	2.11	0.89	1.77	1.28	1.84

Basin-wide, seasonal and annual correction factors for each gridded precipitation product

Crop-specific seasonal estimates of irrigation water demand in South Asia

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Input	Processes	Output

Input

- Climate parameters (Temp, Precipitation and Radiation)
- Soil & land use data
- CO_2, country specific efficiencies

Processes

Bio-Physical processes
Phenology, AET Interception, Soil water & Temperature, Irrigation water, Photo synthesis

Output

- Potential / actual crop and grass yield/ production
- Crop irrigation water demand
- Irrigation water supply, Irrigation water consumption
- Rain water consumption

Hester Biemans, Bashir Ahmad, Christian Siderius (2016). Hydrol. Earth Syst. Sci.
JPLmL Model

Net (consumption) vs. gross (withdrawal) irrigation water demand in billion m^3 for South Asian countries

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	Net irrigation demand (consumption)				Other estimat	Percentage groundwater irrigation					Gross irrigation demand (withdrawal)				Other estimates
	Kharif (M6–10)	Rabi (M11–3)	Summer (M4–5)	Total	Total	Kharif (M6–10)	Rabi (M11–3)	Summer (M4–5)	Total		Kharif (M6–10)	Rabi (M11–3)	Summer (M4–5)	Total	Total
Nepal	0.1	1.0	0.2	1.4		19%	62%	34%	54%		0.3	2.0	0.5	2.7	10[e]
Pakistan	38	42	16	96	117[d]	25%	68%	25%	44%		110	86	47	243	200.2[h], 162.7[b], 117–120[c], 187.8[g]
India	59	14	31	235	317[d]	27%	79%	63%	64%		136	249	58	443	575.9[h], 54[f], 558.4[b], 710–715[i]
Bangladesh	0.1	11	0.3	12		10%	43%	2%	41%		0.2	24	0.8	25	3[e]
South Asia	97	202	48	346		26%	74%	50%	58%	247	361	106	714	985	

Crop specific periods of peak water demand forming Critical Moments

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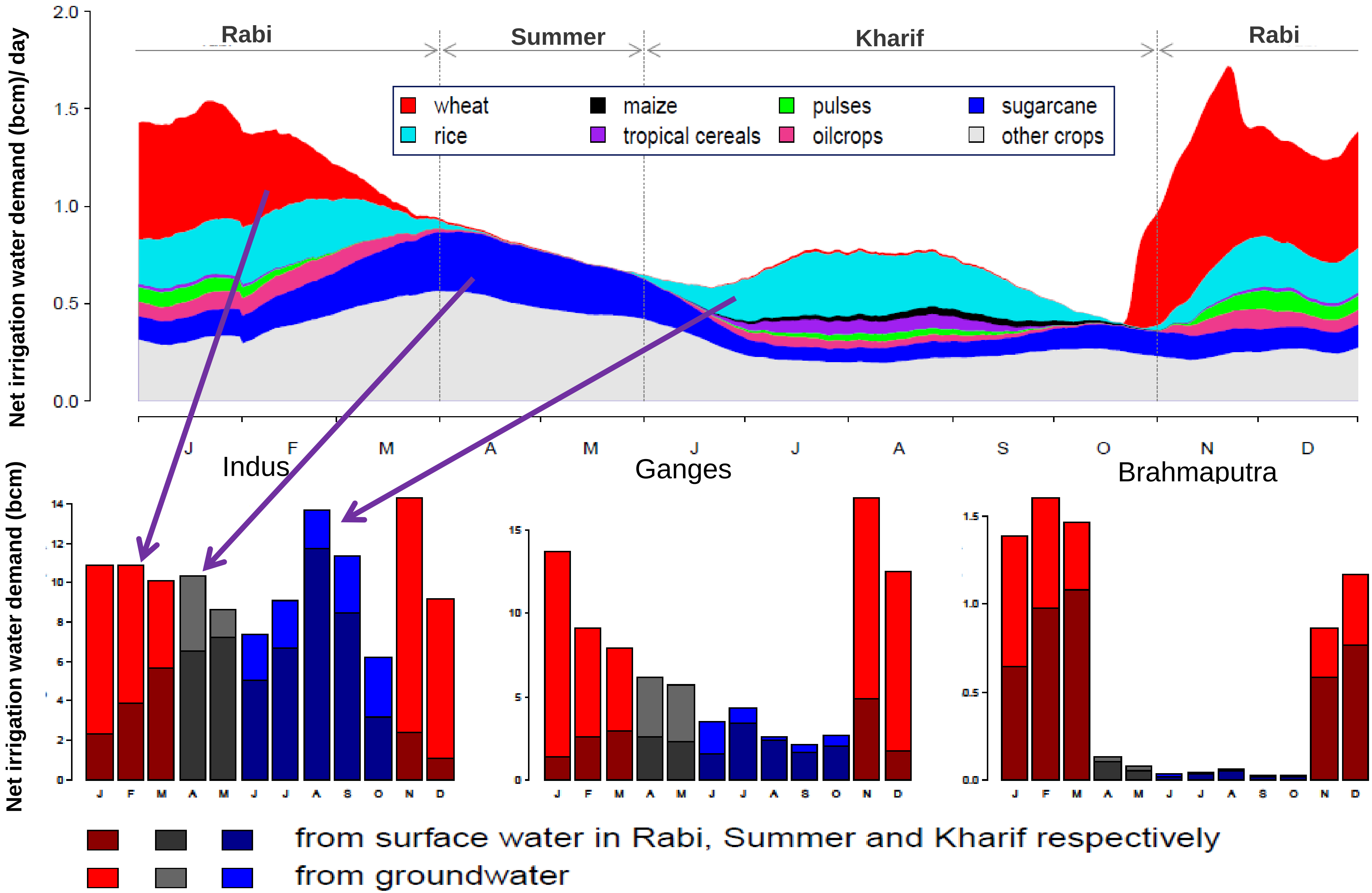

RC3: Assessment of climate change adaptation measures

- Develop robust evidence on the effectiveness and applicability of adaptation practices and policies against region-specific critical moments in the four sectors.
- Develop new approaches to conduct inclusive socio-economic cost-benefit analysis of adaptation practices and policies such as the Marginal Cost Method.
- Developing demonstration and piloting sites in the study basin for demonstration of climate smart interventions

Glacier and Snow-fed Irrigation Systems

- Melt – Water from snow and glaciers is the only mechanism for irrigation in most Upper Indus Basin
- Glacier and snow-fed irrigation systems support the food security and livelihoods of the majority of the people living in the high altitude areas
- This study has been designed to develop evidence on the Melt-Water irrigation regimes and access gaps that need further Investigation.

Glacier and Snow-fed Irrigation Systems

Major Research Questions

- What is the extent, importance, role, characteristics of melt-water irrigation and its contributions to livelihoods?
- What is the level of well-being trends in terms of gender inclusive socio-economic changes, whether these have been changing since the past decade, and if so what changes have occurred?
- To what extent are people dependent on melt-water irrigation versus other sources of livelihoods, and how has this been changing over the past decade?
- What issues need further investigation, which will act as a basis for designing 2017 research program?
- What is the interest of community in collaborative action research?

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Adaptive Water Governance in Himalayan Towns

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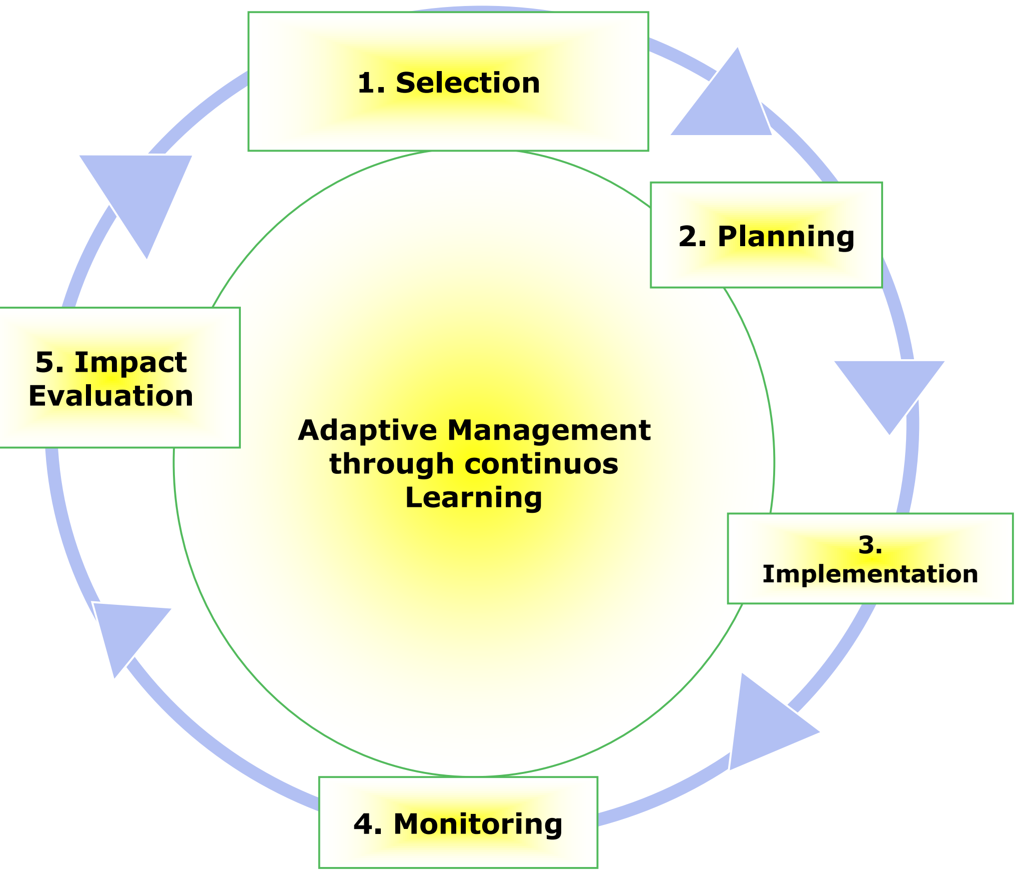
Introduction

- Study to identify the issues of urbanization and climate change in the Himalayan towns.
- This study is focusing on urban water, its management, its governance and impacts of climate change on urban water
- This study is focusing on emerging urban settlements in Himalayan river basins, such as **“Murree”** in Pakistan

Management of Pilot



1. Selection of Pilots: potential out-scaling and upscaling- clear ToC

2. Planning Stage:

- Stakeholder Led Planning
- Good Baseline for M&E
- Participatory M&E.

3. Implementation of Pilots

- Consultation with communities & government, CBOs and NGOs.

4. **Monitoring & Evaluation**

- PM&E
- Reporting
- Lessons Learnt

5. Impact Evaluation

- Rigorous impact evaluation to see viability, out scaling and potential for upscaling and policy uptake

Quality Evaluation Processes

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The objective is to be confident on attributing the change to the intervention with robust evidence

- Setting up before and after & Comparison Group
  - Socio-economic data collection
  - Bio-physical and climate data
  - Visual documentary and stories

Through scientific statistical techniques

- Continuous Participatory Monitoring-
  - Lessons Learnt and Course Correction
  - In Certain cases midline survey
- Evaluation

Through Qualitative Participatory Techniques

- Evaluation (continued)
  - Programme Management Evaluation
  - Programme Impact Evaluation
  - Assessment of expected outcomes,
  - viability and relevance for outscaling and upscaling'

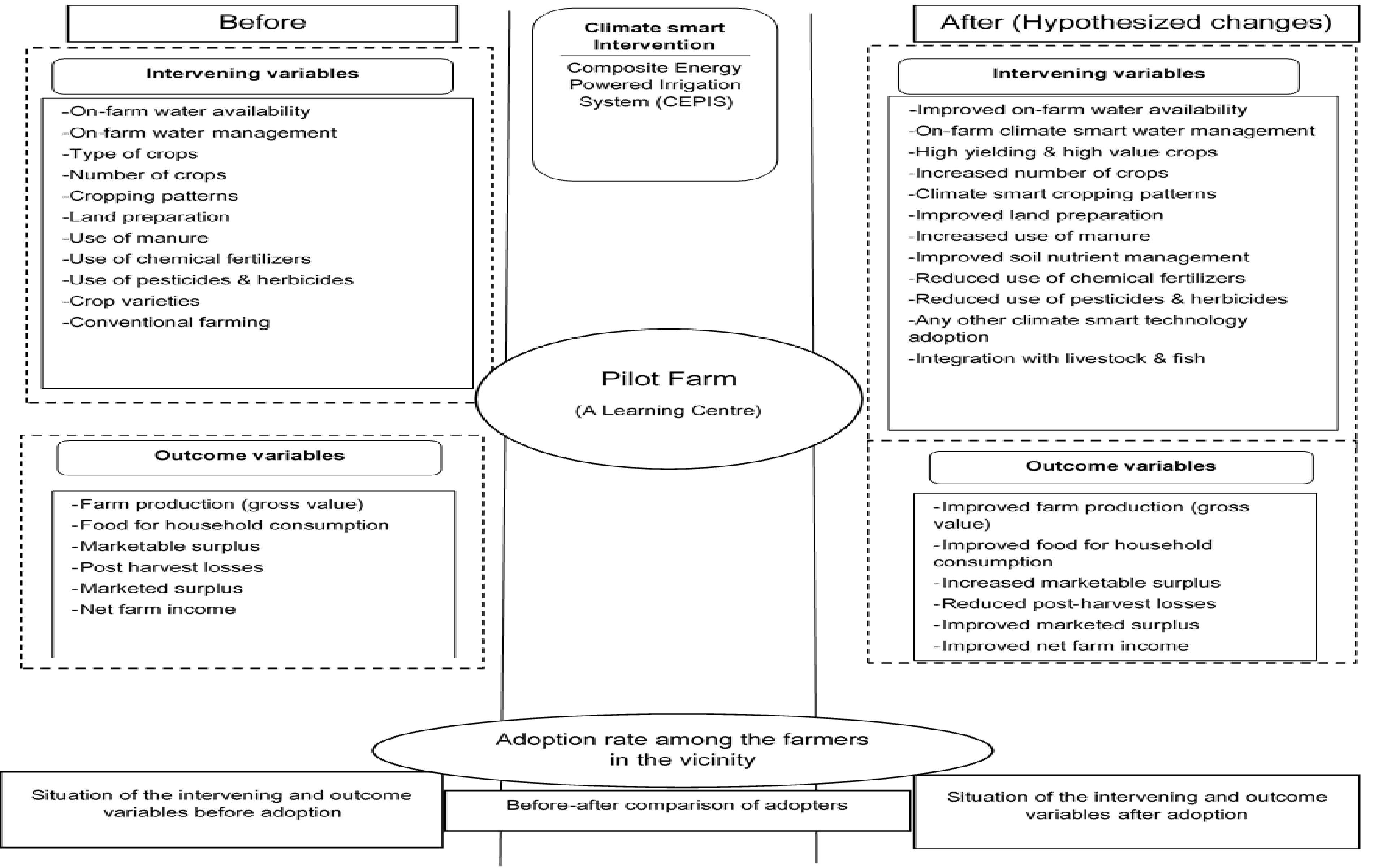
Through scientific statistical techniques

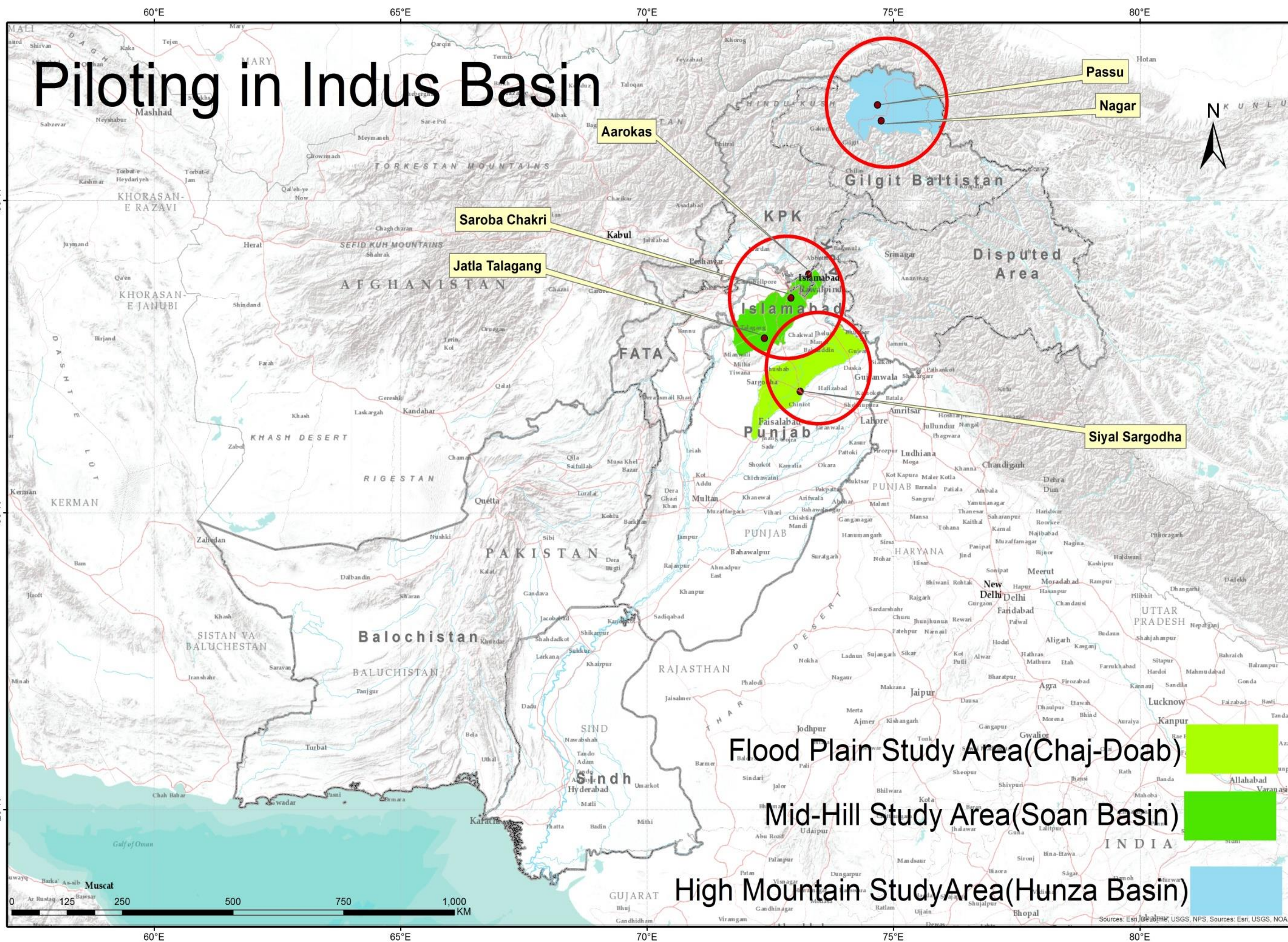
- Communication & Reporting
  - Policy Recommendations
  - Outscaling and Upscaling Strategies
  - Final Pilot Project Report

Outscaling and Upscaling Strategies

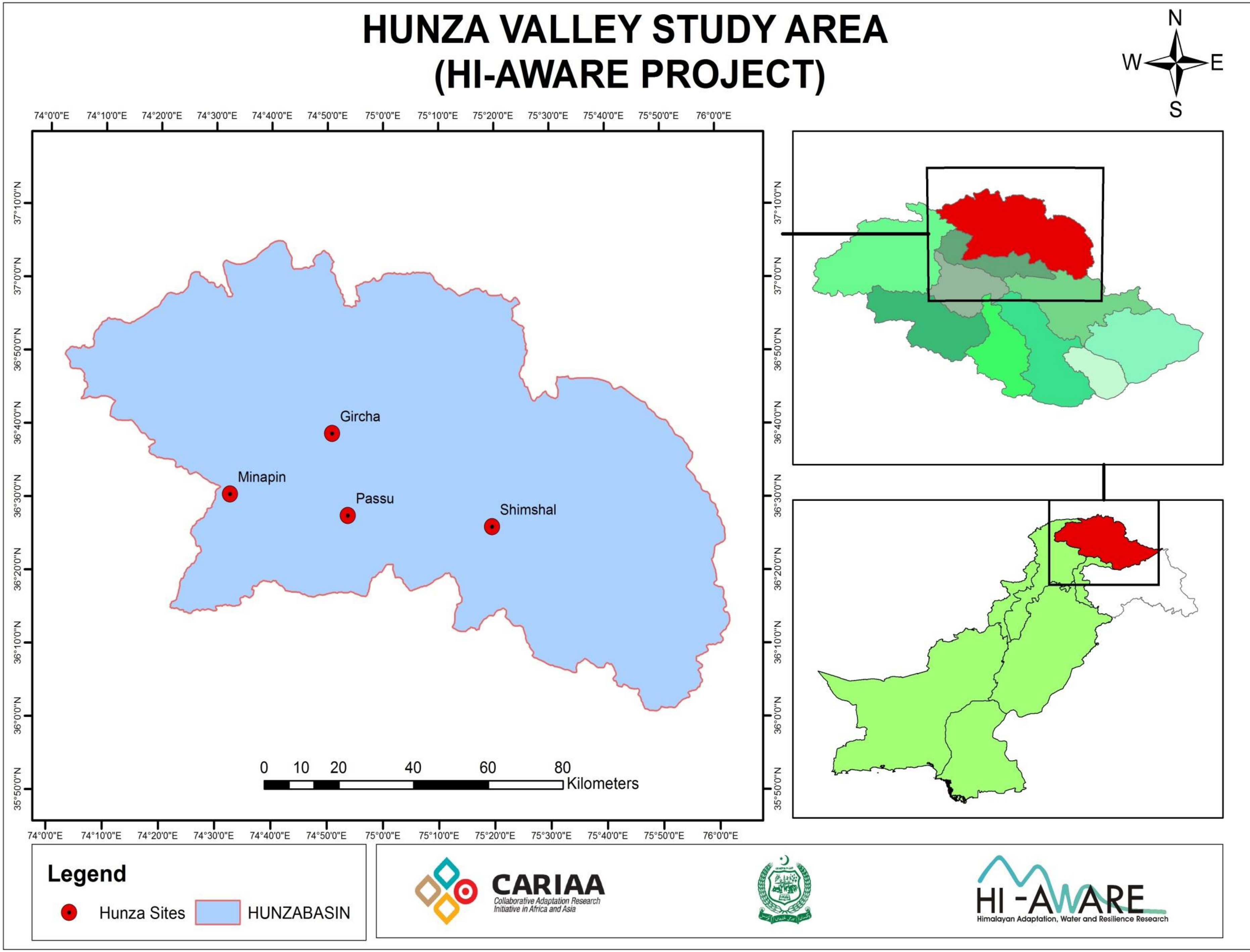



Example of the design- Chakri, Pakistan





Piloting in Indus Basin
Passu
Nagar
Aarokas
Saroba Chakri
Jatla Talagang
Siyal Sargodha
Gilgit Baltistan
KPK
Islamabad
FATA
Punjab
Balochistan
Sindh
Disputed Area
AFGHANISTAN
PAKISTAN
INDIA
N
Flood Plain Study Area(Chaj-Doab)
Mid-Hill Study Area(Soan Basin)
High Mountain StudyArea(Hunza Basin)
0 125 250 500 750 1,000 KM
60°E 65°E 70°E 75°E 80°E
35°N 30°N 25°N


HUNZA VALLEY STUDY AREA
(HI-AWARE PROJECT)
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74°0'0"E
74°10'0"E
74°20'0"E
74°30'0"E
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76°0'0"E
37°10'0"N
37°0'0"N
36°50'0"N
36°40'0"N
36°30'0"N
36°20'0"N
36°10'0"N
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Gircha
Minapin
Passu
Shimshal
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20
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Kilometers
Legend
Hunza Sites
HUNZABASIN
CARIAA
Collaborative Adaptation Research Initiative in Africa and Asia
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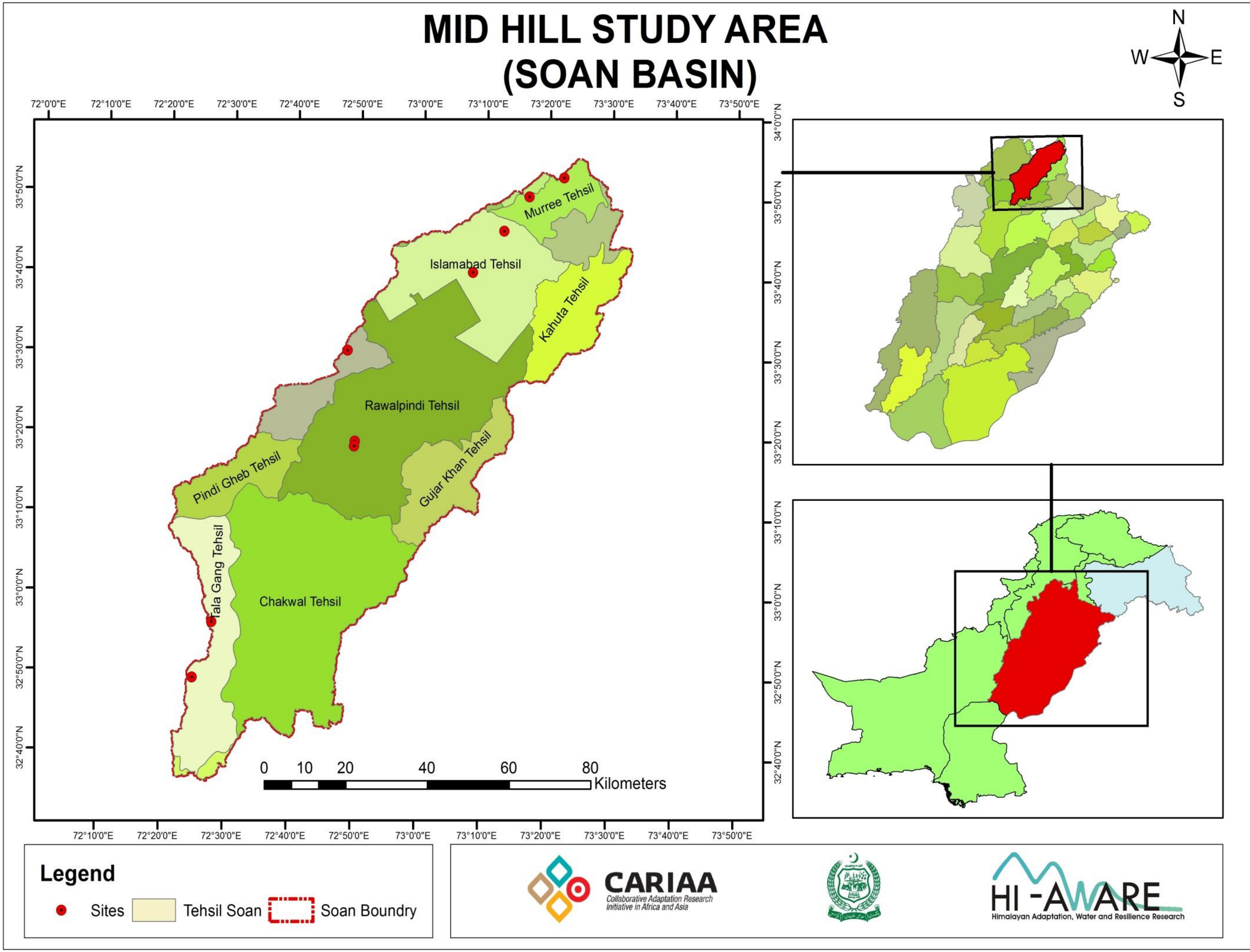
MID HILL STUDY AREA
(SOAN BASIN)
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Murree Tehsil
Islamabad Tehsil
Kahuta Tehsil
Rawalpindi Tehsil
Pindi Gheb Tehsil
Gujar Khan Tehsil
Tala Gang Tehsil
Chakwal Tehsil
0 10 20 40 60 80 Kilometers
Legend
Sites
Tehsil Soan
Soan Boundry
CARIAA
Collaborative Adaptation Research Initiative in Africa and Asia
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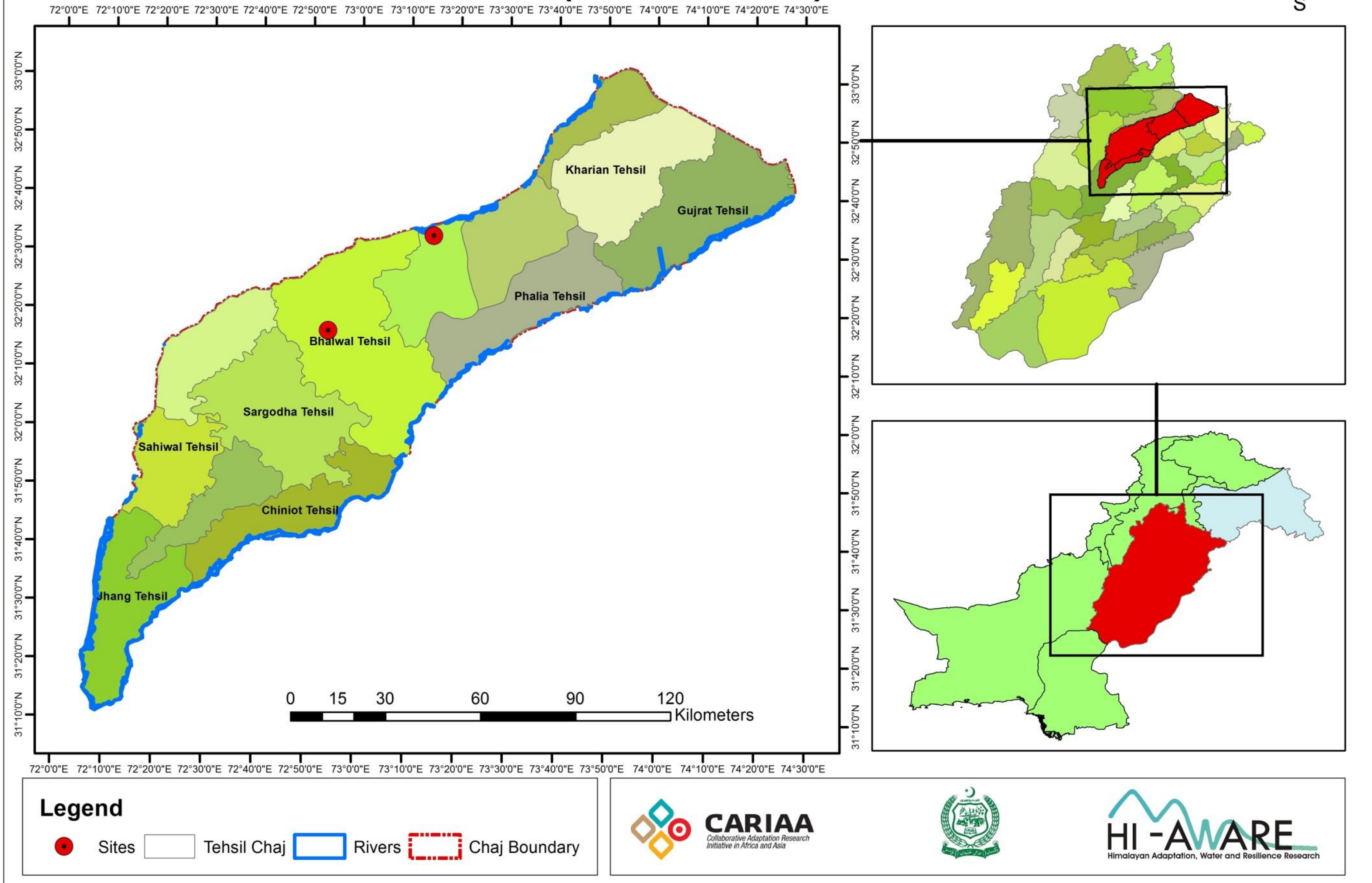
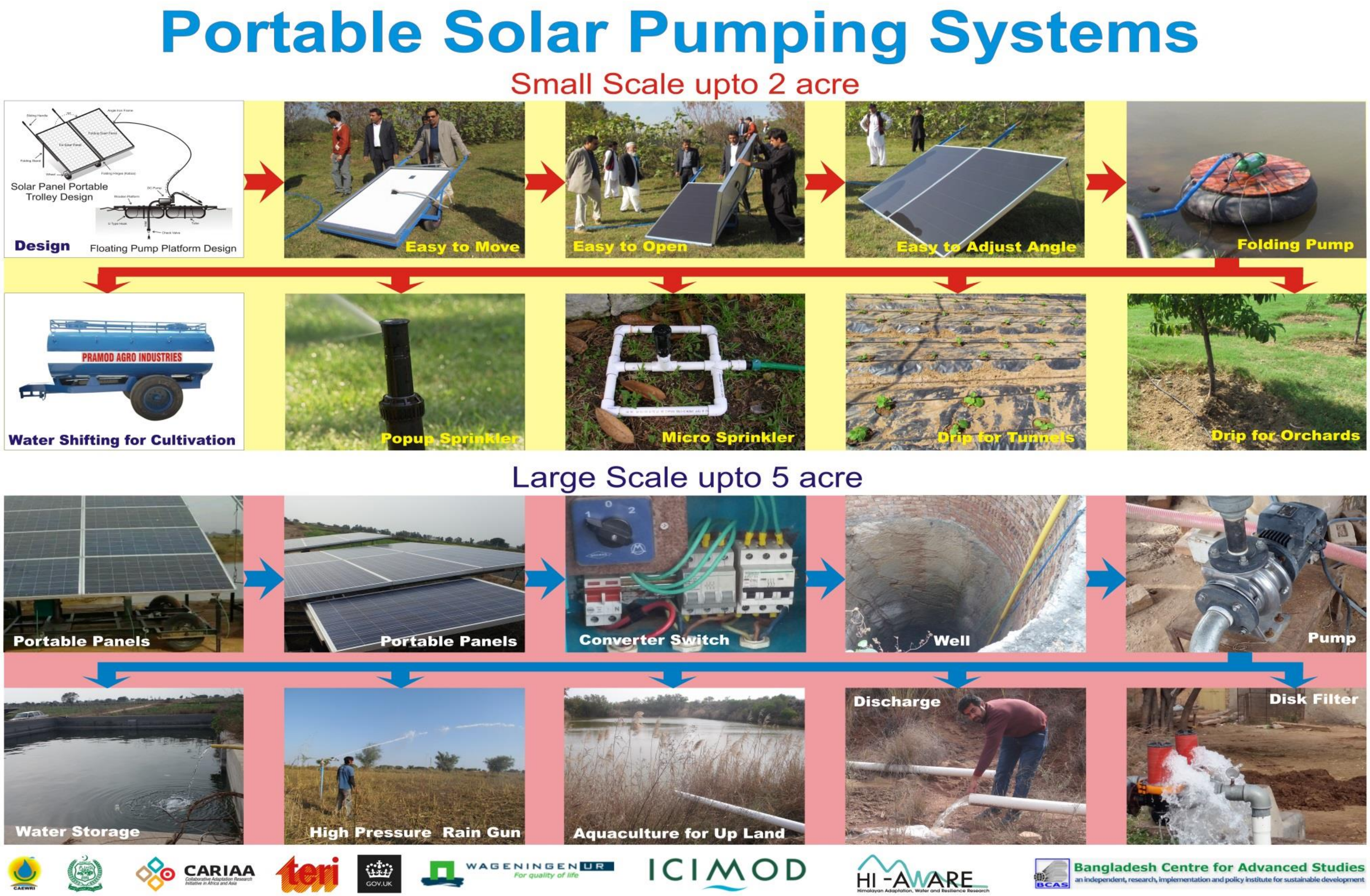
FLOOD PLAIN STUDY AREA (CHAJ DOAB)



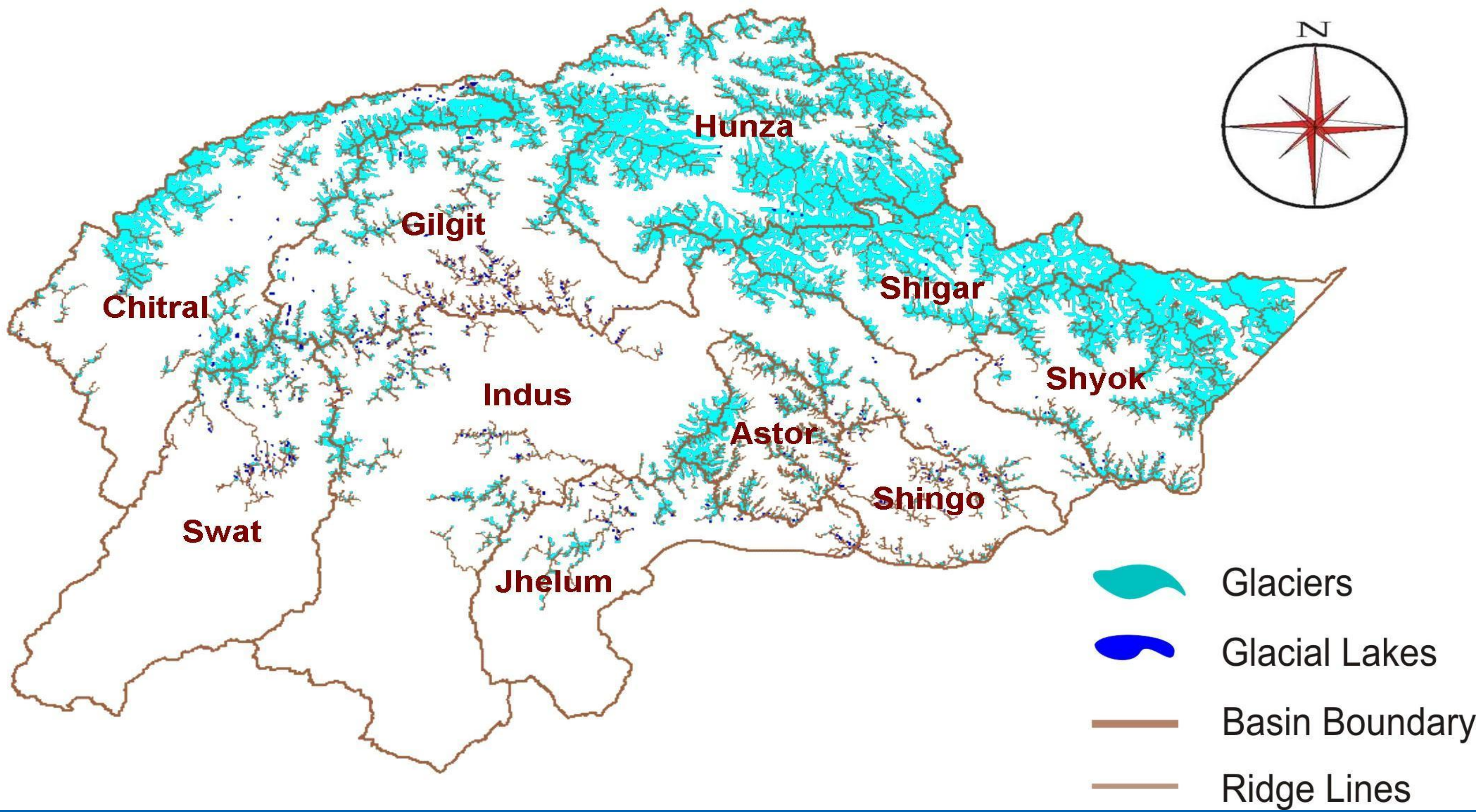
Piloting of various water and energy smart technologies at training site Chakri



Achievements to Date

- Situational Analysis in 03 Study Areas
- External KMC Strategy
- Data Management Policy
- 2 fully supported PhDs in Netherland (1 woman, 1 man)
- 1 partially supported PhD in Germany
- 10 MSc students (3 women)
- 02 high impact factor journal publication
- 3 journal articles
- 3 Working Paper (9 in pipeline)
- 5 stakeholder engagement events
- 3 blogs
- RiU Strategy

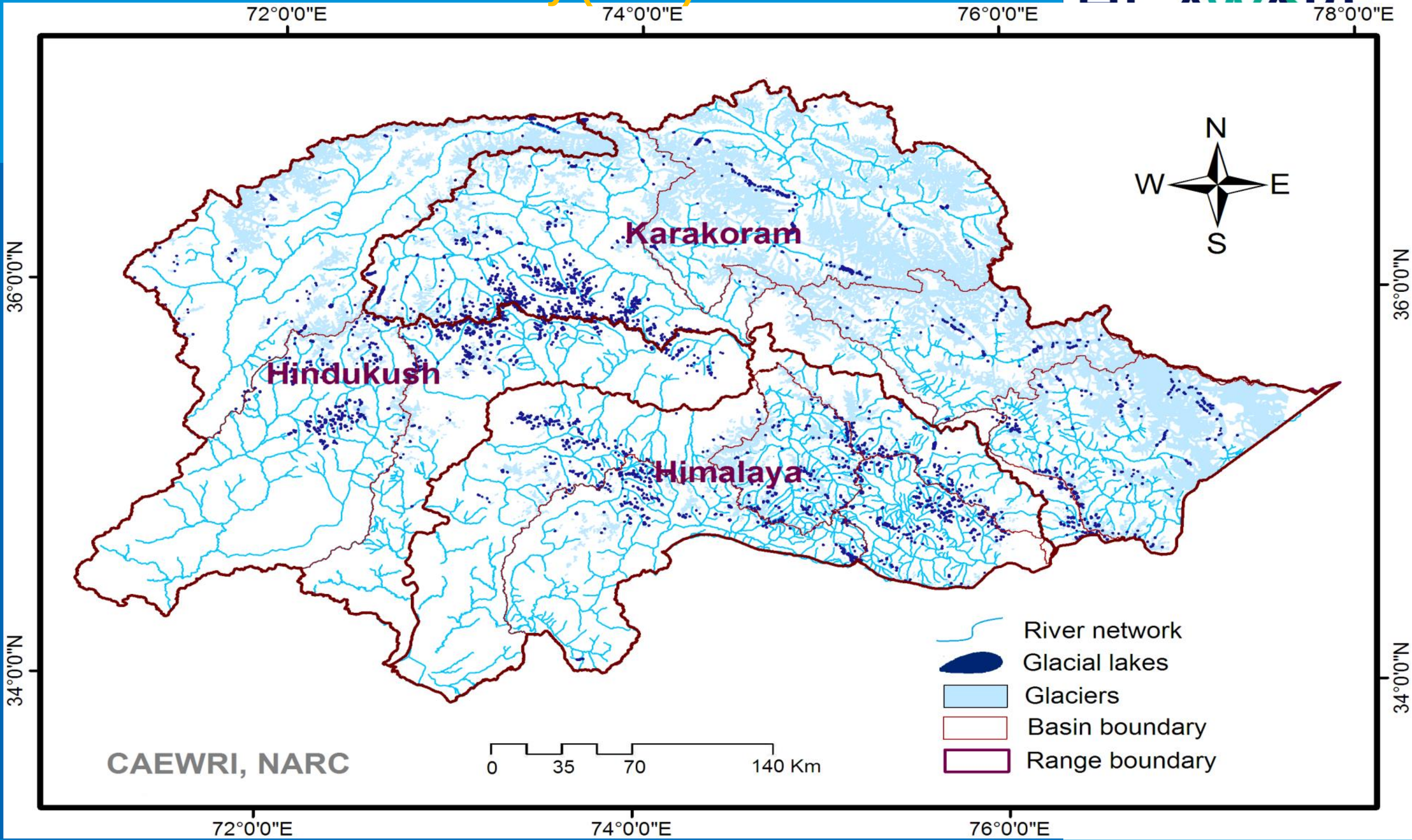
1. Inventory of Glaciers and Lakes of Upper Indus basin (2001)



Total number of Glaciers 5,218
Total glaciated area........ 15041 sq km
Est. Ice Reserves.......... 2,738 cub km

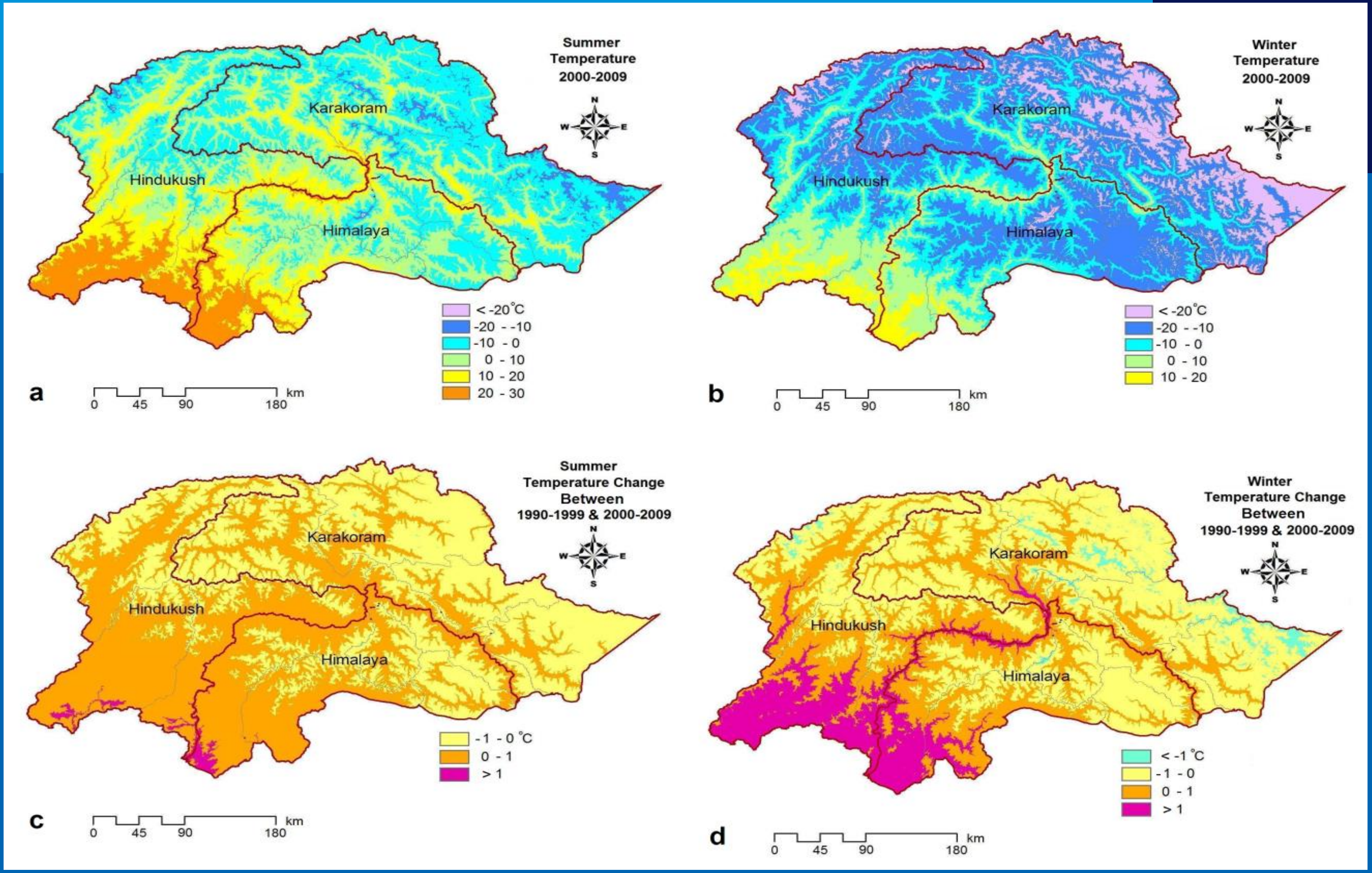
Glacial Lakes... 2,420
Major Lakes… 1,328
Potential D. Lakes.. 52

Updation of glacial lakes and dangerous lakes (GLOF) Inventory (2013)



	Year 2001-02	Year 2013
Glacial Lakes...	2,420	3,044 ↑
Lakes area sq. km	126.5	134.8 ↑
Potential D. Lakes..	52	36

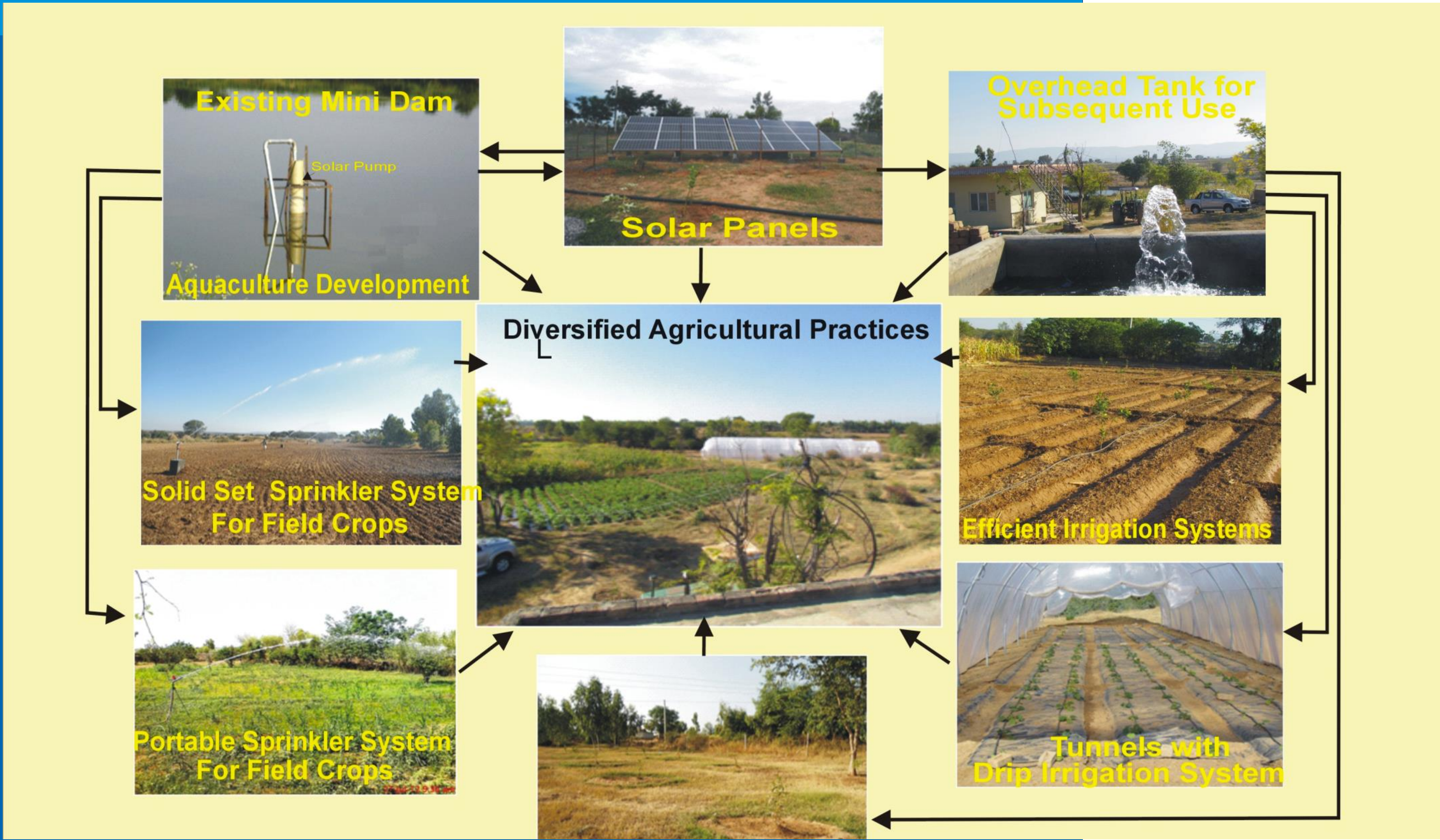
Climate Variability and Change Analysis in Upper Indus basin



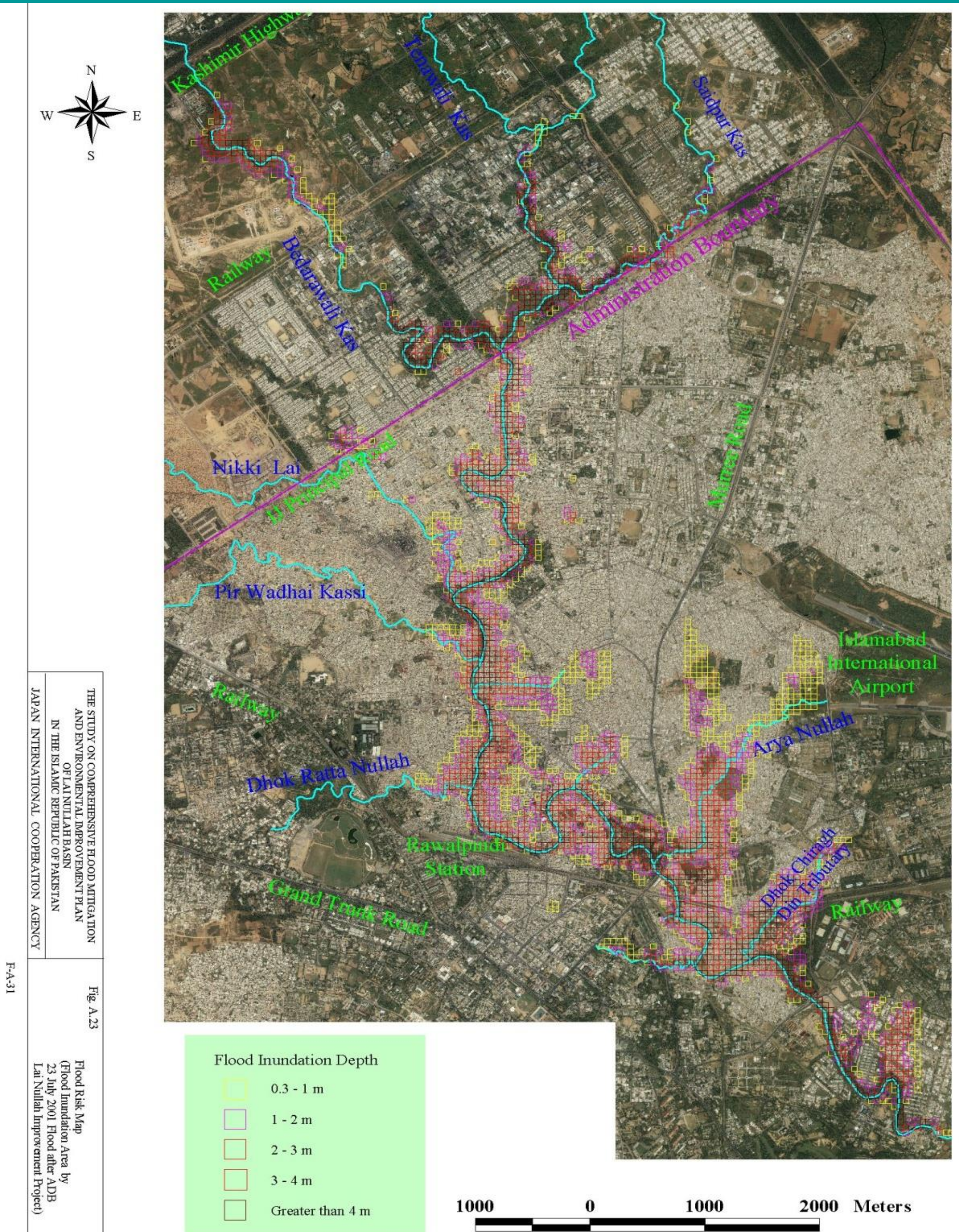
Major parts of the central valleys of UIB (below 3,500 m) are dominated by +10 - +20°C temperature range during summer and by -10 - +10°C range in winter during 2000-2009 period

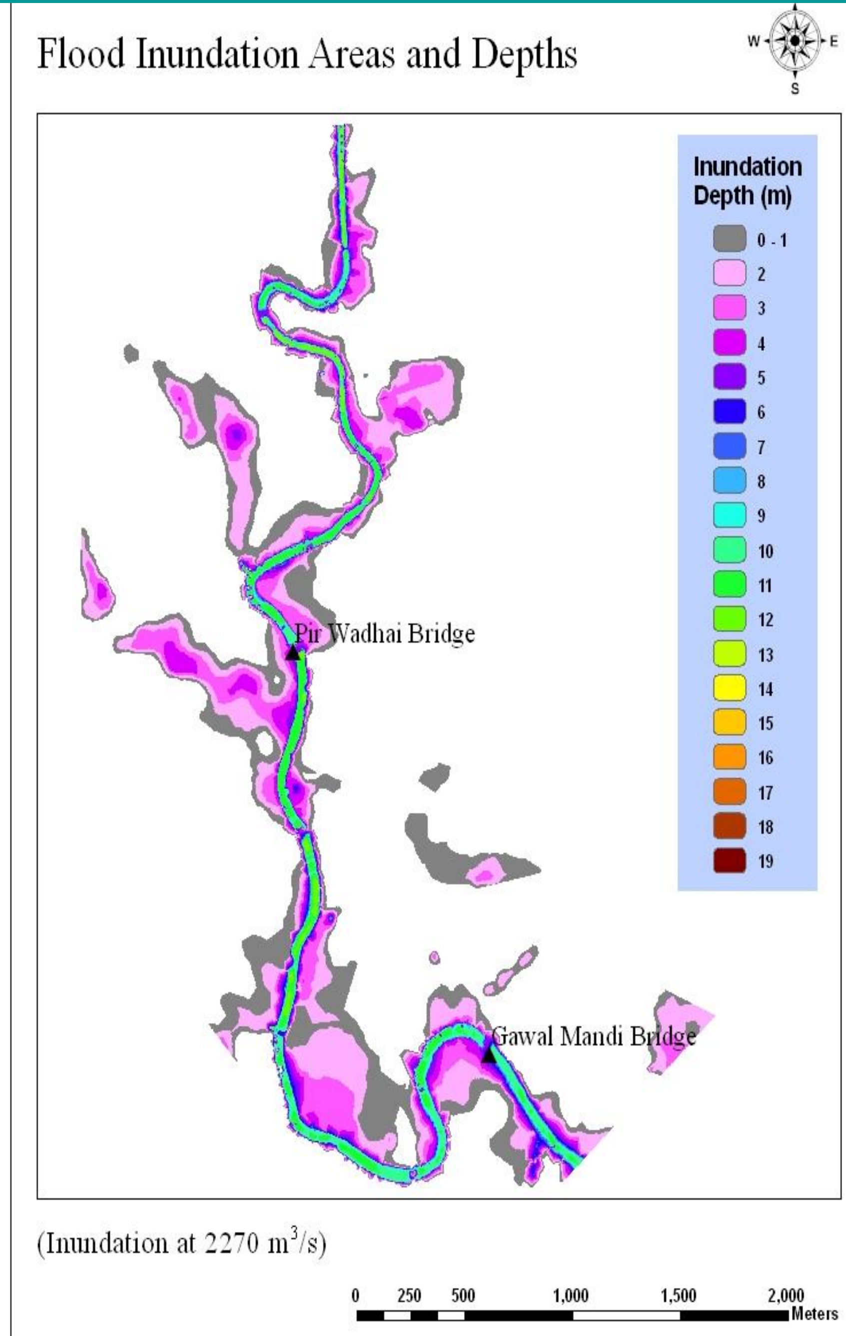
The change in mean maximum temperature was positive in the valleys while it was negative over high mountain ranges during 1990-1999 & 2000-2009 periods.

Climate Smart Food Security Modeat at Fateh Jang

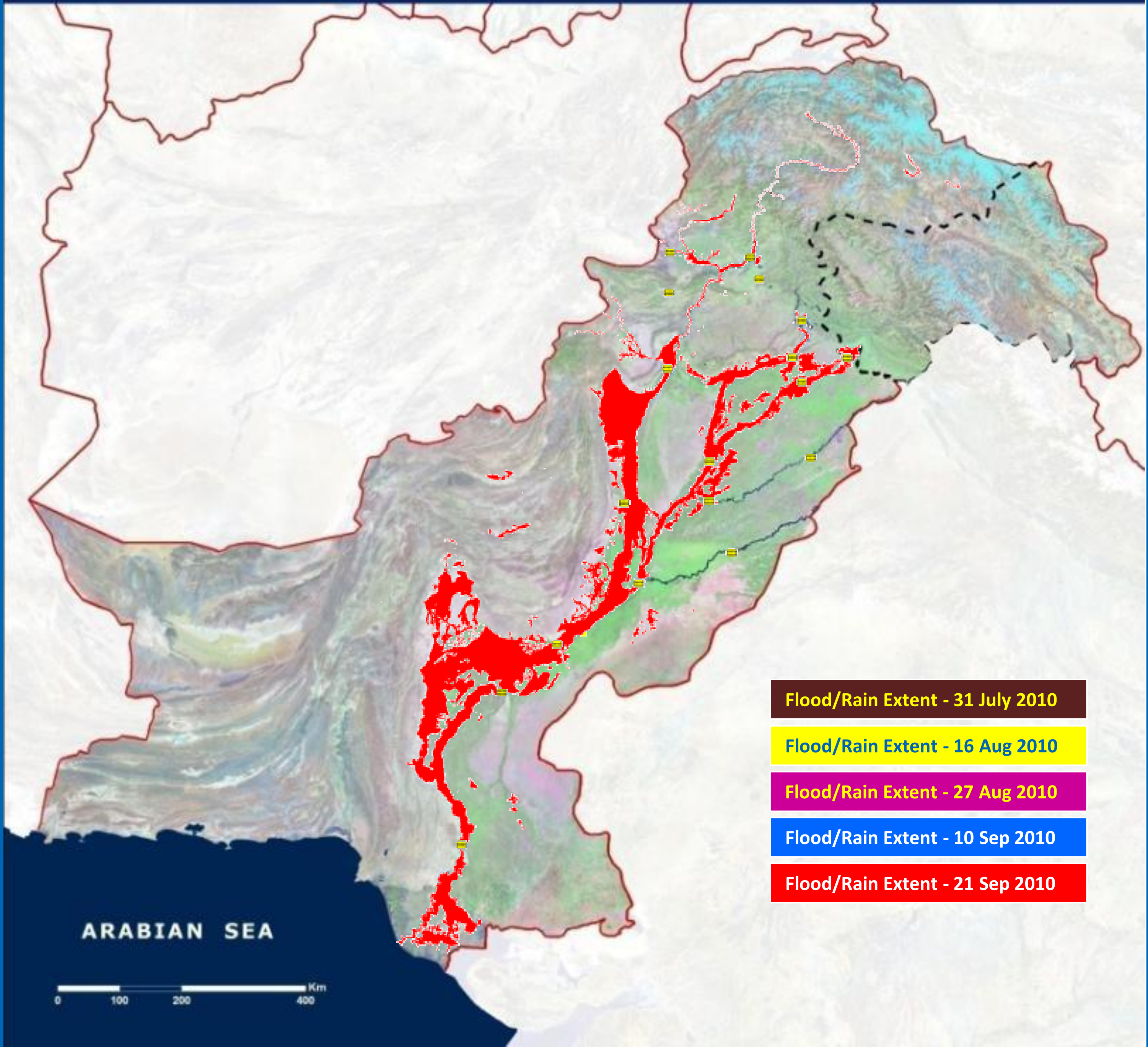


Flood Extent and Risk Mapping of Nallah Lai Rawalpindi

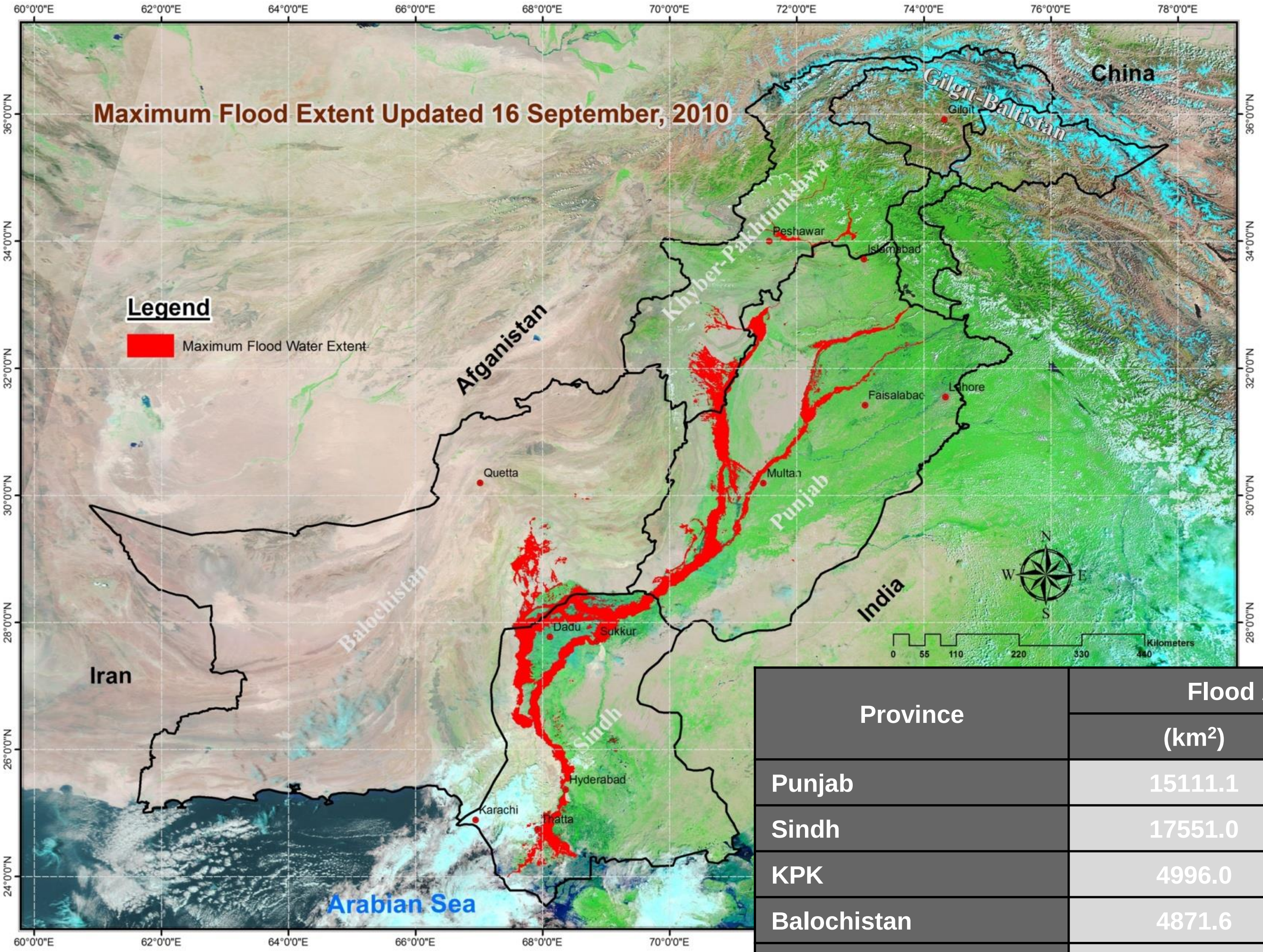




PAKISTAN: FLOOD/RAIN 2010

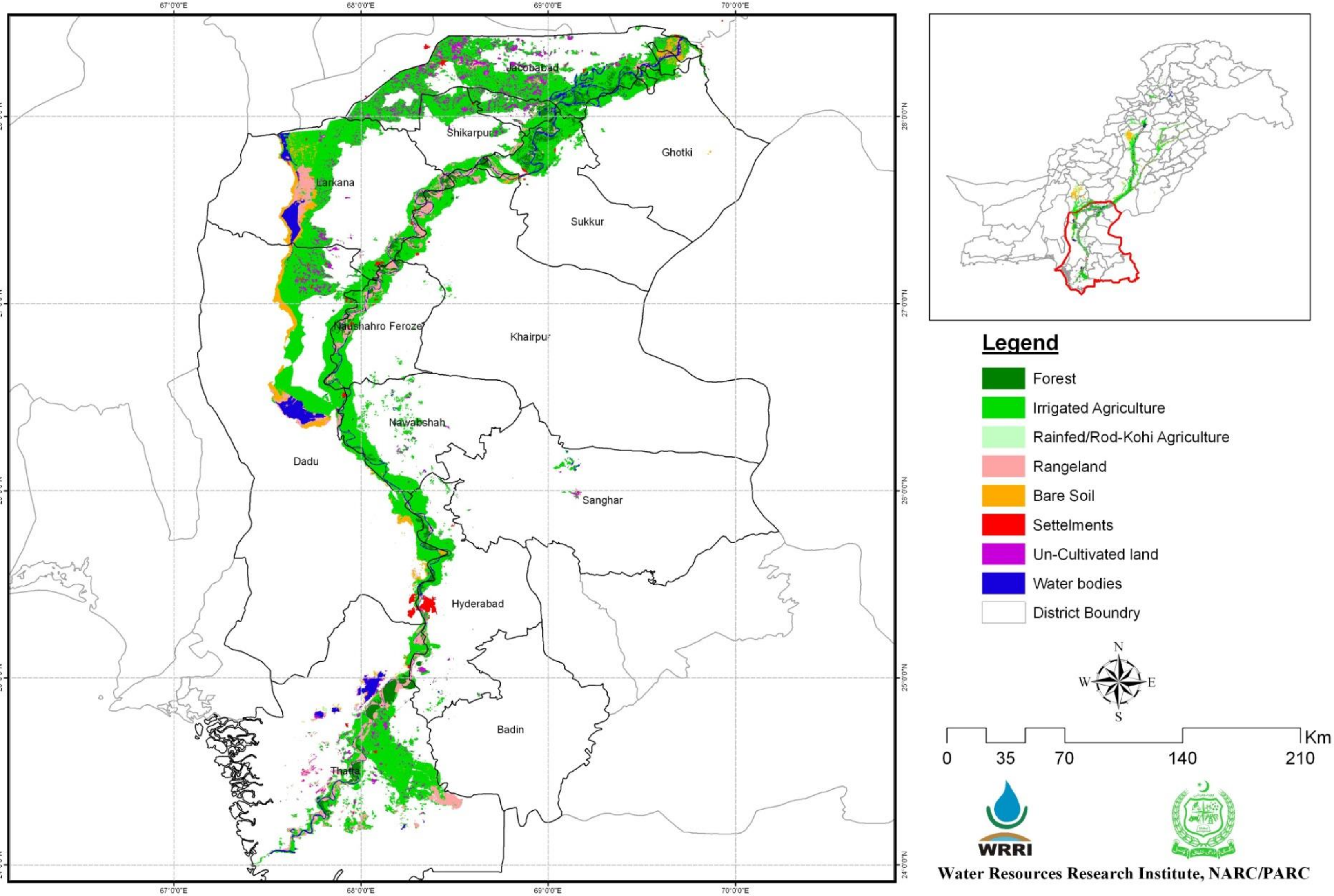


Flood inundation and Extent -2010 using Remote Sensing data



Province	Flood Affected Area	
	(km²)	(Acres)
Punjab	15111.1	3,733,947
Sindh	17551.0	4,336,863
KPK	4996.0	1,234,518
Balochistan	4871.6	1,203,769
Azad Jammu and Kashmir	35.2	8697
Pakistan	42564.9	10,517,794

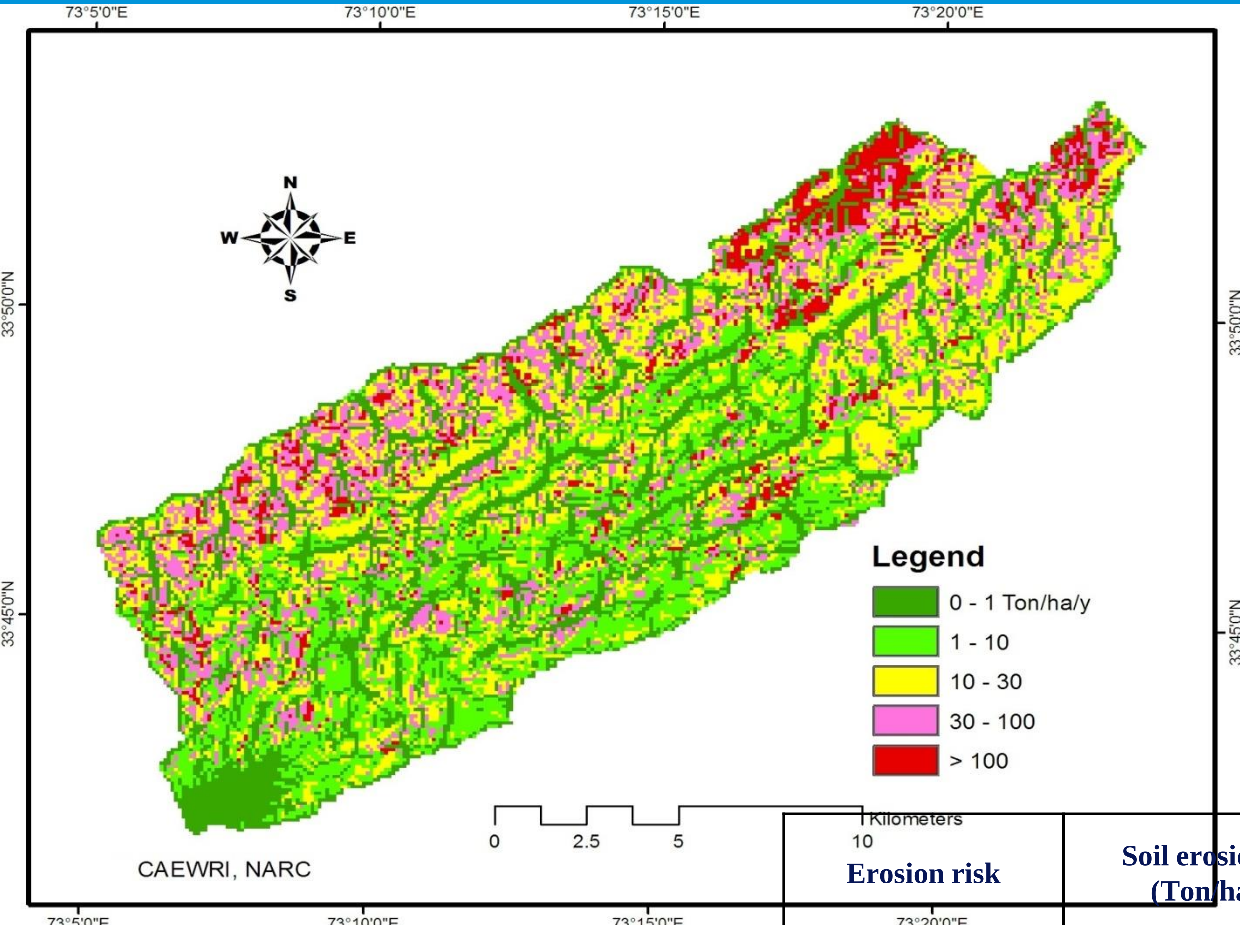
Landuse Map of Flood Affected Areas of Sindh



Water Resources Research Institute, NARC/PARC

Research

Soil erosion intensity map of Rawal watershed area

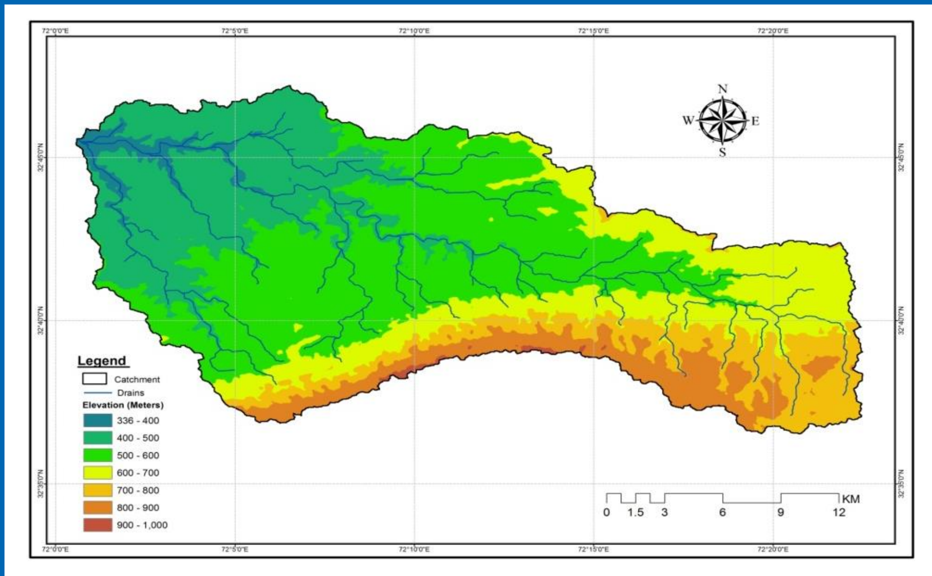


Risk of soil erosion predicted in the Rawal watershed area

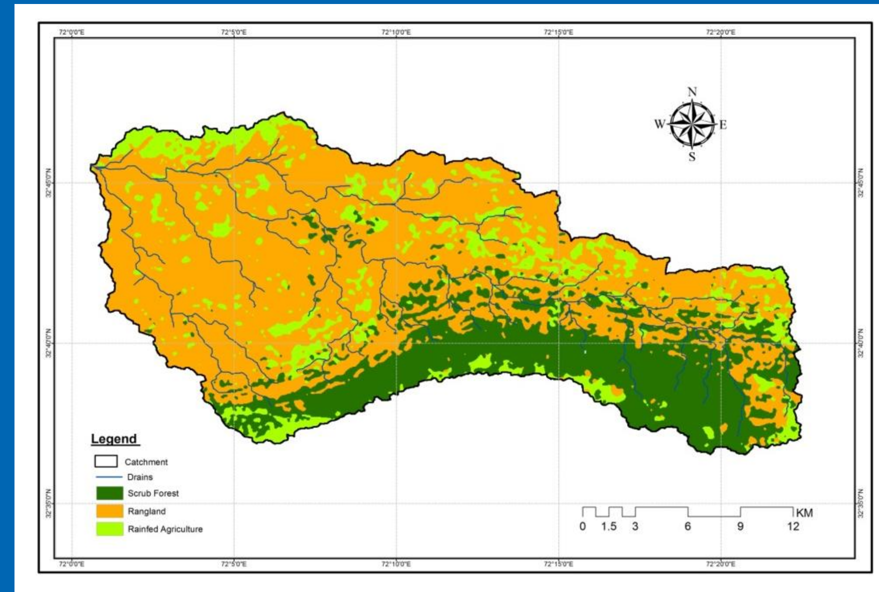
Erosion risk	Soil erosion rate (Ton/ha/yr)	Area (km²)	Area %
V. Low	0 – 1	77.0	28.3
Low	1 – 10	58.2	21.4
Medium	10 - 30	72.4	26.6
High	30 - 100	45.4	16.7
V. High	>100	19.3	7.1
Total		272.0	100.0

Watershed Characterization and Monitoring using RS data

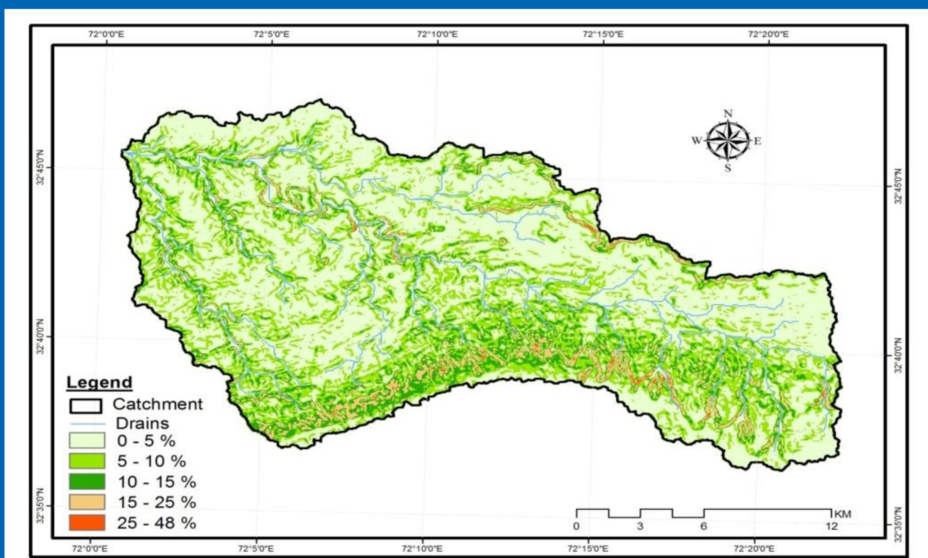
Relief and rivernetwork Ghabbir Dam



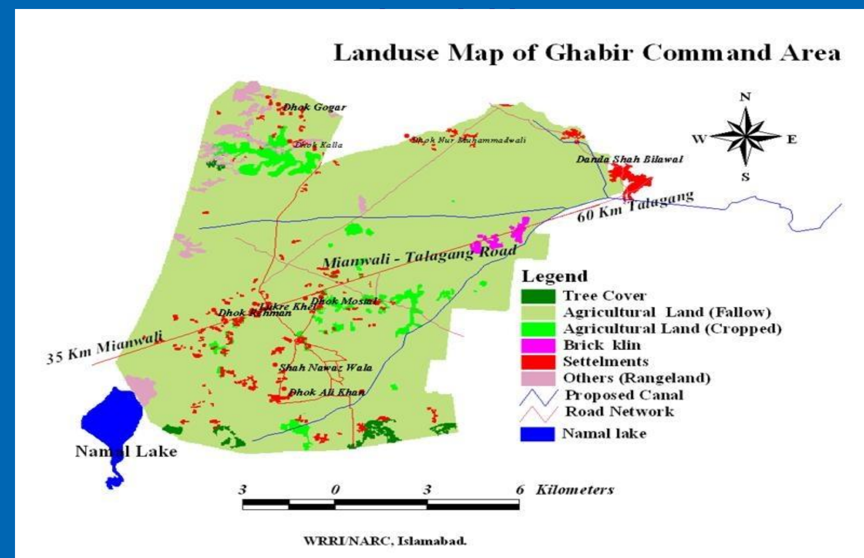
Landuse at watershed scale



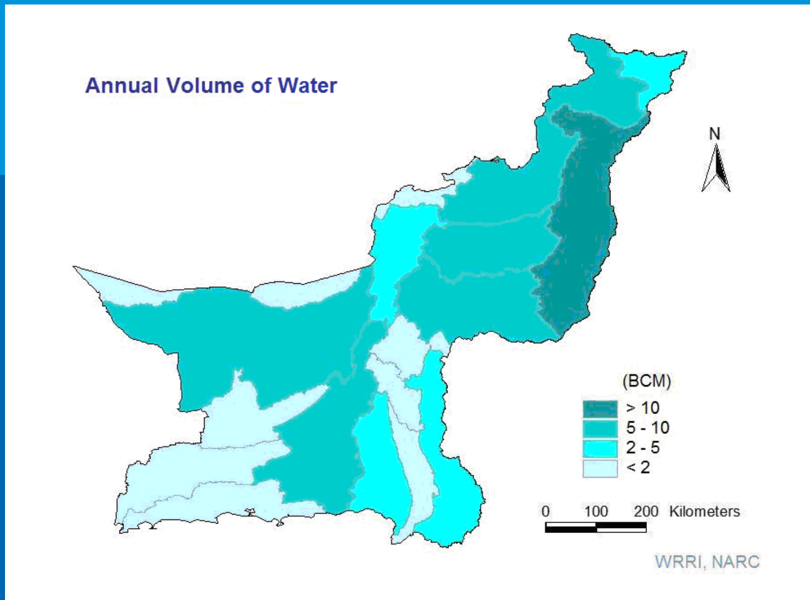
Percent Slope of Watershed

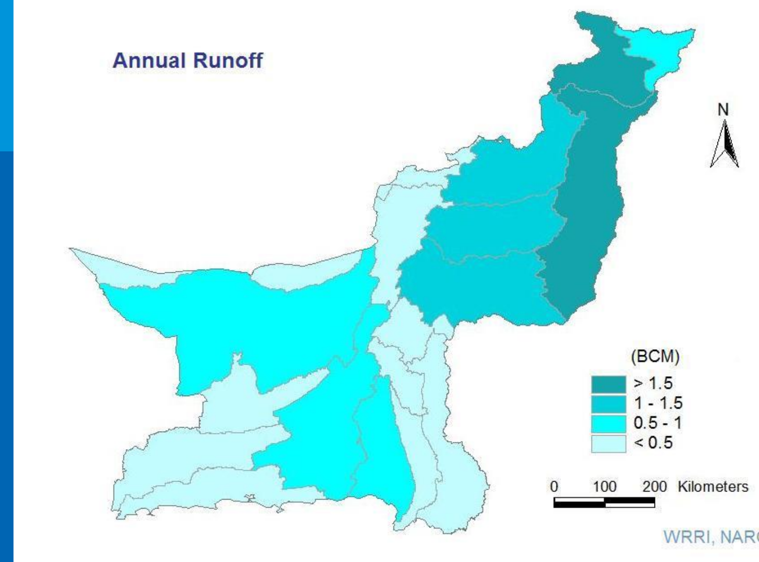


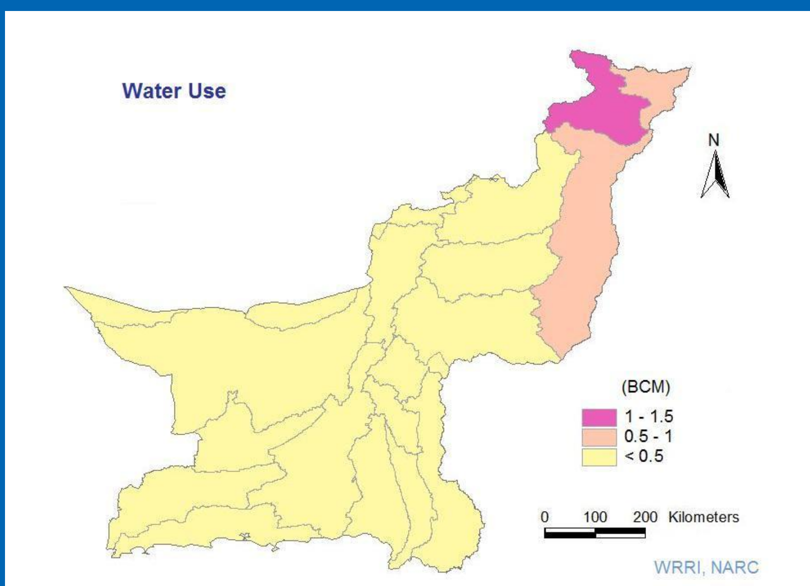
Command Area landuse Ghabir Dam

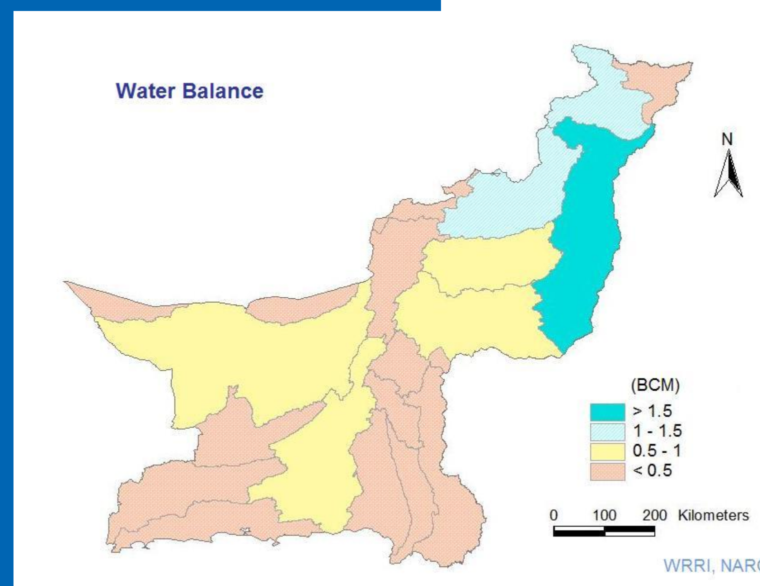


Assessment of Water Conservation Potential … areas









Project Design Matrix for Country (Phase-I)		
Country		Pakistan
River Basin		the Indus River basin
Lead Organization(s)		UNESCO
Project Purpose		To upgrade the flood forecasting and early warning systems of Pakistan, and to conduct risk mapping of flood plains along the Indus River
(1) Data & Statistics	Output	On-time and reliable flood forecasting and flood inundation extent information
	Activites	To collect precipitation and discharge data and share it with other executing partners i.e. ICHARM, NUST and UET for flood hydrological modeling. To conduct soil hydraulic characteristics study in the catchment areas
	Executor	FFD, NUST, UET, ICHARM, PCRWR, WAPDA, PIDA, SIDA
	Expected Partner	UNESCO, NDMA, Ministry of Planning Development and Reforms, FFC
(2) Risk Assessment	Output	To update flood hazard map in lower Indus catchment
	Activites	Identify the flood vulnerability based on past floods and designed floods
	Executor	SUPARCO, JAXA
	Expected Partner	UNESCO, NDMA, Ministry of Planning Development and Reforms, FFC, WAPDA, SIDA
(3) Risk Change Identification	Output	Identification of flood-prone area in the whole Indus River basin under land use change and land cover change
	Activites	Flood hazard mapping and development of a spatial visualization tool for flood risk identification
	Executor	SUPARCO, JAXA, PMD, PARC (land use change and land cover change)
	Expected Partner	UNESCO, NDMA, Ministry of Planning Development and Reforms, FFC, PIDA, SIDA
	Output	Facilitate policy makers to help reduce the human and socioeconomic impacts of flooding in Pakistan

(4) Support in Sound Policy-making	Output	Facilitate policy makers to help reduce the human and socioeconomic impacts of flooding in Pakistan
	Activites	To analyse the existing National Disaster Management Policy and help fill gaps and to facilitate the updation of existing SOPs for barrage and dam operations during flood season
	Executor	CDMP (Peshawar University), NUST
	Expected Partner	UNESCO, NDMA, Ministry of Planning Development and Reform, FFC, IRSA, PIDA, SIDA
(5) Support in Community of Practice	Output	Storage of rainwater to reduce water runoff causing floods in lowland areas, reduction in soil erosion through reduction in water runoff, capacity building of communities on different land and water management technologies, and utilization of harvested rainwater through efficient means to grow high value crops
	Activites	Community Based Training Program on Watershed Management for Flood Control
	Executor	PARC, SAWCRI,
	Expected Partner	UNESCO, BARI, ABAD, OFWM

Thank you

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Himalayan Adaptation, Water and Resilience Research

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Collaborative Adaptation Research Initiative in Africa and Asia

Supported by the UK's Department for International Development (DFID) and Canada's International Development Research Centre (IDRC)

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