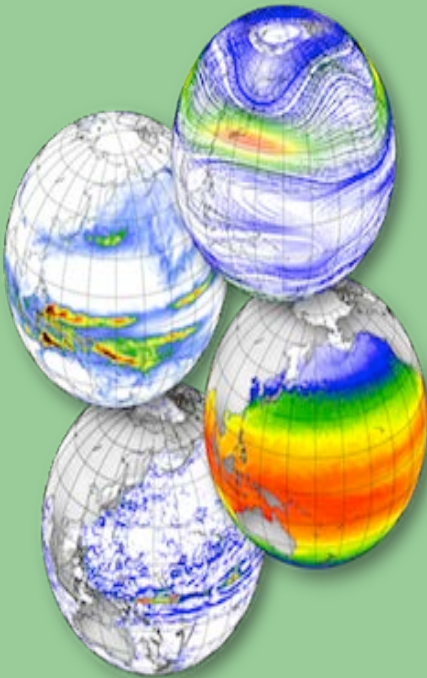


Courting Catastrophe through GEOSS-AWCI Program



Mr Hazrat Mir

Chief Meteorologist PMD



Rationale

PMD is extensively involved in **metering and modeling the water resource**

Since **Meteorology is the fundamental basis of Integrated Water Resources Management, PMD is implementing tools and technologies for effective **use of GEOSS data** in water sector**



Rationale

In line with GOALS of GEOSS-AWCI,
new projects have been initiated in
cooperation with international
agencies **to improve predictability,**
and interpret the information
applicable to various water
environments in Pakistan

The outcomes are **contributing to**
mitigate water-related disasters
through effective **Early Warnings.**



Projects related to Water Sector

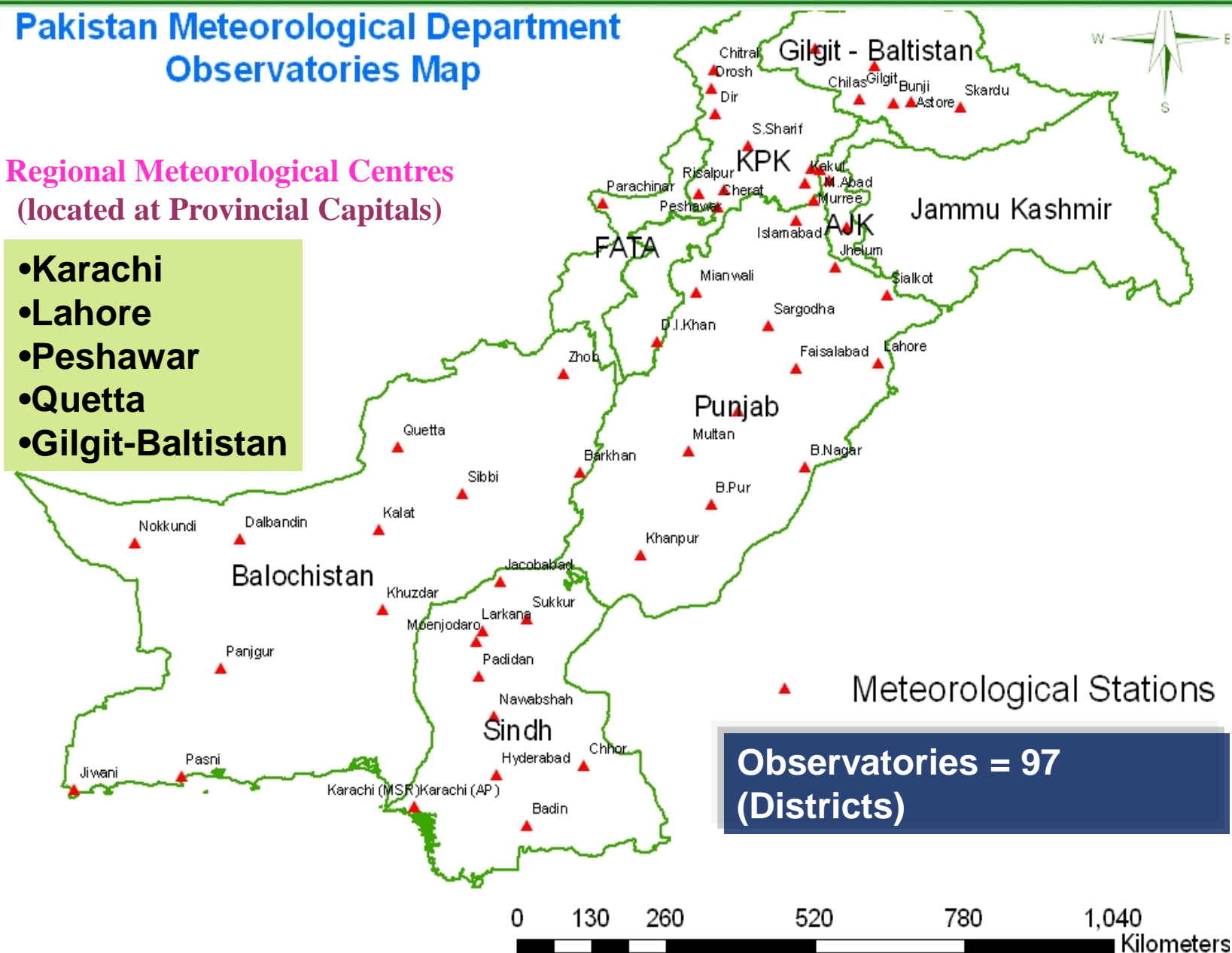
- ✓ **IFAS Project Phase I**
- ✓ **IFAS Project Phase II**
- ✓ **GLOF Project Phase I**
- ✓ **GLOF Project Phase II**
- ✓ **Specialized Medium Range Forecasting Center (SMRFC) Project**
- ✓ **Drought Monitoring & Early Warning Project**



Pakistan Meteorological Department Observatories Map

Regional Meteorological Centres
(located at Provincial Capitals)

- Karachi
- Lahore
- Peshawar
- Quetta
- Gilgit-Baltistan



Observatories = 97
(Districts)

OPERATIONAL HYDROLOGICAL SERVICES OF PMD

Flood Forecasting Division (FFD) Lahore is a specialized unit of PMD for this purpose.

Responsibilities

- i. Flood Forecasting**
- ii. River stream flow forecasting**
- iii. Water availability Forecast for Dams**
- iv. Assisting Water Management at Dams specially during Monsoon**

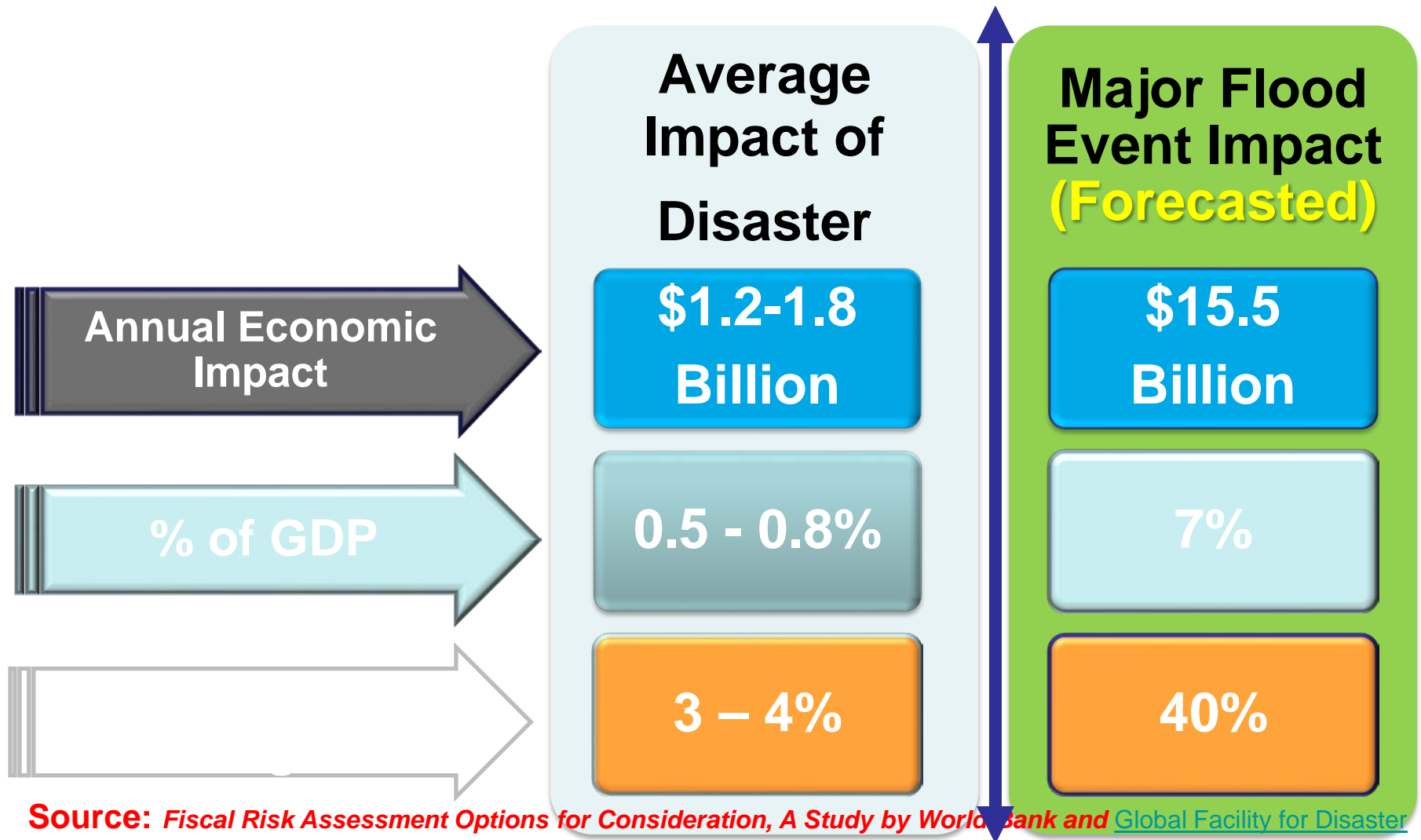
Floods - 2010



Floods - 2011

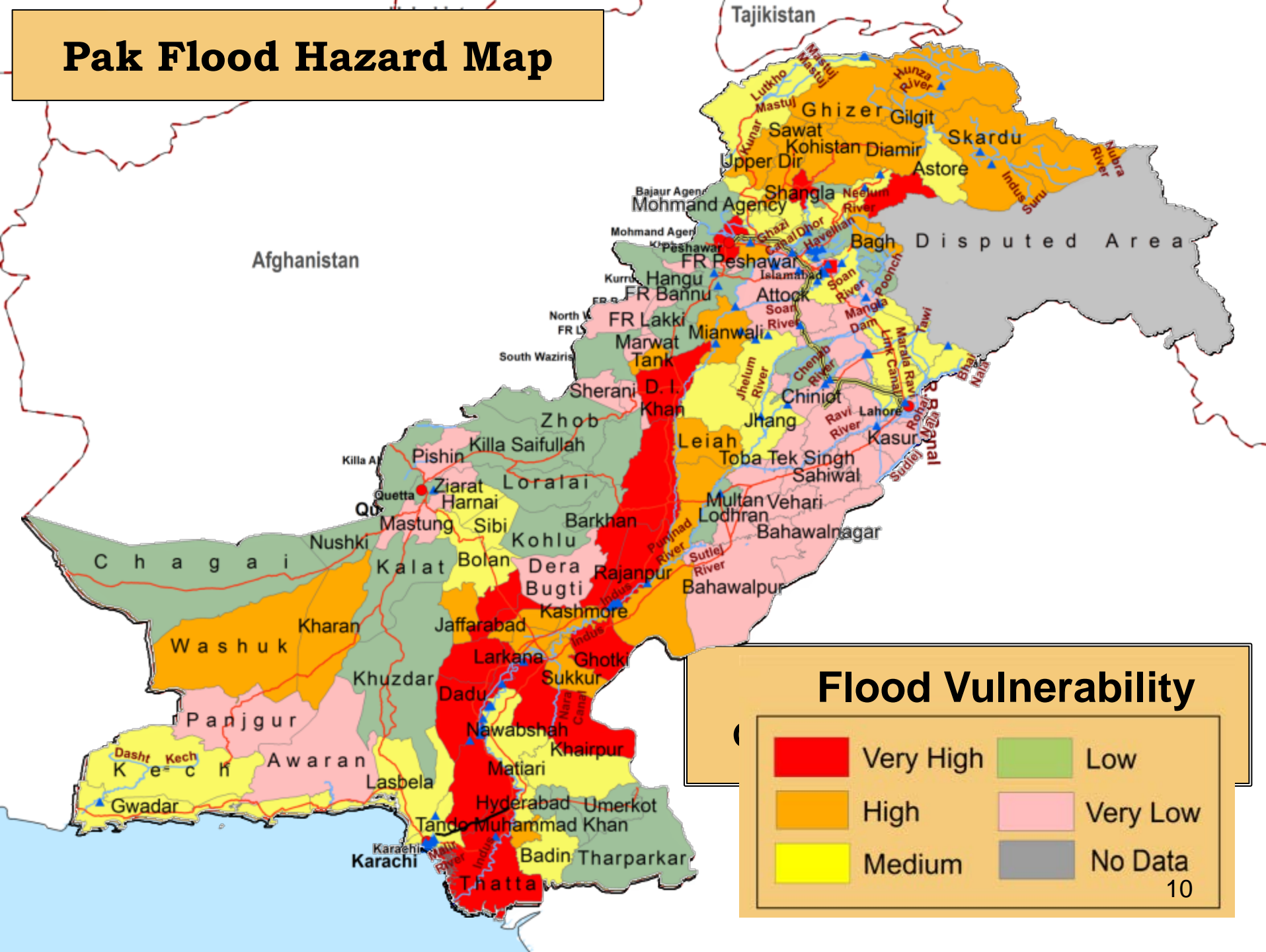


Economic Impact of Major Disasters Since 2005



Source: *Fiscal Risk Assessment Options for Consideration, A Study by World Bank and Global Facility for Disaster*

Pak Flood Hazard Map



Preparation and Dissemination of Flood Forecast

(15th June to 15th October)

Analysis of Meteorological Condition

- Analysis of different Wx Charts, (Surface, upper, 0000UTC to onward as desire)
- Study analyzed Wx charts and different models through their websites
- Study the HRM Model products(PMD website)
- Study the GFS Model & other models

Analysis Hydrological Condition/Parameter

- Rainfall data from PMD stations
- Rainfall, Discharge data, WAPDA, Irrigation, PCIW
- Rim Station and below Rim Station data of all rivers(Hydrological Form)
- Out put of FEWS & CLS Model
- Out put of PMD developed Model
- GFS Model
- Latest all Wx/Doppler Radar Data
- Latest Satellite Imagery

Further Technique

Statistical Technique & Empirical Technique

Conference

Group discussion of 6-7 Meteorologist and Hydrologist

Issuance of Flood Forecast Bulletins

- Bulletin A & Bulletin B (For next 24-hours)
- Early Warning: different Significant Warning/Advisory as and when required for a particular area

Dissemination Dissemination Through

- Uploaded on website
- 5-fax machines
- PMD's website (Click Flood Update)
- Most concerned persons informed on telephones
- SMS to very Concerns
- Live beeper on Television and Radio
- In Camera interview on TV etc
- Daily Press Conference
- Attended meeting with local Govt. on Critical Situations

Media for Public & Concerned Authorities also

- Electronic Media
- Print Media
- Radio

Concerned Agencies

- FFC (Federal Flood Commission)
- NDMA(National Disaster Management Authority)
- Prime Minister/President Relief
- Commissioner
- Irrigation Department
- WAPDA
- Pak. Army
- All Provincial Govt. etc and 300 agencies

World largest contiguous Irrigation System
(US\$ 300 Million); (RIVERS OF PAKISTAN)

WESTERN RIVERS

AFGHANISTAN

KABUL

INDUS

JHELUM

CHENAB

W. & S. W. Hill
Torrents

S. W. Hill
Torrents

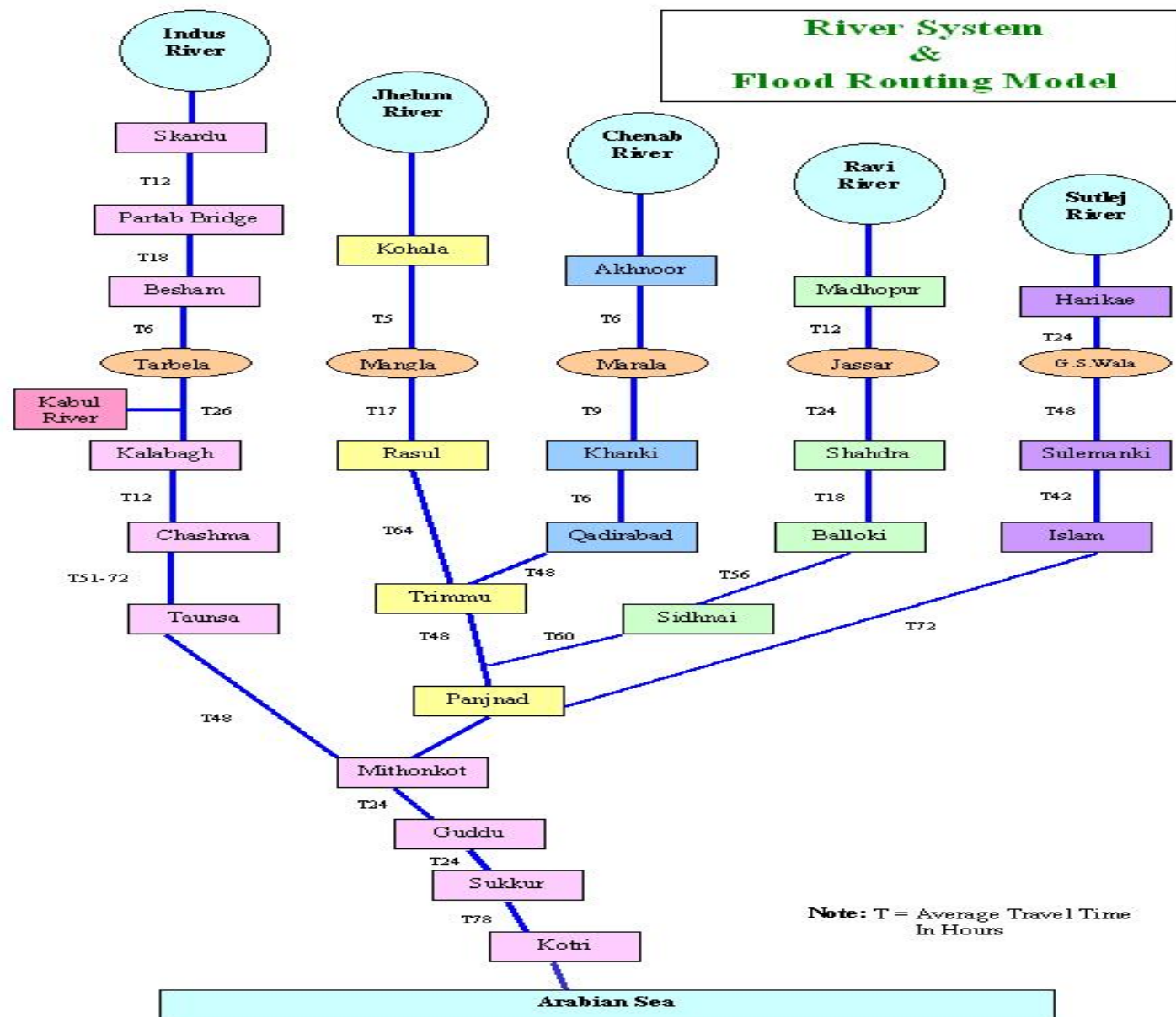
RAVI
SUTLEJ

BEAS

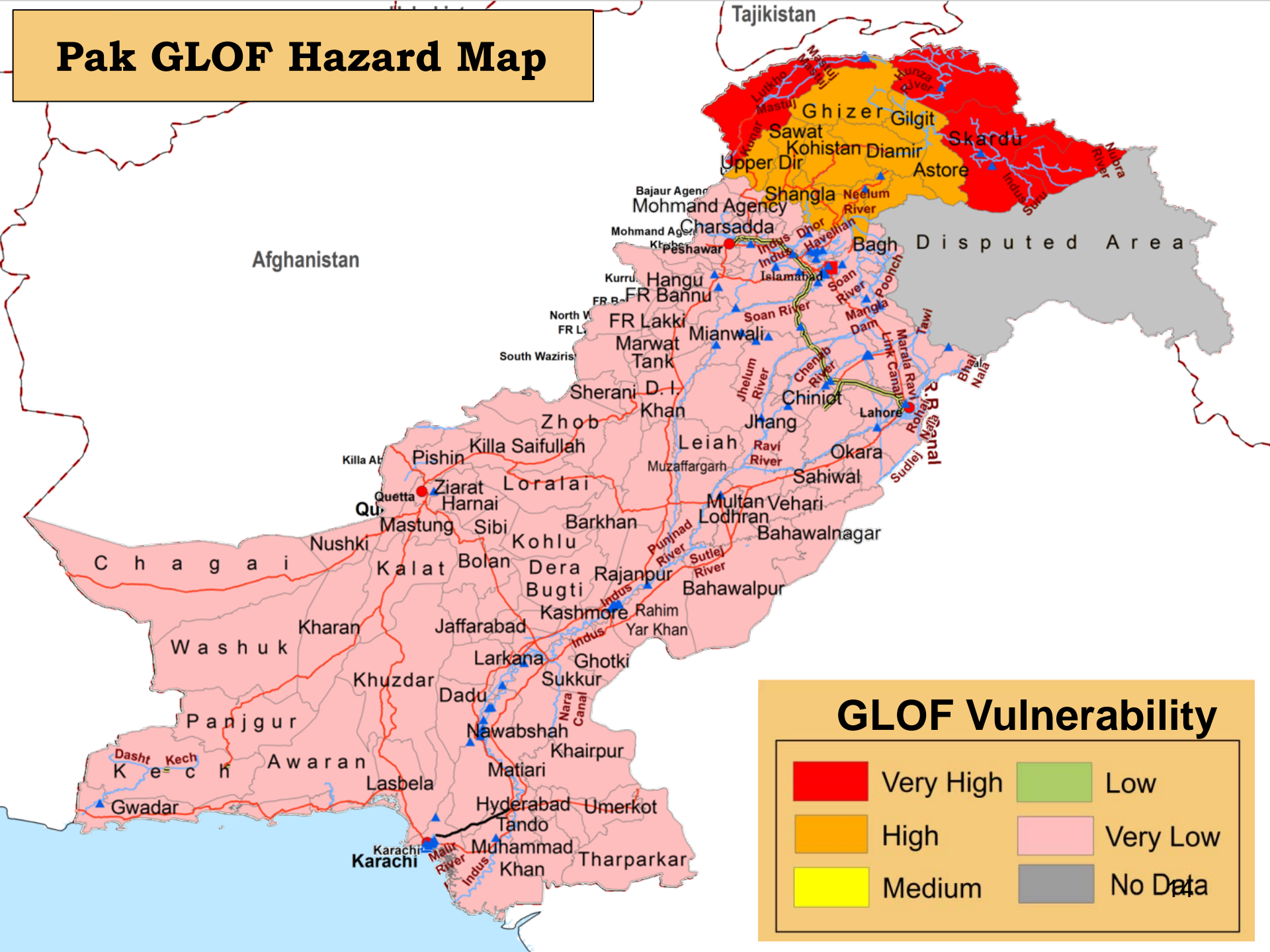
INDIA

EASTERN RIVERS

Population	180 M	
Cultivable Area	73 Ma	
Irrigated Area	36 Ma	
Major Storage Reservoirs	3	
Barrages	19	
Main Canals	45	
Link Canals	12	
Small Dams (approx 3 MAF)	140	



Pak GLOF Hazard Map

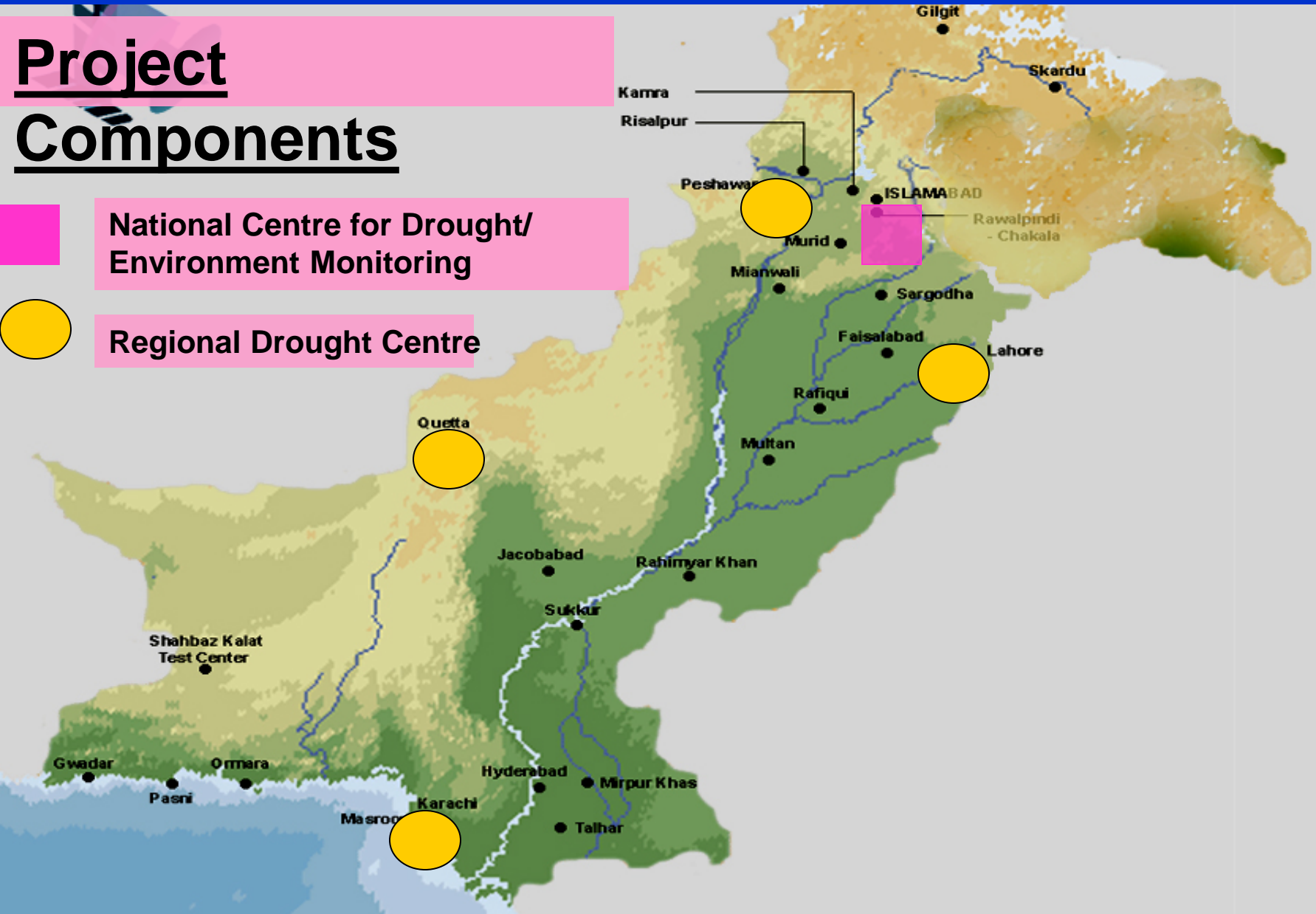


Drought/Environment Monitoring & Early Warning Centre

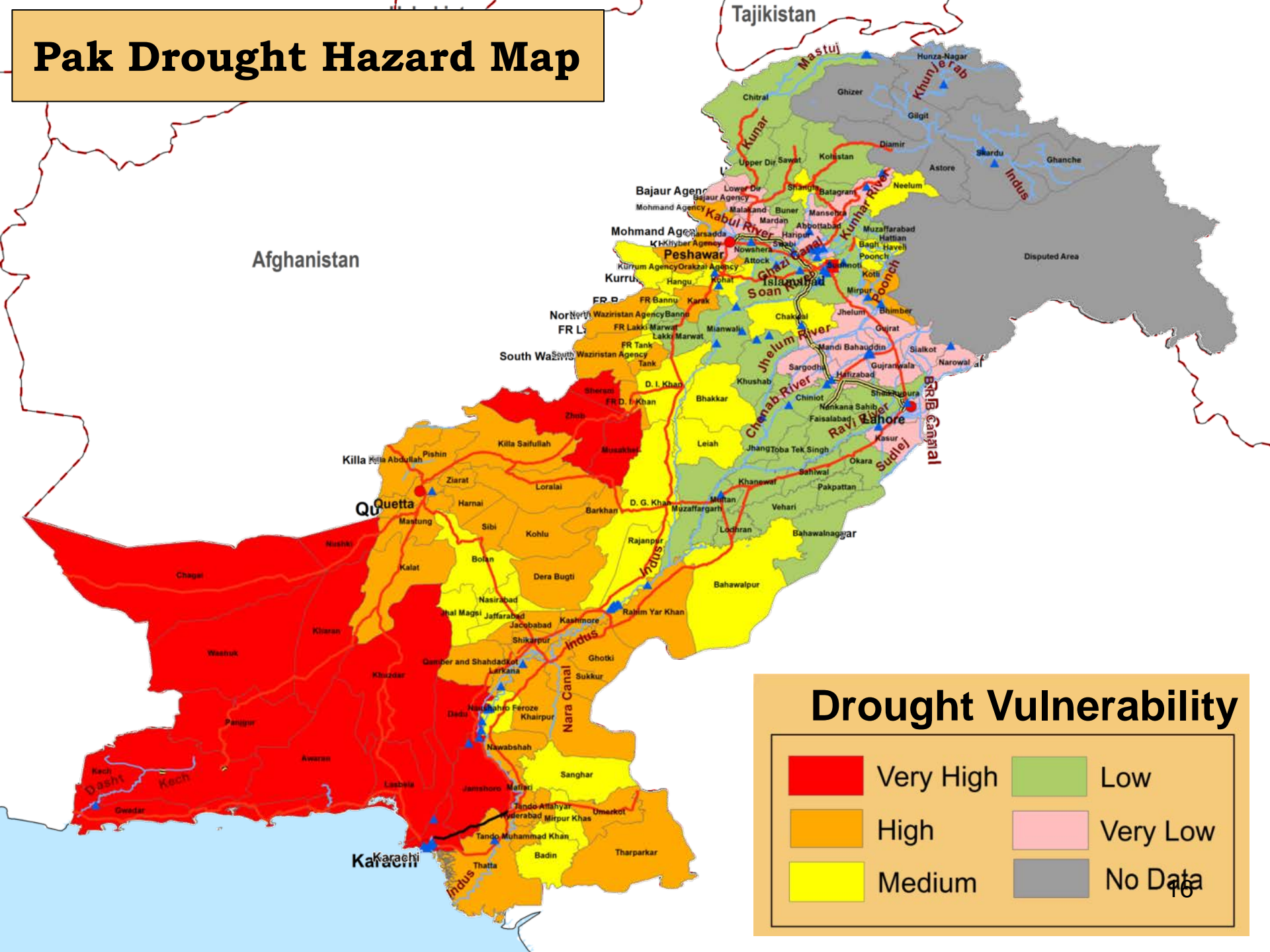
Project Components

 National Centre for Drought/Environment Monitoring

 Regional Drought Centre



Pak Drought Hazard Map



Drought Vulnerability

	Very High		Low
	High		Very Low
	Medium		No Data

Satellite Products being used for Drought Monitoring

Duration 16th Dec 2016 to 31st Dec 2016

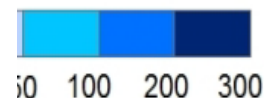
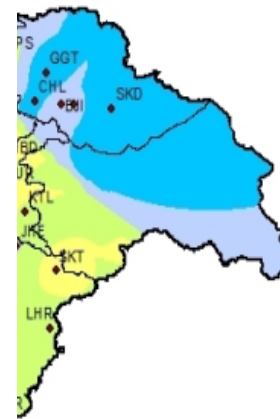
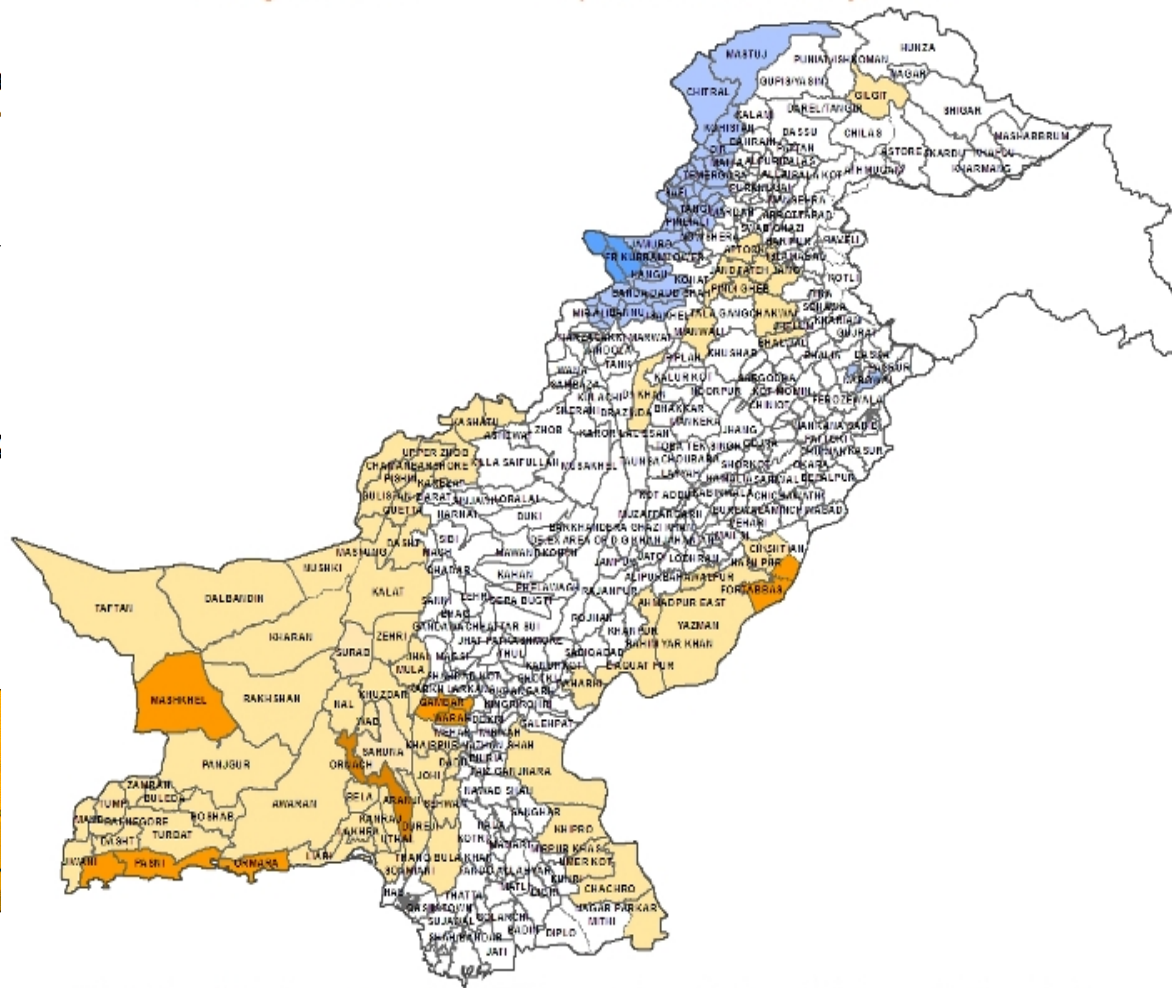
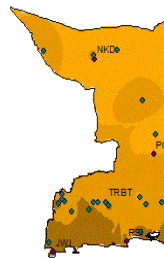
Drought Monitor

Updated 2nd January, 2017

Land Surface

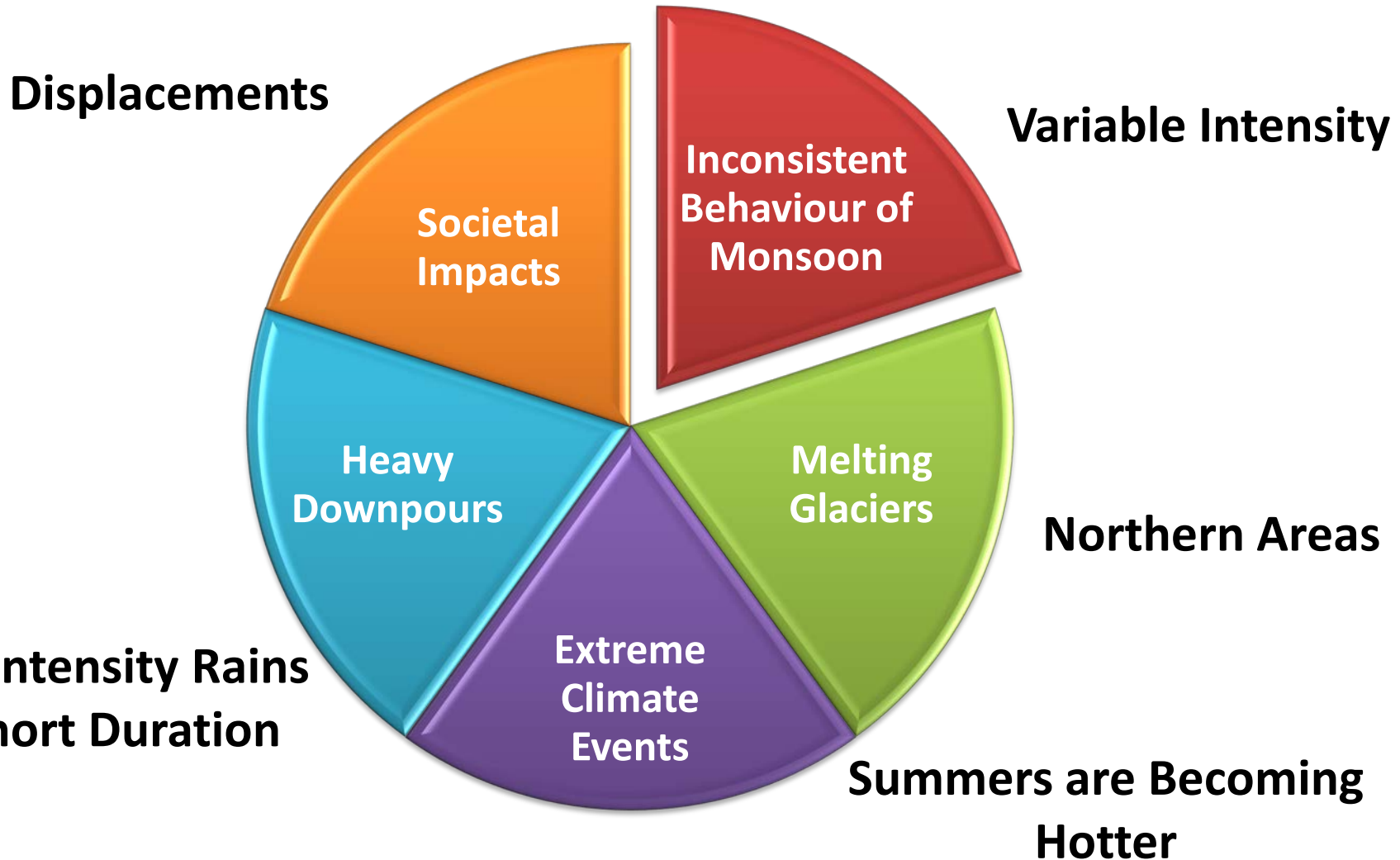
11 -

11 -





Global Climate Impact on Pakistan





Pakistan Meteorological Department
Government of Pakistan



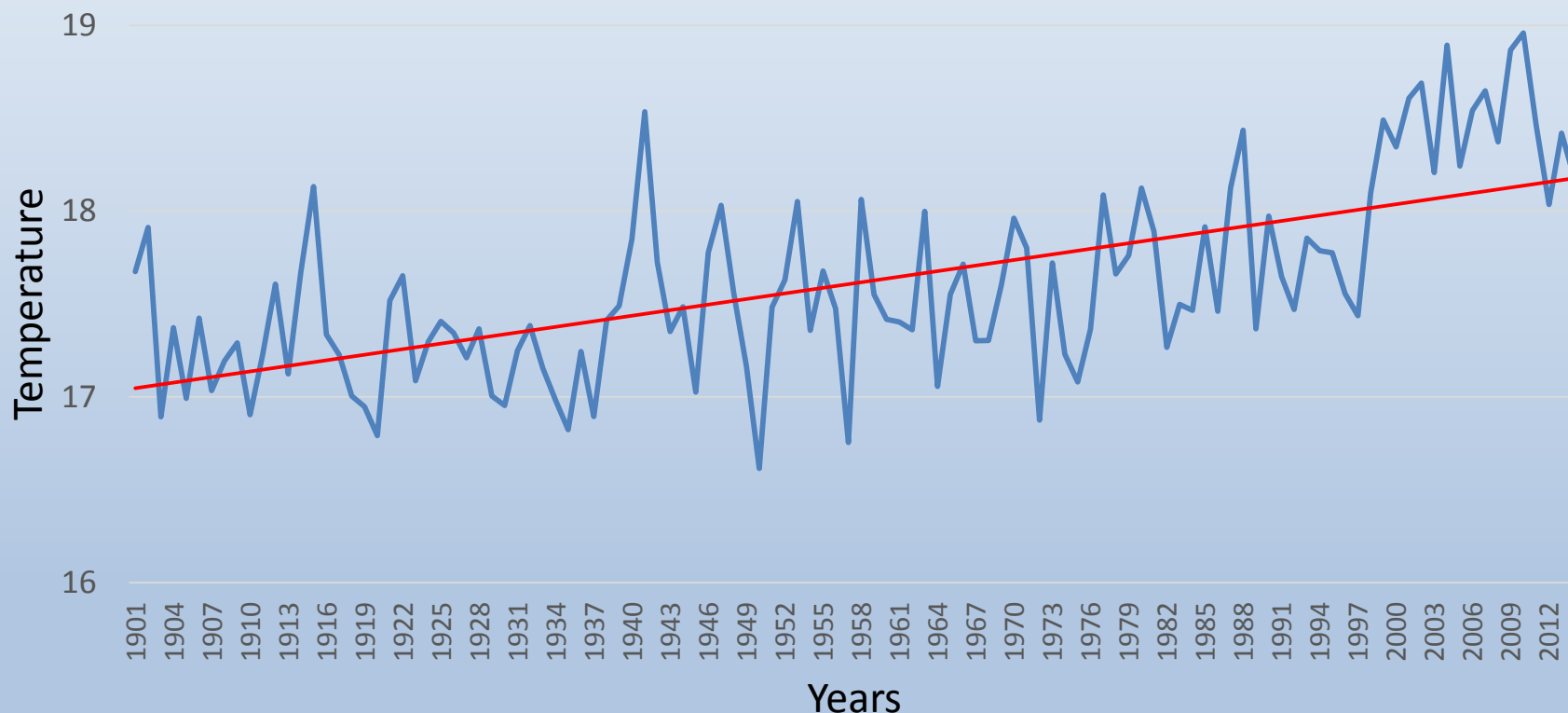
Climate Change In Pakistan



Annual Mean Temperatures (°C) Trends

Pakistan

• 1901-2014



Rate of Change = 0.10°C per Decade



Climate Change Trends over Pakistan

- The slope of the mean annual temperature over Pakistan during the 48-year period 1960-2007 was found as:

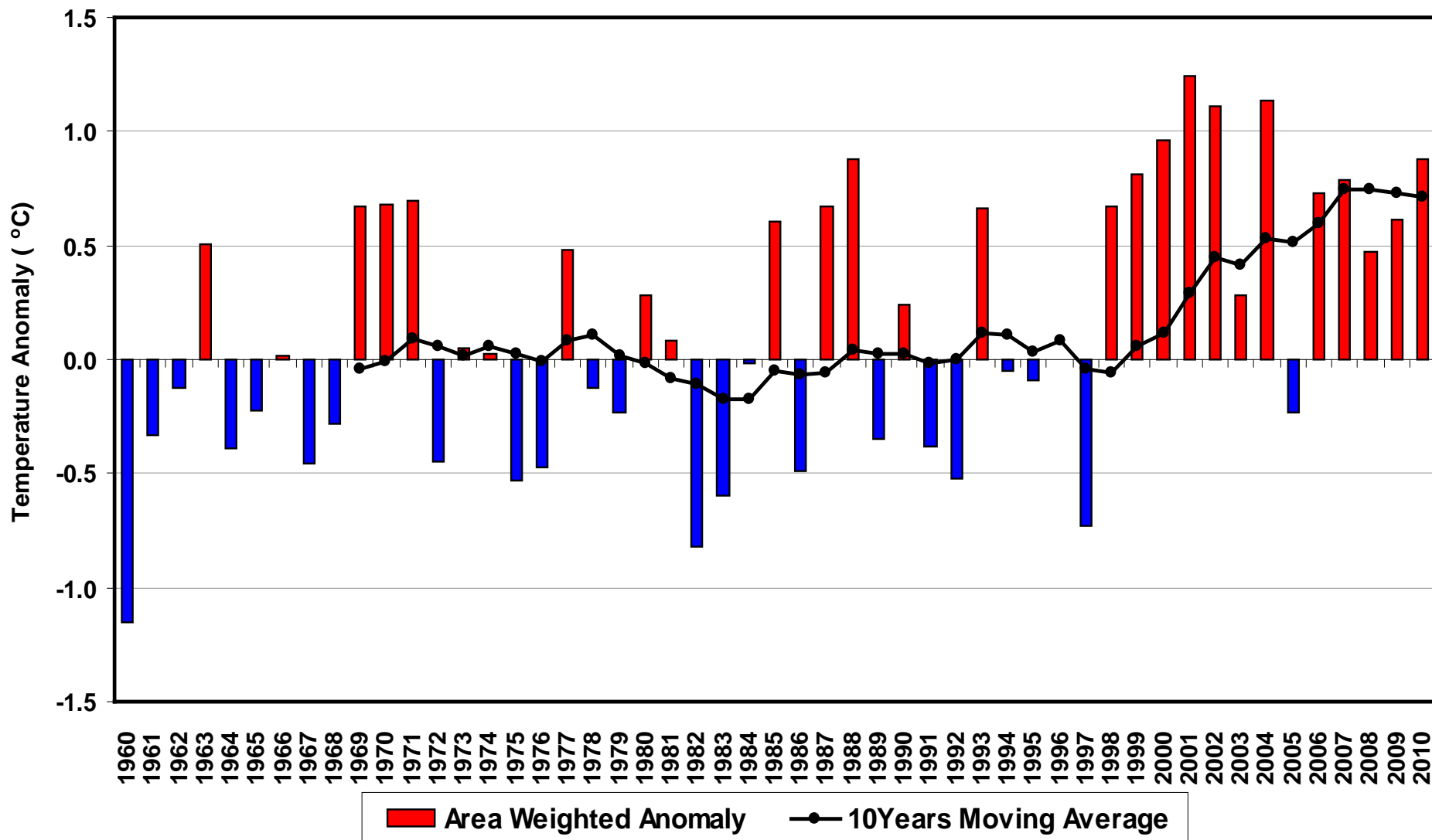
1901-2000 0.06 °C per decade

1960-2007 0.24 °C per decade

- The rate of increase is higher than the rate of increase observed globally

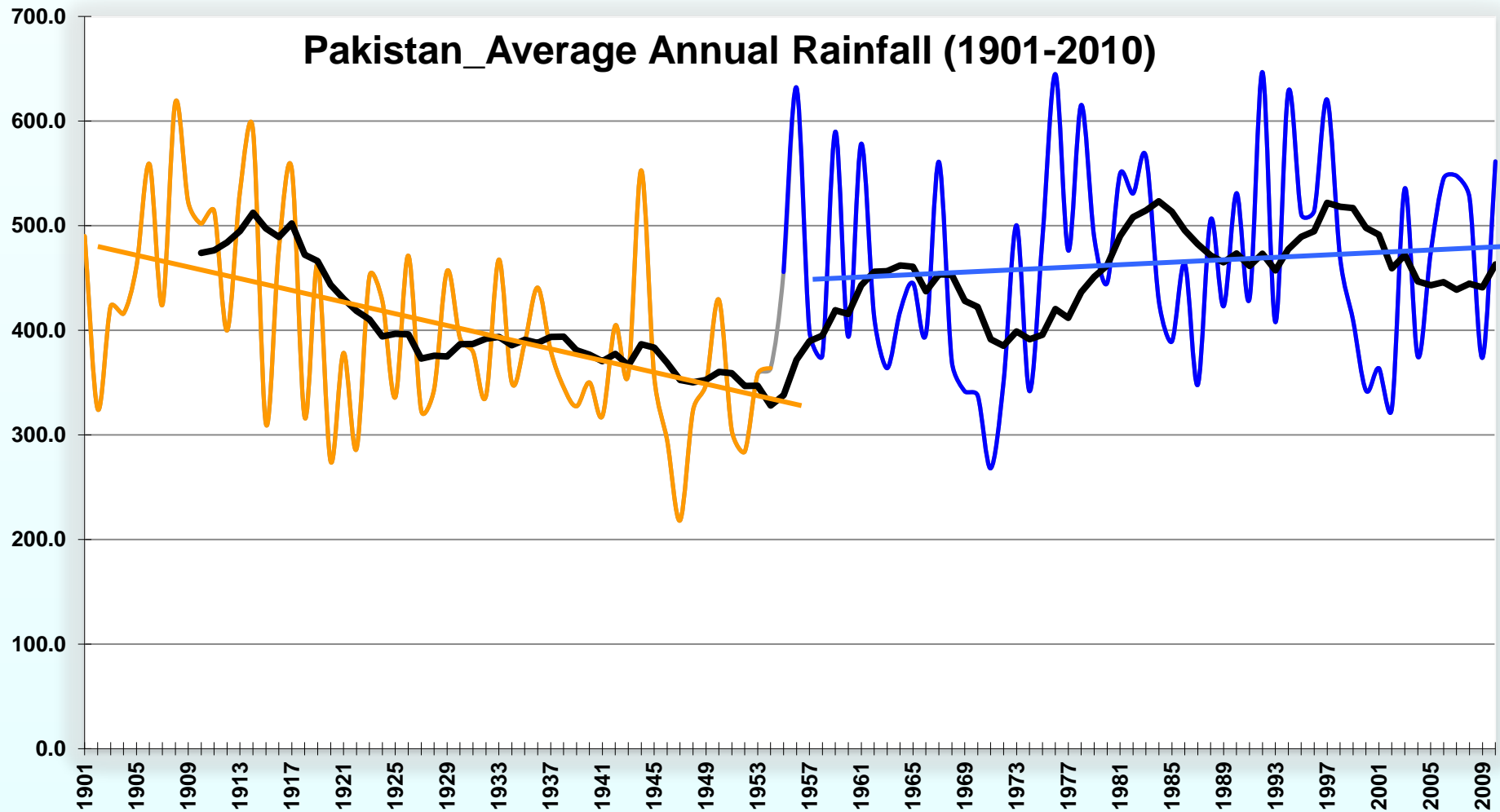


Area Weighted Mean Temperature Anomaly of Pakistan (1960-2010)





Pakistan_Average Annual Rainfall (1901-2010)



— All_Pakistan_Rainfall_Annual

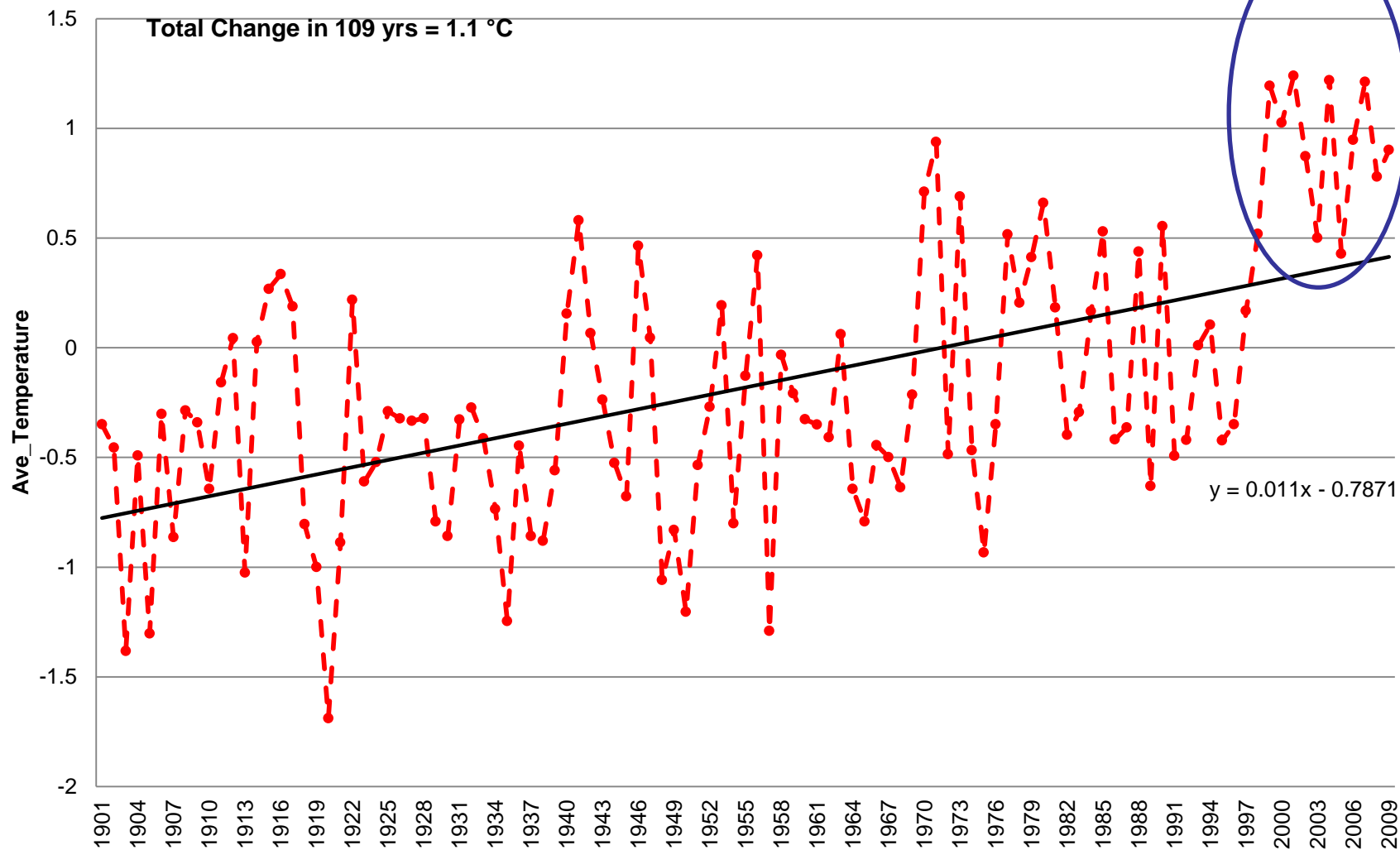
— 1901-1954

— 1955-2010

— 10 区間移動平均 (All_Pakistan_Rainfall_Annual)

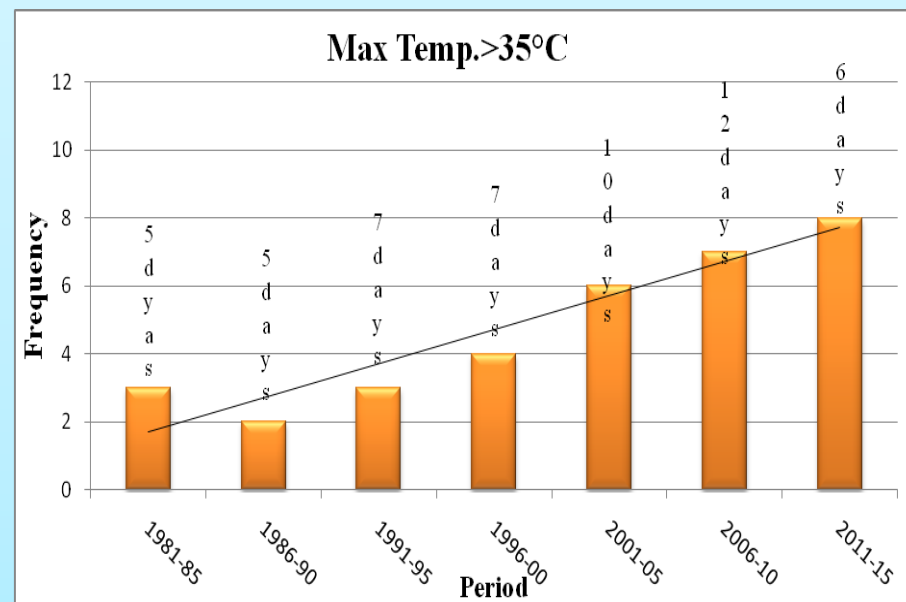
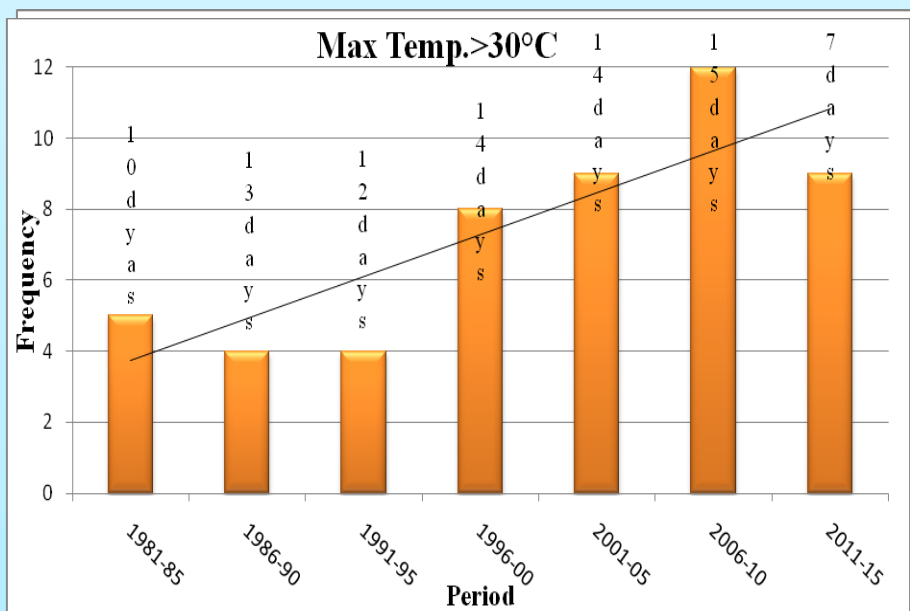


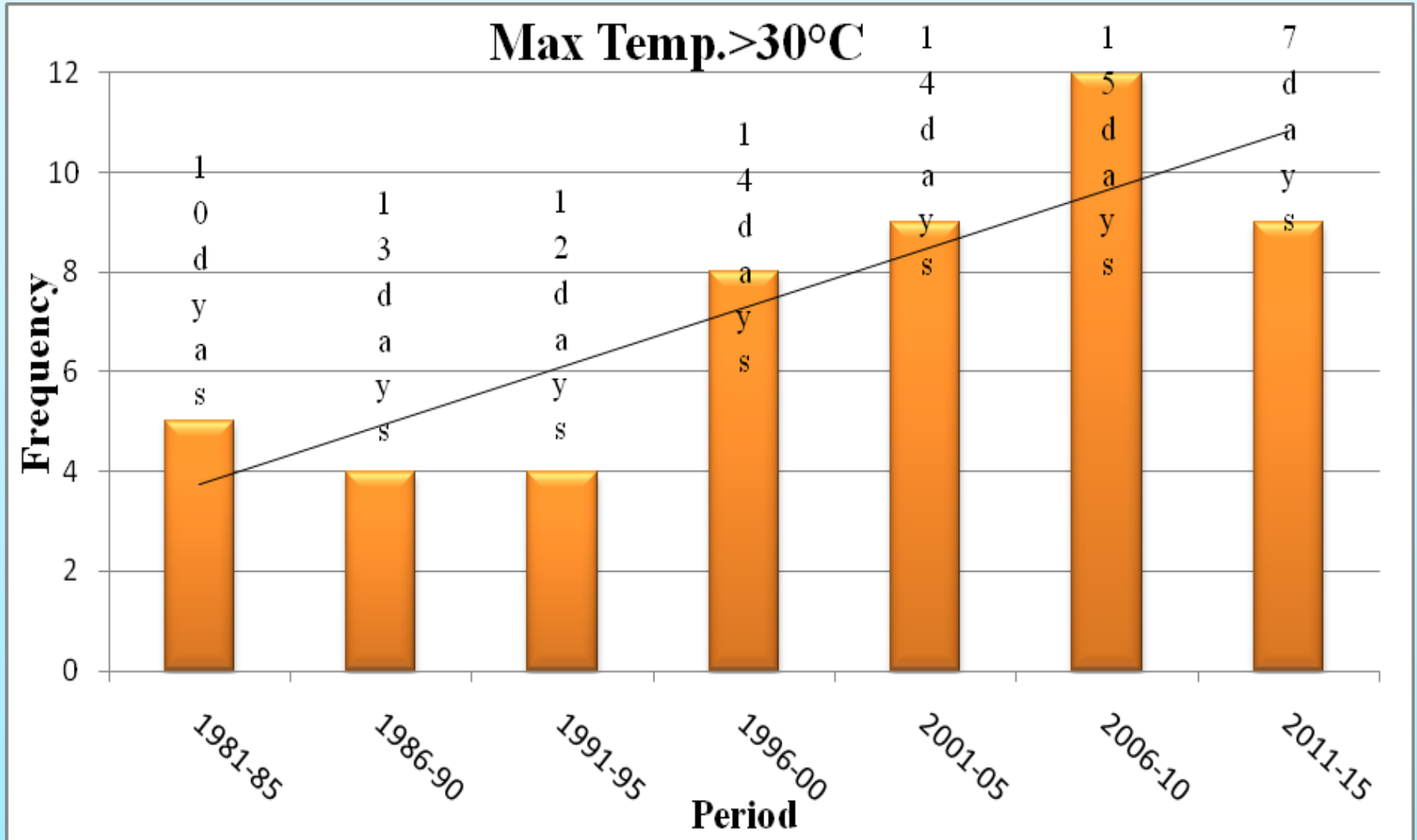
Average Temperature of Northern Areas of Pakistan (1901-2009) based on Climate Research Unit (CRU data)





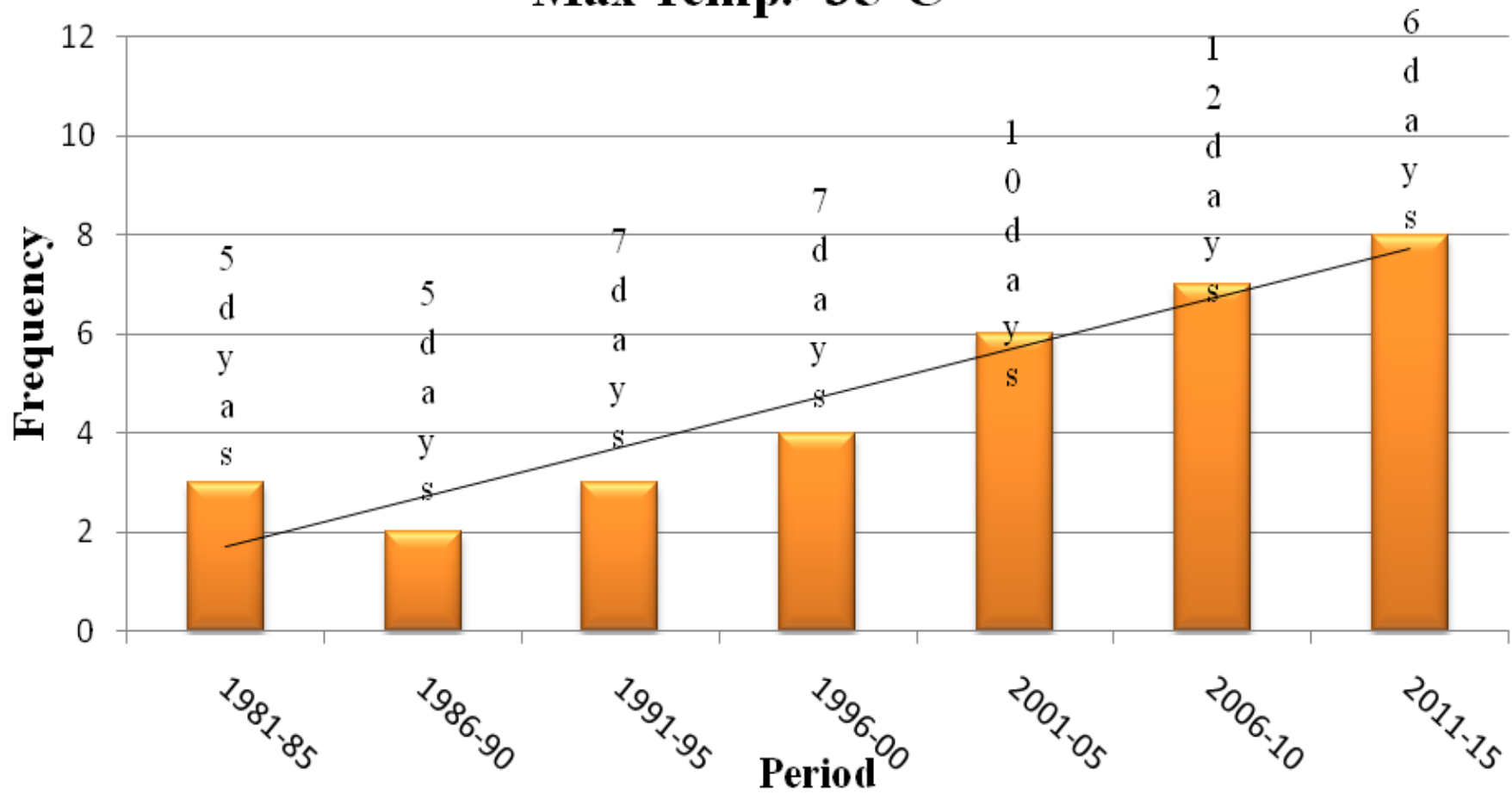
Heatwave Frequency in Upper KP and GB





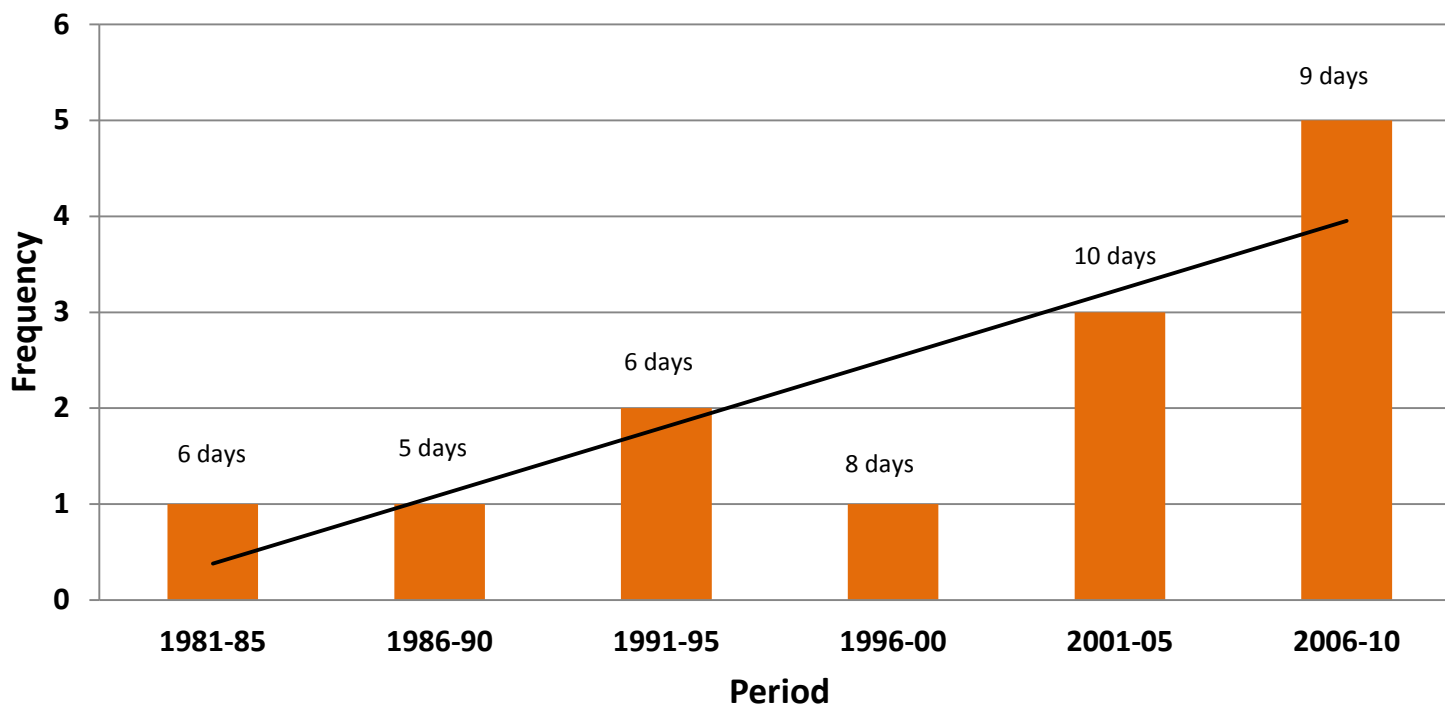


Max Temp. > 35°C



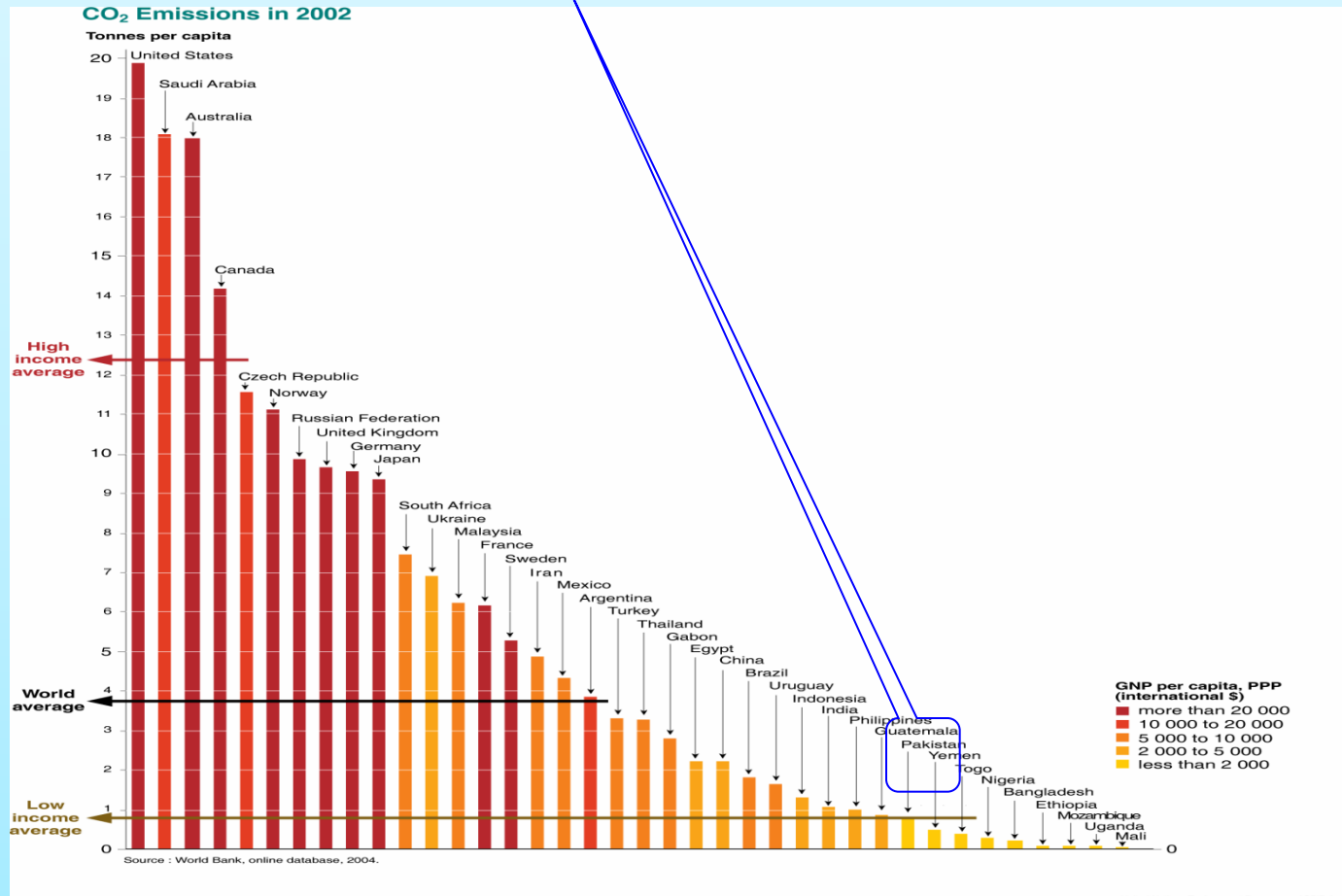


Max Temp. $>40^{\circ}\text{C}$



Emissions – where Pakistan Stands on the climate front?

One of the lowest per capita emitters



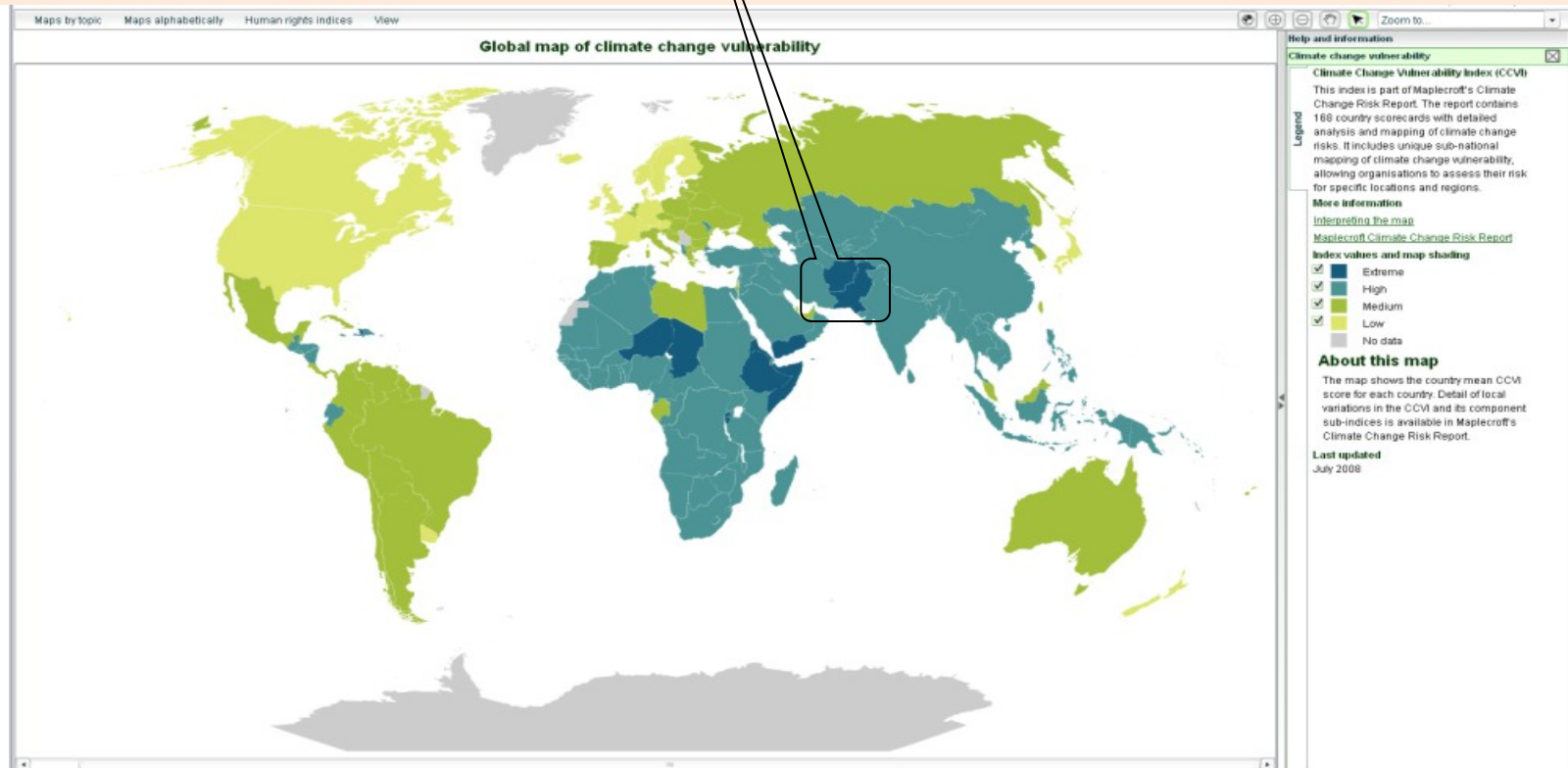
Pakistan Meteorological Department
Government of Pakistan



Impacts—Pakistan Vulnerabilities analysis in the context of climate impacts

Yet one of the **worst victims** of climate change
& best examples of **climate injustice**

Maplecroft vulnerability index places us in **High/Extreme** category / Columbia Univ indx does the same (<http://ciesin.columbia.edu/data/climate>)





Water is security issue

CLIMATE CHANGE Glacier DEPLETION

Water pollution Siltation in Mega Dam

Increasing water deficit Water sharing issue

Water Security

- **Water Sector: Current Status and Vulnerability**
 - Pakistan is extremely short of fresh water resources.
 - Water-stressed country water availability heading towards less than 1000 cubic meter/y by 2035 (WB 2006).
 - Pakistan's primary sources of water are rainfall (50 maf) by monsoon and westerly winds and river inflows (141 maf) in the Indus River System fed by glaciers and snowmelt from the Hindukush-Karakoram-Himalayas.

Water Security (Con)

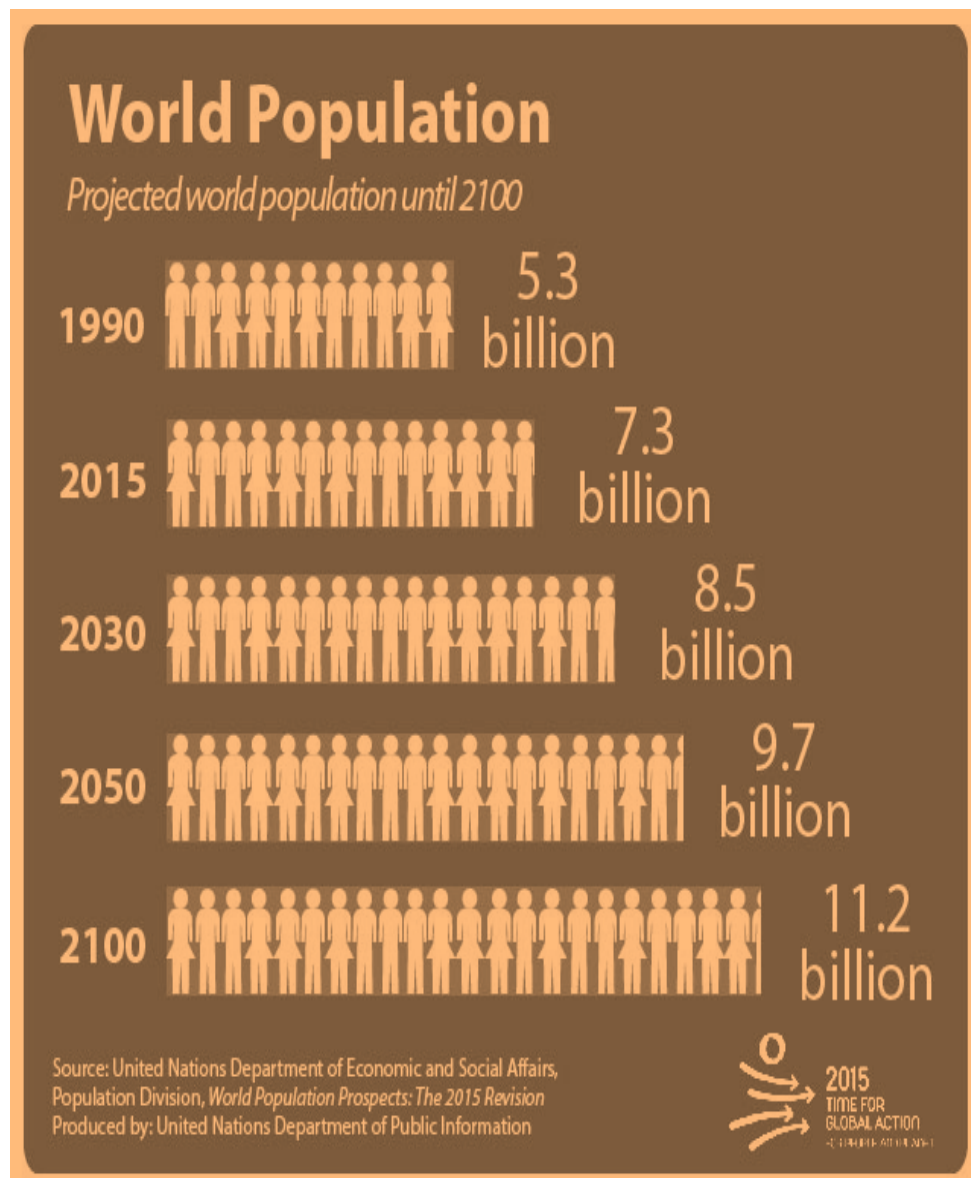
– The shares of main contributing rivers to the IRS in Pakistan are:

1. Indus: 44%,
2. Chenab: 19%,
3. Jhelum: 16%,
4. Kabul: 16% and Others: 5%.

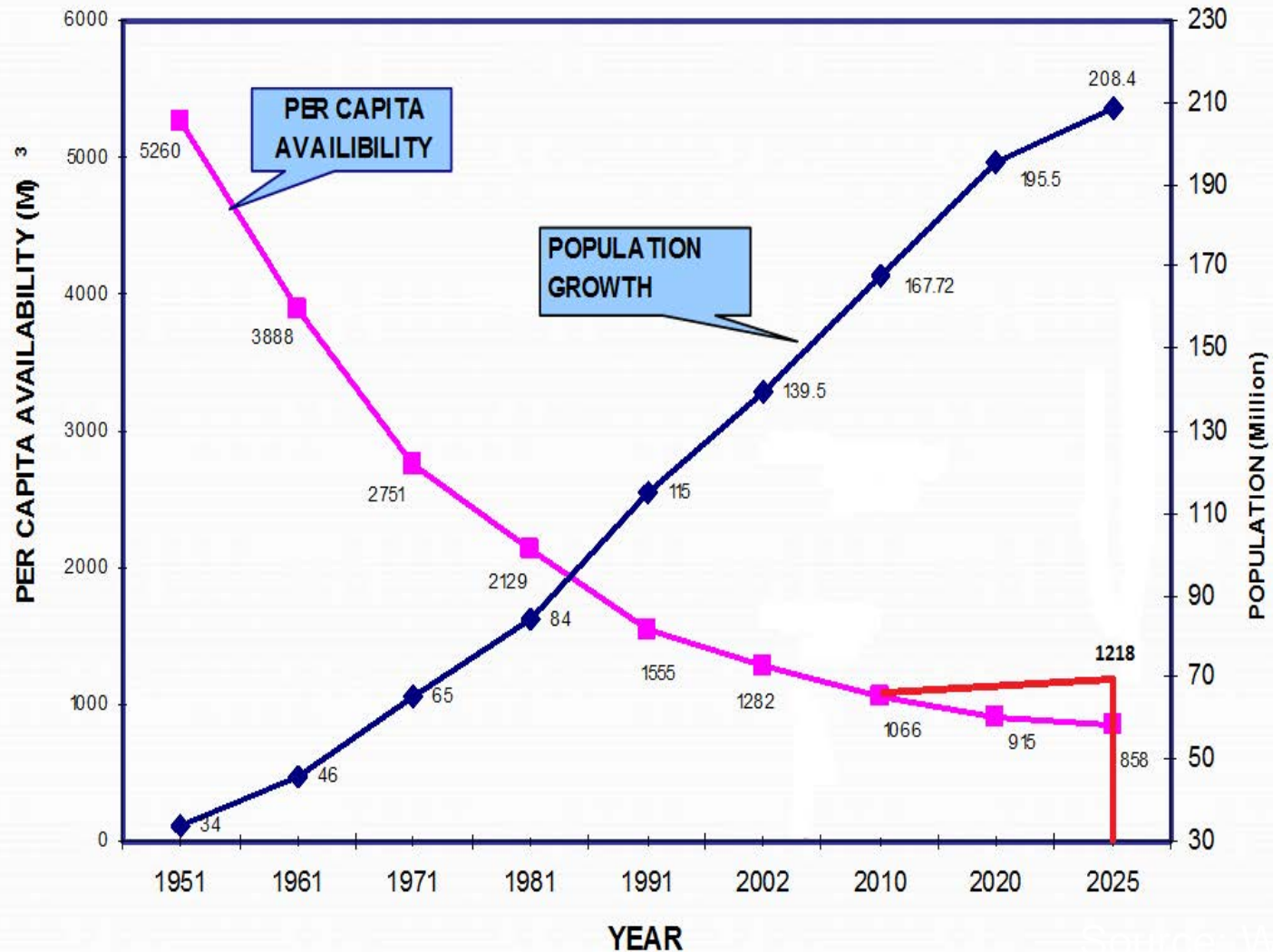
- The per capita availability of river water, which was 5,650 cubic meter/y in 1951
- and 1000 cubic meter/y in 2010, is expected to decline further to 800 cubic meter/y till 2026.



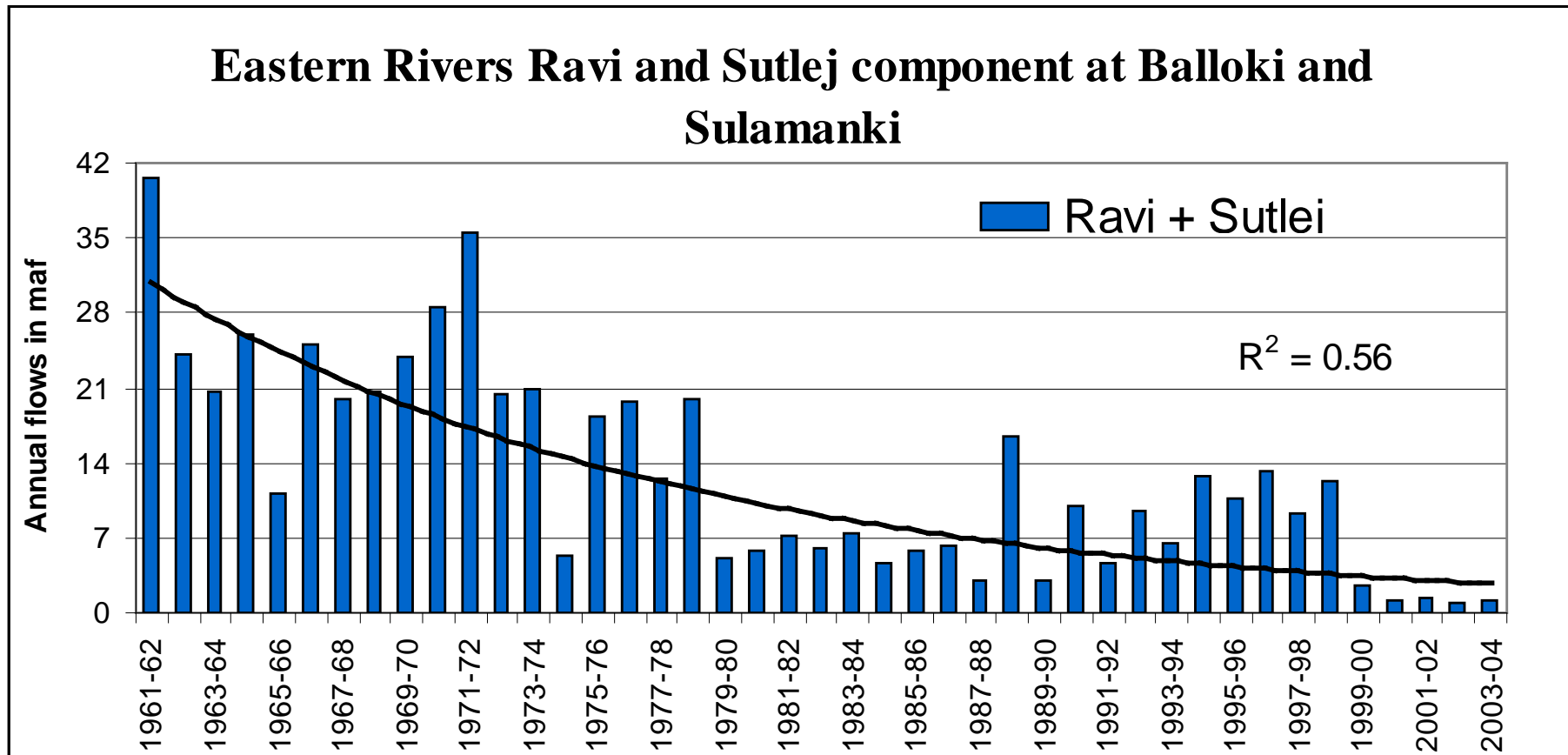
- World population is growing 80 million per year (Pakistan growing rate is 3 million per year)
- In 2050, world population expects to be increased to 9.7 billion (expected Pakistan population is +300 million)



Condition of Per Capita Availability with expected increased Rainfall by 2025



Decrease of Eastern Inflow from India – as a result of Indus Water Treaty



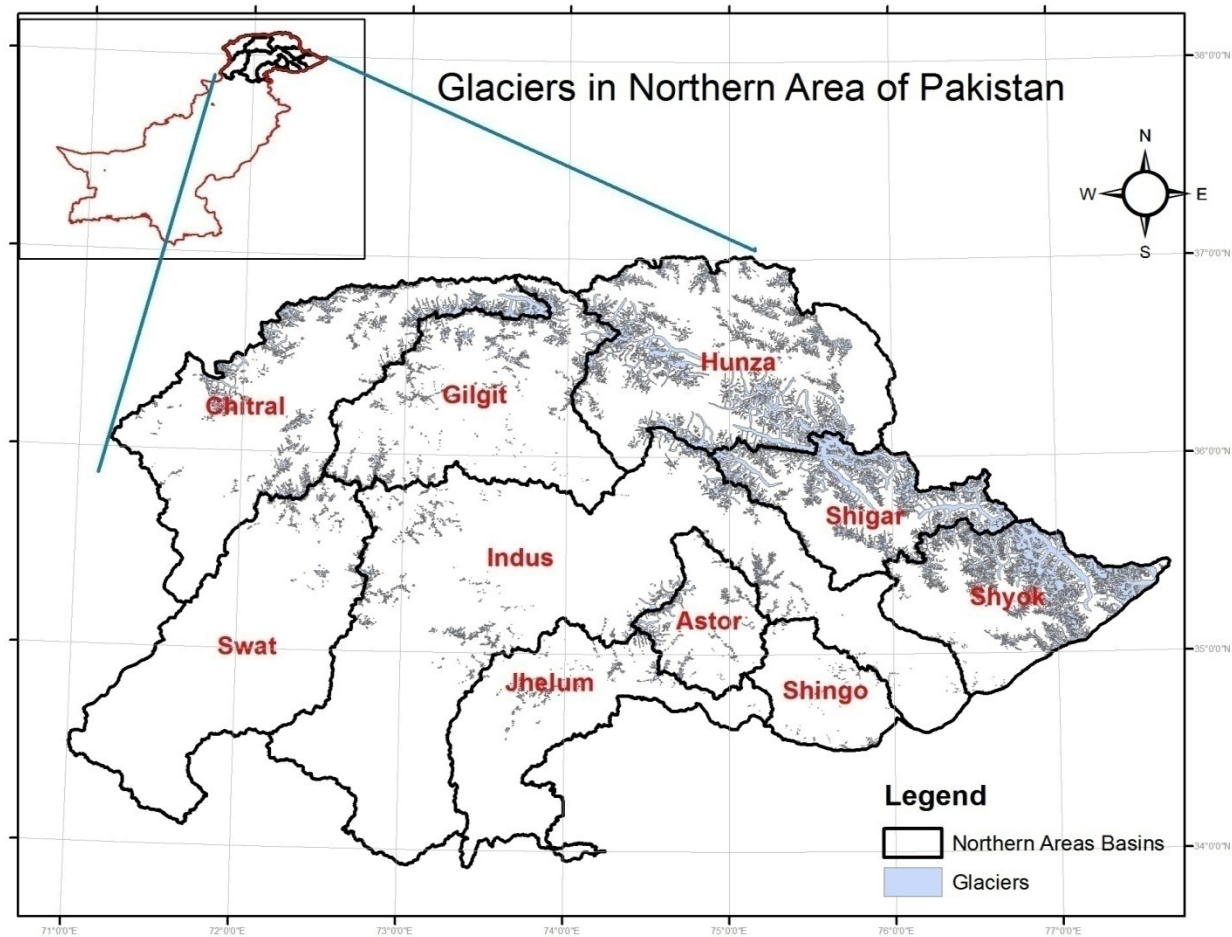
Water Security

- Pakistan's rivers are predominantly fed by Hindu Kush, Karakoram and Himalayan glaciers. These are receding due to climate change

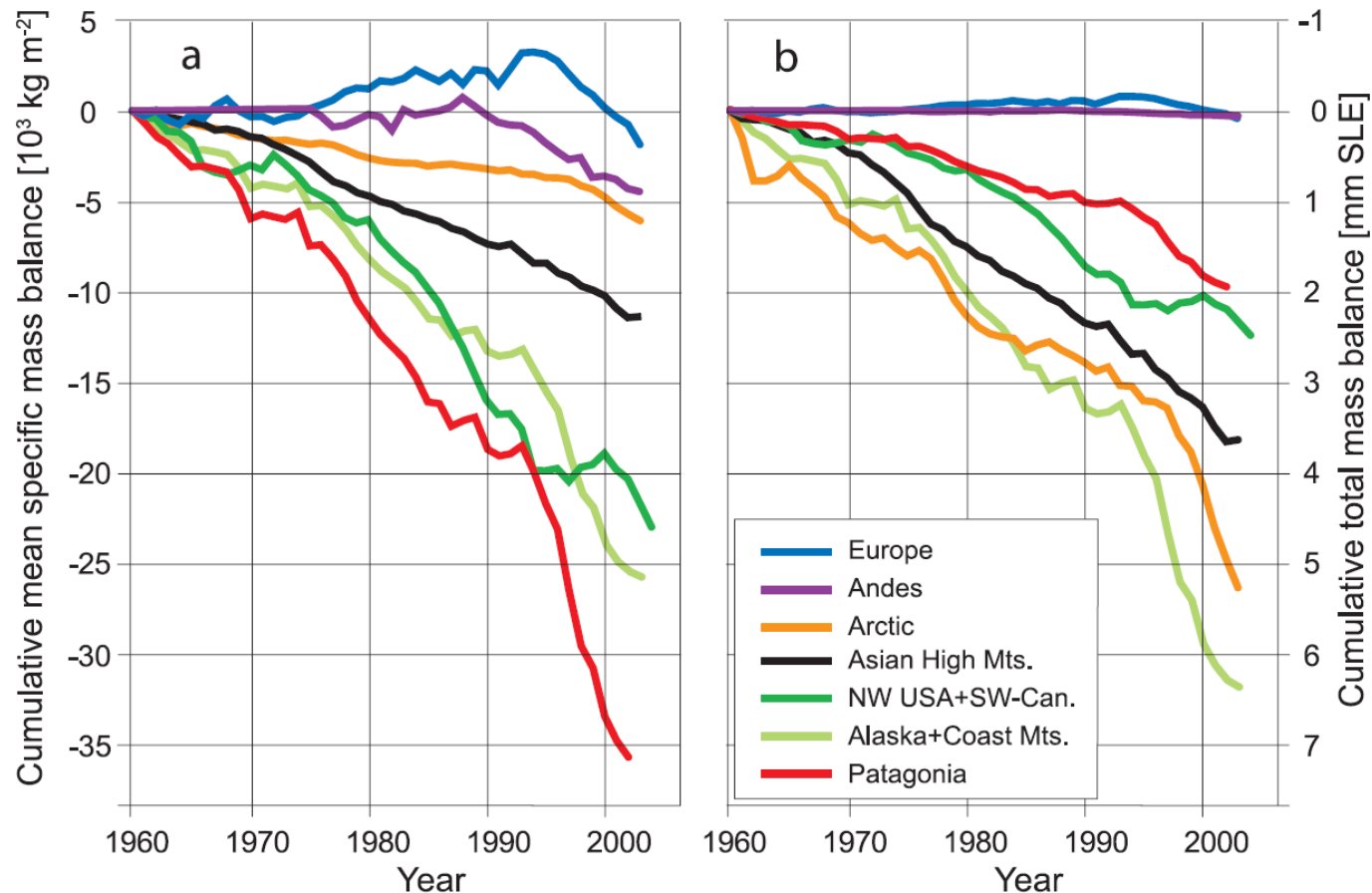


Pakistan's Cryospheric Assets

Number of Glaciers	Area of Glaciers (km ²)	Volume of Ice (km ³)	Ranges
7259	11780	2066	Himalaya Karakoram Hindukush



Response of Glacial Resources to Climate Change



Vulnerabilities of the region and Need for strengthening the early warning system

Climate of Pakistan

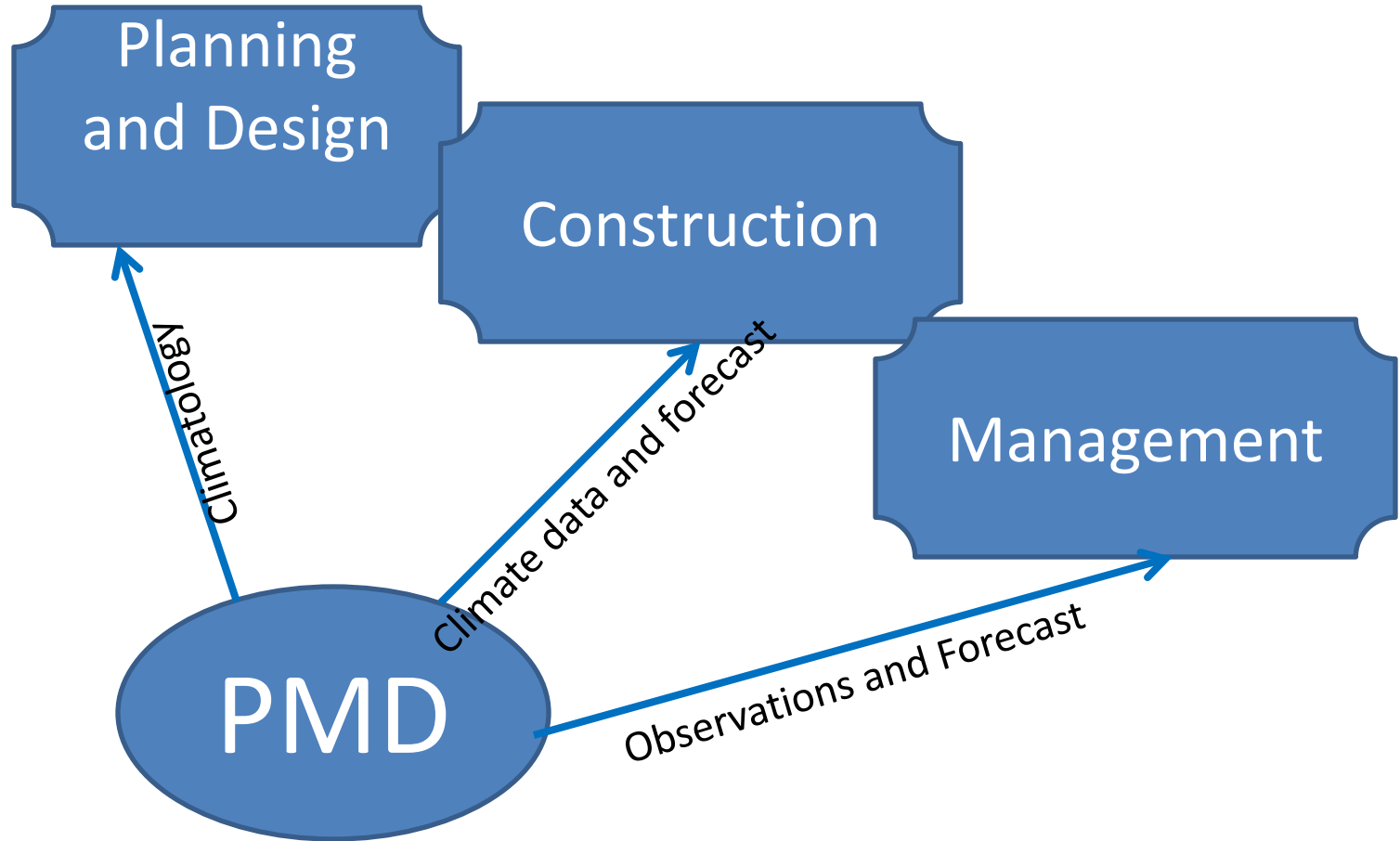
Pakistan is historically prone to Extreme Weather Events/Disasters, such as;

■ Snow-melt Flooding	■ Extreme Heat in May/June
■ Heavy Rains/River Flooding	■ Extreme Rainfall (Monsoon)
■ Torrential Rain/Flash Flooding	■ Extreme Rainfall (Monsoon)
■ Urban Flooding	■ Extreme Rainfall (Monsoon)
■ Cyclones/Coastal Flooding	■ Tropical Cyclones (Pre & Post Monsoon)
■ Water Crises/Droughts	■ Dry Spell (Deficient Monsoon/Winter rain)

In Pakistan, more than 70% Extreme Weather Events are associated with Monsoon Season



Role of PMD in Water Sector Development & Management





- **Existing Capability?**

- Weather prediction capability limited due to lack of met-data and advanced technology for aviation services (wind profilers)

- **Hydrological Data?**

- Lack of real time hydrological data (Radars, AWS, Telemetric...).
- Trans-boundary data for eastern rivers not available.
- Lack of GLOF monitoring & Flash Flood Warning System

- **Seismic Network?**

- Lacking in Tsunami warning system & Seismic monitoring network

- **Human Resource?**

- Limited Career Progression & Retention of qualified staff (PhD)
- No capacity development with new & advanced technology
- No incentives (SPS & Research Allowance) for Scientists and field force at remote areas

- **Awareness?**

- Lack of awareness due to dissemination system (TV, Radio, Cell...)

- **Cost-Benefit Ratio?**

- Climate Change - Investment of One dime in advance can save 36 dime.



Rs. Million

SN	Description	Remarks
Radars	<ul style="list-style-type: none">•12 New•5 Replacement	Provinces
Met Data (Observation Network)	<ul style="list-style-type: none">• 40 New, 430 AWS•10 Agro-met•8 Wind Profilers (Aviation)	Federal Govt
Flood Warning Centers Regional Centers GLOF Flash Flood WC	<ul style="list-style-type: none">• 5 Centers (Provincial)• 20 Stations in GB & Chitral• 8 Vulnerable Sites (Hill Torrents)	Federal Govt
Seismic Data	10 Stations (Tsunami & Micro-seismicity)	Federal Govt
Awareness	TV/FM Radio/Cell	Federal Govt
Technology	HPCC (High Power Computer Clustered)	Federal Govt
Capacity Development	Scientists skill according to new & advanced technology	Federal Govt



Pakistan Meteorological Department

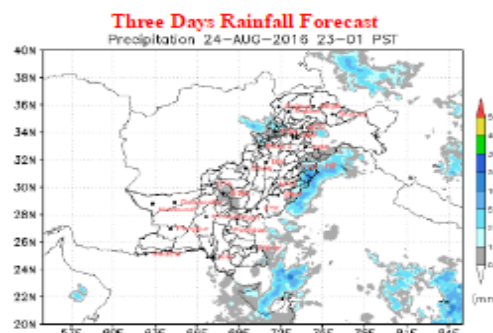
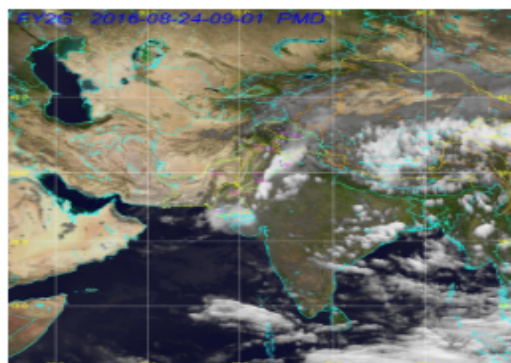
Government of Pakistan

ISO 9001:2008 Certified Provider of Aviation Meteorological Services View Certificate



Mainly hot and humid weather is expected in most parts of the country. However rain-thunderstorm is expected in some parts of the country.

- About PMD
- Leaders
- Services
- Address Book
- Met Observatories
- PMD Projects
- Climate & Astronomical Data
- Historical Events
- Numerical Weather Products
- Seasonal Forecast
- Academic Strength
- Events Pictures/Videos
- Training and Courses
- Publication/Reports
- Quarterly News Bulletin
- AWS Data
- Conferences and Seminars
- Official Forms
- Circulars
- Pension Cell
- Jobs
- Tender
- Official Email
- Contact Us
- Youth Corner (Met.Edu)
- Webmaster



Pakistan Weather	Satellite/Radar Images
National Forecast, Cities Forecast Weekly, Seasonal Outlook	Pakistan, Asia, Global Satellite Images Radar Network
Aviation Products	Flood Update
Aviation Weather Charts, NMCC Charts Metars, Tafors	Flood Forecasts, Dams Flows, Lai Nullah GIS Maps, Rainfall/Temperature
Drought Monitoring	Farmer's Weather
Current Drought Situation/Monitoring Soil Moisture Analysis/Advisory	Farmers Forecasts, Agromet Bulletins Crop Vegetation Index, Crops Report
Tropical Cyclone/Marine Weather	Earthquake Information
Tides, Wave Height, Wind speed Coastal Areas Forecast, SST	Recent Earthquakes, Seismic Reports Seismic Monitoring Network
Research Activities	Synoptic Data
R&D, NWP Products, Publications, Climate Data Pollen Count, Pak.Jrn.of Meteorology	Daily Synoptic Data Browsing Surface/Upper Air Met Data

Yesterday's Highest Maximum Temperatures: Turbat 44 °C, Sibbi 43°C, Islamabad 36°C, Lahore 36°C, Karachi 36°C

Current Weather at 03 PM (PST) Dated: Wednesday, August 24, 2016 ☀️ ☁️ Cloudy	Daily Weather Report	Monsoon Progress 🌧️
	Weather Advisory/ Press Release	Seasonal Forecast
	Weather Alert / Glof.Alert-3-Update	Farmers Advisory (زرعی موسم)
Maximum Temp. Dated: Tuesday, August 23, 2016	Real-Time Flood Report (Lai Nullah)	
Chilas 38.5 °C Chitral 34.0 °C		





UNDERSTAND the Climate Risk
COMMUNICATE the Climate Risk



Thank you!