# INSTITUTIONS TO COPE HYDROLOGICAL VARIABILITY: CASES FROM PAKISTAN

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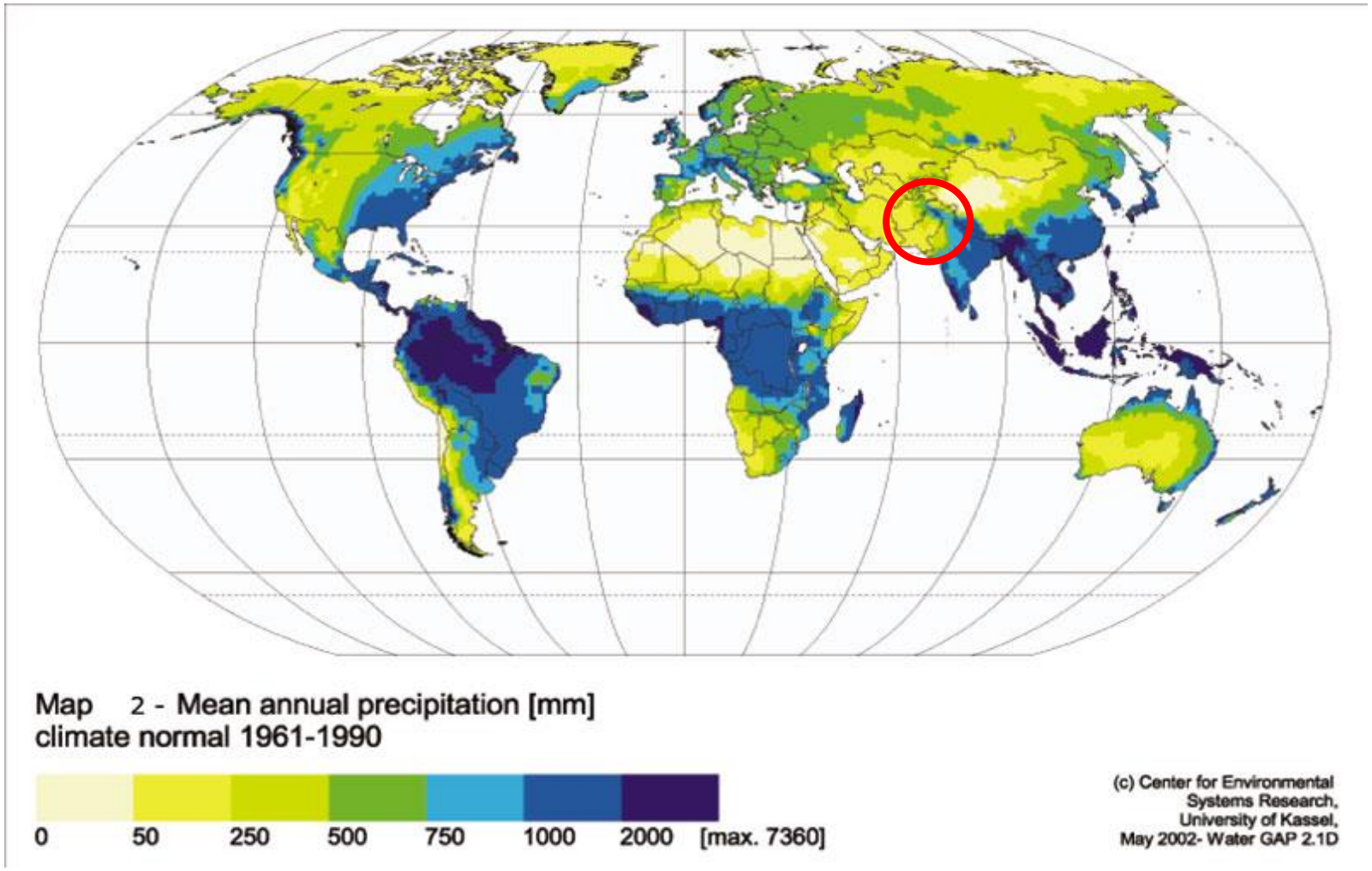
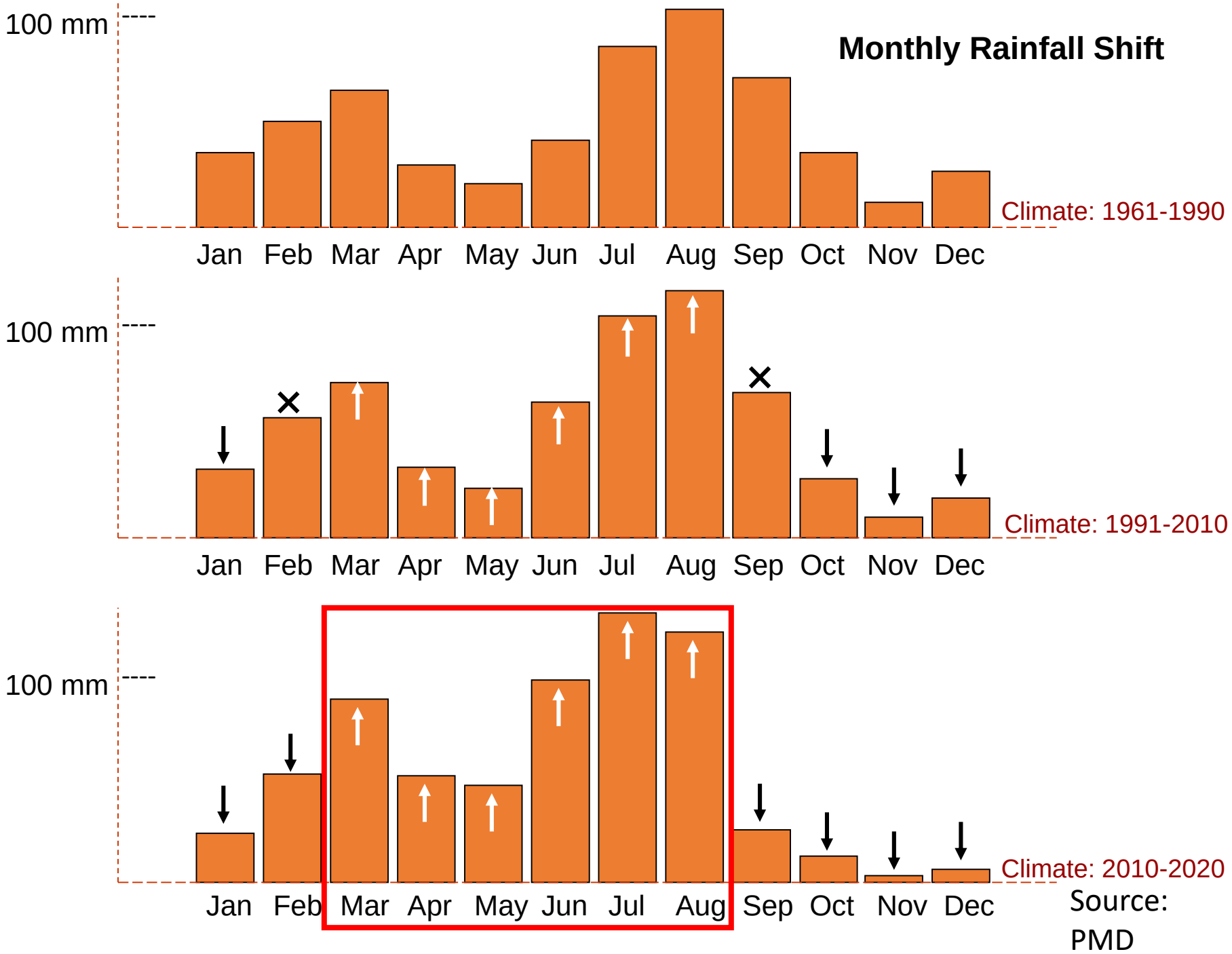
# Hydrological Variability

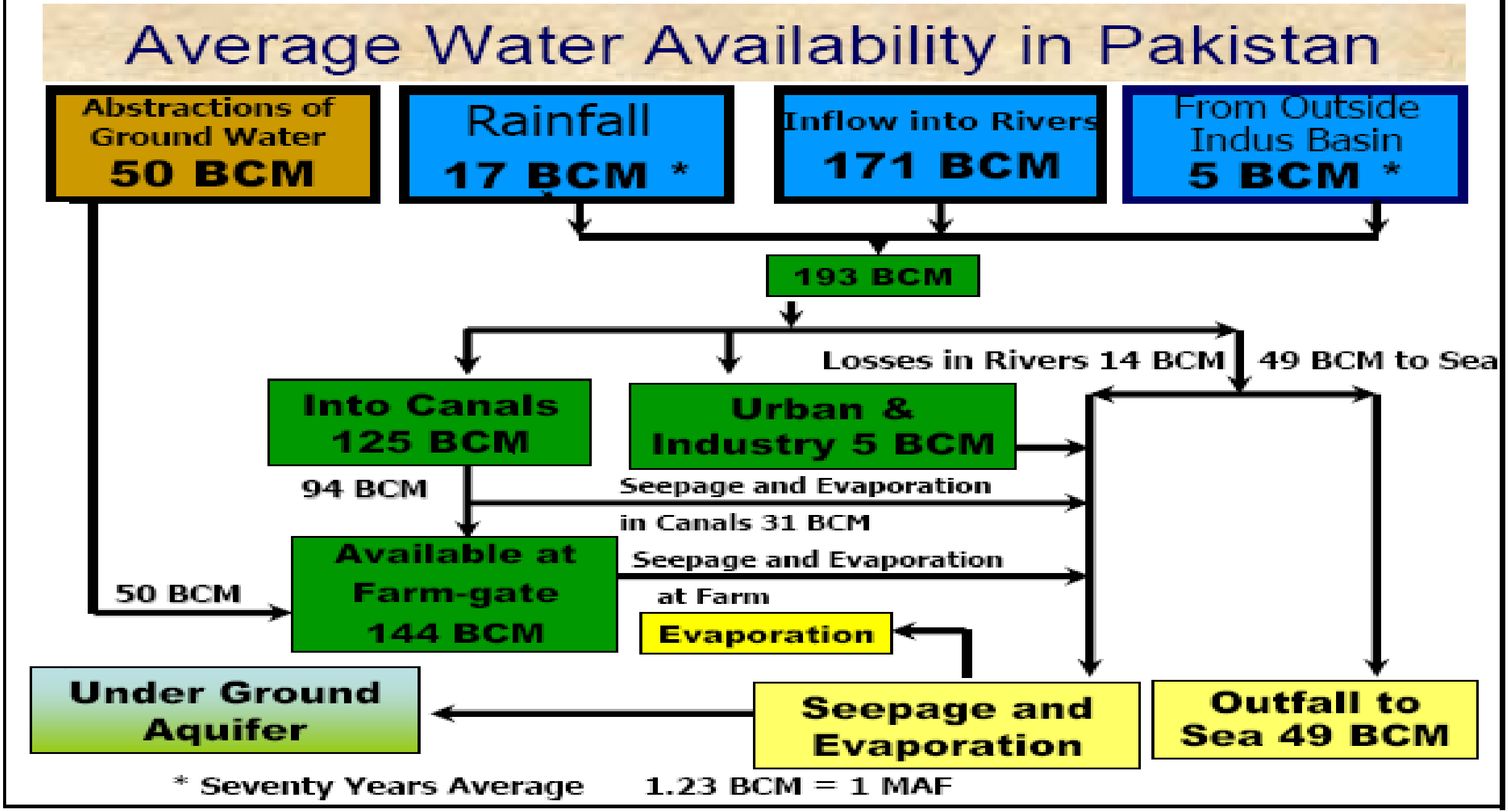
- Hydrological variability and scarcity are major issues in irrigated agriculture in arid/semi-arid environments
- The cases of success provide low hanging fruits to learn lessons for improvement
- The cases in this presentation show different levels of hydrological variability and institutions to cope it

# Precipitation Variability

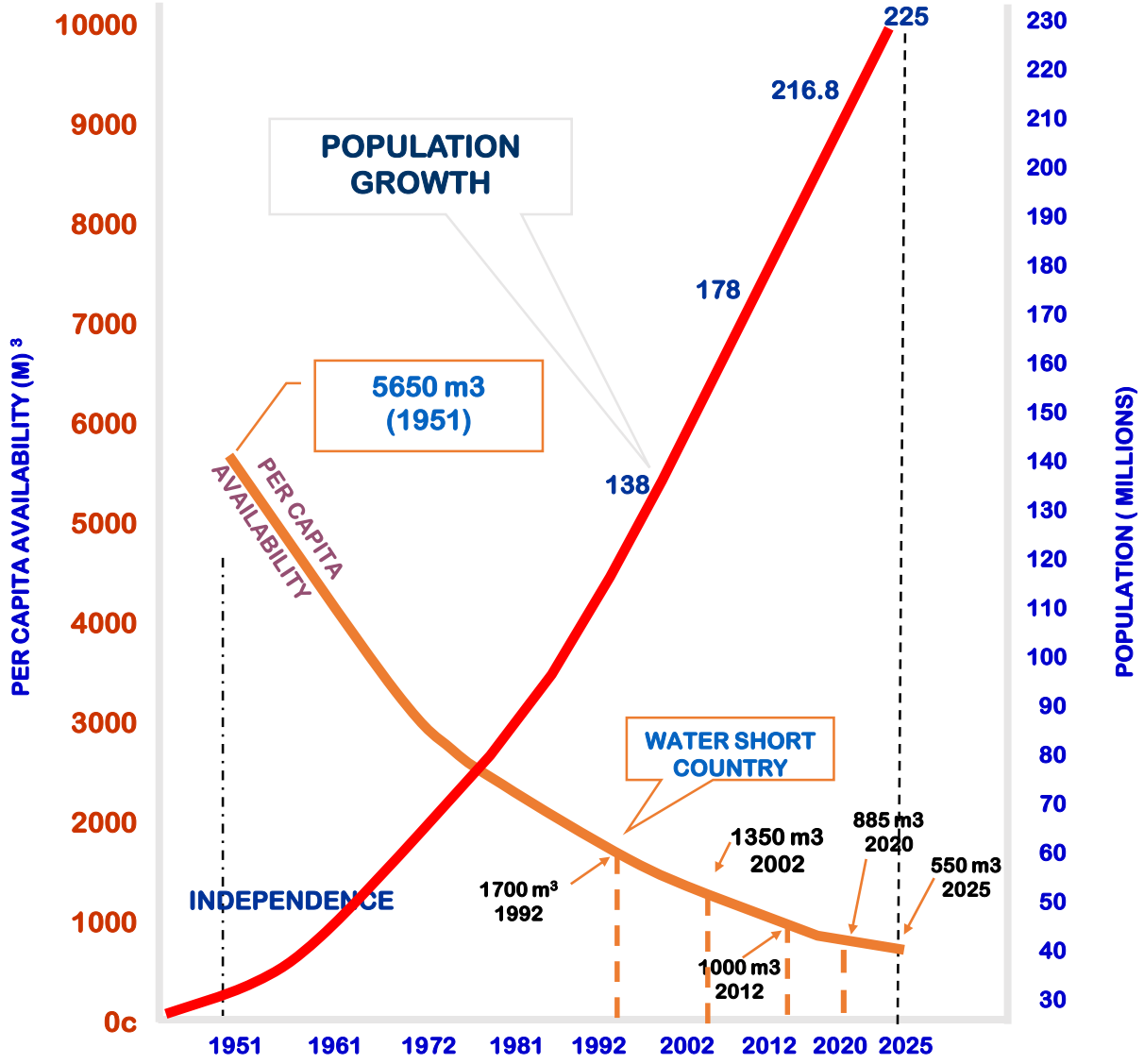



Monthly Rainfall Shift
100 mm
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Climate: 1961-1990
100 mm
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Climate: 1991-2010
100 mm
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Climate: 2010-2020
Source:
PMD

# Average Water Availability in Pakistan



# Per capita Fresh water availability



# Diversity in irrigation systems

- Huge variation in agro-ecological conditions i.e. from sea level to K-2.
- Largest contiguous irrigation system in the world
- Small scale irrigation systems are found in all ecologies majorly in arid and semi arid zones.
- Large irrigation systems get huge attention due to transboundary and hydroelectric issues
  - More attention in term of supporting public goods (crop varieties, agronomic packages etc.) given to resource rich large systems
  - Agri. subsidies support large systems
- Small irrigation systems in Pakistan get less focus in research and academic circle, getting a status of ‘Orphanage’

# Sources of Hydrological Variability in Large System - IBIS

- Storage is mostly blamed for irrigation water scarcity in Indus Basin Irrigation System
- There are huge inter and intra-canal variations depending on location of farm
- This has resulted in water logging due to excess water in some areas and left other areas with aridity and salinity due to heavy reliance on underground saline water
- The existing institutional architecture failed to resolve system wide inequity and variabilities

# Institutional structure in large system - IBIS

Despite of huge investments in physical infrastructure, the systems are increasingly facing under-performance:

- Too many institutions with little responsibility
- Too many laws without proper enforceability
- Poor institutional capacity
- Top down management – little role of users in system management
- Water is not seen as socio-economic good but more as an engineering artifact

# Governance Institutions

- Federal
  - Ministry of water and power
  - Min. of Science and Technology
  - Min. of Agriculture
  - Min. of Environment
  - Atomic Energy Commission
  - WAPDA, IRSA, FFC, CEA
  - IWASRI
  - PCRWR
  - Federal Water Management Cell
- Provincial
  - Irrigation departments
  - PIDAs
  - Local government dept.
  - Line agencies

# Laws and Regulations

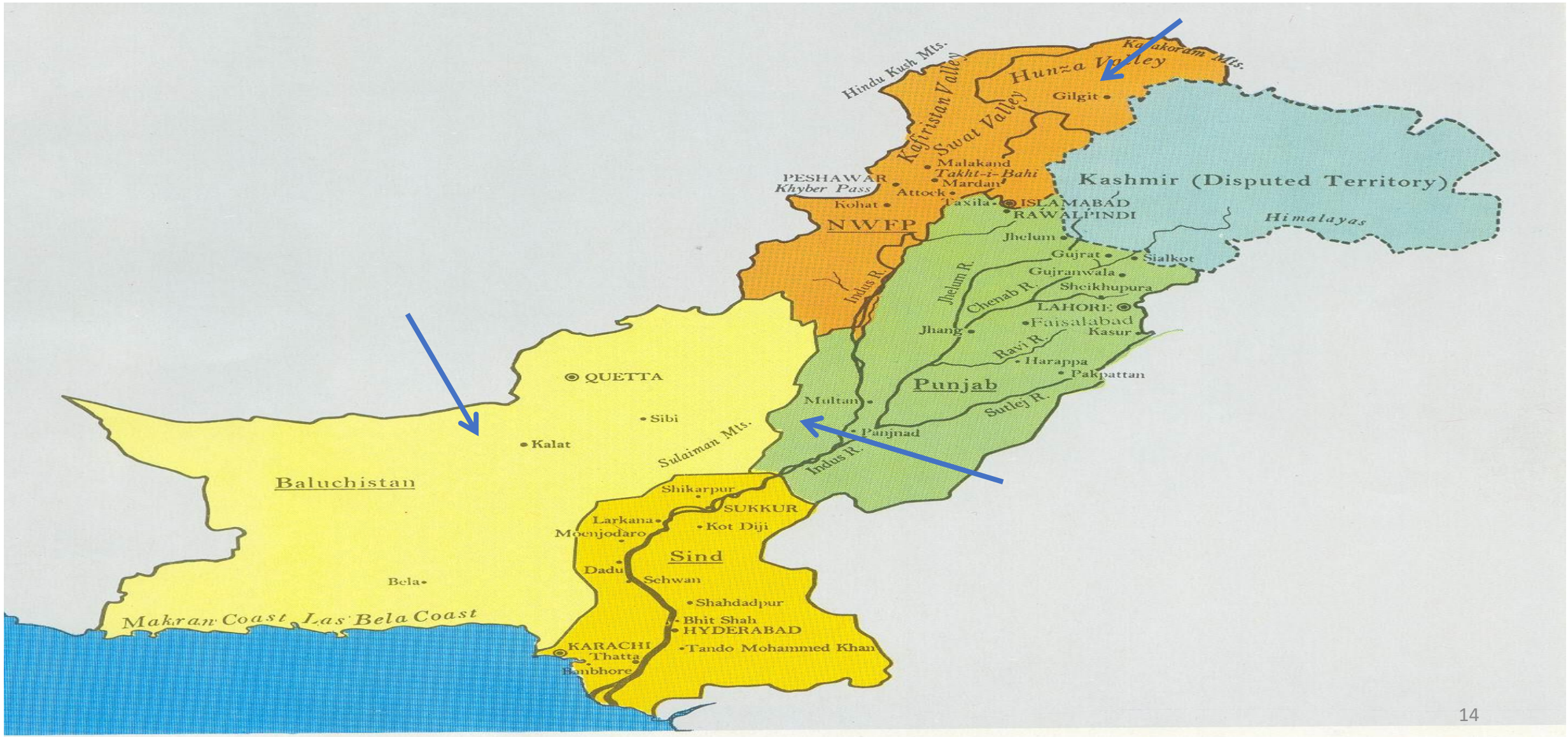
- **Federal**
  - WAPDA Act 1958
  - Water Accord 1991
  - IRSA ACT 1992
  - Environment Act 1992
  - Council of Common Interests (Constitutional body)

- **Provincial**
  - Irrigation and Drainage Act 1873
  - Punjab Soil Reclamation Act 1952
  - Balochistan Water Ordinannce 1980
  - Water Users Association Act 1982
  - PIDAs Atc 1997

# Small Systems

- Spate/flood irrigation systems in Punjab and KPK and Balochistan provinces
- Karezes in Balochistan
- Snowmelt/Stream flow systems in Northern Areas (Gilgit)

# Study Sites


Hindu Kush Mts.
Kafiristan Valley
Swat Valley
Hunza Valley
Karakoram Mts.
Gilgit
Malakand
Takht-i-Bahi
Mardan
PESHAWAR
Khyber Pass
Attock
Taxila
ISLAMABAD
RAWALPINDI
Kohat
NWFP
Kashmir (Disputed Territory)
Himalayas
Jhelum
Gujrat
Sialkot
Gujranwala
Sheikhupura
LAHORE
Faisalabad
Jhang
Kasur
Harappa
Pakpattan
Punjab
Multan
Sutlej R.
Panjnad
Indus R.
Jhelum R.
Chenab R.
Ravi R.
Indus R.
QUETTA
Sibi
Kalat
Sulaiman Mts.
Baluchistan
Shikarpur
SUKKUR
Larkana
Kot Diji
Moenjodaro
Sind
Dadu
Schwan
Bela
Shahdadpur
Bhit Shah
HYDERABAD
Tando Mohammed Khan
Makran Coast
Las Bela Coast
KARACHI
Thatta
Bhambhore

# Spate Irrigation Systems

- Spate Irrigation (locally named as *Rod Kohi)* is a flood water harvesting and management system where flood water is generated by heavy rainfall in upper catchments and it is unpredictable in occurrence and unreliable in amount.
- These systems have inherent extreme hydrological variability due to their reliance on rainfall
- The nature of farming in spate irrigation and challenges to collective action are different from large irrigation systems:
  - High uncertainty about water
  - Probability of getting water not evenly distributed across systems
  - Reactive water rights better suited to manage uncertainty

# Spate irrigation Systems..cont.

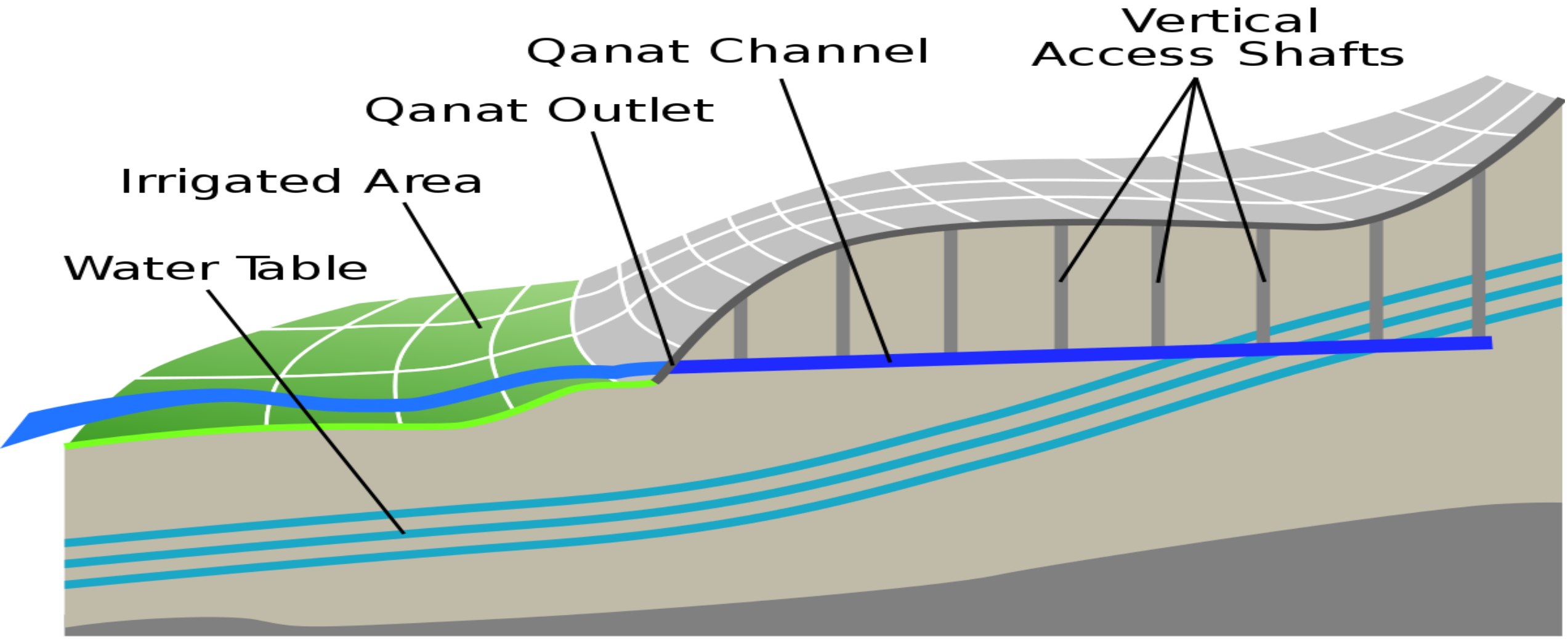
# Spate systems —Self-governance and sustainability to cope hydrological variability

- Presence of conditions of design principles (resource and user boundaries, local monitoring, local conflict resolution etc.)
- Reactive and flexible water rights crafted by users
- Hydrological variability spread to all users

# Karez Irrigation Systems (Balochistan province)

- Karez is an indigenous method of irrigation in which groundwater is tapped by a tunnel through gravity flow
- After running for some distance the tunnel comes out in the open and the water is conducted to the command area

# Karez Irrigation Systems (Balochistan province)



# Karez Irrigation Systems (Balochistan province)

- Karez irrigation is practiced in 22 countries from China to Chile including Pakistan. In Pakistan it is confined to the province of Balochistan which has a tribal society
- Currently, 15 million hectares (6% of World's irrigated lands) are irrigated by Karez system: half of the area is situated in Iran and the rest in other countries (Afghanistan, Pakistan, Azerbaijan, Oman, Morocco, and Mexico)

# Karez Irrigation..Contd.

- Importance attached to irrigation from Karez systems may be gauged from local saying: ‘A mosque should be demolished if it obstructs the course of Karez (Makran District Gazetteer, P-187, published 1906)
- In Balochistan, until 1970, around 3000 Karez systems were in use, providing water supply to farmers
- Only few partially functional karezes found now

# Karez Irrigation.. Sources of disturbance

- Subsidy on Electricity by Government
- No public-sector programs to improvise the traditional Karez systems
- Some Karez systems are still working in Balochistan where due to lack of electricity and tube-well subsidy, the ground-water table remained stable
- Karez systems successful worked for centuries due to a well defined group of users with water rights, local monitoring and conflict resolution mechanisms (most of the Ostrom's Design Principles)
- The decline of Karez systems also resulted in erosion of social capital and self governance

# Snow melt irrigation systems in HKH

- Northern Pakistan is meeting point of the mighty mountains ranges i.e. Hindukush-Karakoram-Himalyas
- Tops of these mountains are covered with snow. Summer is mild and winter is cold
- Rivers flow far below the cultivable land, entire dependence is on streams/Nallahs/Kuhls fed by glacial melt water
- Variation in flow as sometime flows entirely dry up and other time freeze entirely

# Snow melt systems--Contd

- Kuhls/Eels (irrigation channels) were made by early settlers, Mirs, and Rajas
- Each channel/kuhl commands a scheme, which is maintained through active participation of water users.
- Rajaki (traditional system of kuhl management) is used for kuhls management (maintenance, water distribution etc.)
- Huge investment in repair, de-silting of channels and is managed by villagers themselves even after the abolition of feudal systems in area since 1970
- Interventions of the public-sector institutions are minimal and limited to failed physical infrastructures

# Snow melt irrigation systems—Sources of sustainability

- Aga Khan Rural Support Program played pivotal role to build local community of water users in majority of the snow melt systems
- AKRSP used a proper mix of scientific and traditional knowledge
- Series of meeting and dialogues between technical experts, social organizers and communities to make a best fit
- AKRSP also help communities to bring more area under cultivation so as to keep farming competitive under increasing population and commercialization, through minimum 75% votes in favor of any decision

# Summary-Synthesis

| System | Infrastructural Interventions | Impacts | Capacity to cope hydrological variability |
|---|---|---|---|
| Spate (settled areas of Punjab) | State Law and management interference; concrete structures | Deteriorating collective action; devastated concrete diversions; conflicts among community | Poor |
| Spate (Tribal areas of Punjab) | Customary rules; Local material based diversion structures | Strong collective action; | Good |
| Karezes (Electricity reaches areas) | Electricity subsidy to promote agri production | Deep water table and dried karezez | Poor |
| Karez (no tubewell installations areas) | Traditional karez based social structure | Strong collective action and self governance | Good |

# Summary-Synthesis..Contd.

| System | Infrastructural Interventions | Impacts | Overall condition |
|---|---|---|---|
| Snow-melt systems | AKRSP work honoring indigenous knowledge | Strong local action and improved livelihoods | Very Good |
| | Government intervened in form of irrigation structures | Structures not matching the system requirements | Poor |

# Institutions to Cope Hydrological Variability

- Different systems need different interventions based on biophysical and social context - no ‘one size fits all’ policy
- The large canal system failed to harvest social capital around irrigation system despite of efforts through Irrigation Management Transfer
- Some small local systems have successfully handled extreme hydrological variability through locally evolved institutions – e.g Spate irrigation systems
- State interventions without consideration of local context and hydrological principles results in drastic failure (case of electricity subsidy in Karez command areas)

# Institutions to Cope Hydrological Variability

- Institutions based on scientific principles and indigenous knowledge make successful case for sustainable irrigation systems (case of Snowmelt systems)
- Failure of large systems in minimizing variability is due to poor local and transboundary institutional arrangements
- External efforts to transfer irrigation management is not successful without consideration of local context and issues
- External assistance can be beneficial provided:
  - Local knowledge and scientific knowledge are mixed to best fit the problem
  - State bureaucracy and line departments should not challenge collectively decided resource institutions
  - Systems specific R&D is needed to meet local needs through proper research

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# Thank You

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## Questions & Comments

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