Water cycle and water resources management under possible (ongoing) impacts of the climate change

Dr. Bashir Ahmad

Water Resources Research Institute

Islamabad Pakistann

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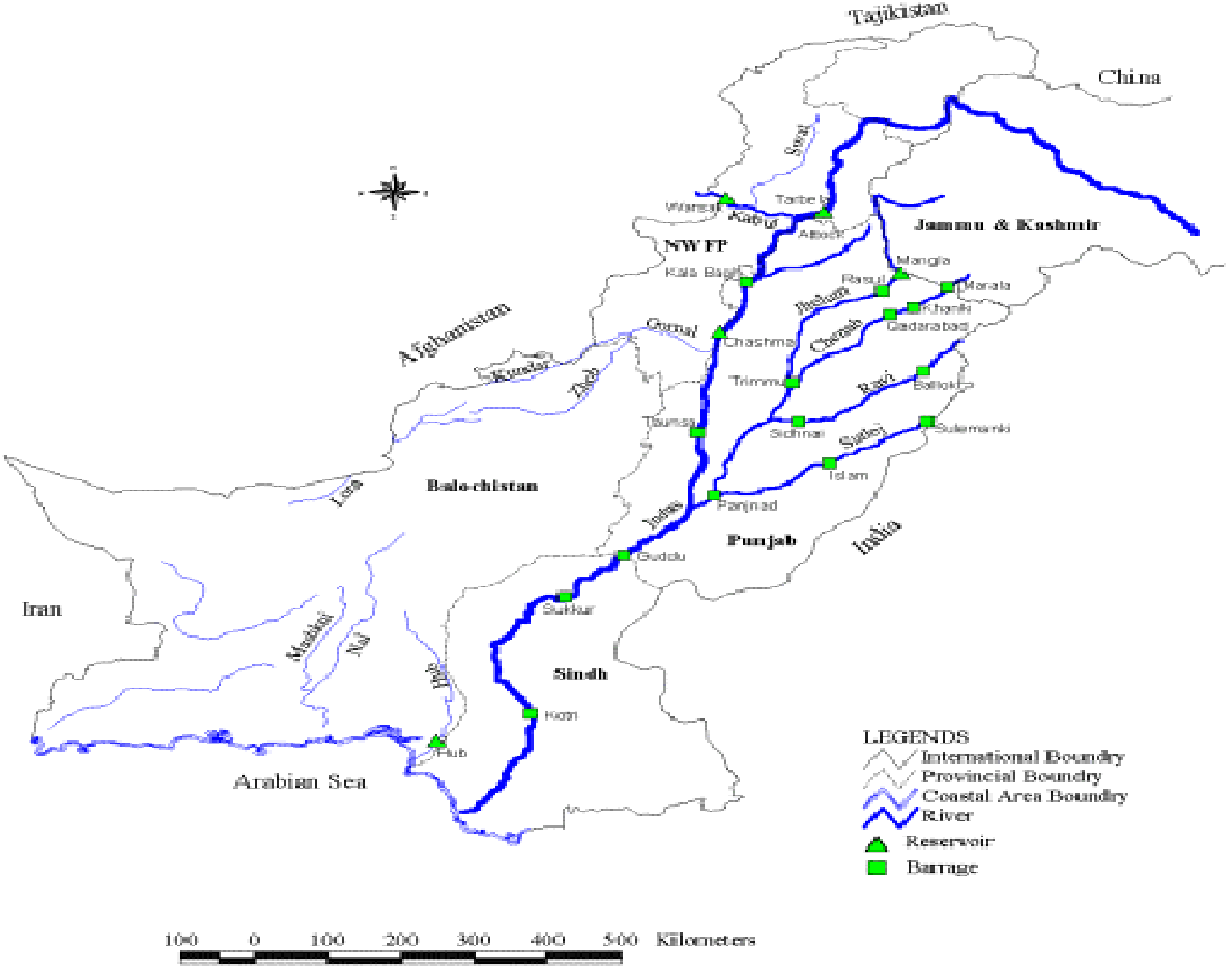
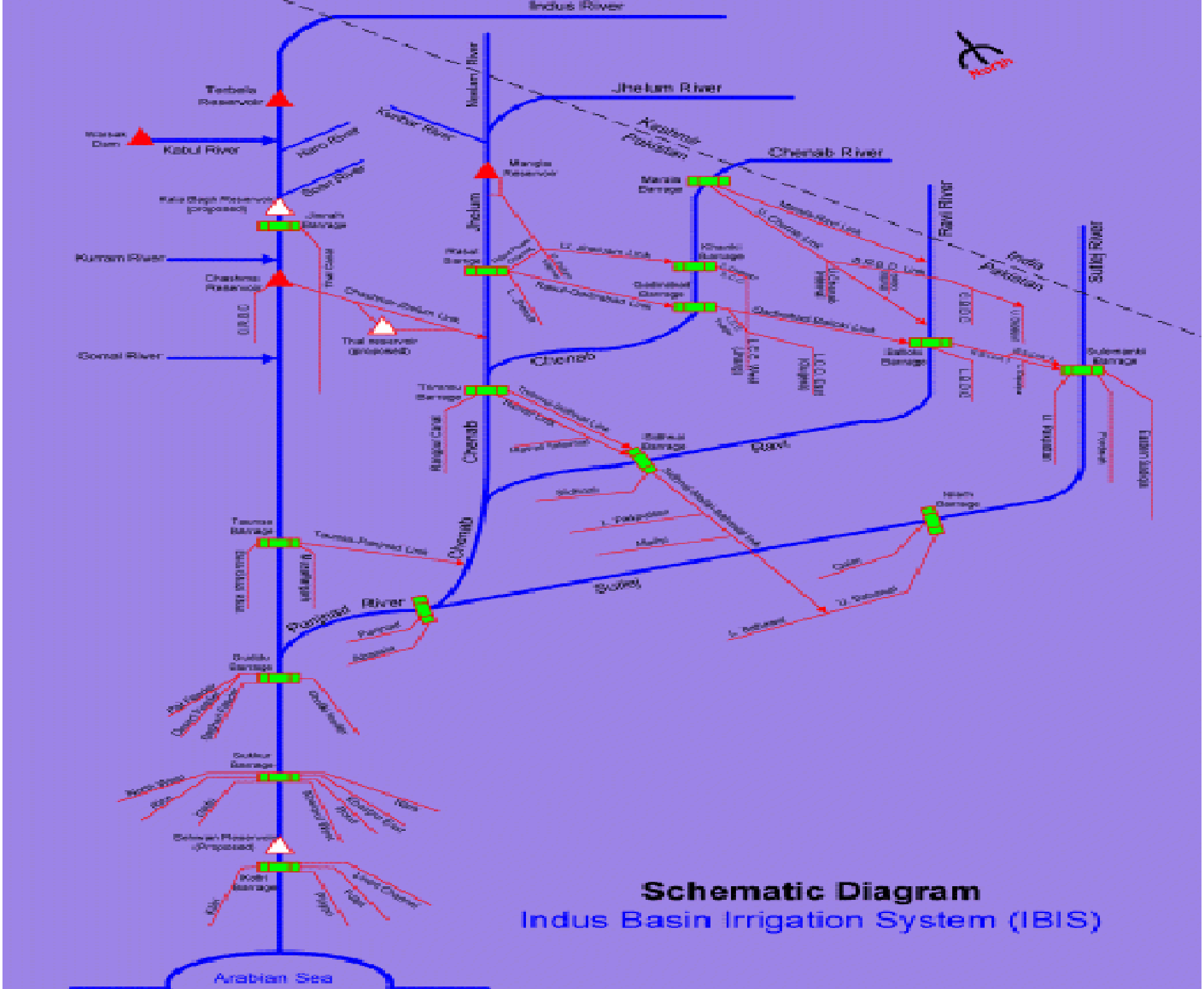
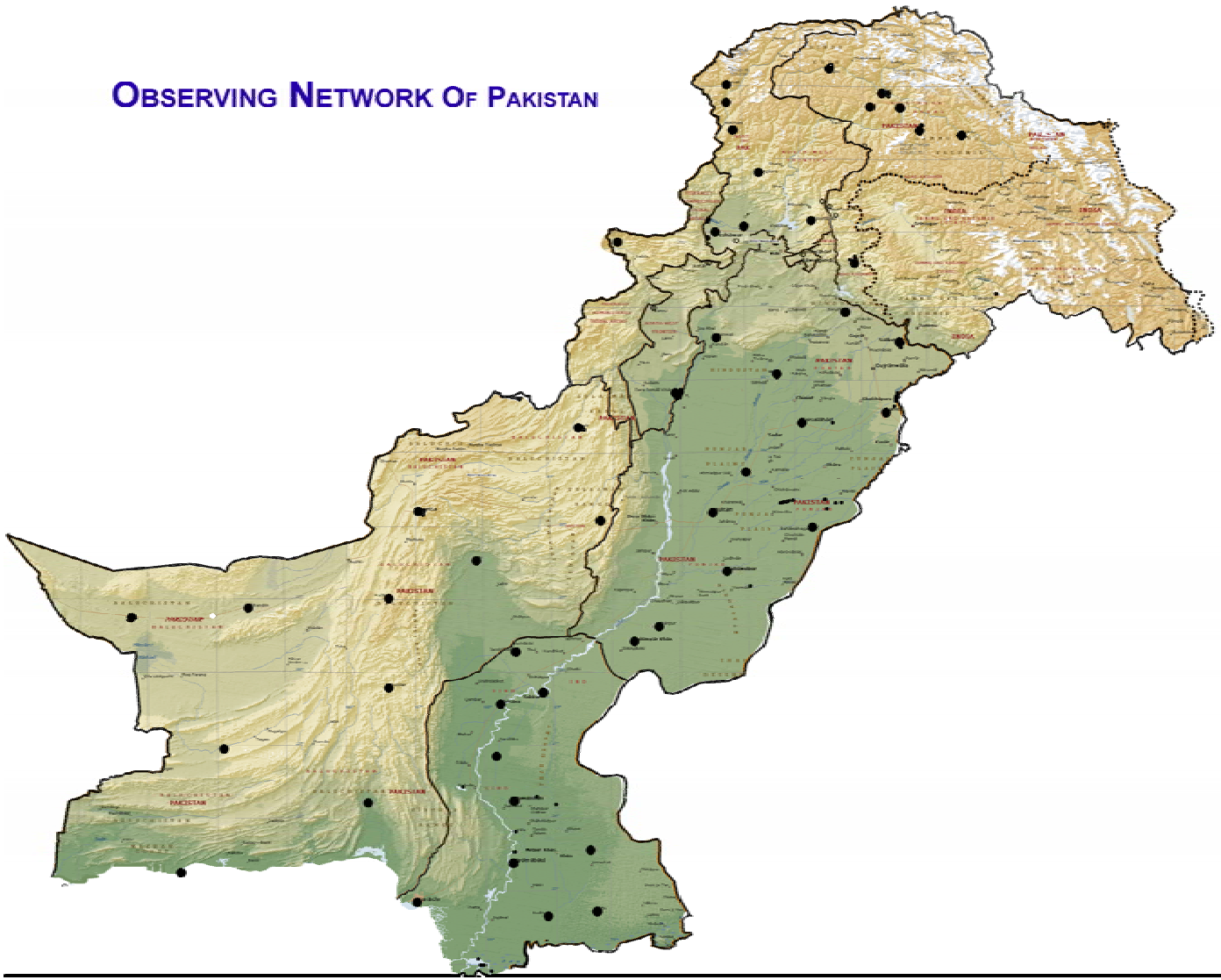
Major Rivers of Pakistan

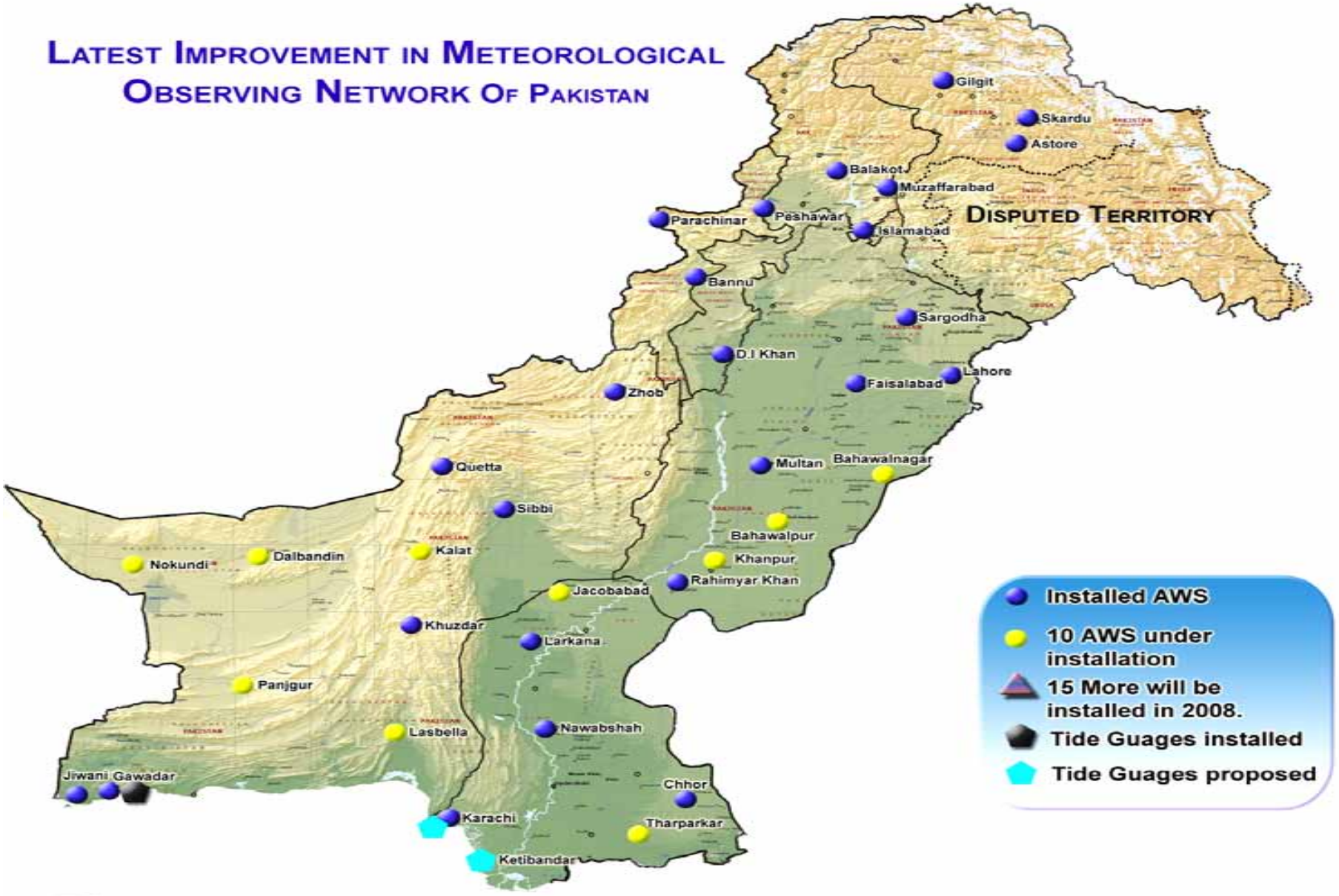



Indus River
Jhelum River
Chenab River
Ravi River
Sutlej River
Tarbela Reservoir
Kabul River
Kurram River
Gomal River
Mangla Reservoir
Chashma Reservoir
Trimmu Barrage
Qadirabad Barrage
Balloki Barrage
Sulemanki Barrage
Rasul Barrage
Khanki Barrage
Marala Barrage
Jinnah Barrage
Taunsa Barrage
Guddu Barrage
Sukkur Barrage
Kotri Barrage
Jhelum
Chenab
Ravi
Sutlej
Indus
Arabian Sea
Schematic Diagram
Indus Basin Irrigation System (IBIS)

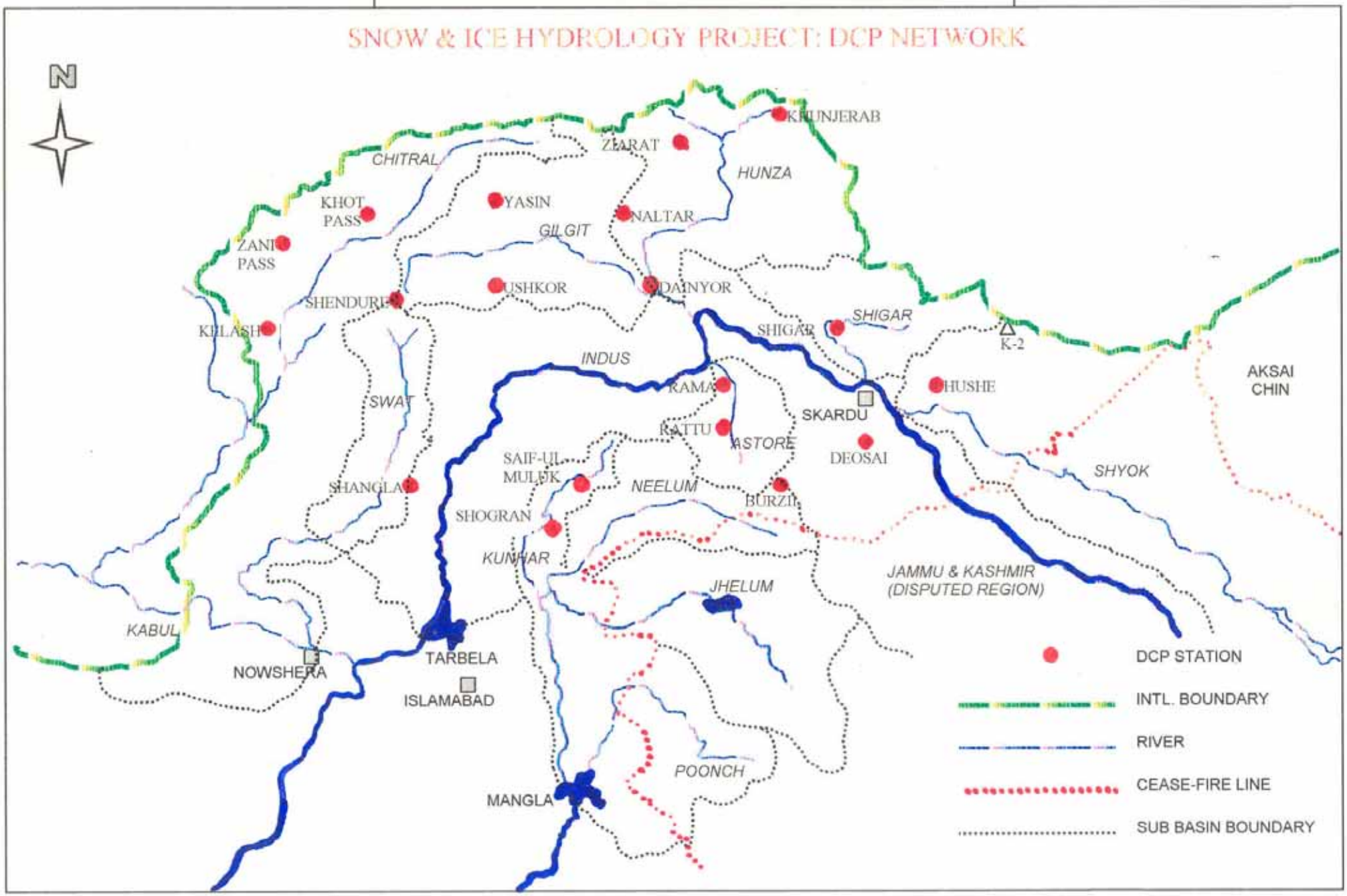
Observation Network



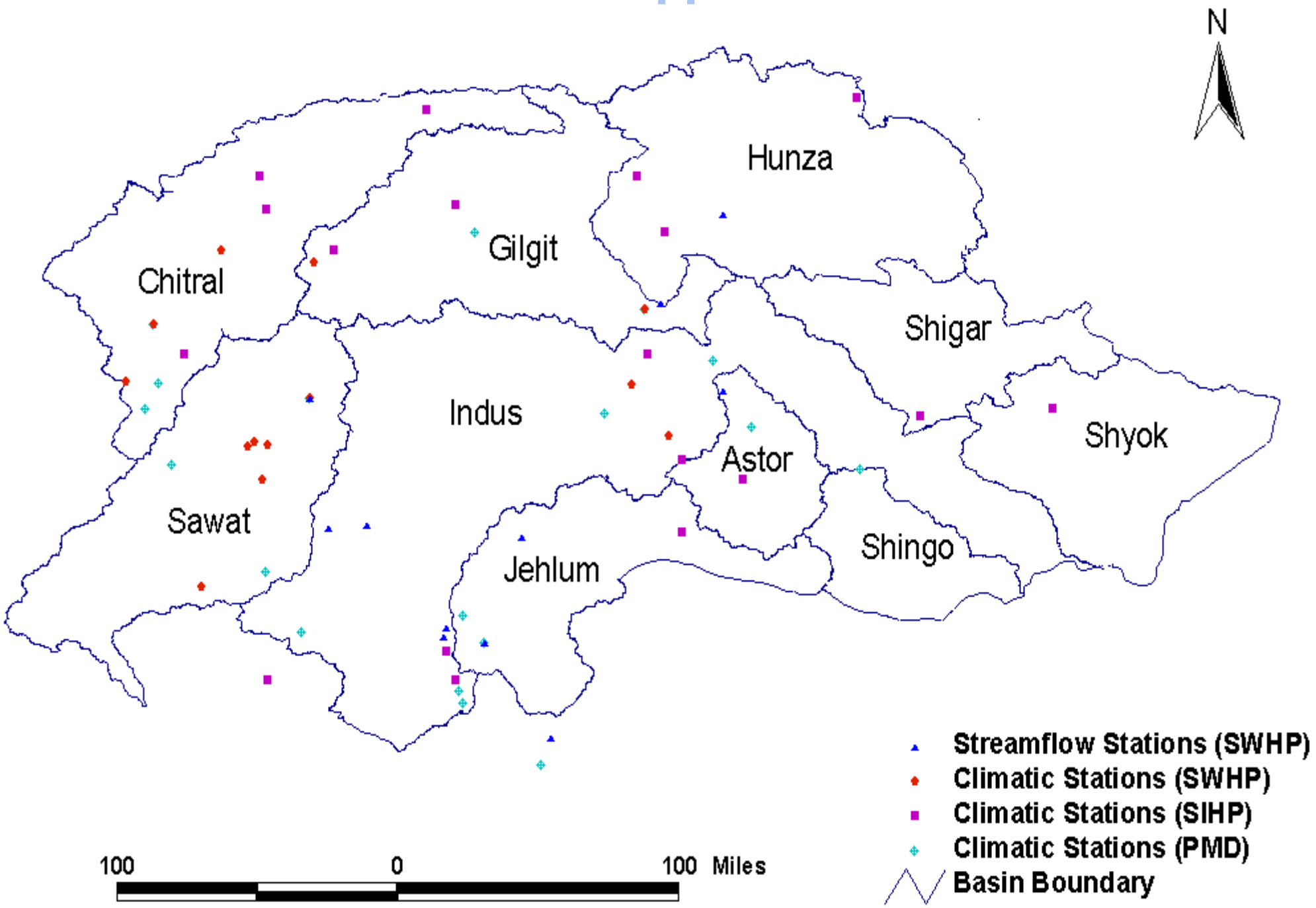
AWS Installations



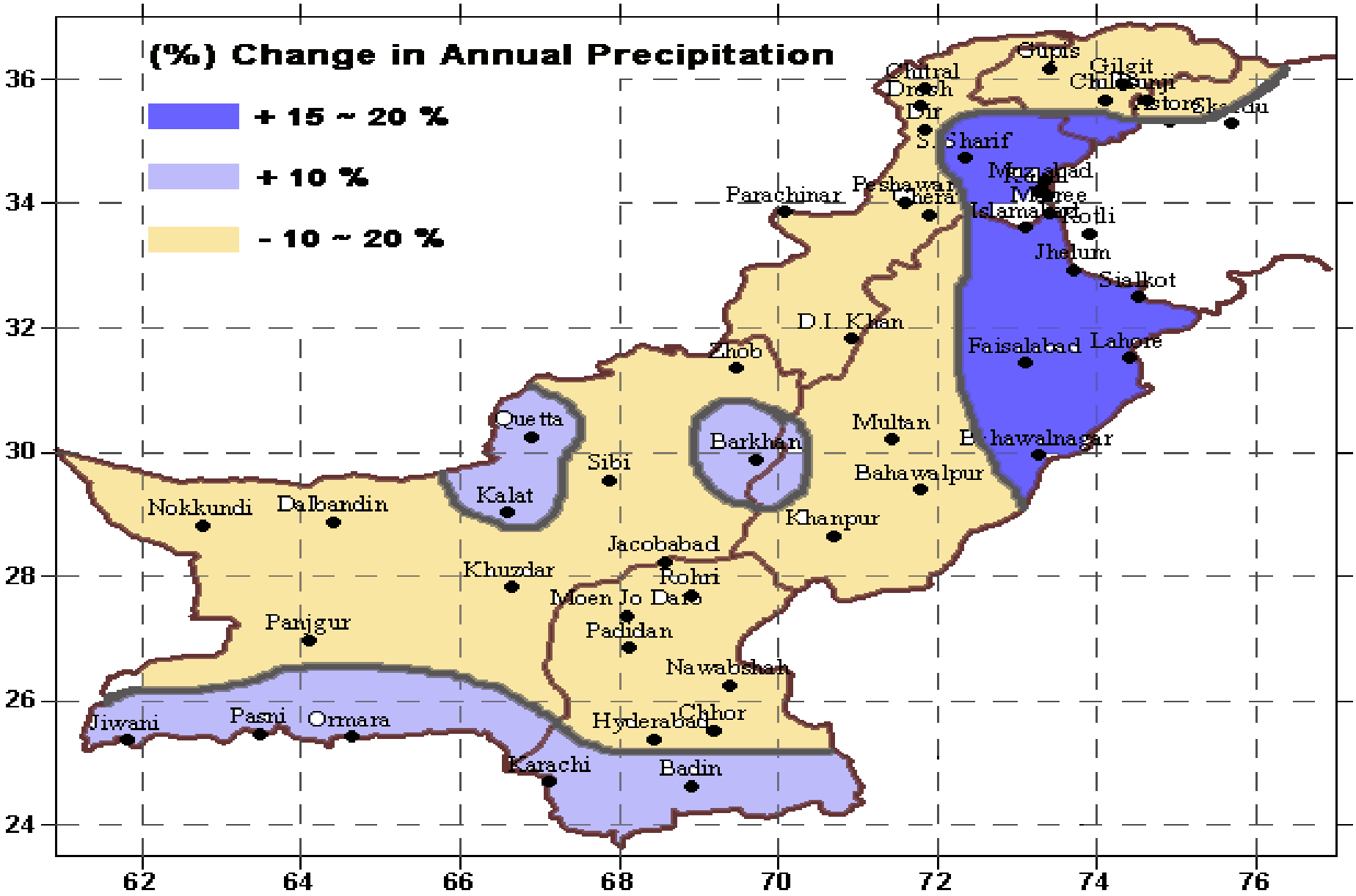
PAKISTAN WATER AND POWER DEVELOPMENT



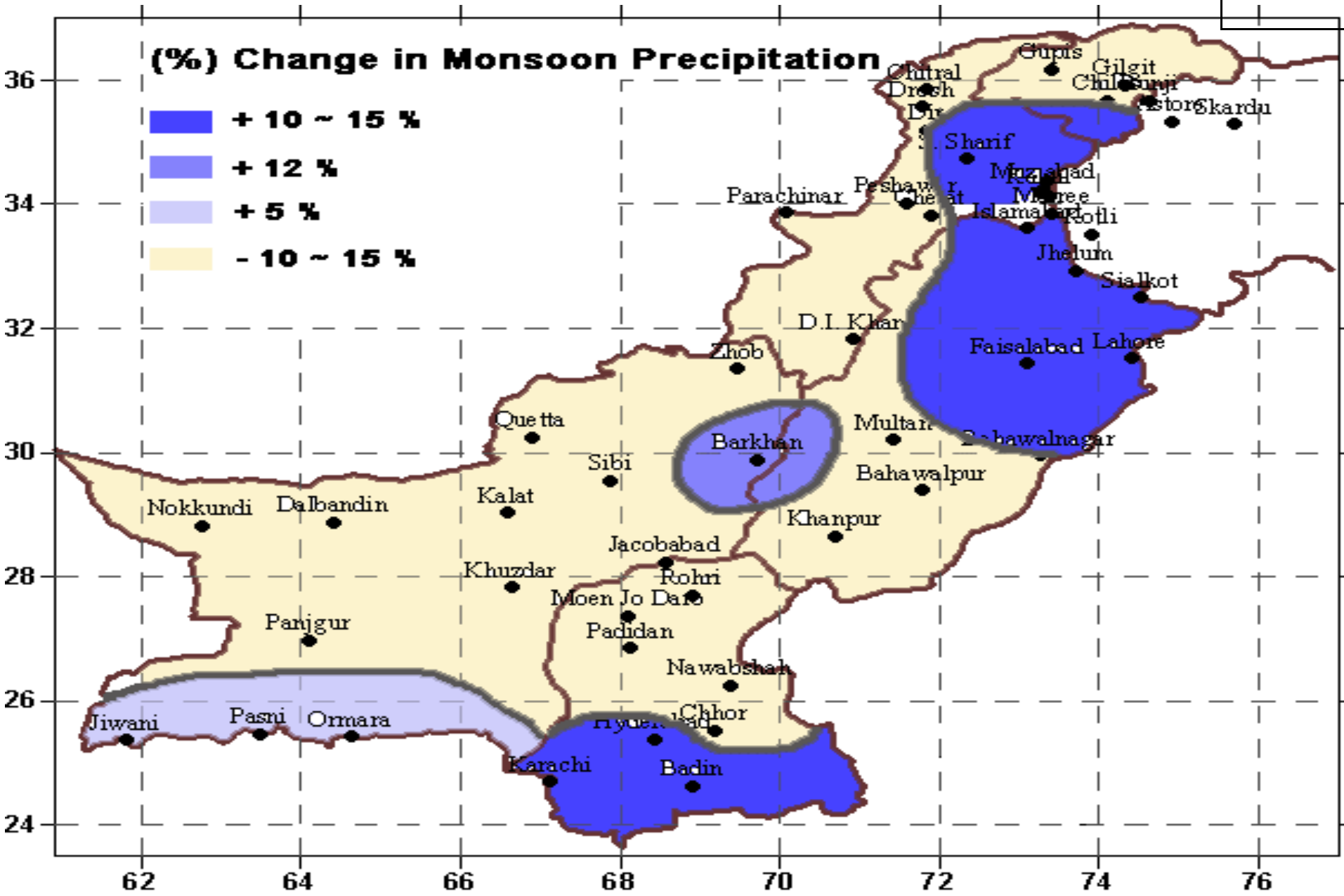
Sub-basins in Upper Indus



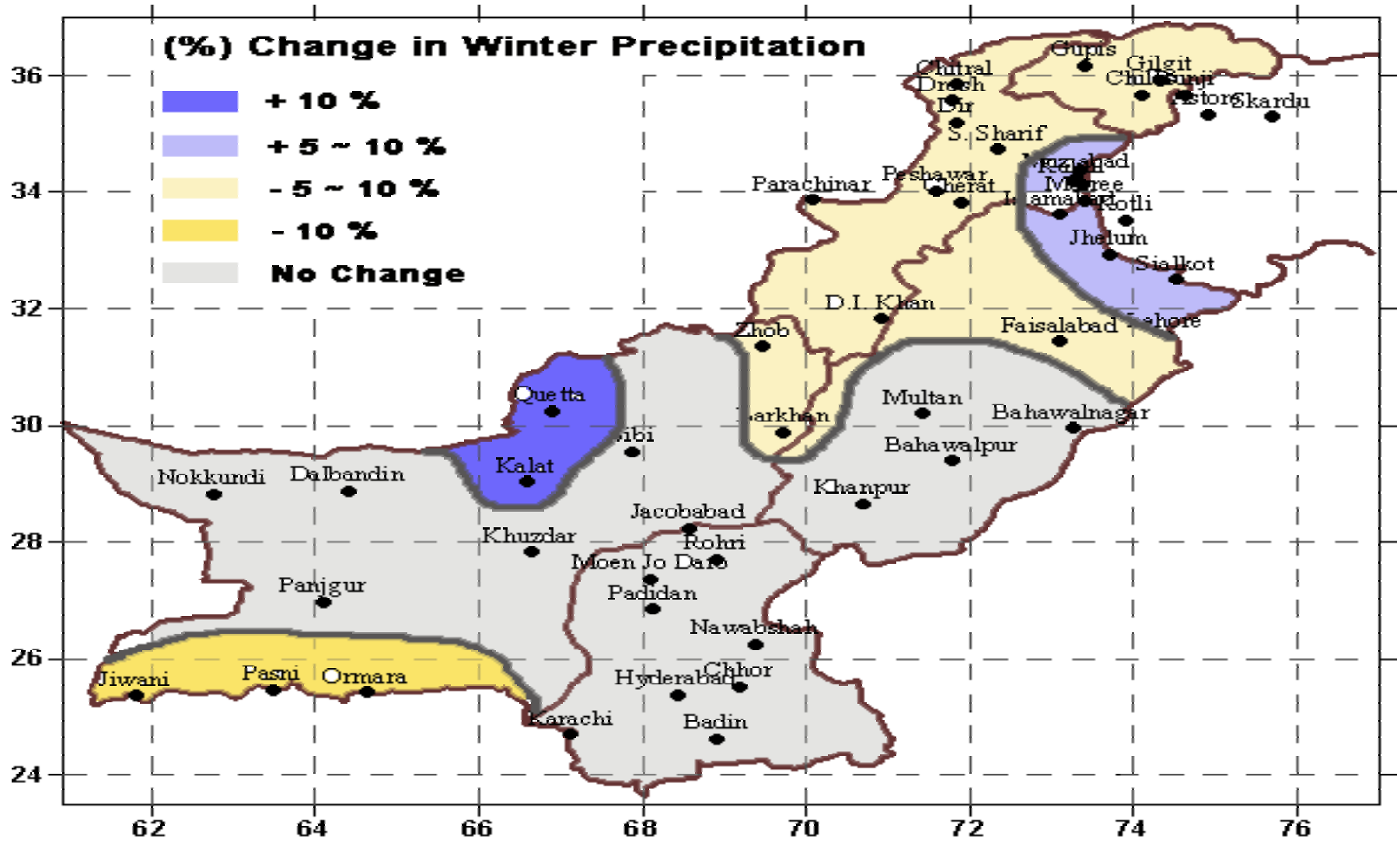
Percentage Change – Annual Precipitation



Percentage Change – Monsoon Precipitation



Percentage Change – Winter Precipitation



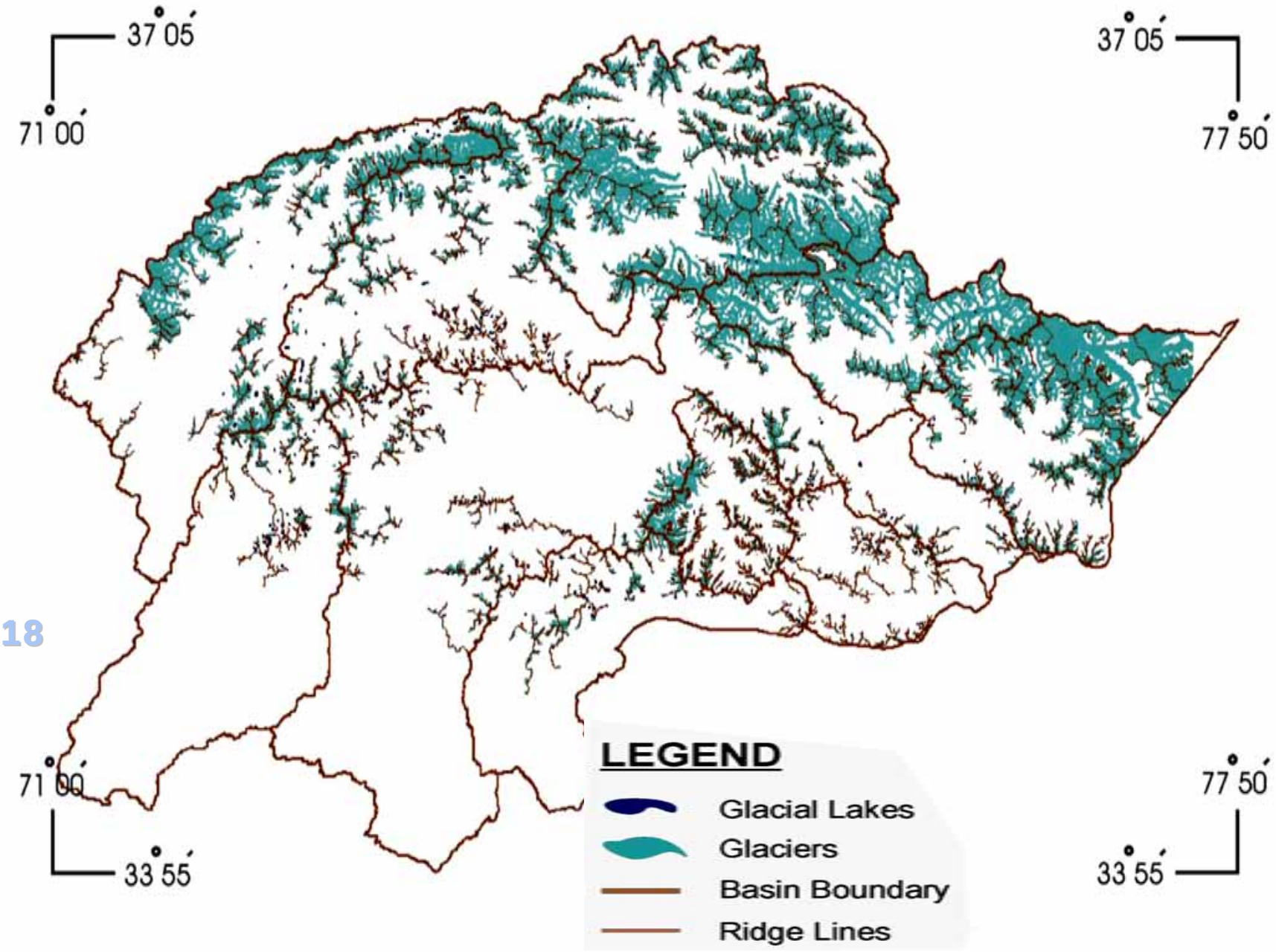
Projected Water Resources under Climate Change

- According to IPCC, TAR (Impacts, Adaptation and Vulnerability, p 563), The average annual runoff in the basin of Indus may decrease by up to 27% Brahmaputra by 14% by the year 2050. The Indus contributes 65% of total river flows
- Rainfall may increase in monsoon region but decrease in other parts of the country

Future Projections for Climate Change in Asia Region

- The GCMs project that average annual mean temperature rise in Asia would be about 2-3°C by 2050;
- Dry and arid regions may become dryer and wet regions wetter, (Pakistan is predominately dry and arid);
- The projected temperature increase will affect cropping patterns, timings and methods, and overall yields;

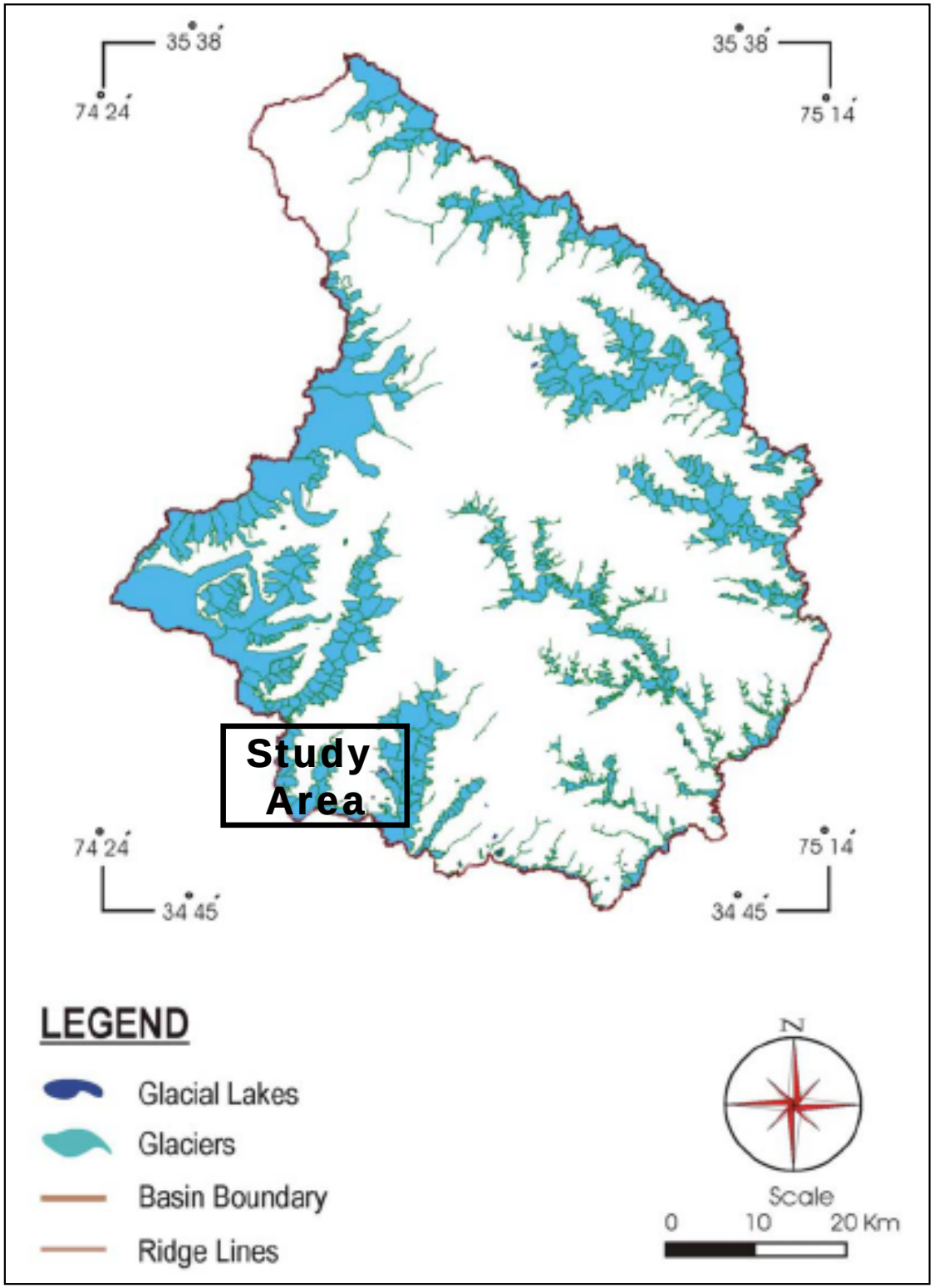
Glaciers of Upper Indus Basins

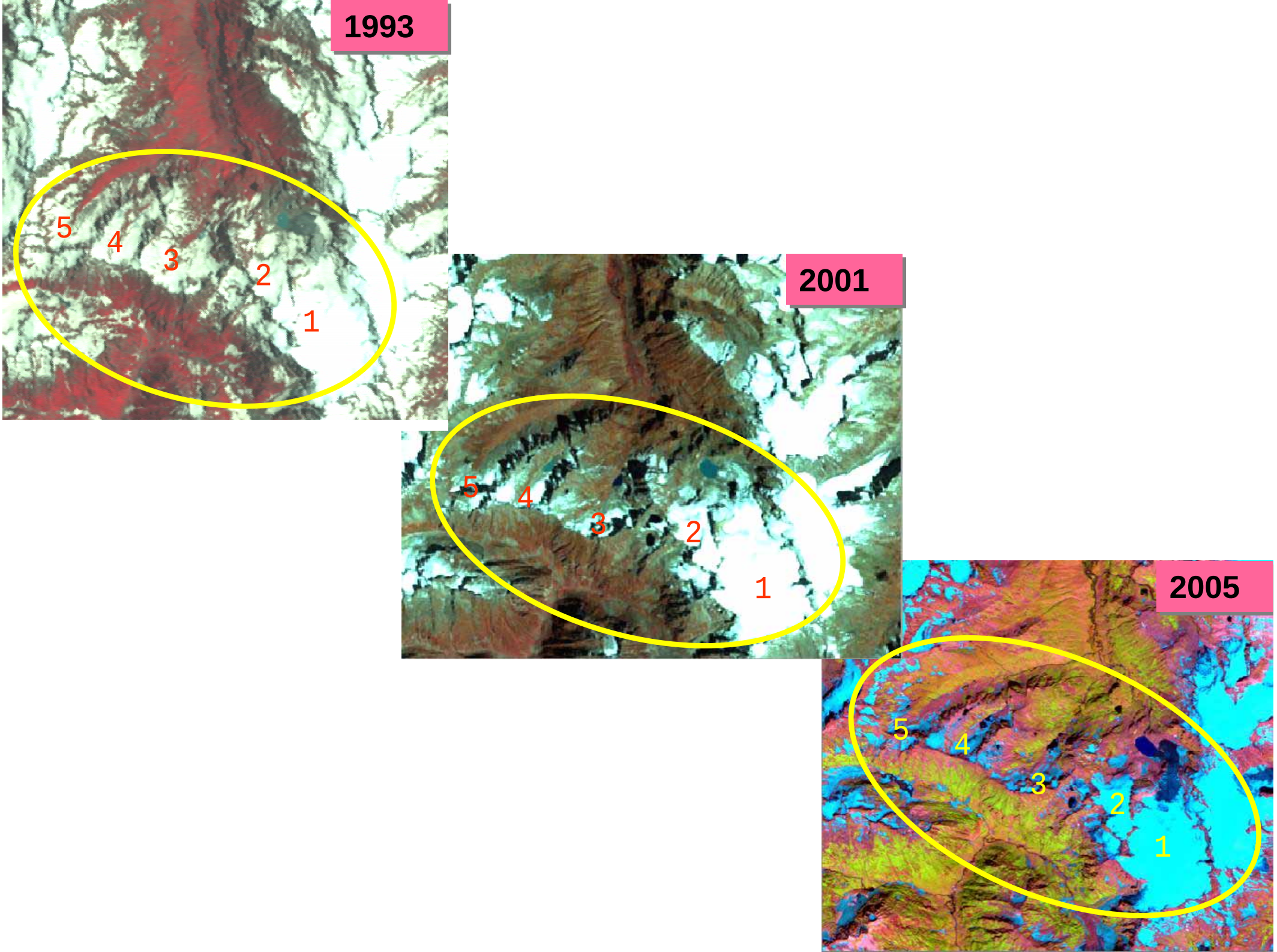


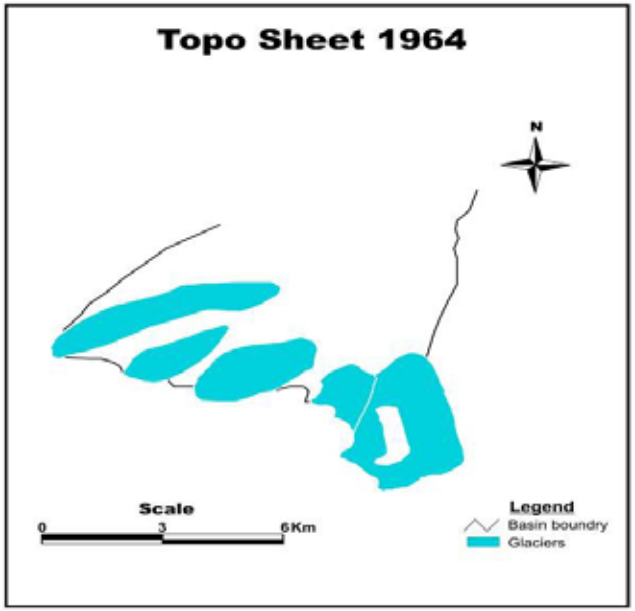
Total Area 5,218

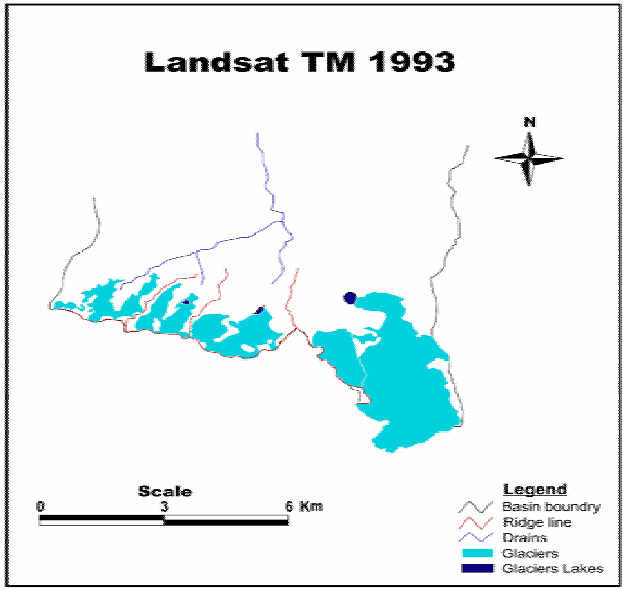
Source: WRRI, NARC (2005) " Inventory of glaciers"

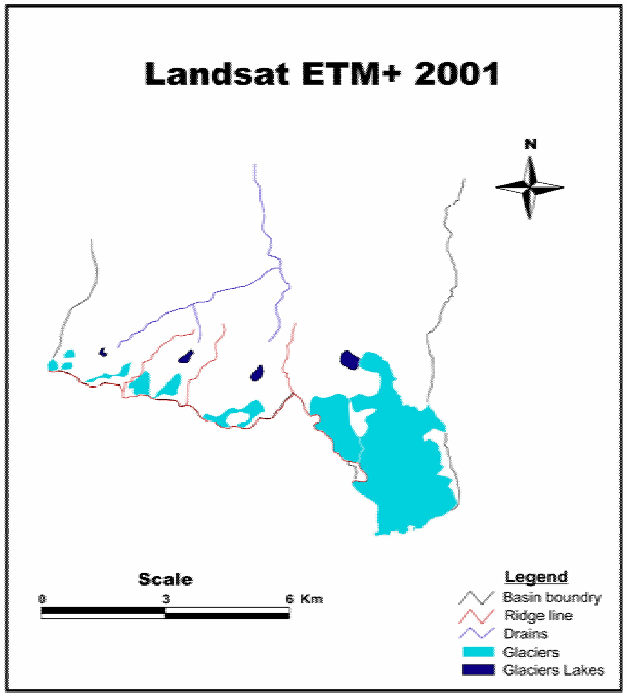
The Glaciers Distribution in Astor River Basin

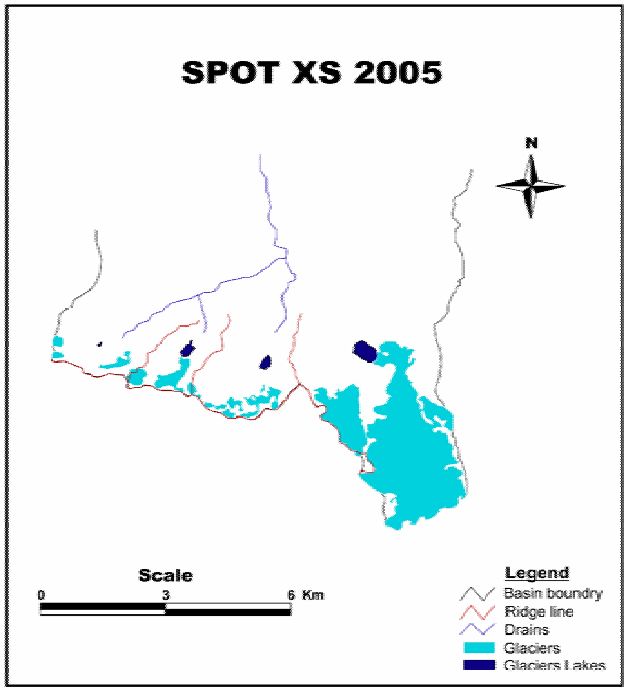



1993
5
4
3
2
1
2001
5
4
3
2
1
2005
5
4
3
2
1



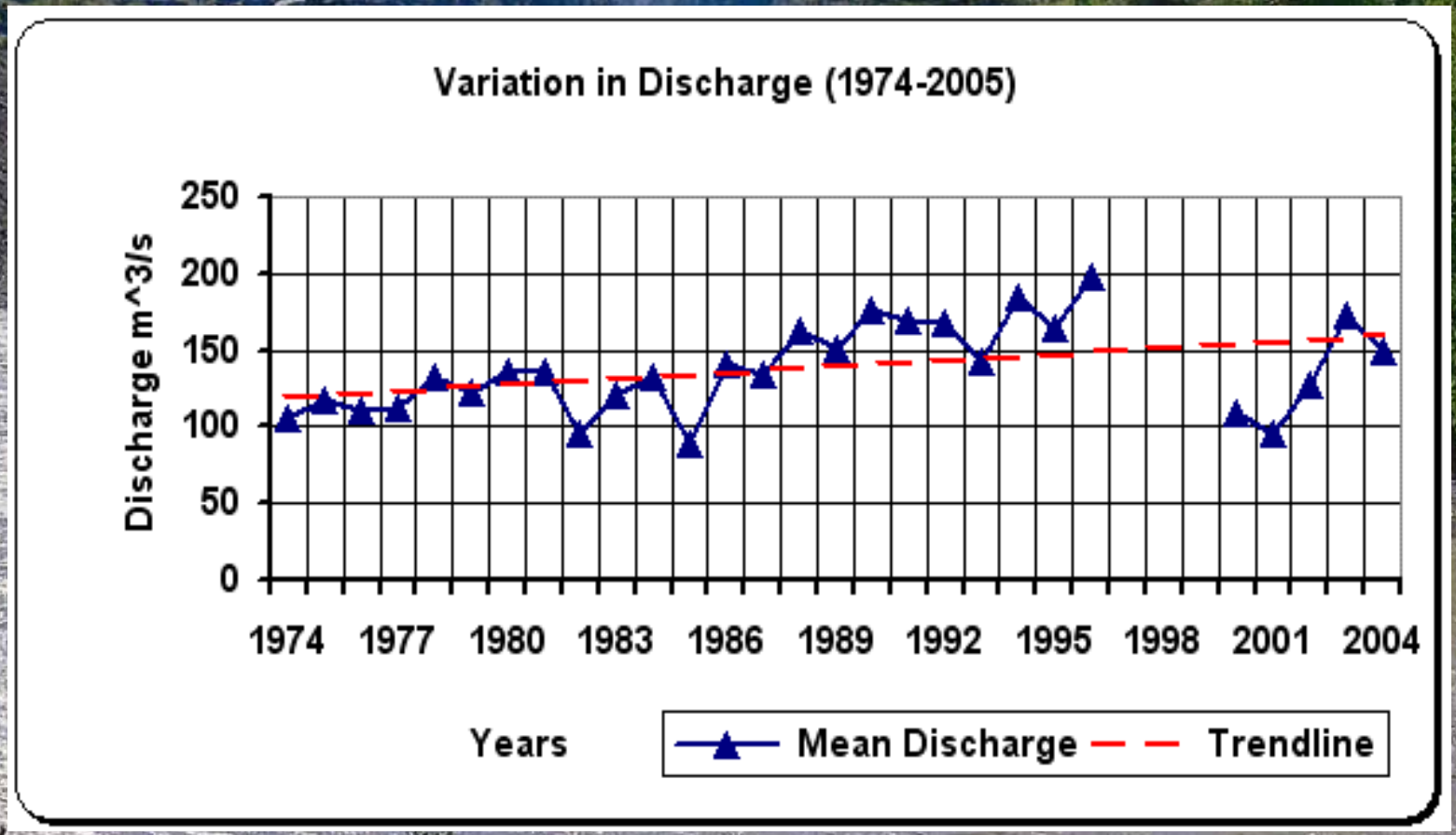






Temporal behavior of Glaciers and Glacial lakes during 1964-2005

Trend of Annual Discharge of Astor River



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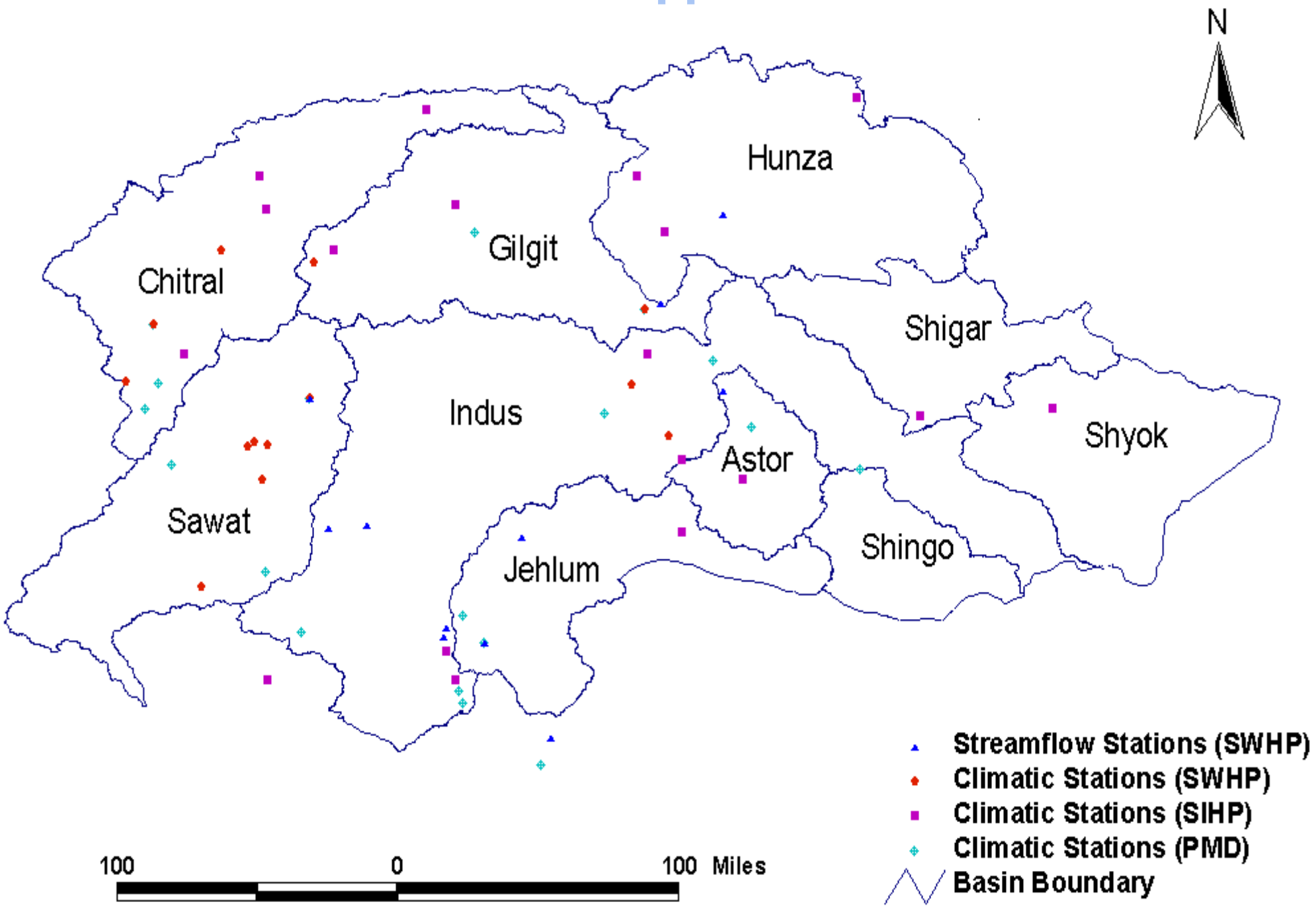
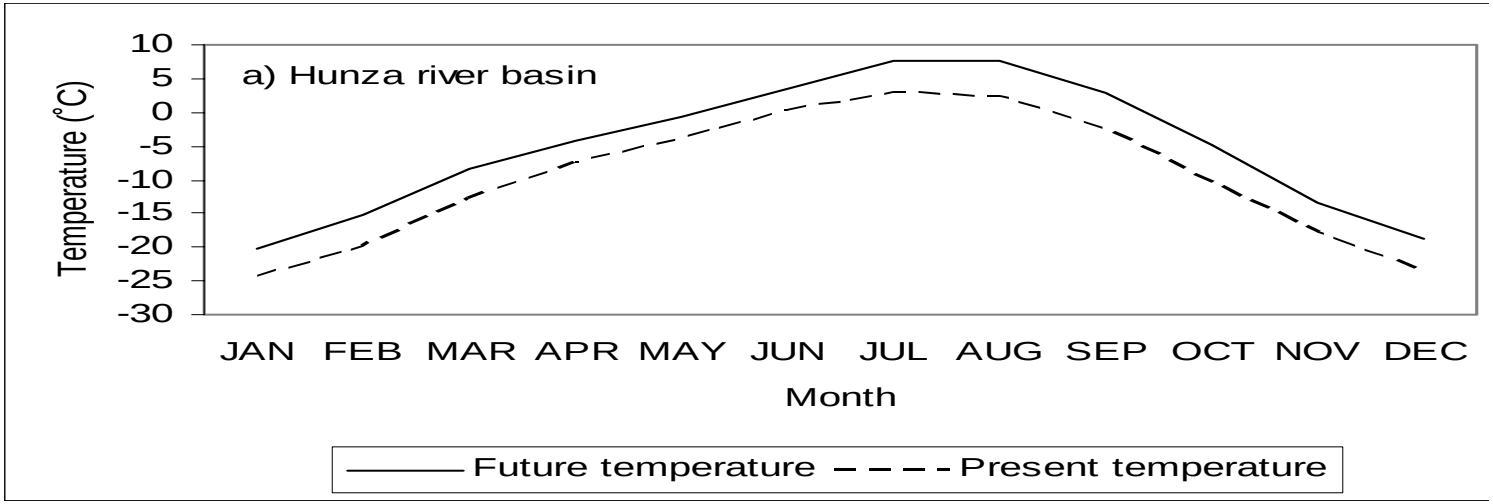
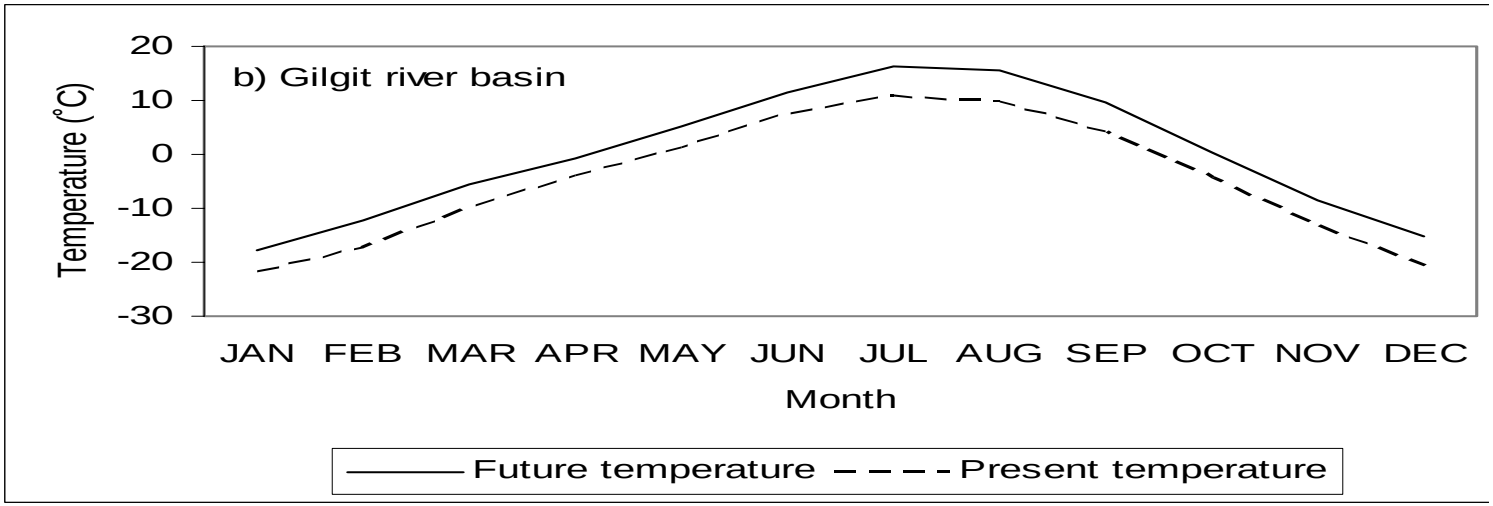
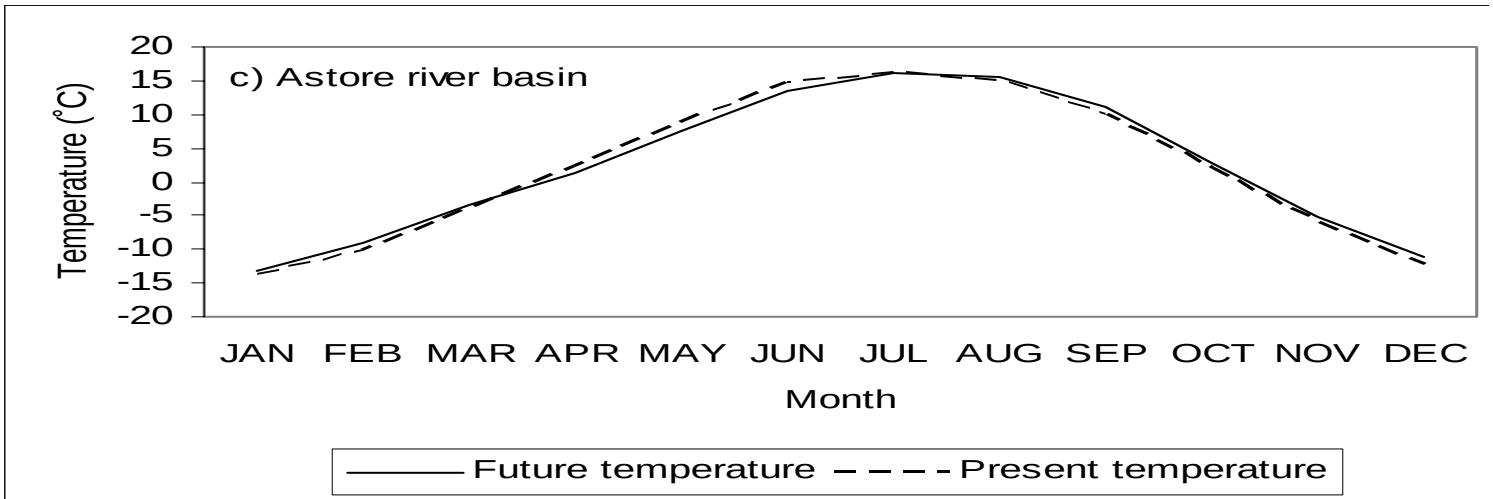


Mean annual cycle of temperature over simulated with PRECIS for present (1961-90) and future (2071-2100) day climate [°C]

(Akthar et al. 2005)

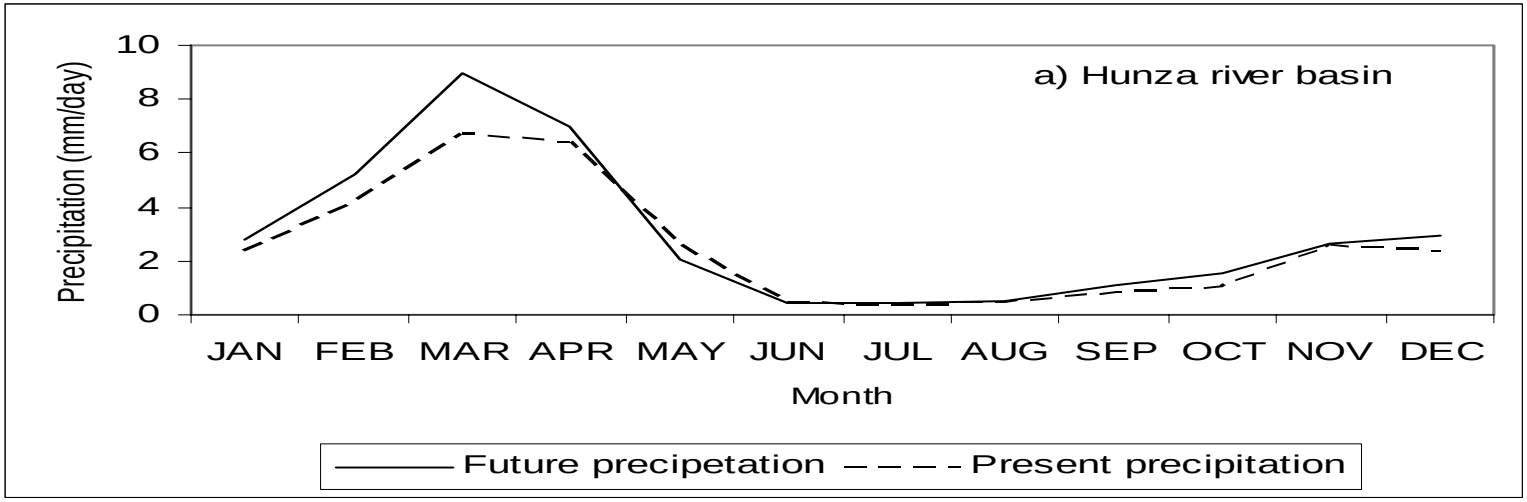


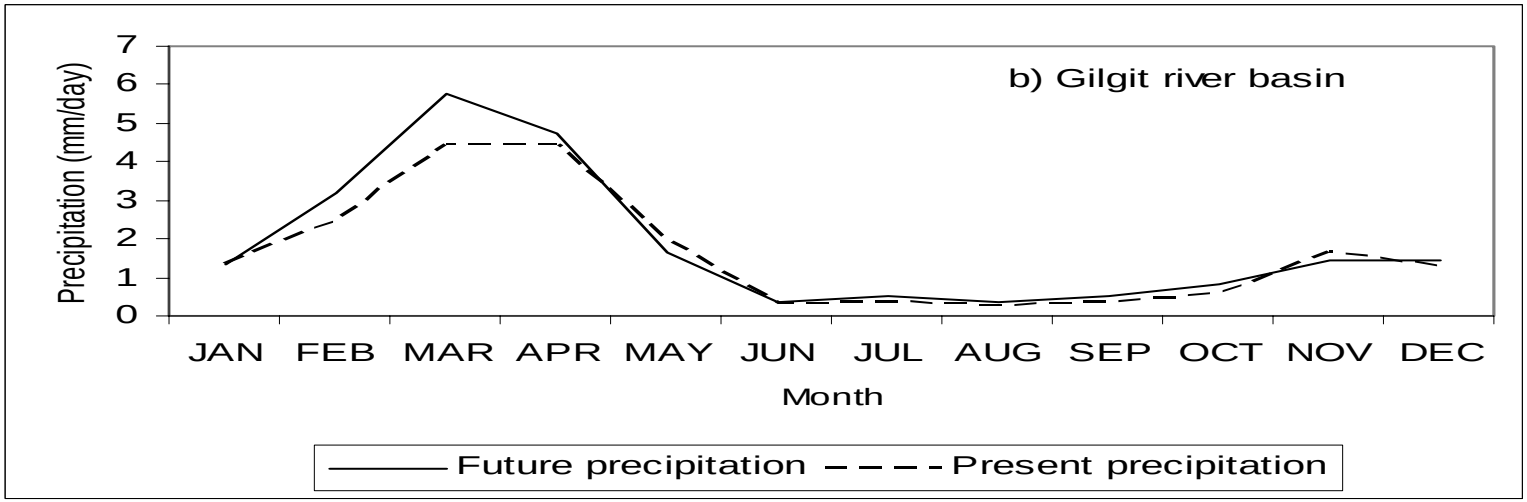


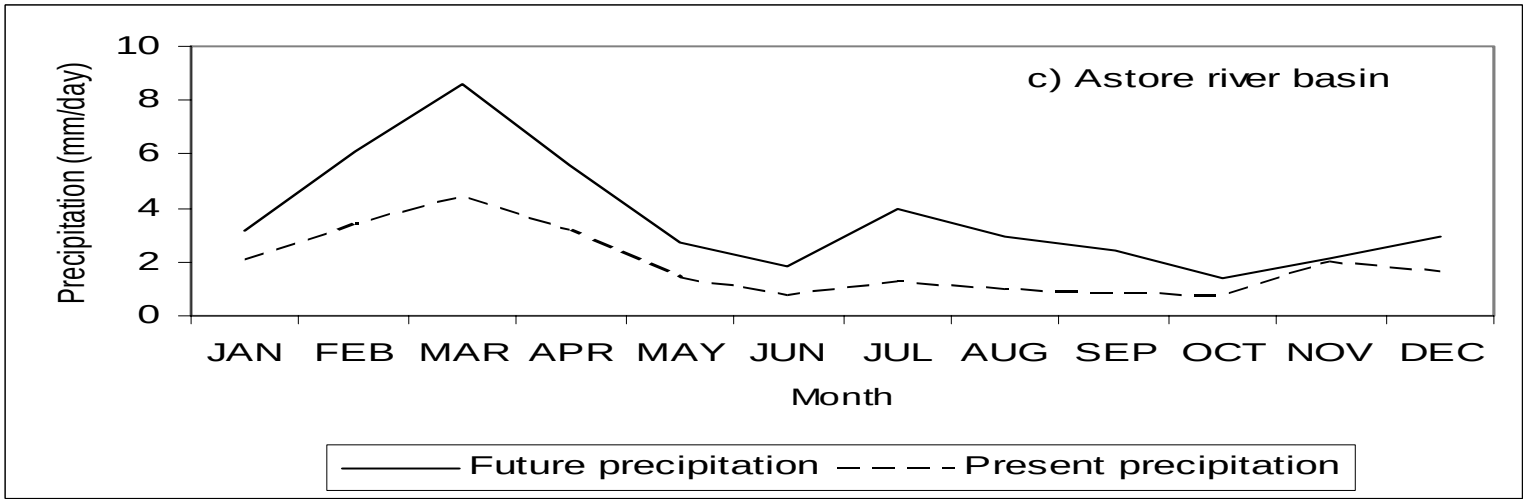


Mean annual cycle of precipitation as simulated with PRECIS for present and future day climate [mm/day]

(Akthar et al. 2005)

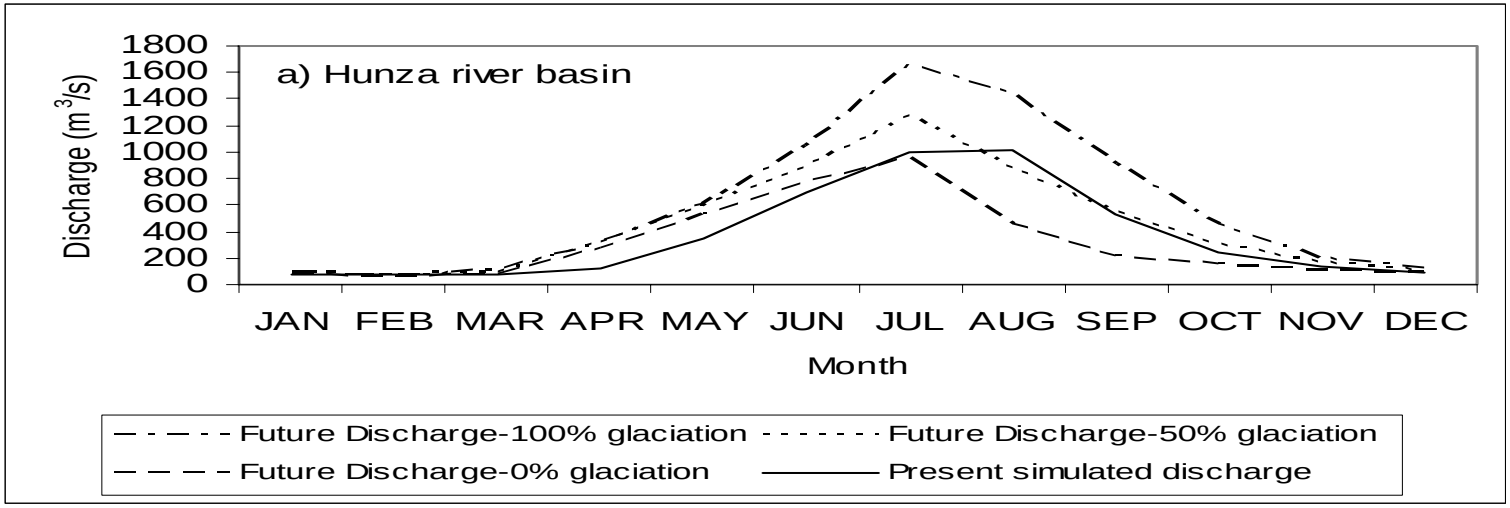


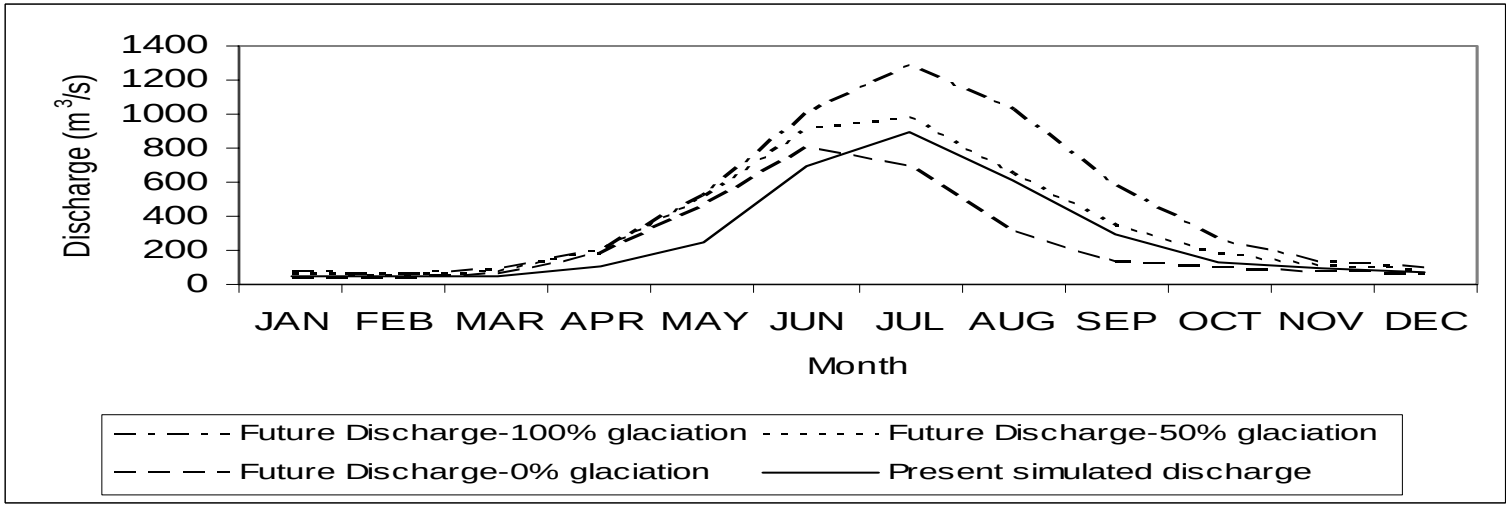


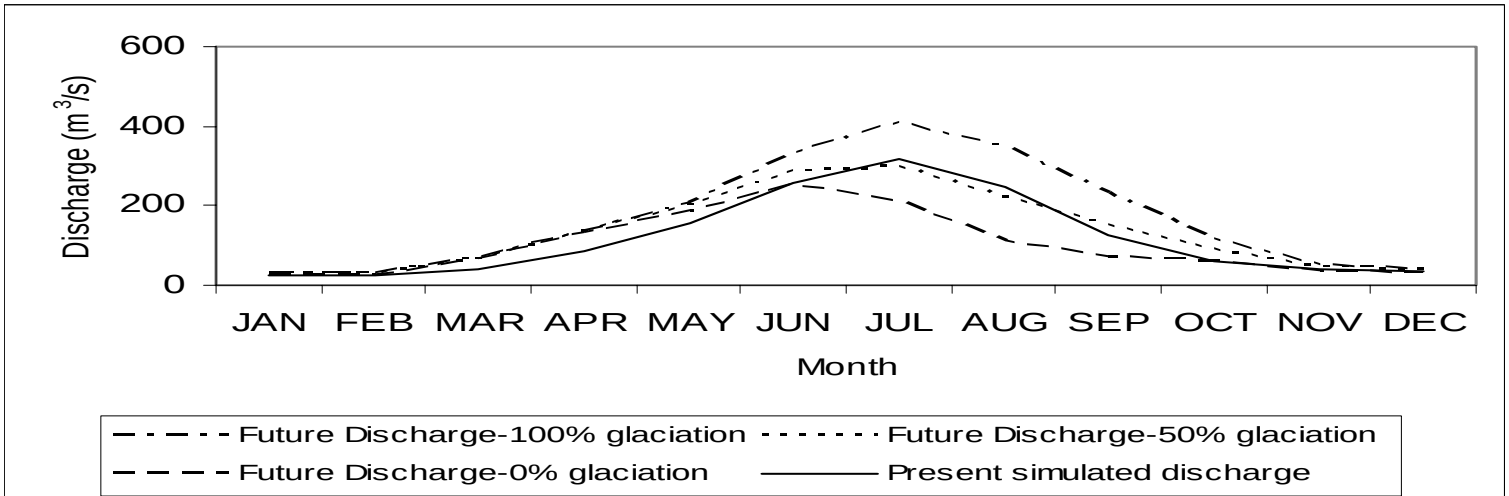


Annual discharge cycle simulated by HBV-PRECIS for the present climate and future climate for three stages of glaciation for three river basins

(Akthar et al. 2005)







MANAGEMENT OF WATER RESOURCES & ADAPTATION

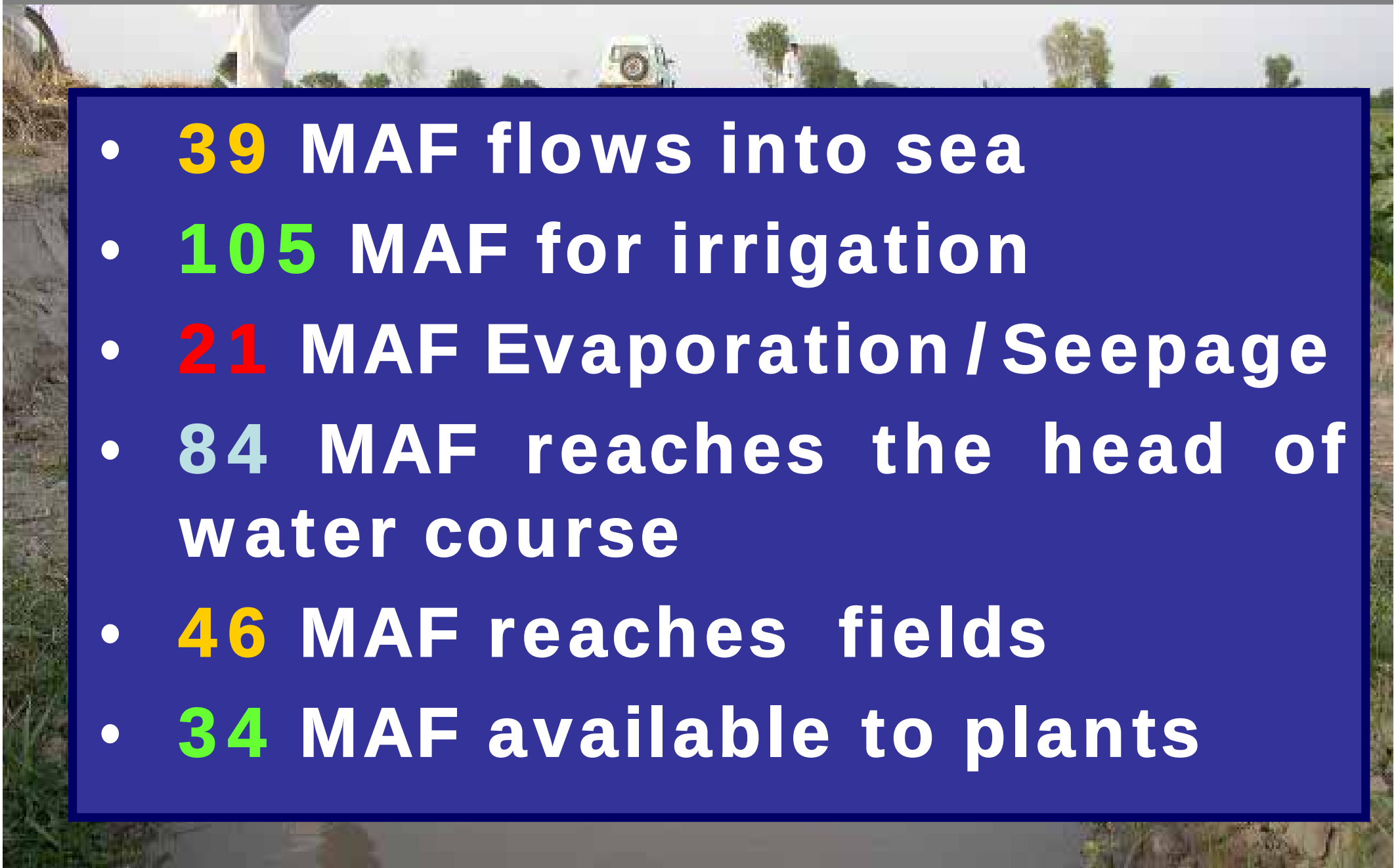
&

WATER REQUIREMENT OF PAKISTAN

TOTAL WATER RESOURCES AVAILABLE

Surface Water availability	Water (MAF)
Mean river inflows	144
Rainfall	26
Hill torrents	17
Total	187
Groundwater availability	50
Total availability	237

SYSTEM LOSSES



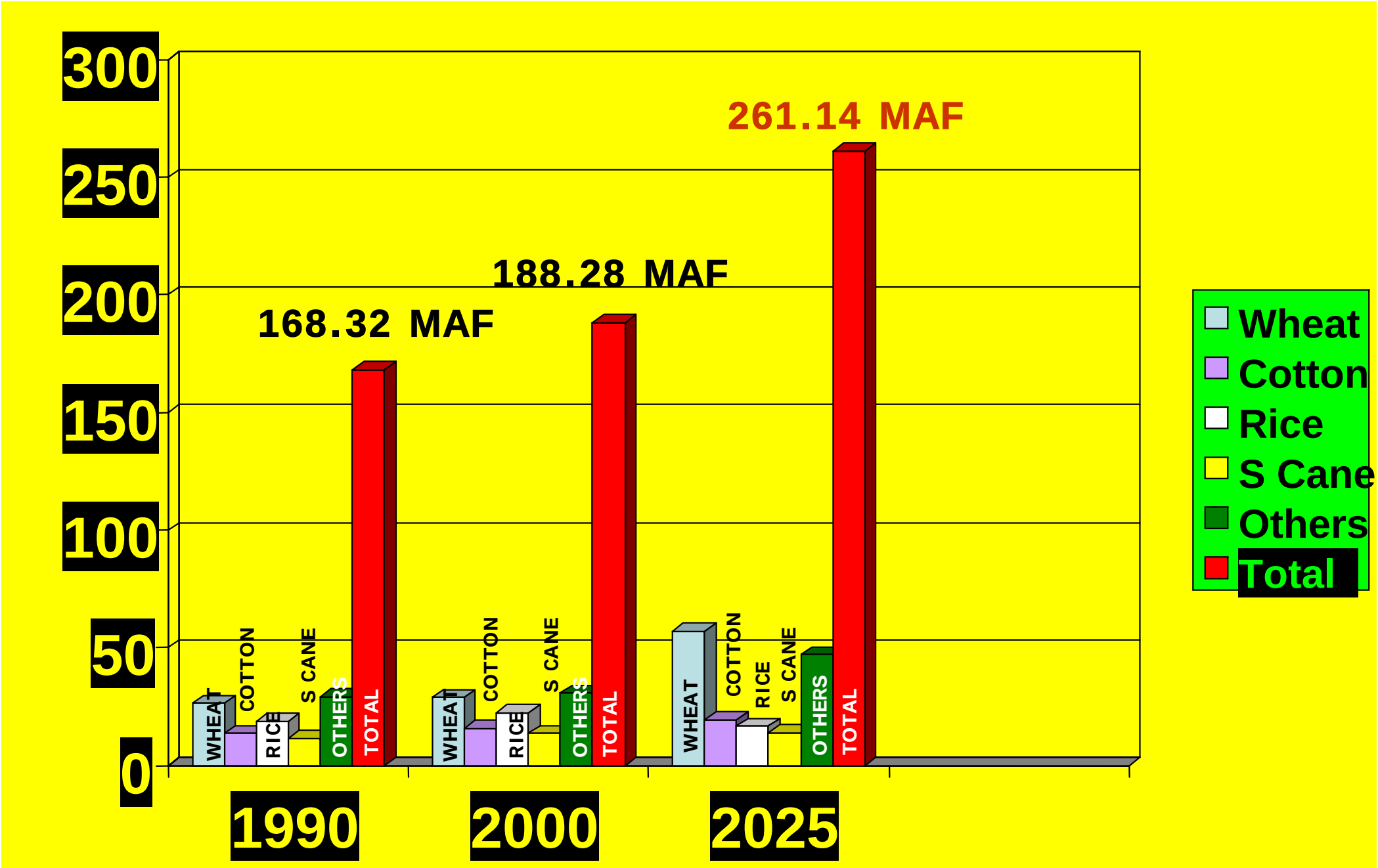
- 39 MAF flows into sea
- 105 MAF for irrigation
- 21 MAF Evaporation/Seepage
- 84 MAF reaches the head of water course
- 46 MAF reaches fields
- 34 MAF available to plants

Projected Water Requirement 2025

Present population	~160 million
Population between	**210 - 240** million
UNDP	240 million
World Bank	225 million
Government of Pakistan	208 million

About 50% more food at present consumption rate and corresponding water requirement of 210 BCM

Agricultural Water Demands (MAF)



INCREASE IN POPULATION

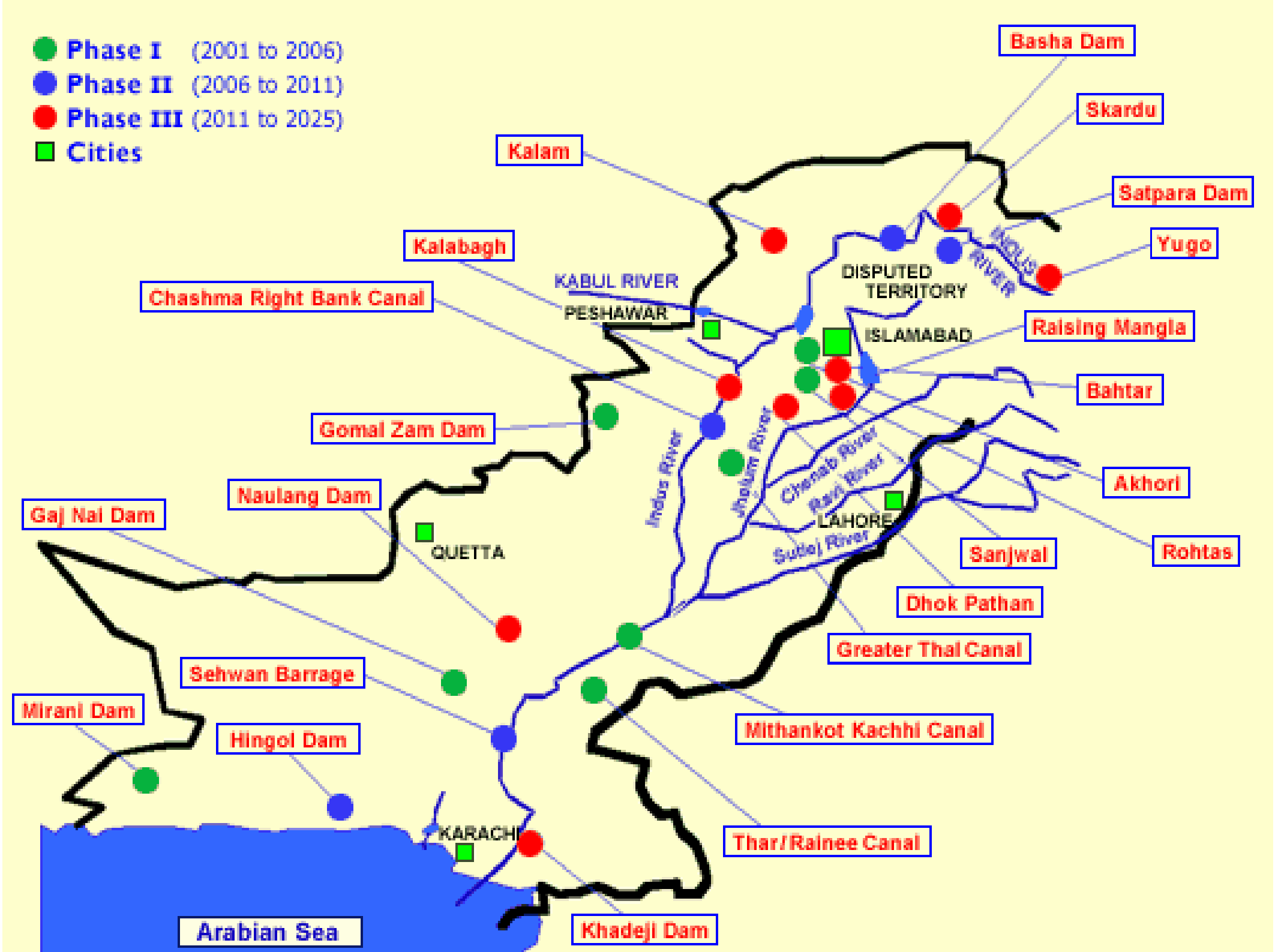
5000
cubic meters

1000
cubic meters

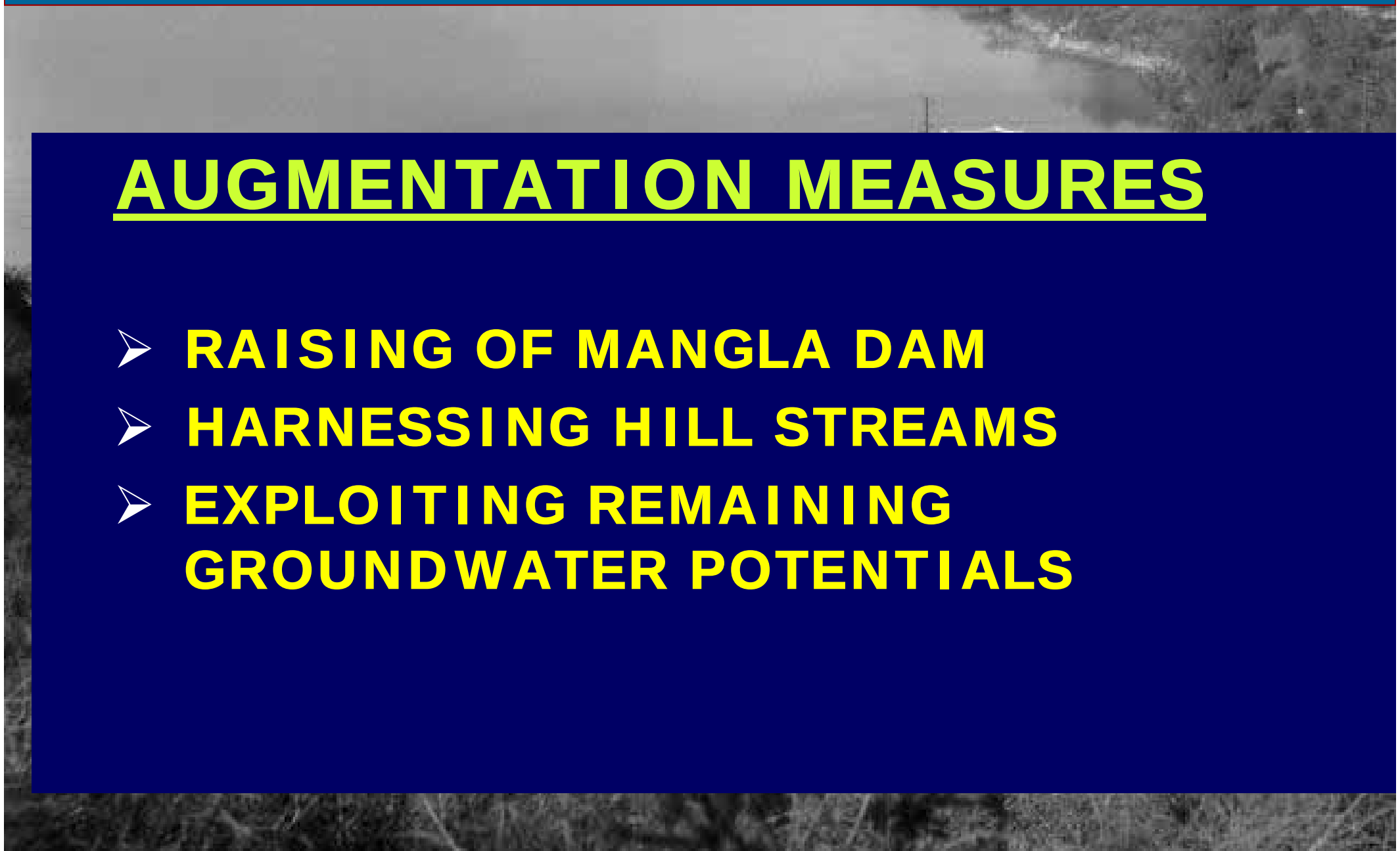
Water Management in the Future

POORLY MANAGED IRRIGATION SYSTEM

DEPLETING GROUND WATER RESOURCES


Phase I (2001 to 2006)
Phase II (2006 to 2011)
Phase III (2011 to 2025)
Cities
Basha Dam
Skardu
Satpara Dam
Yugo
Kalam
Kalabagh
Chashma Right Bank Canal
KABUL RIVER
PESHAWAR
DISPUTED TERRITORY
INDUS RIVER
ISLAMABAD
Raising Mangla
Bahtar
Gomal Zam Dam
Indus River
Jhelum River
Chenab River
Ravi River
Sutlej River
LAHORE
Akhori
Naulang Dam
Gaj Nai Dam
QUETTA
Sanjwal
Rohtas
Dhok Pathan
Greater Thal Canal
Sehwan Barrage
Mithankot Kachhi Canal
Mirani Dam
Hingol Dam
KARACHI
Thar/Rainee Canal
Arabian Sea
Khadeji Dam

PLANNING COMMISSION VISION 2025



AUGMENTATION MEASURES

- RAISING OF MANGLA DAM
- HARNESSING HILL STREAMS
- EXPLOITING REMAINING GROUNDWATER POTENTIALS

PLANNING COMMISSION
VISION 2025

Management Measures

- Lining canals/watercourses
- Changes in cropping pattern
- Using high efficiency irrigation techniques

Future targets under AWCI

- Temporal mapping and database development of cryosphere based on satellite data and field validation
- Investigate and quantify the climate change phenomena and hydrological balance
- Interrelation of climate change, cryosphere and landuse, and its potential impact on hydrological processes
- Water resources management both for operational use and scenario based assessments for planning purposes

Expectation from GOESS

- Sharing various data sets especially remote sensing
- Capacity building in terms of numerical modeling and flood forecasting
- Sharing of ideas and experiences


Thank You