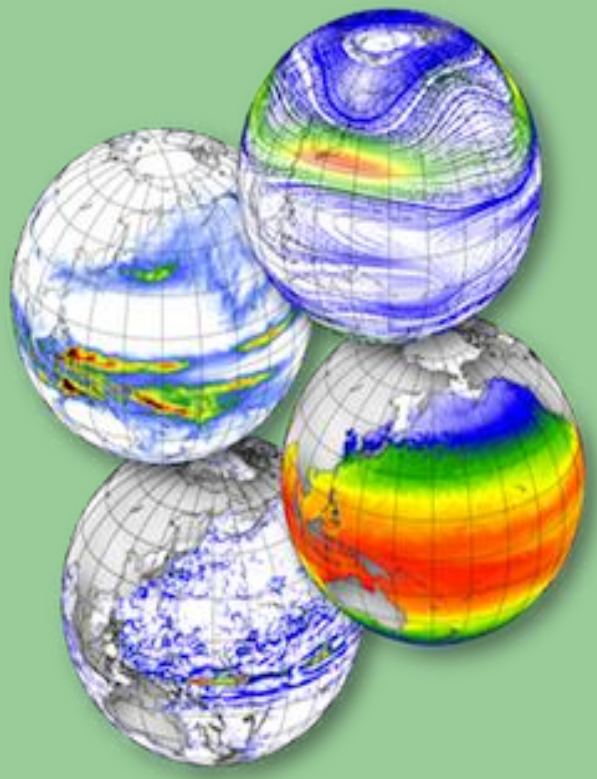
Integrated Monitoring System; A key to Integrated Management of Hrdrometeorological Extremes



Hazrat Mir

Chief Meteorologist PMD

COUNTRY PROFILE

SOCIO-ECONOMIC PROFILE

Population: 218 million

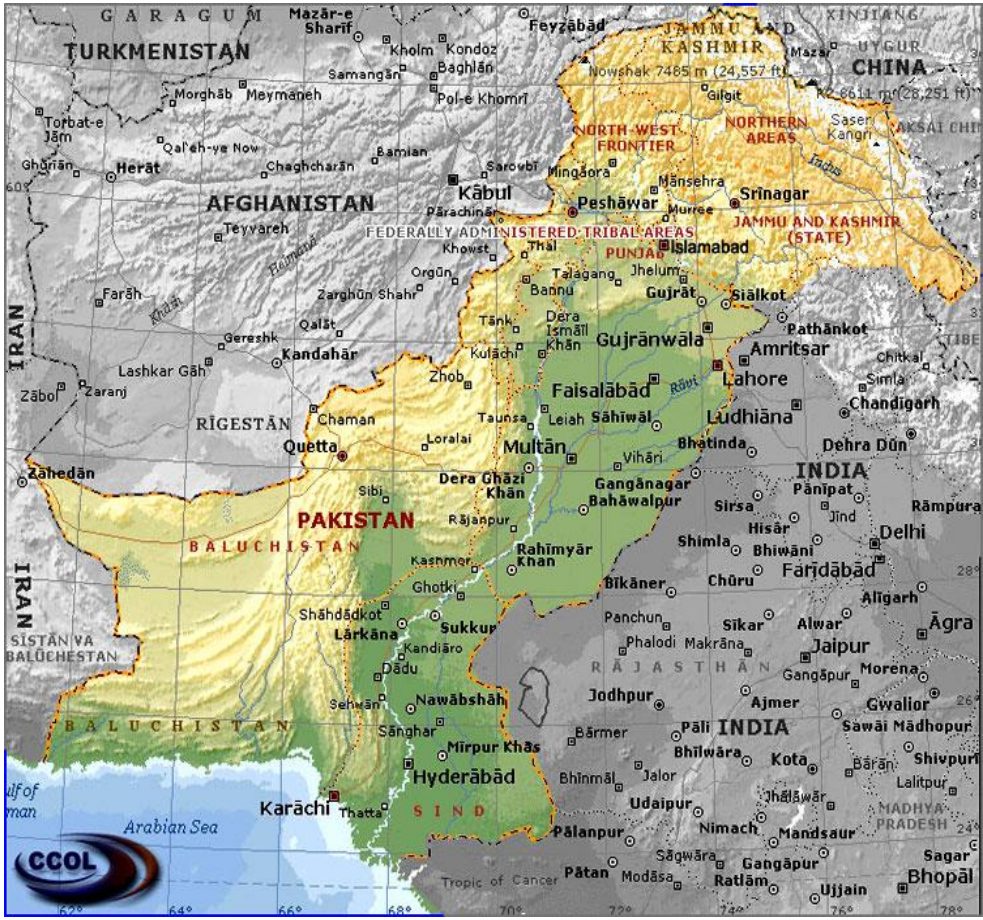
Growth Rate: 2.06%

Literacy rate: 57%

GDP (per capita): $ 1629

Agriculture 24% of GDP

Major crops Wheat, Rice, Cotton, Sugarcane, Maize



Challenges for Managing Floods & Droughts

Population Increase

Economic Development: Vulnerability
Climate Variability: Hazard Frequency
Upstream Urbanisation: Hazard Magnitude

Securing livelihoods

Ecosystem Conservation

The Principles of Integrated Flood & Drought Management

- Manage the Water Cycle as a Whole
- Integrate Land and Water Management
- Manage Risk and Uncertainty
- Ensure a Participatory Approach.
- Focus on high demand sectors (Agriculture, Livestock)
- Adopt Integrated Hazard Management Approaches.

A pre-condition: Integrated Monitoring System

Specialized services for Drought Management

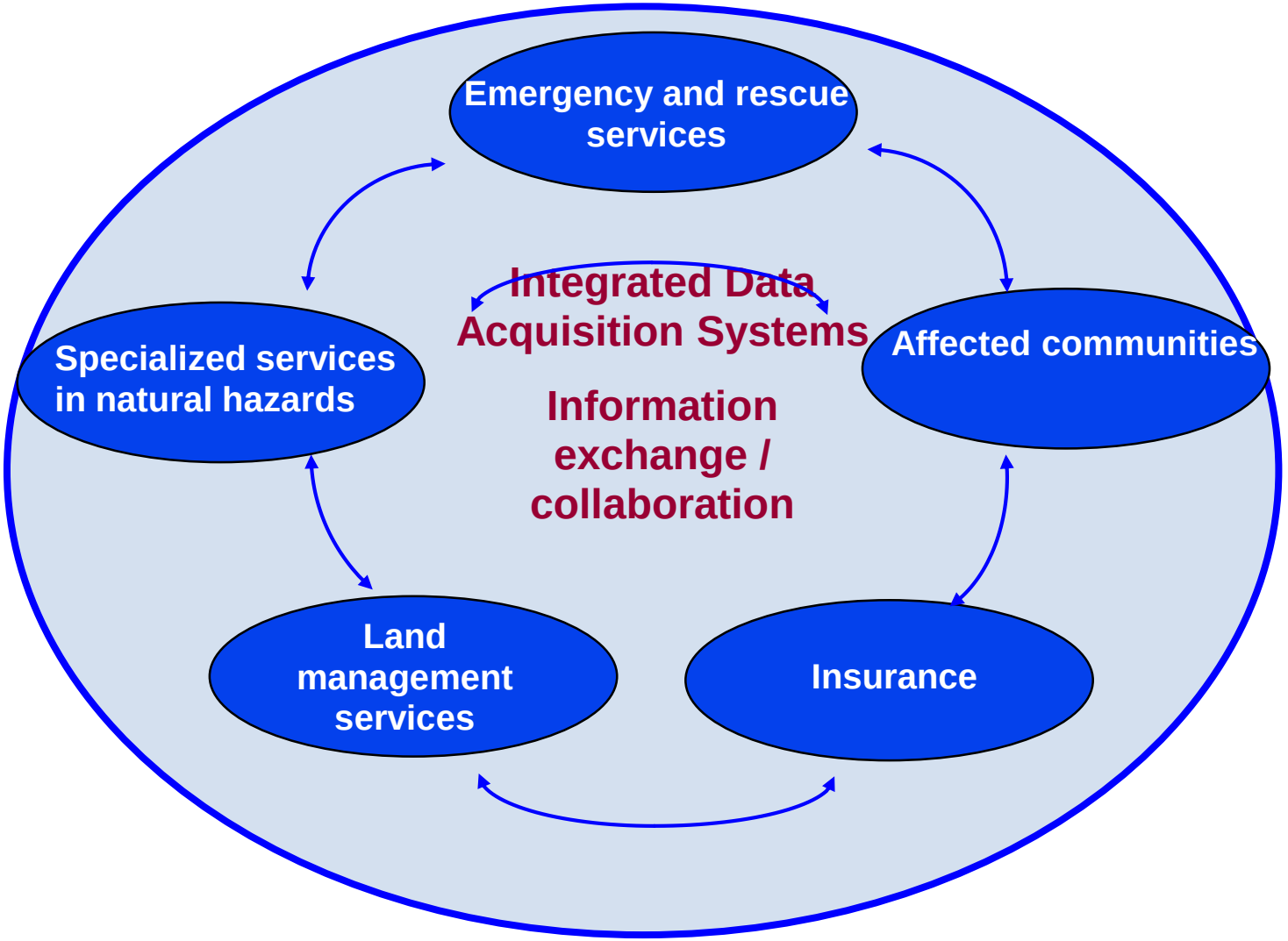
- Meteorological Drought
- Agro-meteorological Drought
- Hydrological; Drought
- Economic Drought
- Desertification
- Land management services

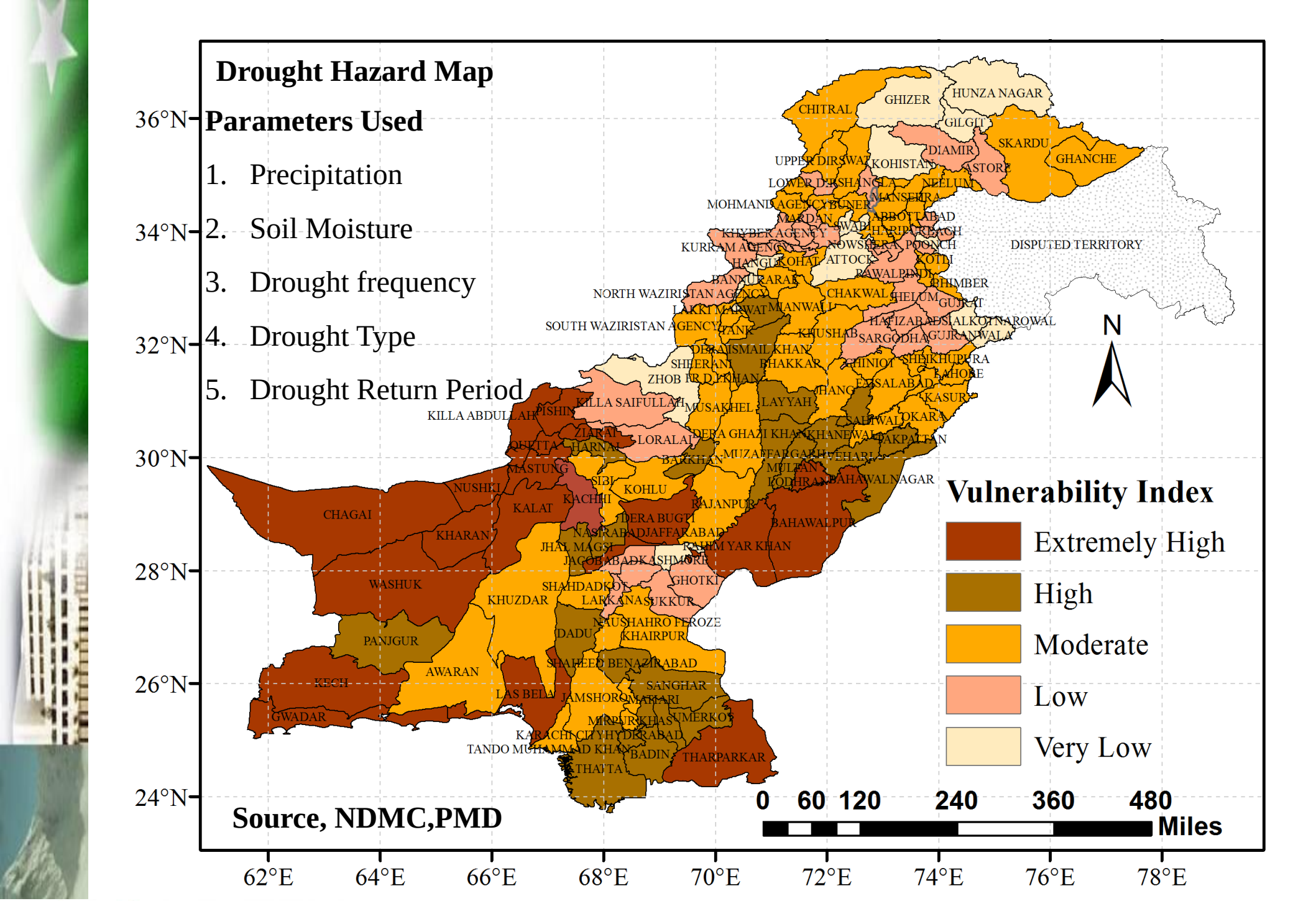
- Air Temperature
- Air Humidity
- Wind Direction
- Wind Speed
- Dew Point
- Rain
- Sea Level Pressure
- Solar Radiation
- Soil Moisture (5,10,20,30,50,100 cm)
- Snow Level
- Run Off
- Ground Water Monitoring
- Satellite Data
- GIS /Decision Support Tools

Specialized services for Flood Management

- Physical separation of rivers from populations and goods
- Capacity enhancement of rivers
- Flood Forecasting
- Storage and retention of runoff
- Flood Warnings
- Emergency management
- Flood recovery

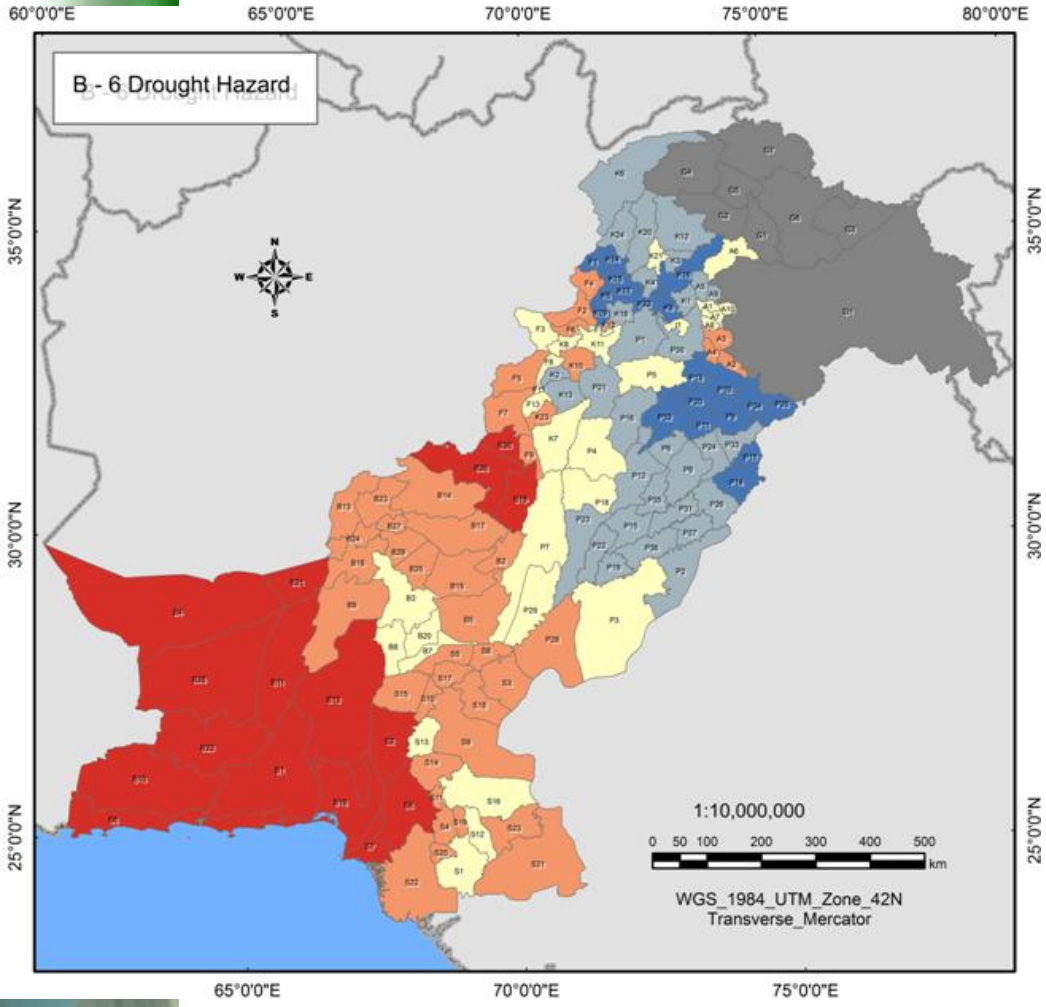
A precondition: multidisciplinary cooperation

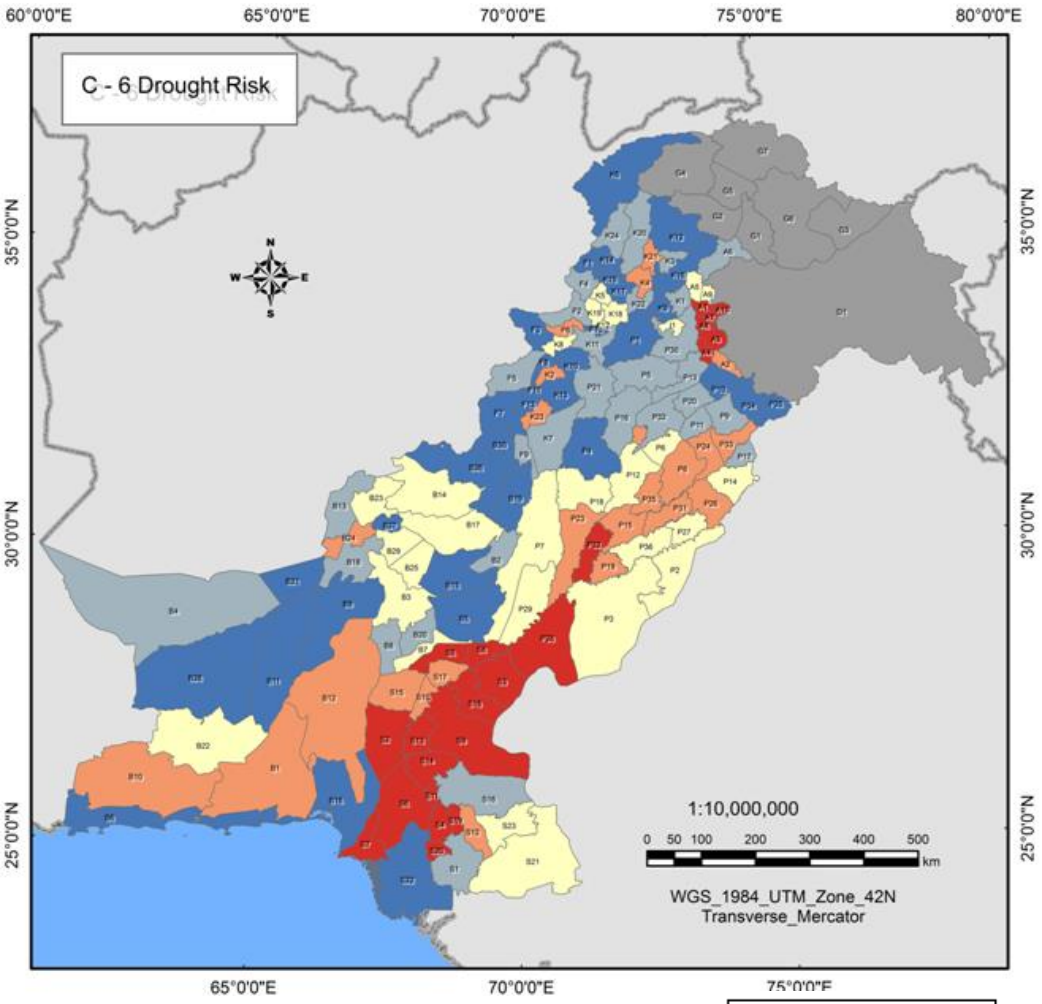




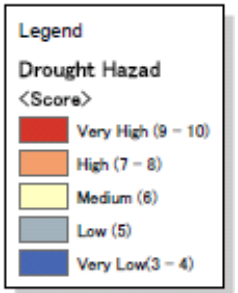
Pakistan Meteorological Department
Government of Pakistan

Drought hazard

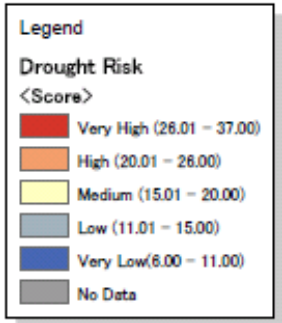




- Mean annual rainfall
- Irrigation Density

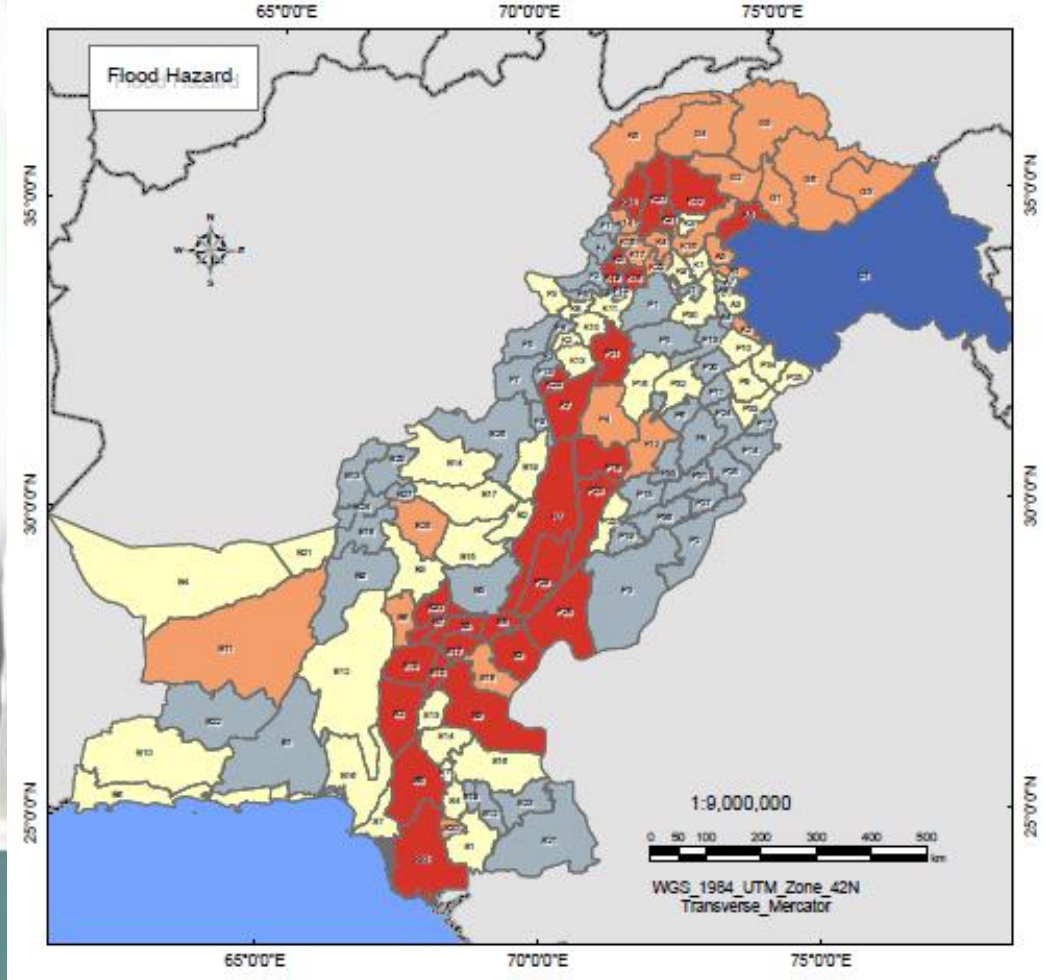


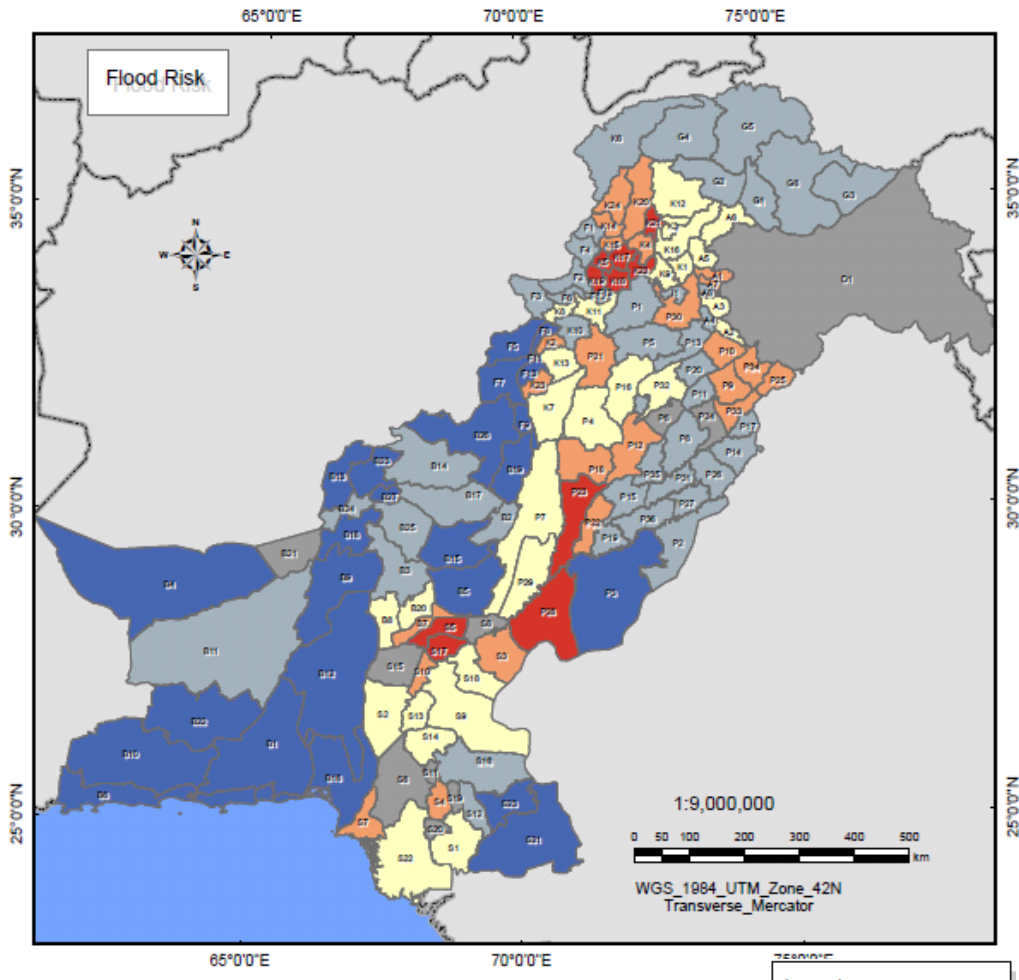
- Population Density
- Principal crops yield



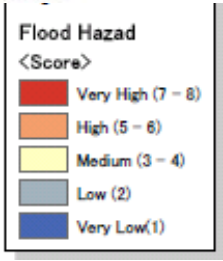
Source :NDMA,Pakistan

Flood hazard

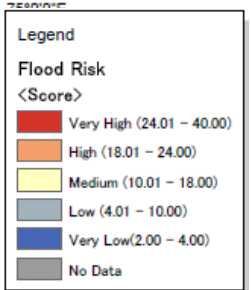




- Disaster Records per district
- affected district by 2010 Floo



- Population Density
- Principal crops yield



Source :NDMA,Pakistan

Remote Sensing Resources Play Critical Role in Integrated Monitoring

Remote Sensing Systems provide REGIONAL to GLOBAL observations with REPEAT VISIT

near SIMULTANEOUS

and provide data in NEAR REAL TIME

Use of Remote Sensing Resources in PMD

Pakistan Meteorological Department

10-cm Doppler Radars

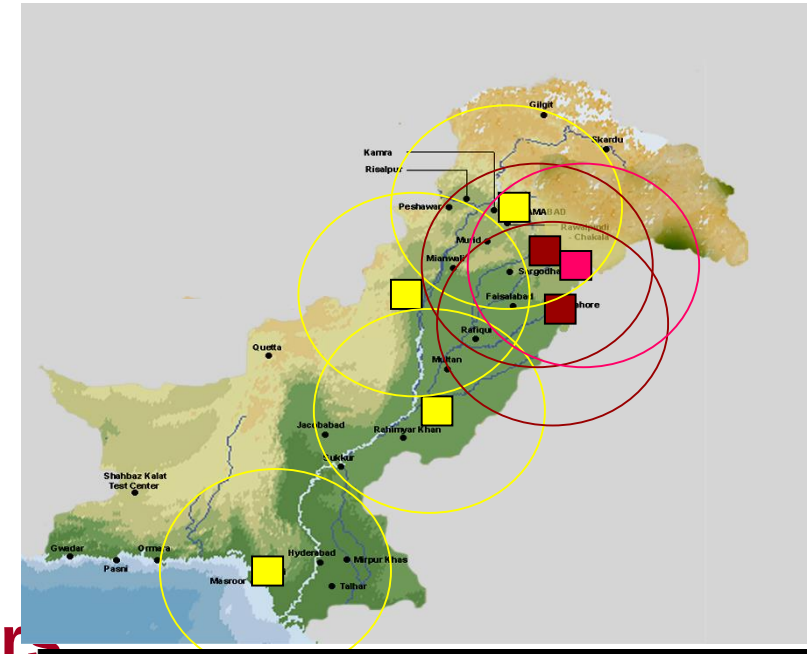
1- Lahore
2- Mangla

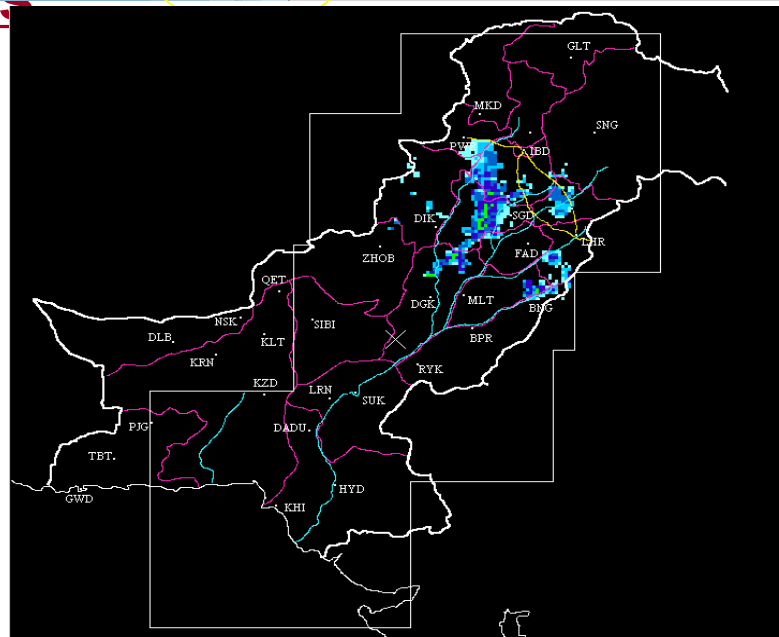
QPM Radar

1- Sialkot

5-cm Wx. Surveillance Radars

1- Islamabad
3- D.I.Khan
4- Rahim Yar Khan
4- Karachi

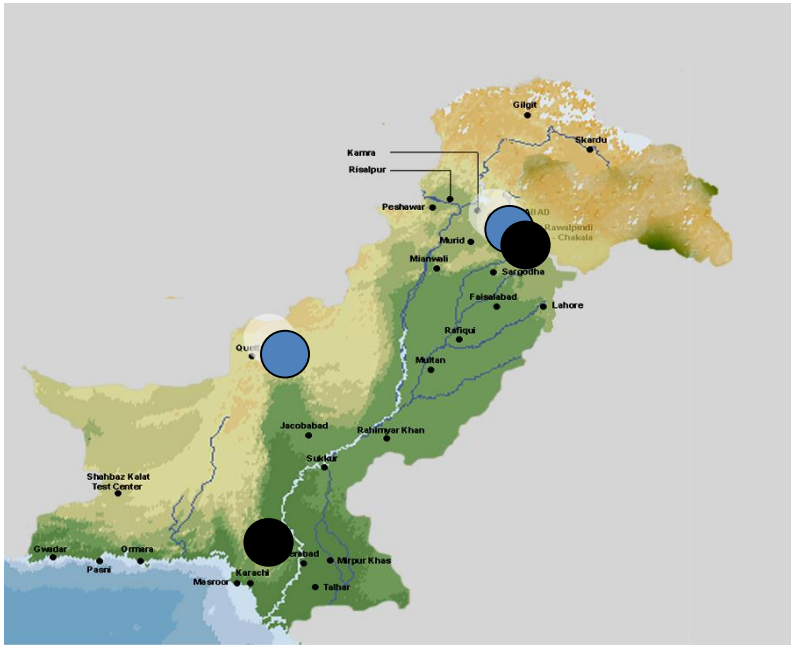




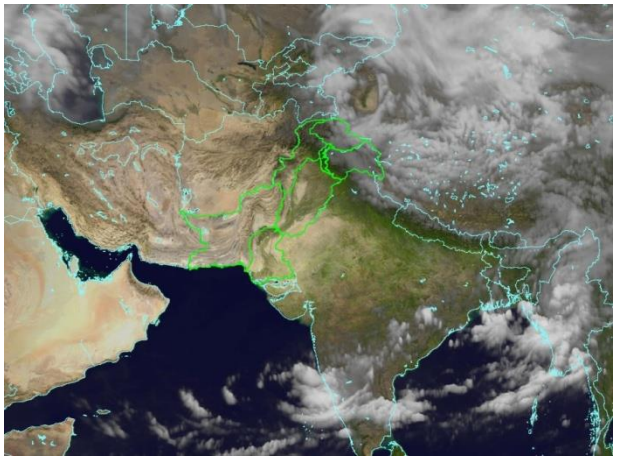
PMD: Pakistan Meteorological Department

Satellite Ground Stations of PMD

- **HRPT**
  - 1- Islamabad
  - 2- Quetta



- **FY-2 E/D**
  - 1- Islamabad
  - 2- Karachi



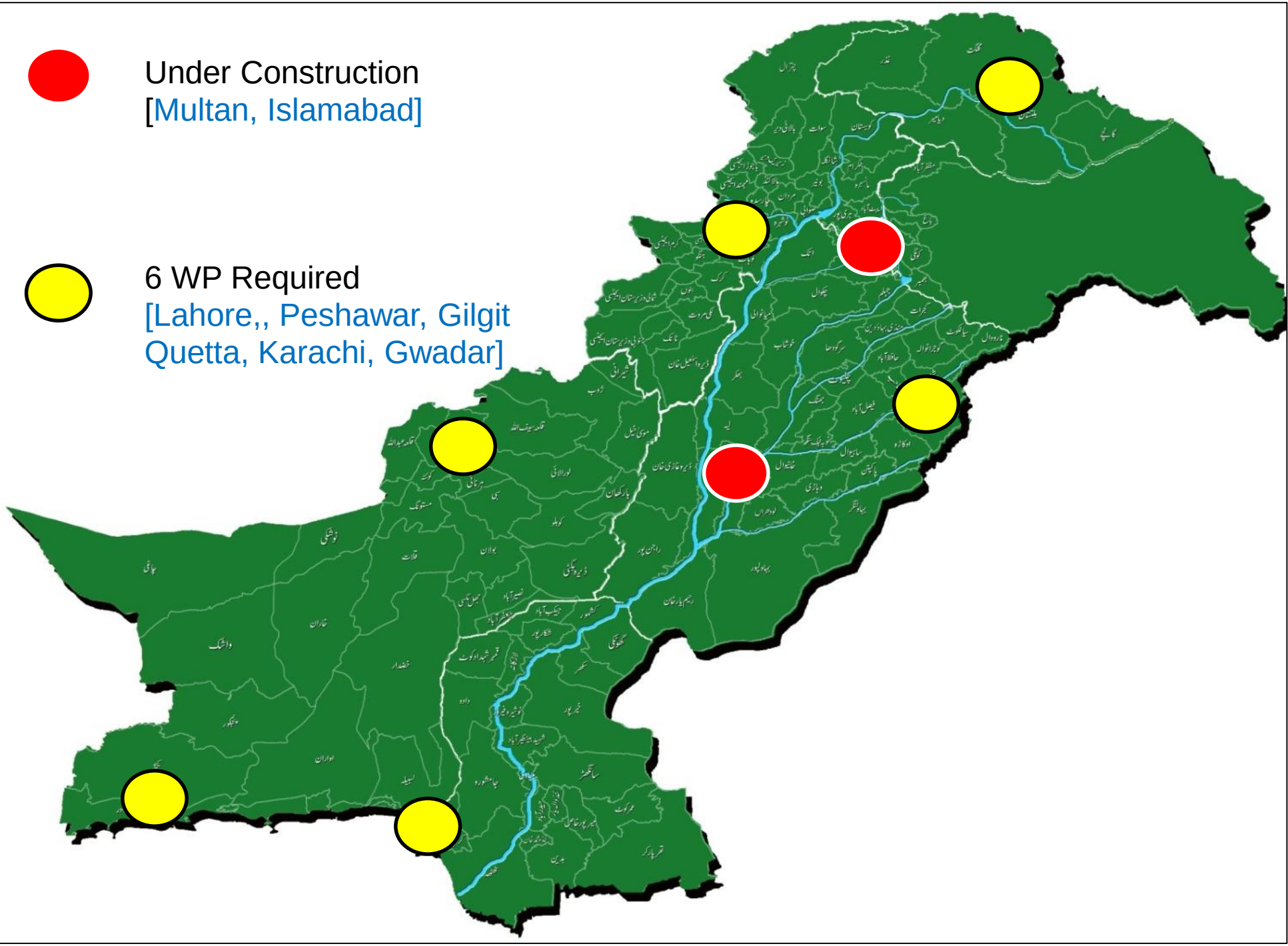
PMD Radars Network Moderanization (Existing and proposed)
(18 radars required)

- Under Construction
  [Islamabad, Karachi, Mardan]
- 6 S-Band Required
  [Lahore, Mangla, Sialkot
  R.Y.Khan, Badin, Gwadar]
- 8 C-Band Required
  [Okara, Multan, DI Khan, Zhob, Quetta
  Khuzdar, Pasni, Sukkur]
- 4 X-Band Required
  [Chitral, Gilgit, Skardu,
  Mansehra]

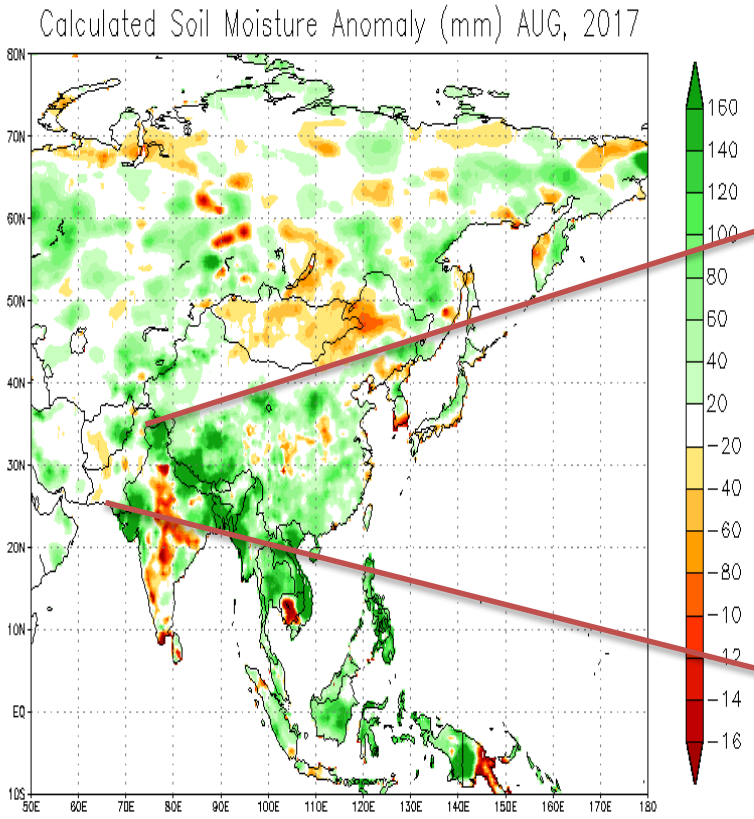
Wind Profilers (WP) for PMD

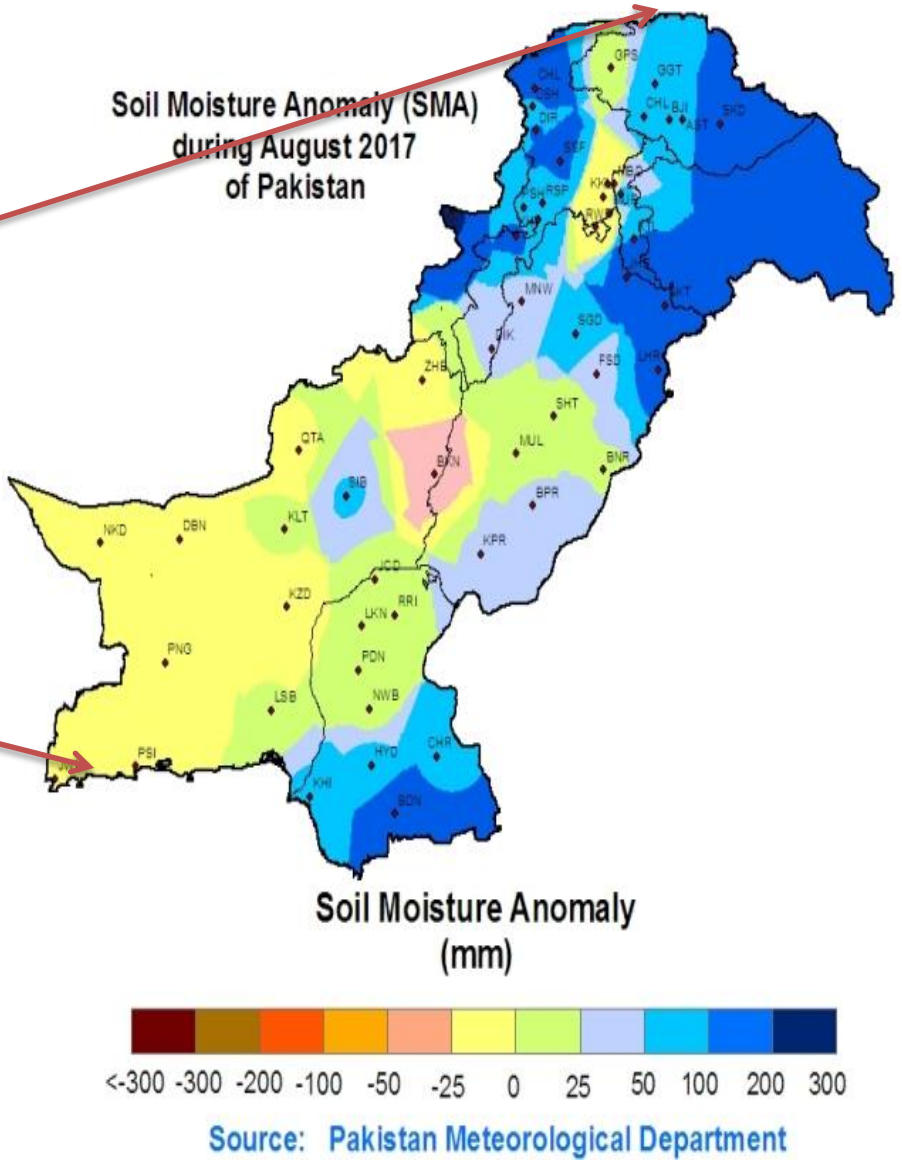
Under Construction
[Multan, Islamabad]

6 WP Required
[Lahore,, Peshawar, Gilgit
Quetta, Karachi, Gwadar]



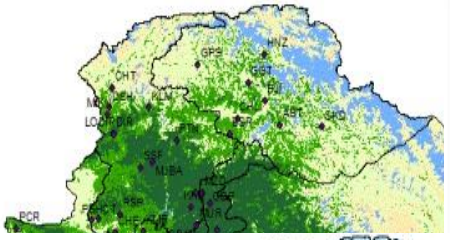
Soil Moisture Analysis



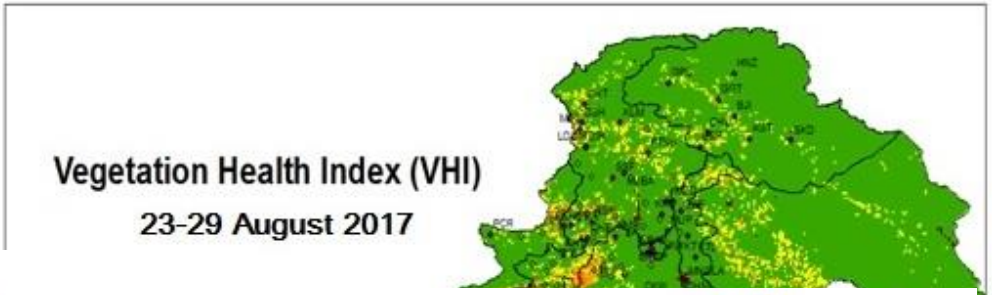


Courtesy: http://www.cpc.ncep.noaa.gov/soilmst/glb_lb/curr.w.anas.gif

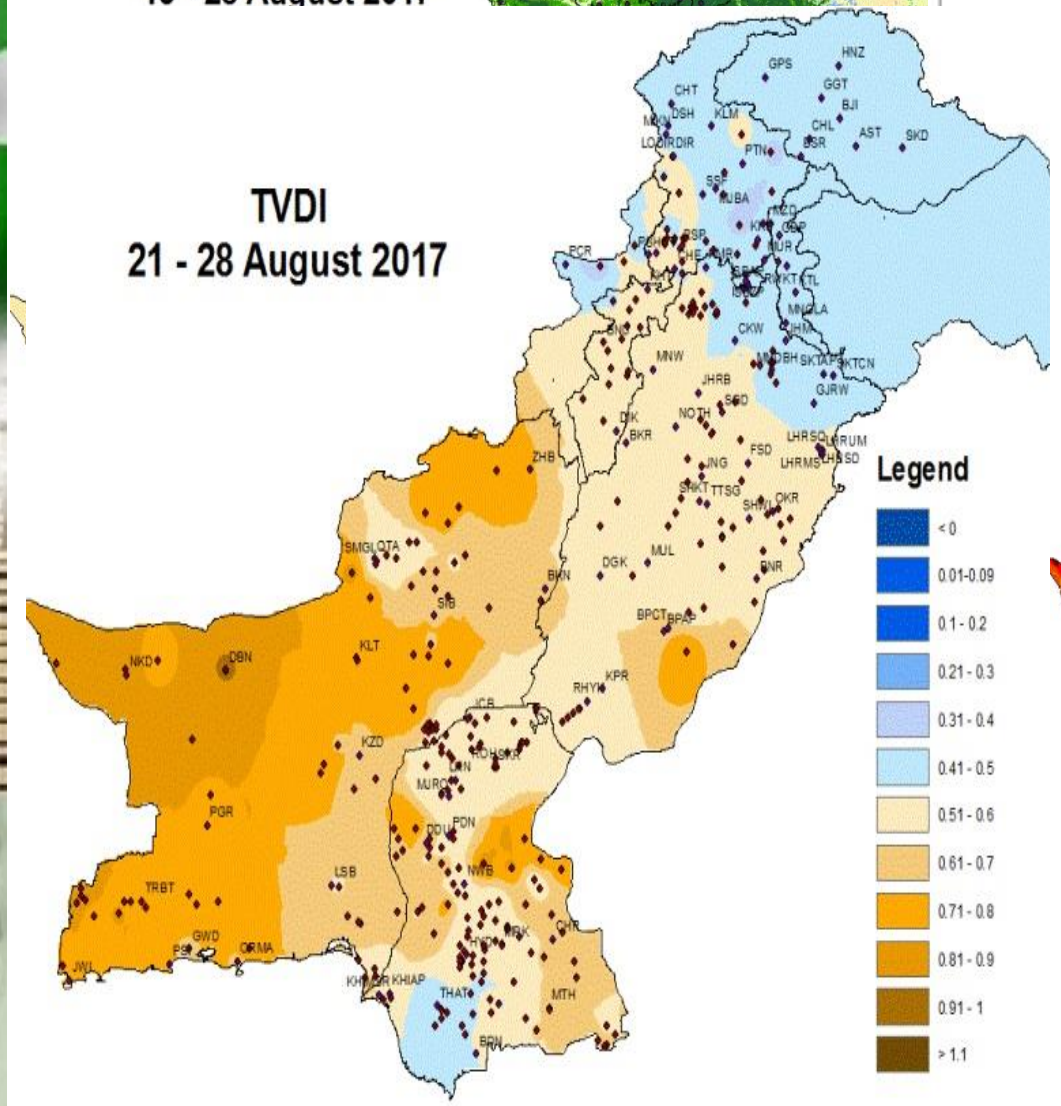
Satellite Derived Products Analysis



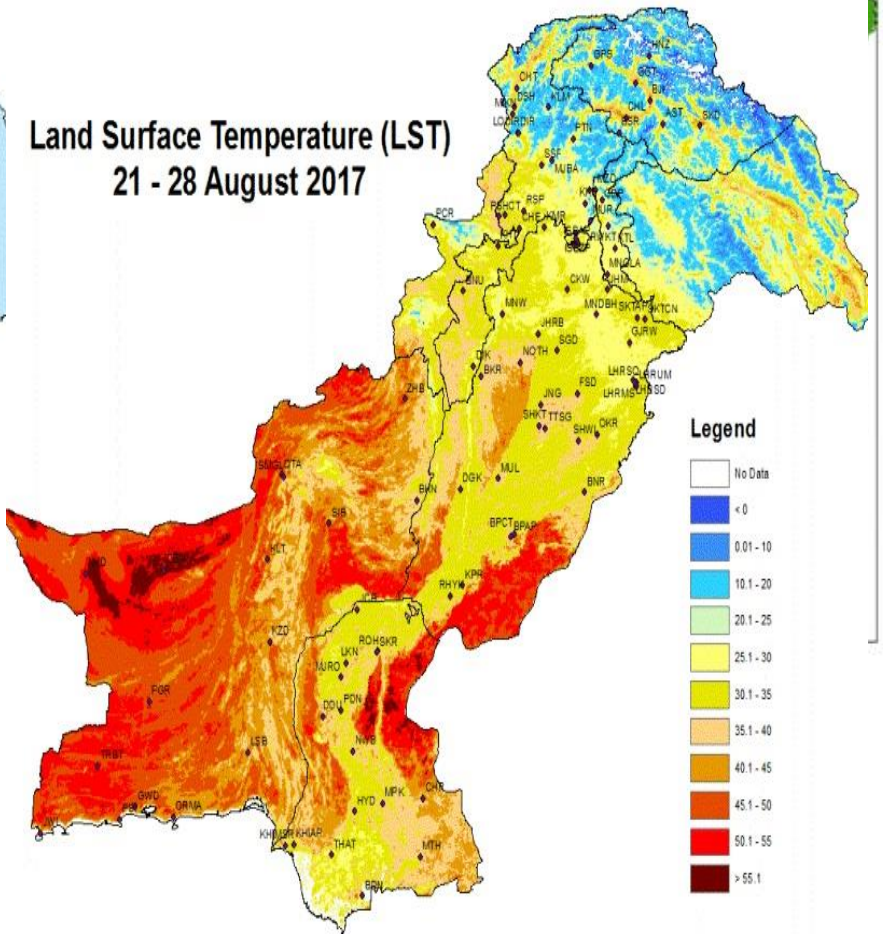
NDVI
13 - 28 August 2017



Vegetation Health Index (VHI)
23-29 August 2017



TVDI
21 - 28 August 2017



Land Surface Temperature (LST)
21 - 28 August 2017

Courtesy: **National Oceanic and Atmospheric Administration (NOAA)**

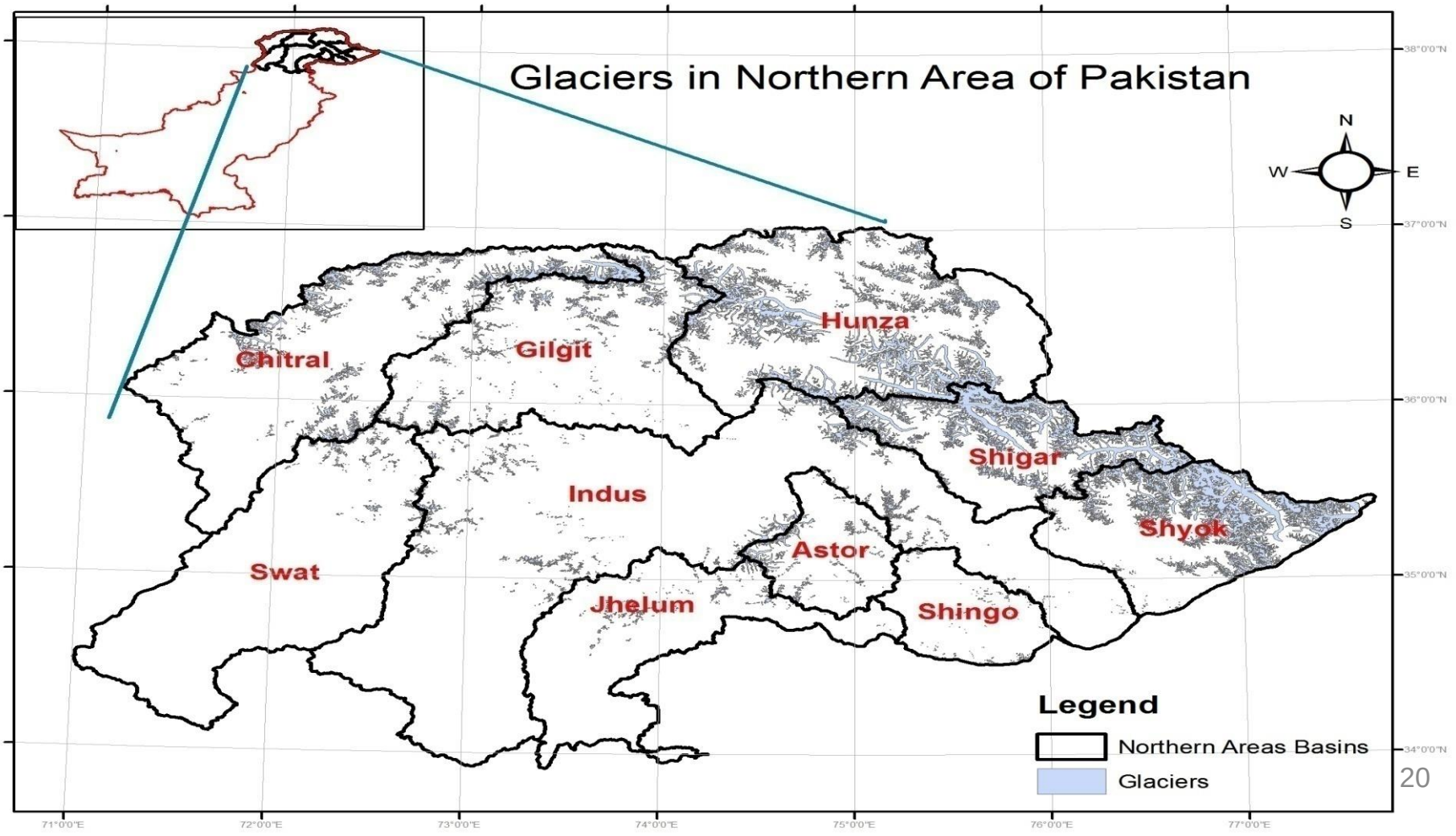
Mountains: Frozen Water Reserves

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

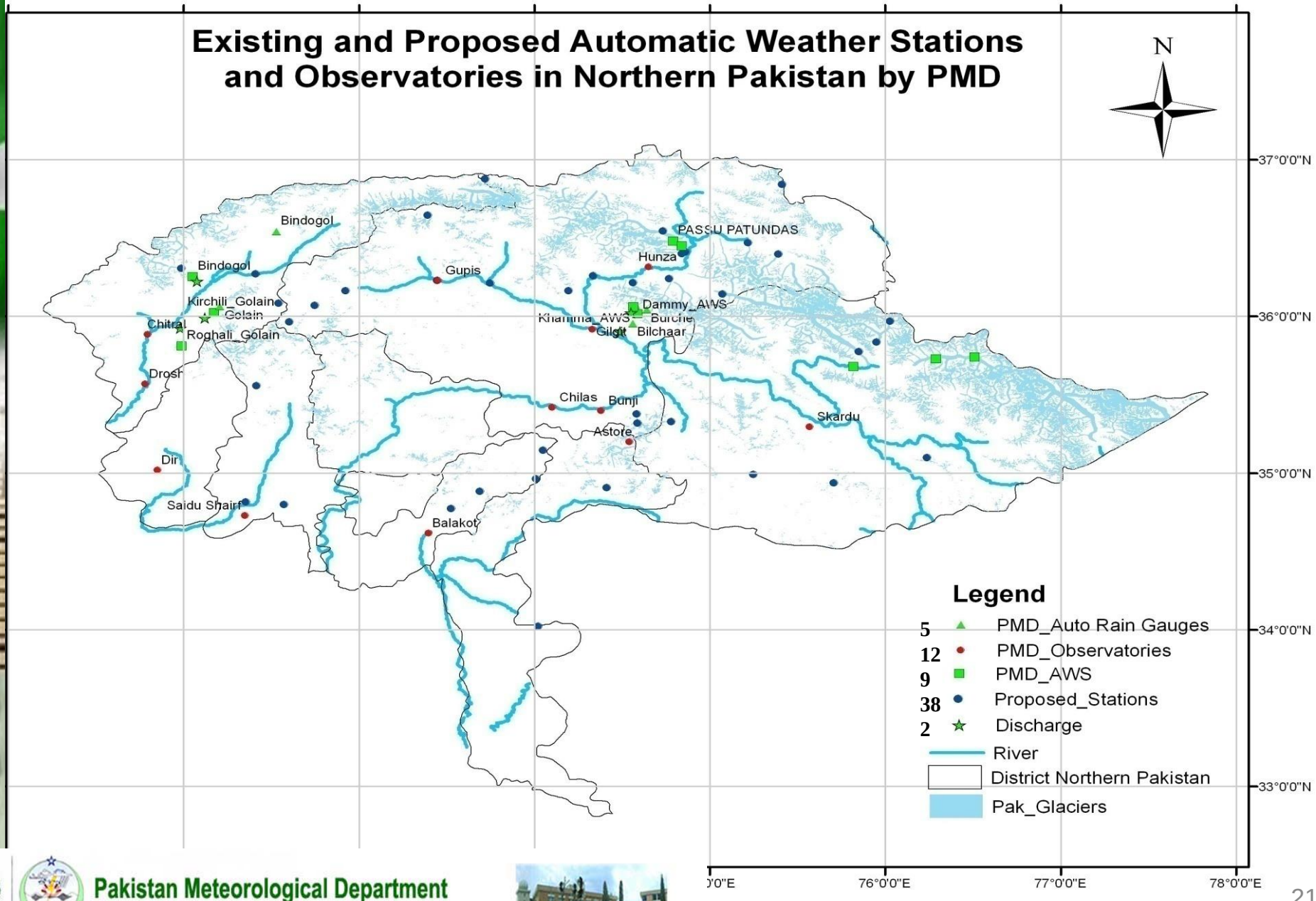


Pakistan's Cryospheric Assets Analysis using Remote Sensing

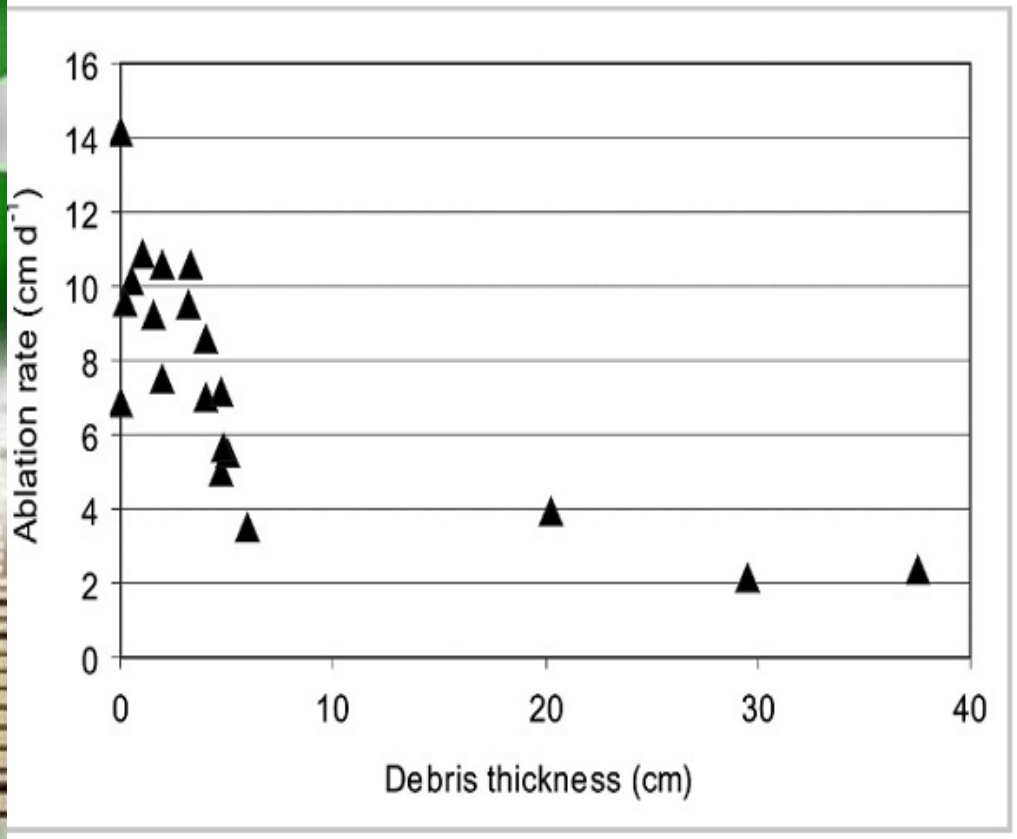
Number of Glaciers	Area of Glaciers (km2)	Volume of Ice (km3)	Ranges
7259	11780	2066	Himalaya Karakoram Hindukush



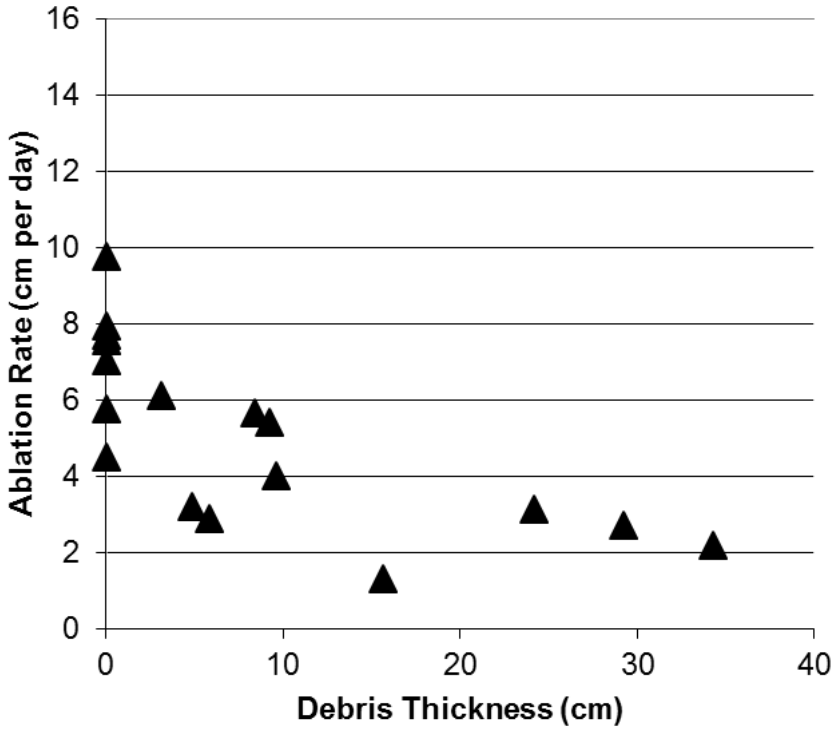
Cryosphere Monitoring Network of Pakistan



Mass Balance at Hinarche Glacier- Comparison Past-Present

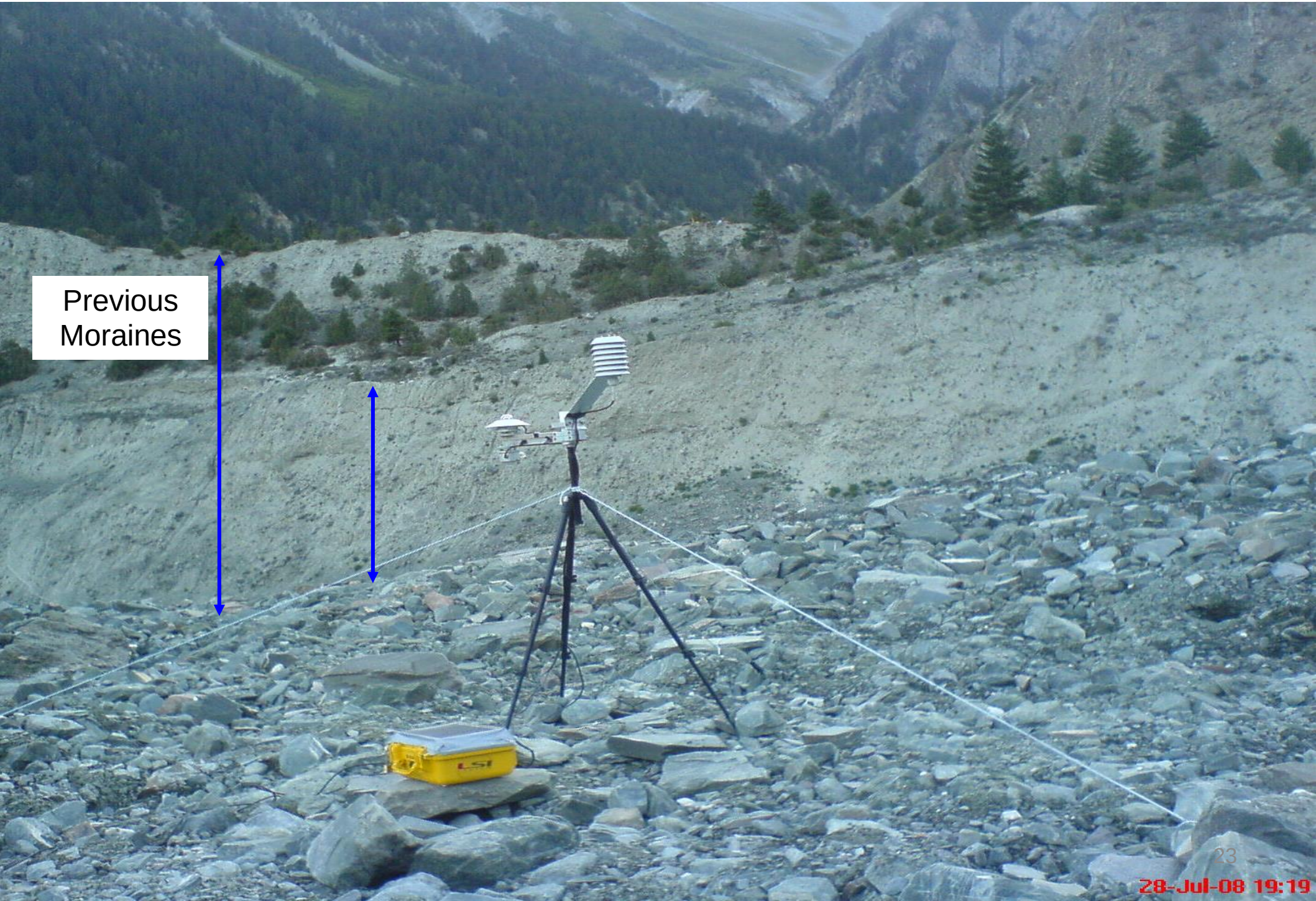


Ablation Stakes Behavior
(Mayer et al, 2010)

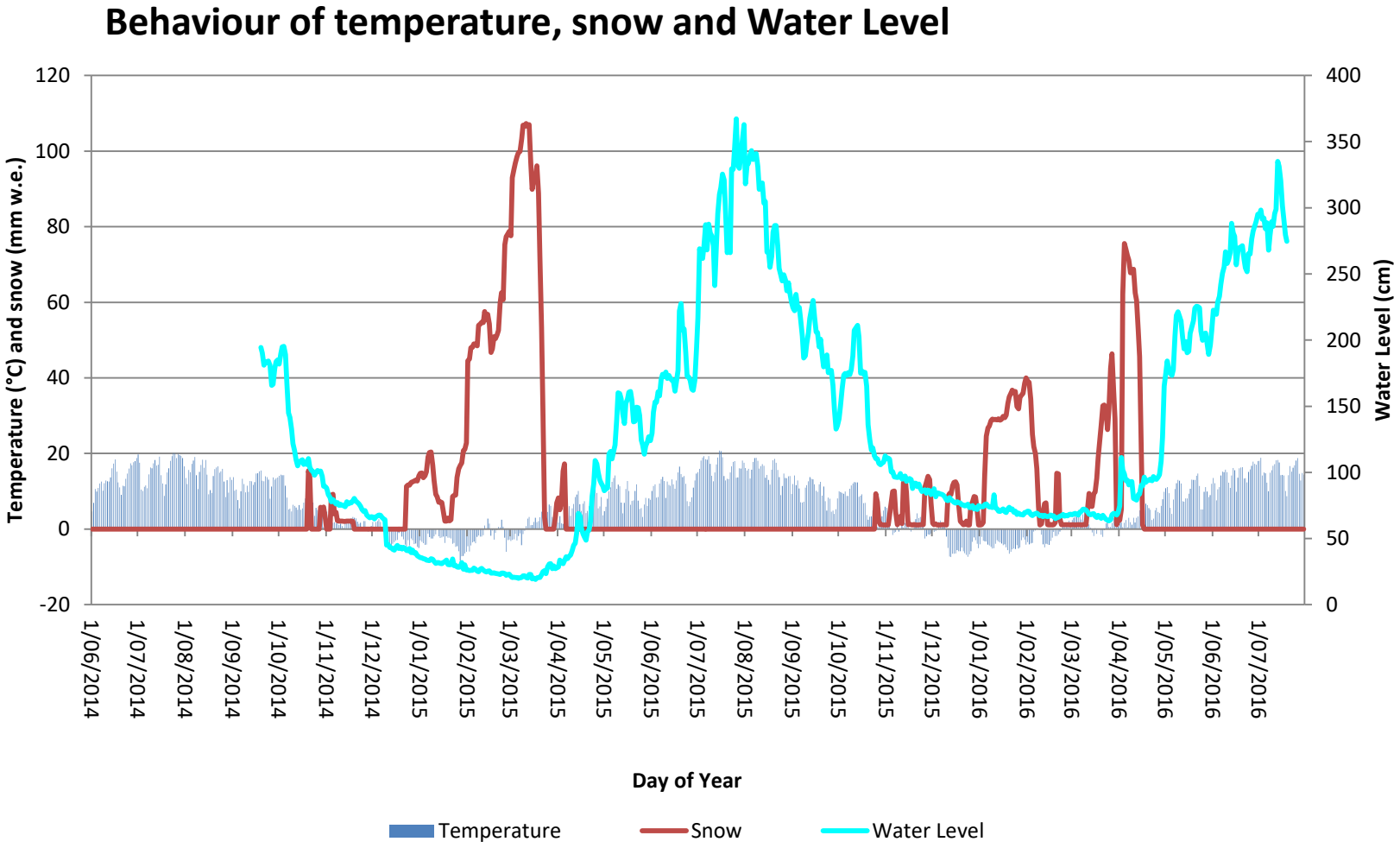


Ablation Stakes Behavior
(Study done by PMD Glacier Monitoring Unit 2015)

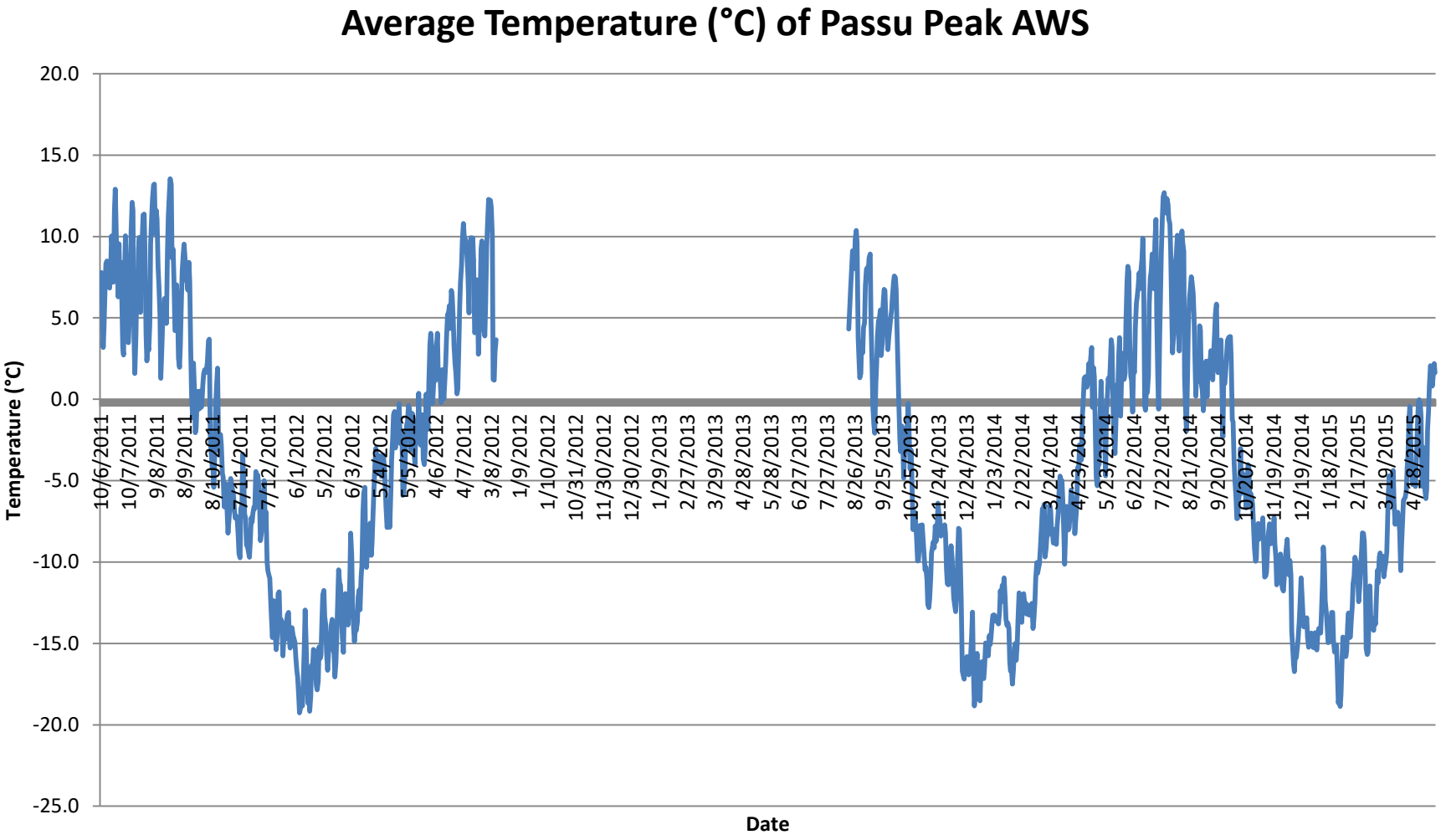
Field Meteorological Observations-Hinarche Glacier



Hydro-Meteorological Behavior of Bagrot Glacier

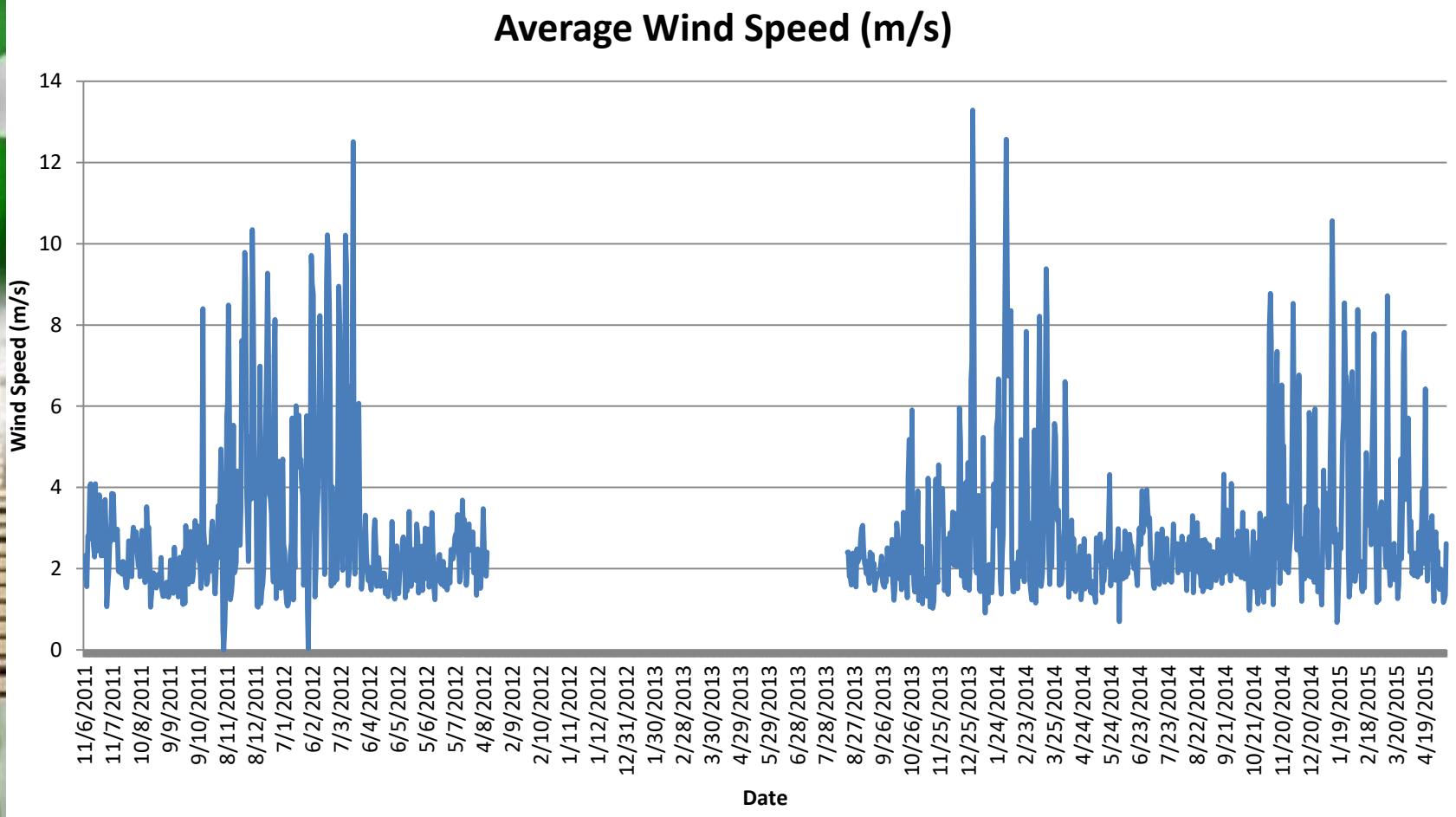


Behaviour of Temperature regime at Passu Peak (4400 m.a.s.l.)



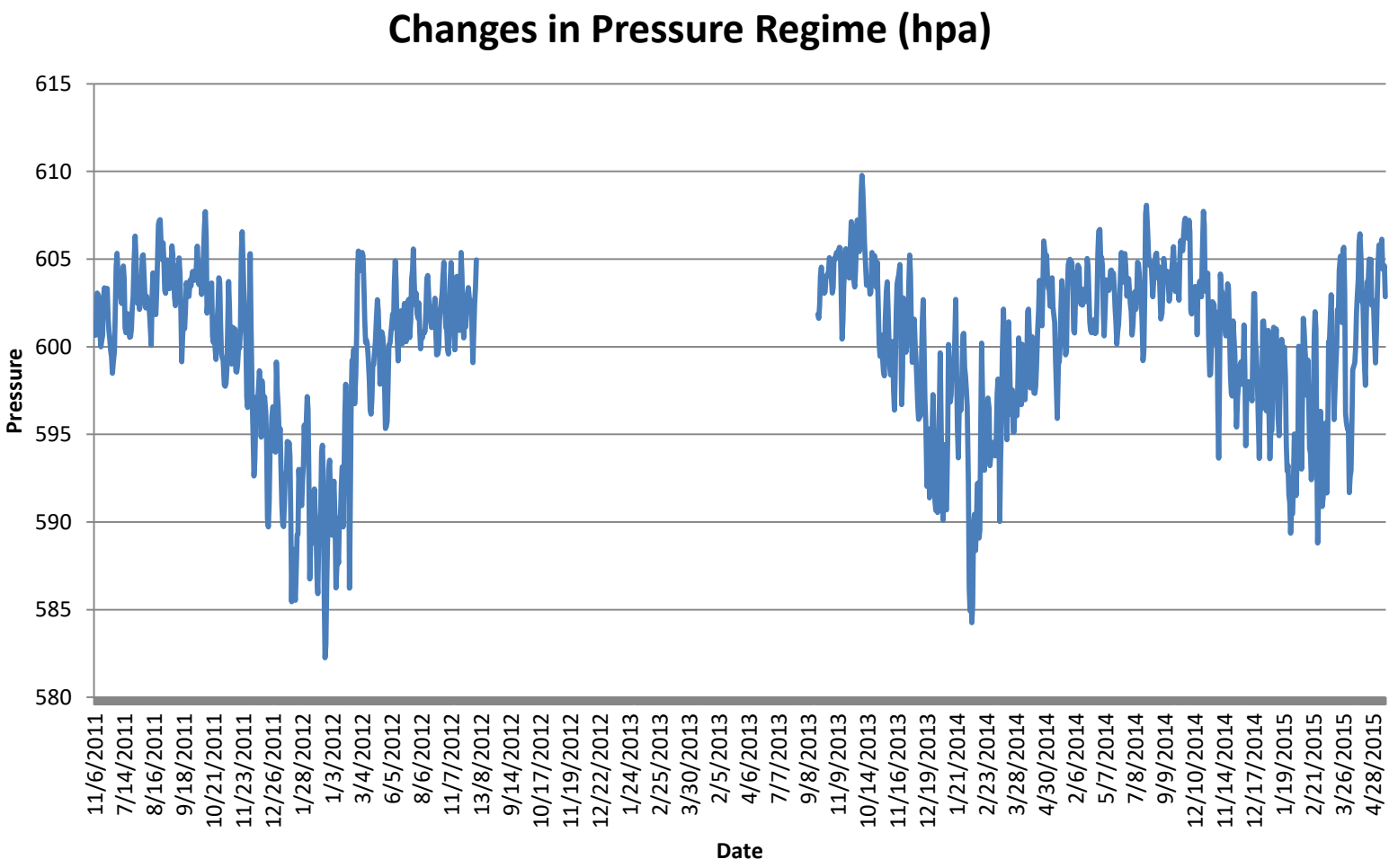
*One year data is missing due to damage to AWS due to harsh climatic conditions

Behaviour of Wind Pattern at Passu Peak (4400 meter above sea level)



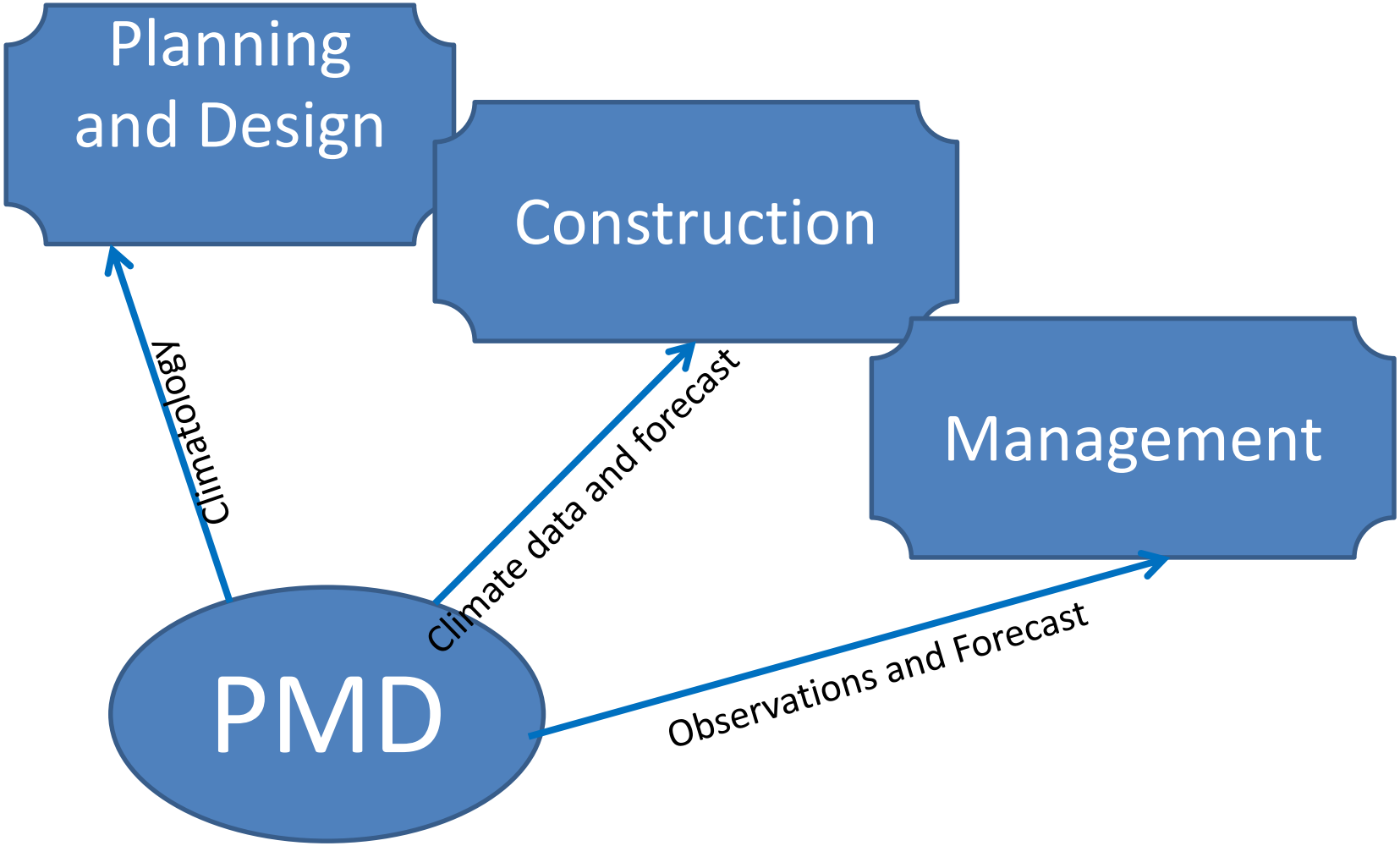
***One year data is missing due to damage to AWS due to harsh climatic conditions**

Behaviour of Pressure Regime at Passu Peak (4400 m.a.s.l.)



*One year data is missing due to damage to AWS due to harsh climatic conditions

Role of PMD in Water Sector Development & Management



Summary

- The glaciers at low elevations are melting
- Results for high elevation are not conclusive
- Need more monitoring stations at high elevations to acquire in-situ precipitation data
- Need dense network of weather stations in glaciated region of Pakistan
- Regular field mass-balance studies on regular basis

CLIMATE CHANGE IMPACTS IN SOUTH ASIA
(PAKISTAN PERSPECTIVE)

Hazrat Mir

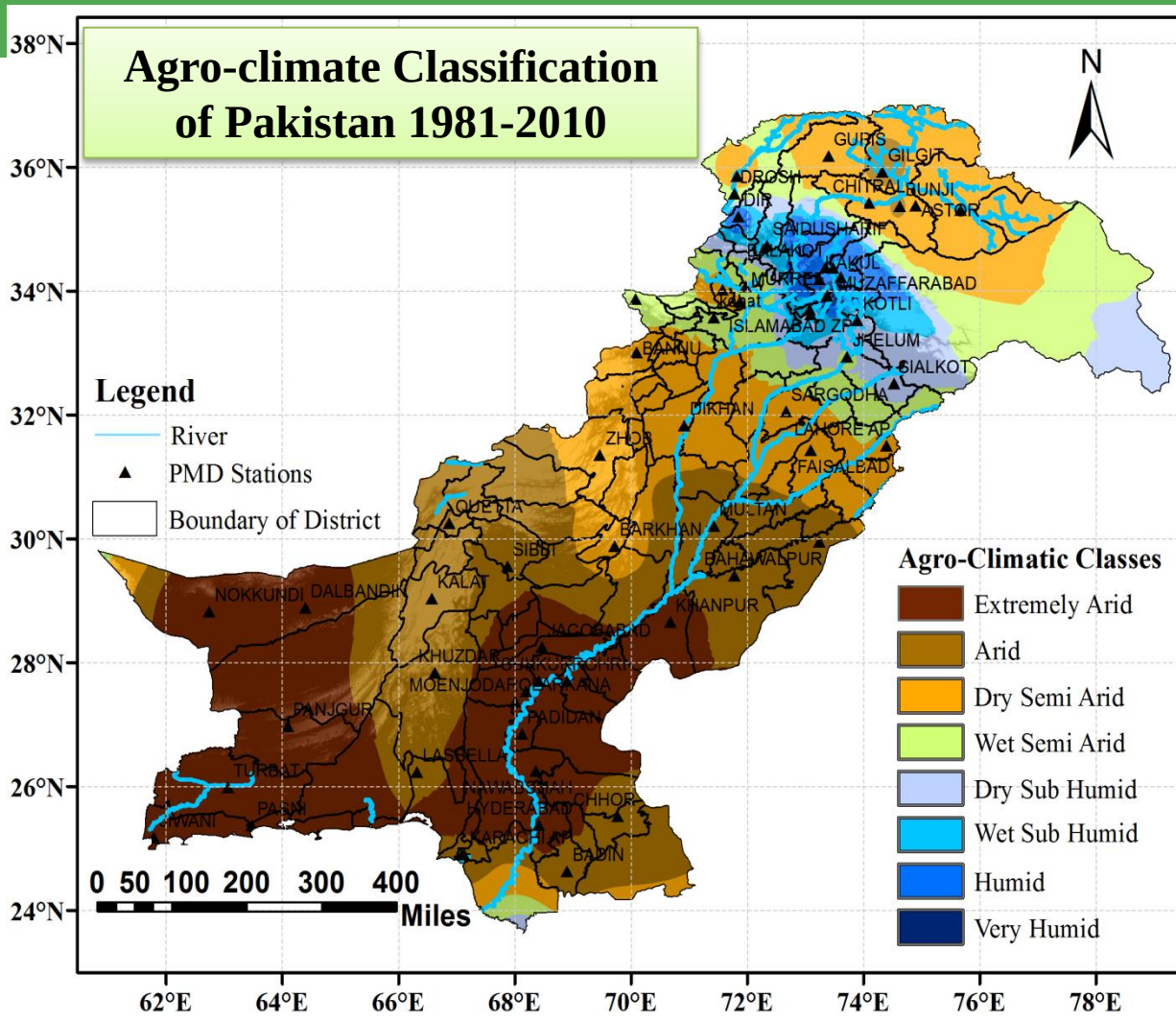
Chief Meteorologist
Pakistan Meteorological Department

http://www.pmd.gov.pk

The Climate

- Climatologically, most parts of Pakistan are arid to semi-arid with significant spatial and temporal variability in climatic parameters

- 65% of the annual rainfall is due to monsoon rains; a dominant hydro-meteorological re-source for Pakistan



The Climate

- The coastal climate is confined to a narrow strip along the coast in the south and southeast, while the north is dominated by the mountain climate. In between the climate is broadly of typical continental nature

- Coastal areas are vulnerable to sea level rise, Storm surges & associated flash flooding

The Climate

❖Hot dry summers,

- Temperatures up to 53^0C at Mohenjodaro, Sindh

❖Cold Winters,

Temperatures up to -24.1°C at Skardu, GB

❖Rainfall

- **Annual average (weighted): 278 mm**
  - North: 250 – 1600 mm
  - South: 80 - 200 mm

❖Monsoon Share: 65%

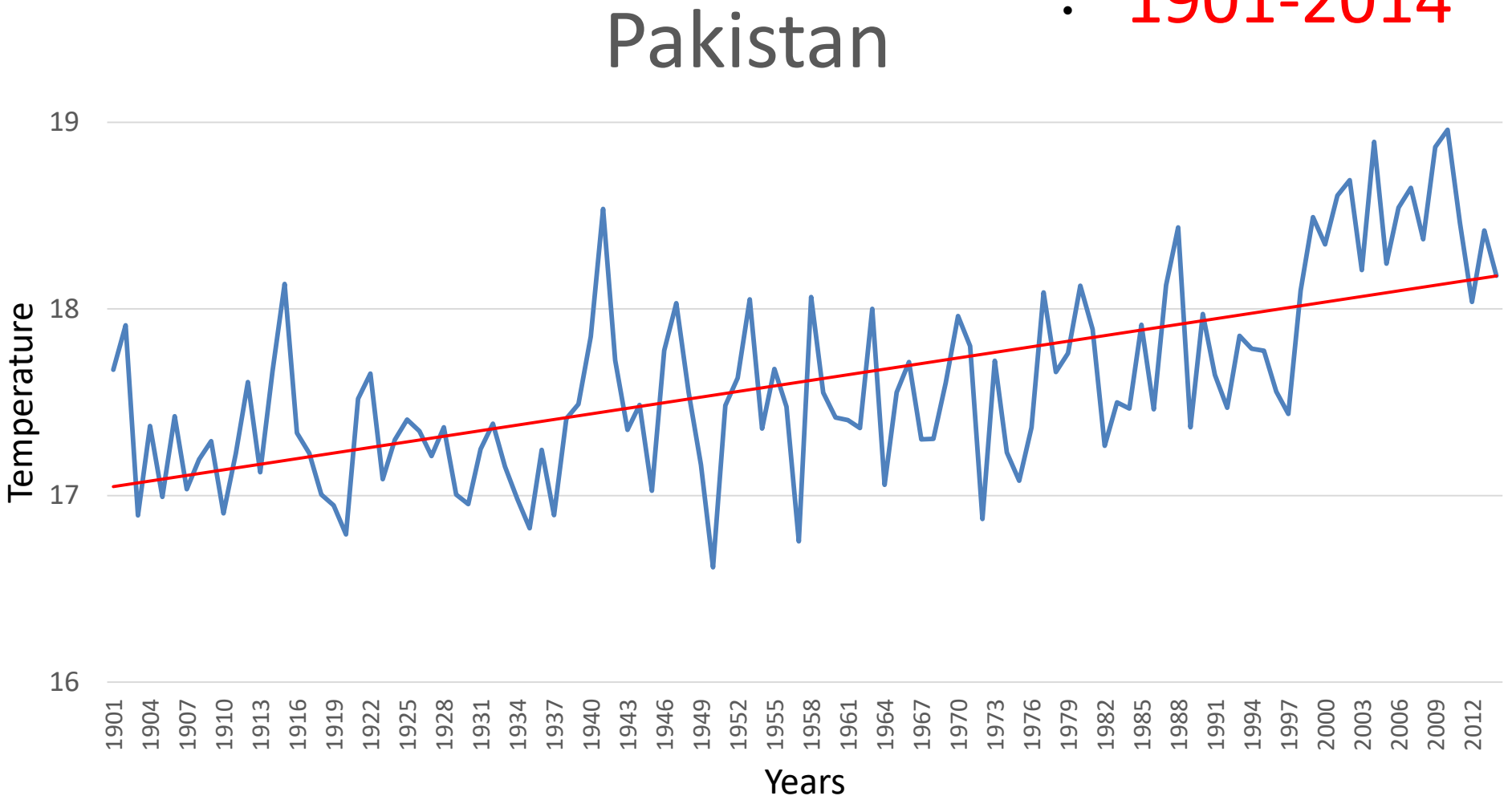
AGRICULTURE

- Largest sector of Economy (24% of GDP)
- 62% population rural; directly or indirectly depends on agriculture
- Industries almost entirely agro based
- >80% exports agro based
- Predominantly depends on irrigation

Trends of Climate Change In Pakistan

Annual Mean Temperatures (°C) Trends

1901-2014



Rate of Change = 0.10°C per Decade

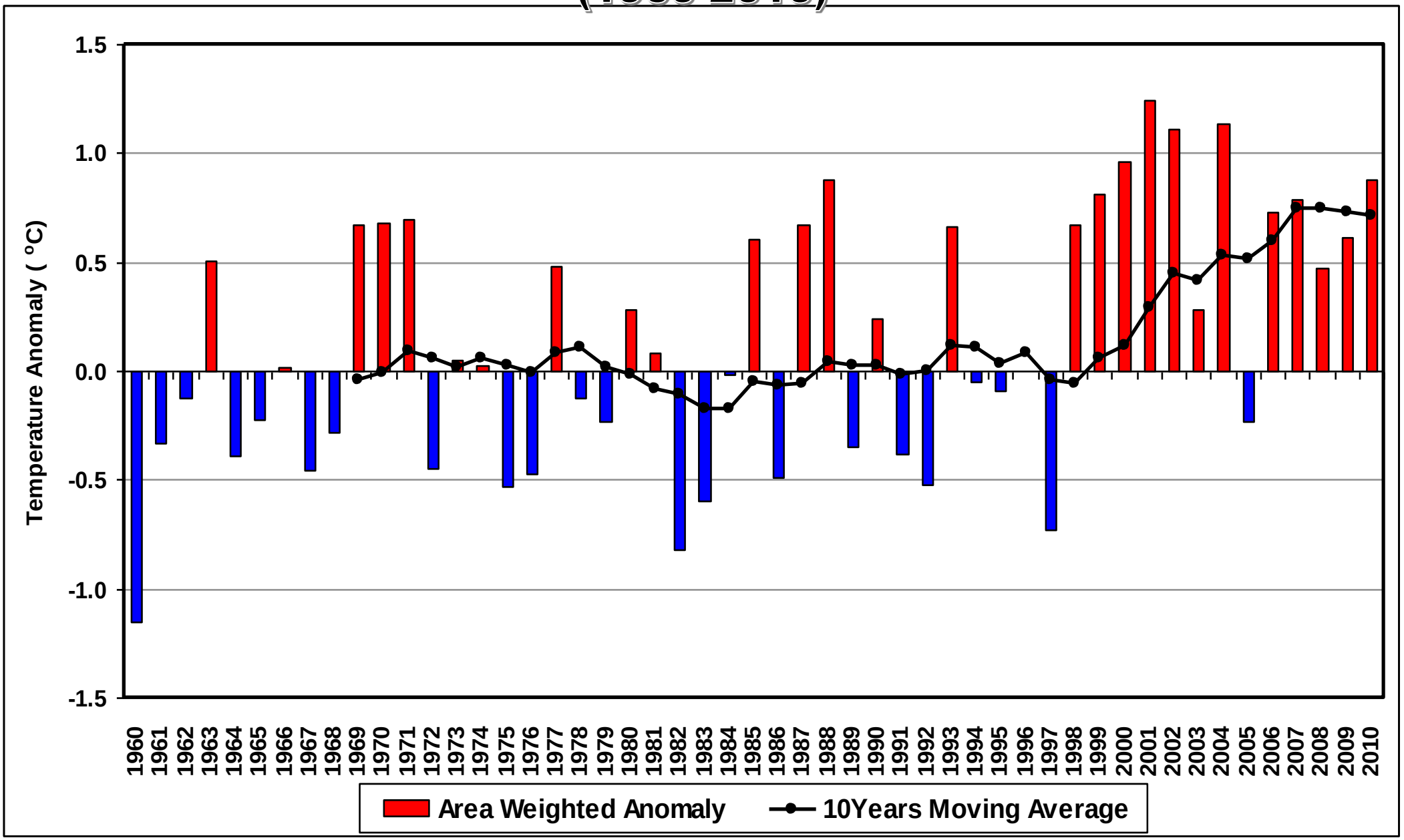
Climate Change Trends over Pakistan

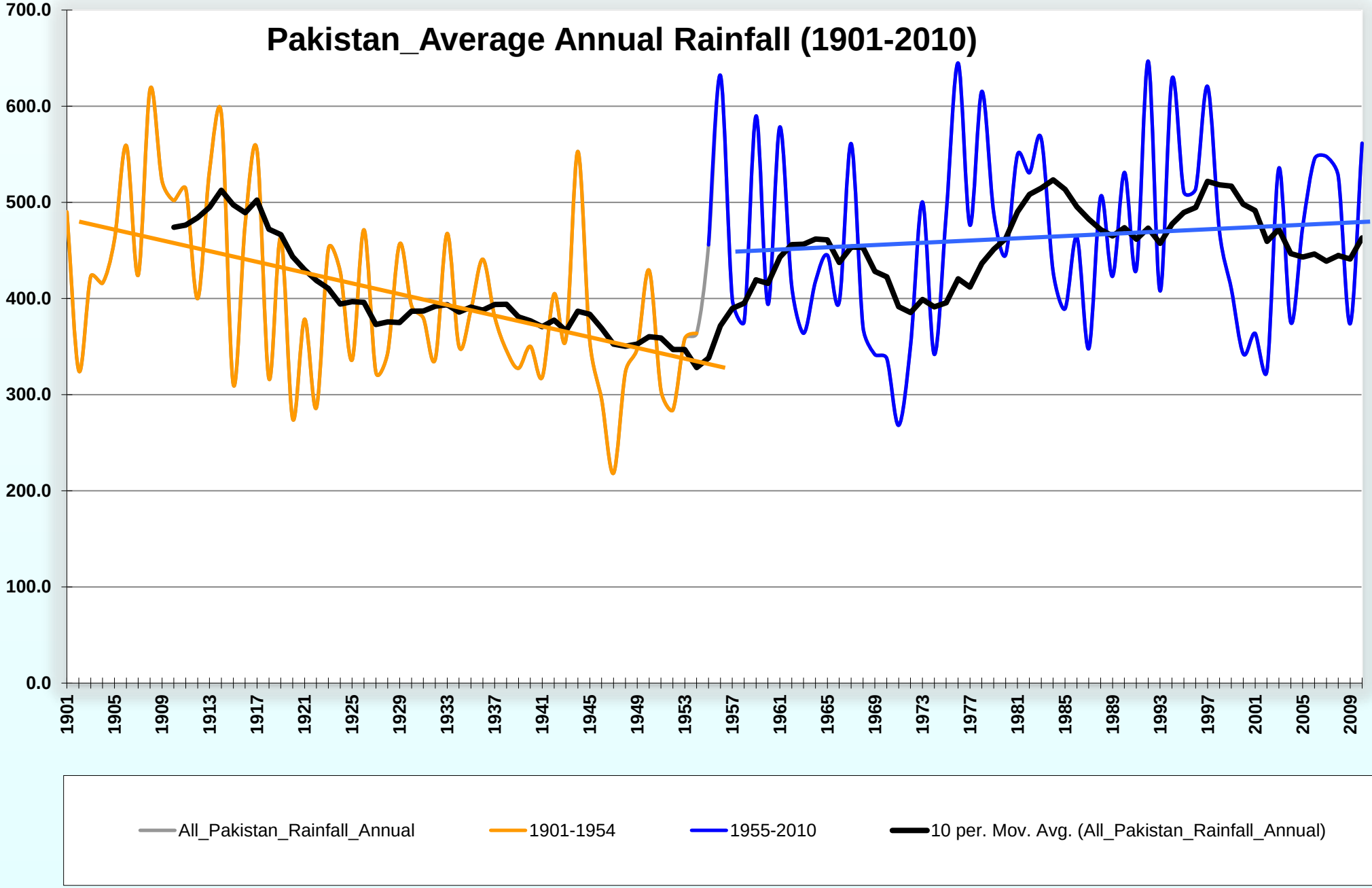
- **The slope of the mean annual temperature over Pakistan during the 48-year period 1960-2007 was found as:**

1901-2000	0.06 °C per decade
1960-2007	0.24 °C per decade

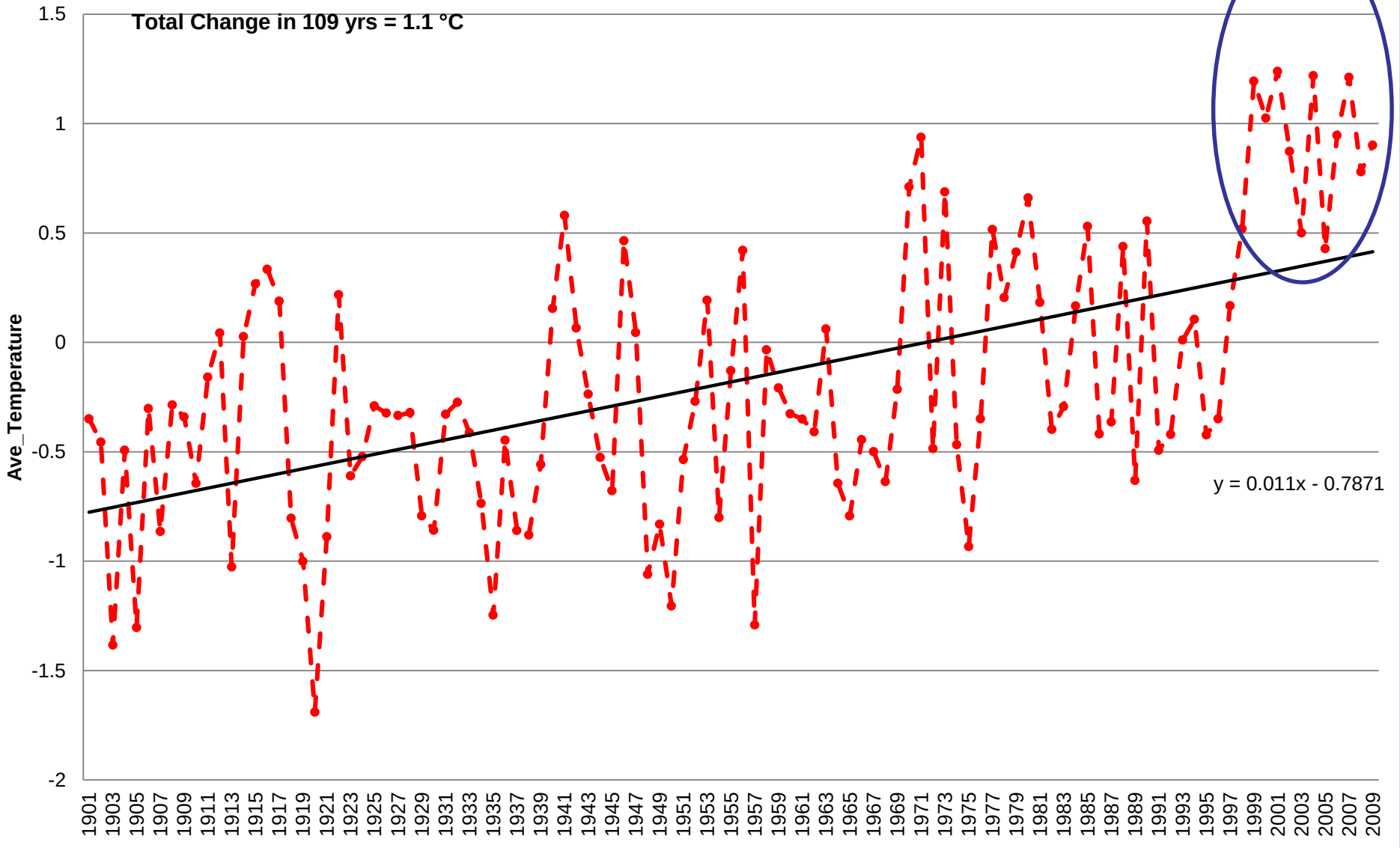
- **The rate of increase is higher than the rate of increase observed globally**

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

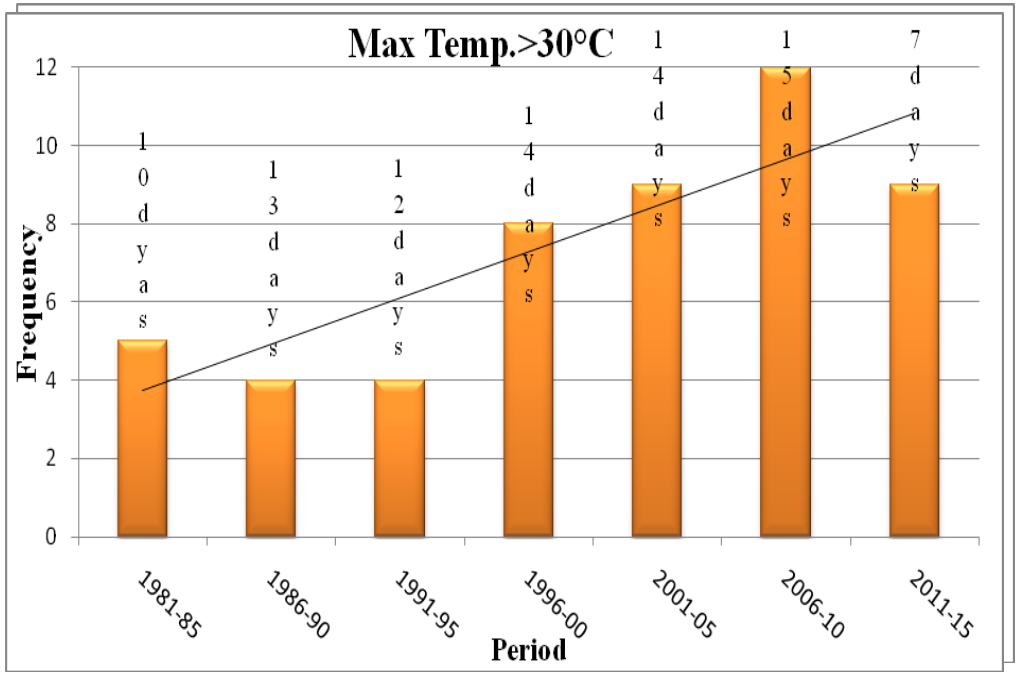


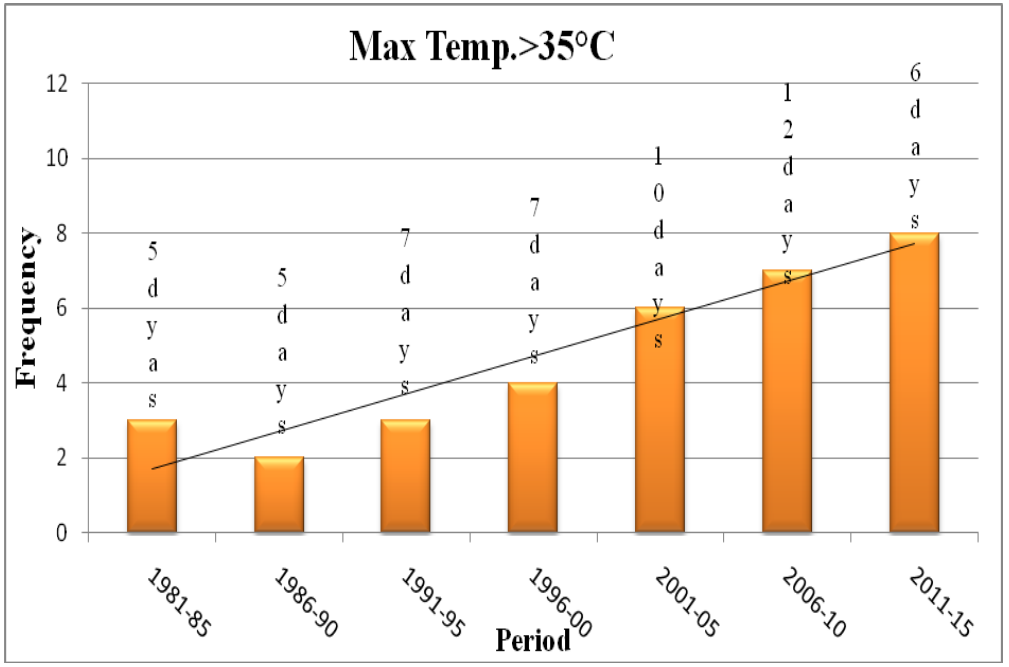

Pakistan_Average Annual Rainfall (1901-2010)
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
1901
1905
1909
1913
1917
1921
1925
1929
1933
1937
1941
1945
1949
1953
1957
1961
1965
1969
1973
1977
1981
1985
1989
1993
1997
2001
2005
2009
All_Pakistan_Rainfall_Annual
1901-1954
1955-2010
10 per. Mov. Avg. (All_Pakistan_Rainfall_Annual)

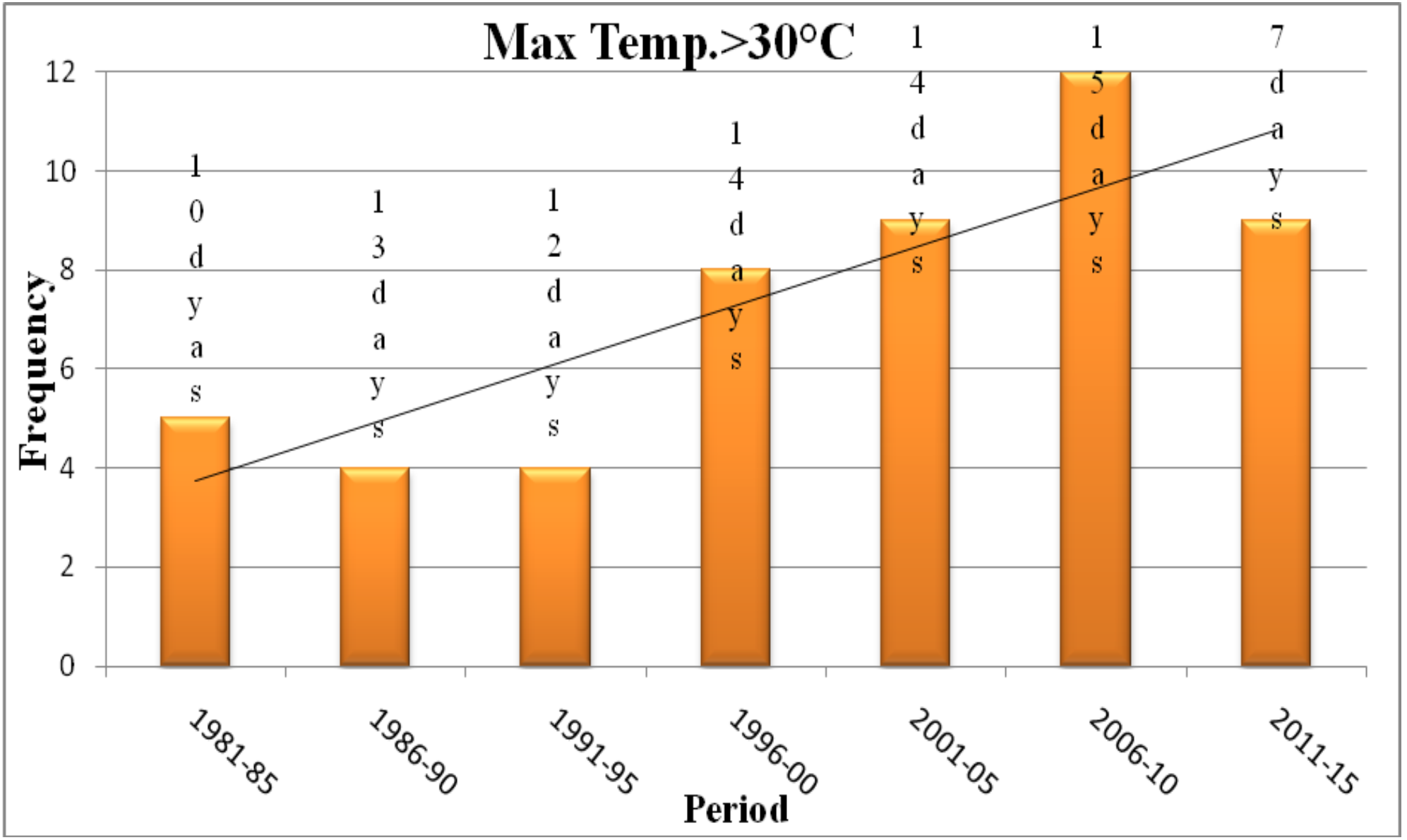
Average Temperature of Northern Areas of Pakistan (1901-2009) based on Climate Research Unit (CRU data

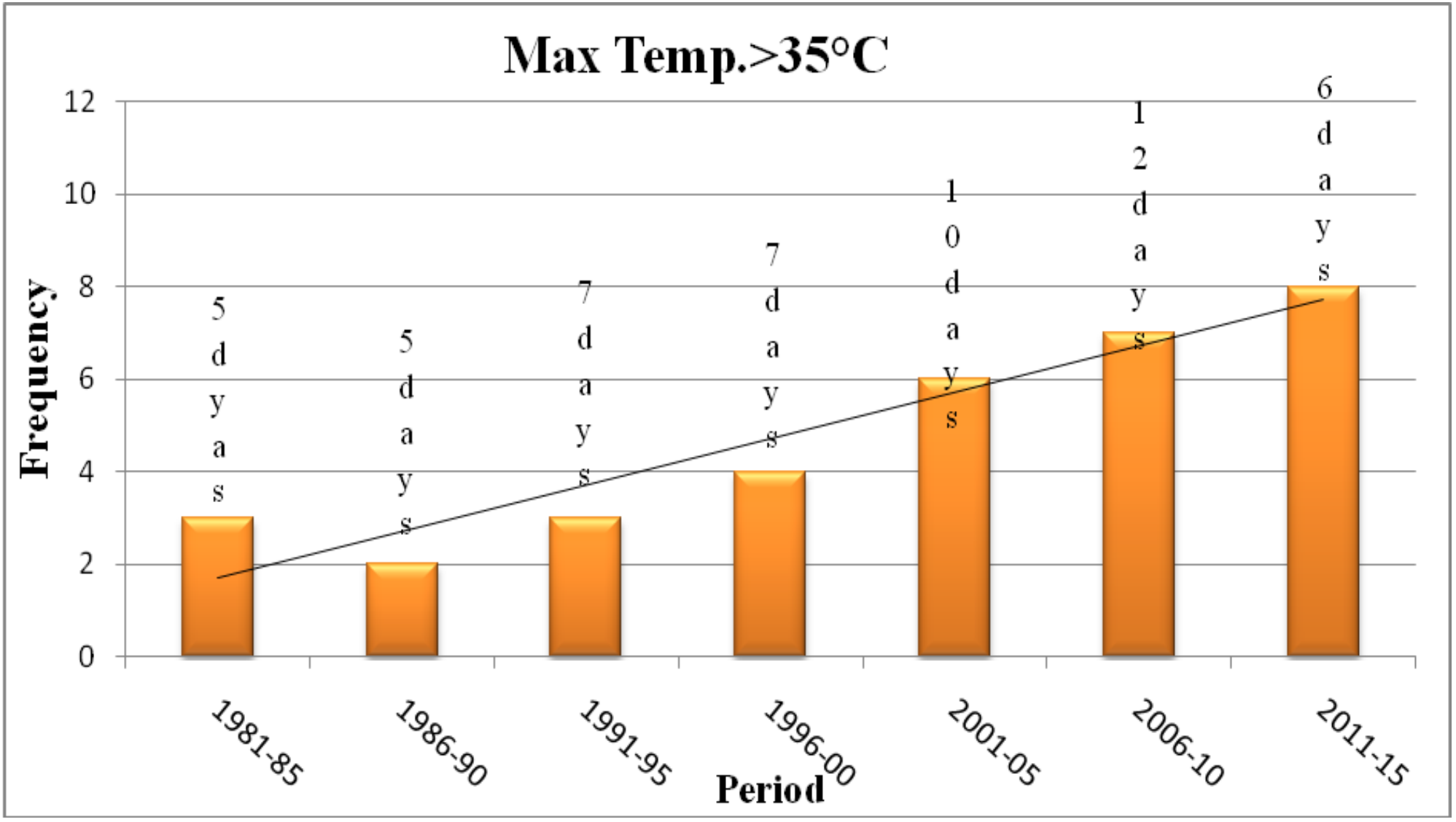


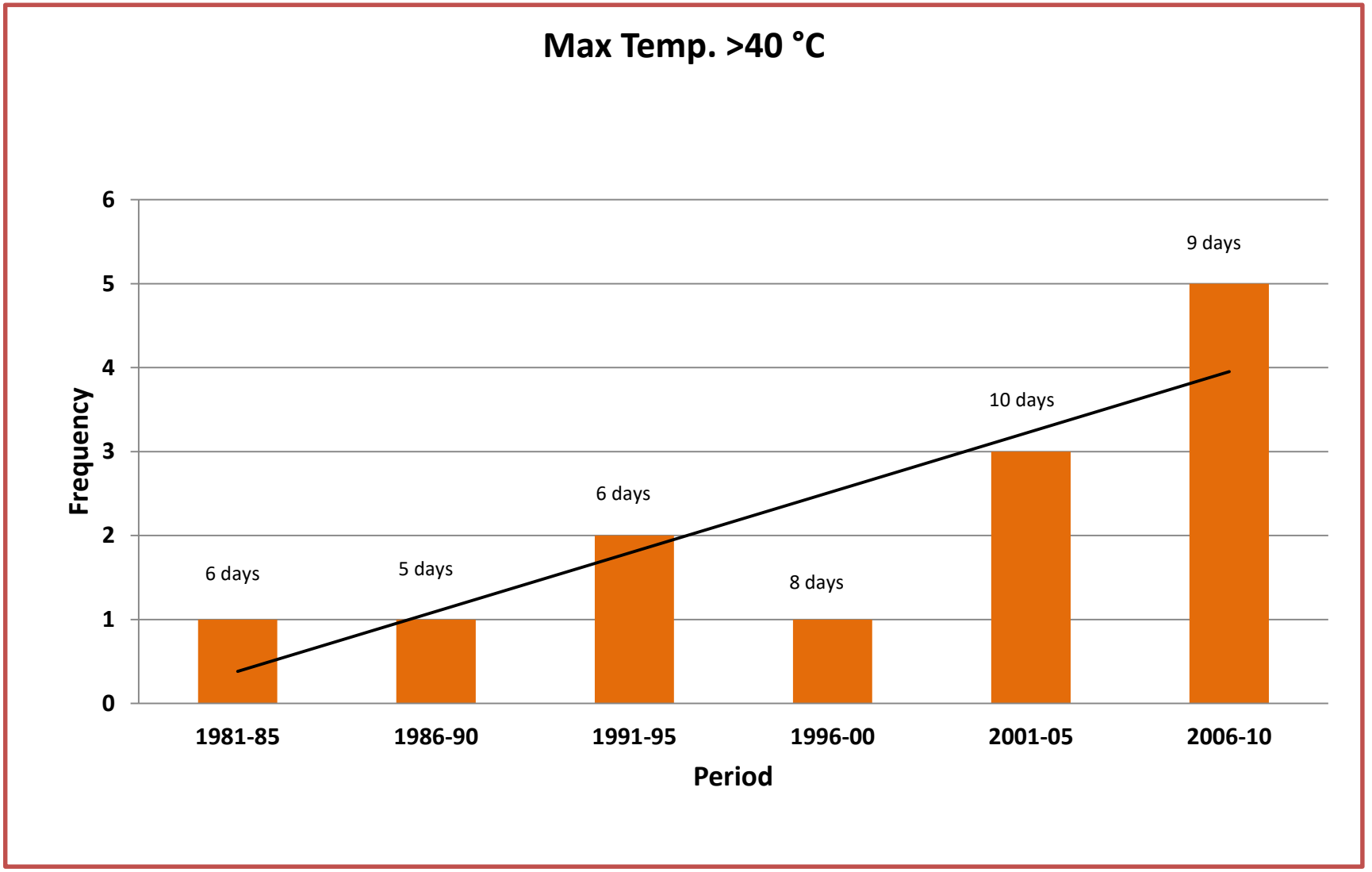
Heatwave Frequency in Upper KP and GB






Max Temp.>30°C
Frequency
Period
0
2
4
6
8
10
12
10 days
13 days
12 days
14 days
14 days
15 days
7 days
1981-85
1986-90
1991-95
1996-00
2001-05
2006-10
2011-15


Max Temp.>35°C
Frequency
0
2
4
6
8
10
12
5 days
5 days
7 days
7 days
10 days
12 days
6 days
1981-85
1986-90
1991-95
1996-00
2001-05
2006-10
2011-15
Period

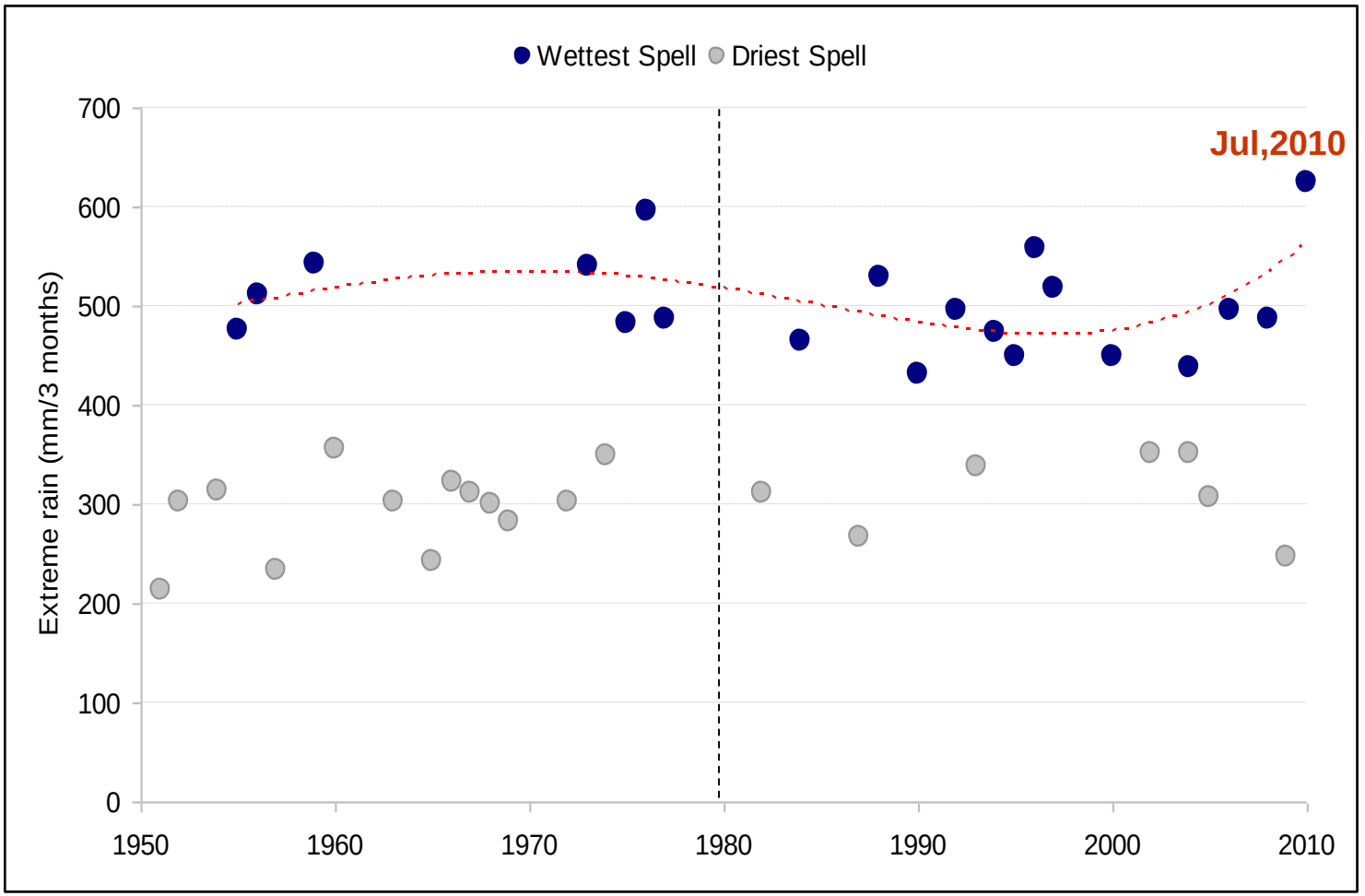

Max Temp. >40 °C
Frequency
0
1
2
3
4
5
6
6 days
5 days
6 days
8 days
10 days
9 days
1981-85
1986-90
1991-95
1996-00
2001-05
2006-10
Period

Precipitation Changes 1951-2010

Precipitation Changes	On annual basis	Monsoon Season (Jun – Sep)	Winter Season (Dec – Mar)
Coastal areas	Negative	Negative	Positive
Quetta region & SE Sindh	Positive	Positive	Positive
Western Balochistan around Nokkundi	Negative	Negative	Negative
Monsoon belt	Positive	Positive	Mostly positive
Northern Mountains	Positive	Positive	Negative

Extreme Rainfall Events (Monsoon) – Climate Change Impact

Northern Pakistan – Wettest (UT) & Driest (LT) Events (1951-2010)



Impacts of Climate change

Regular climate

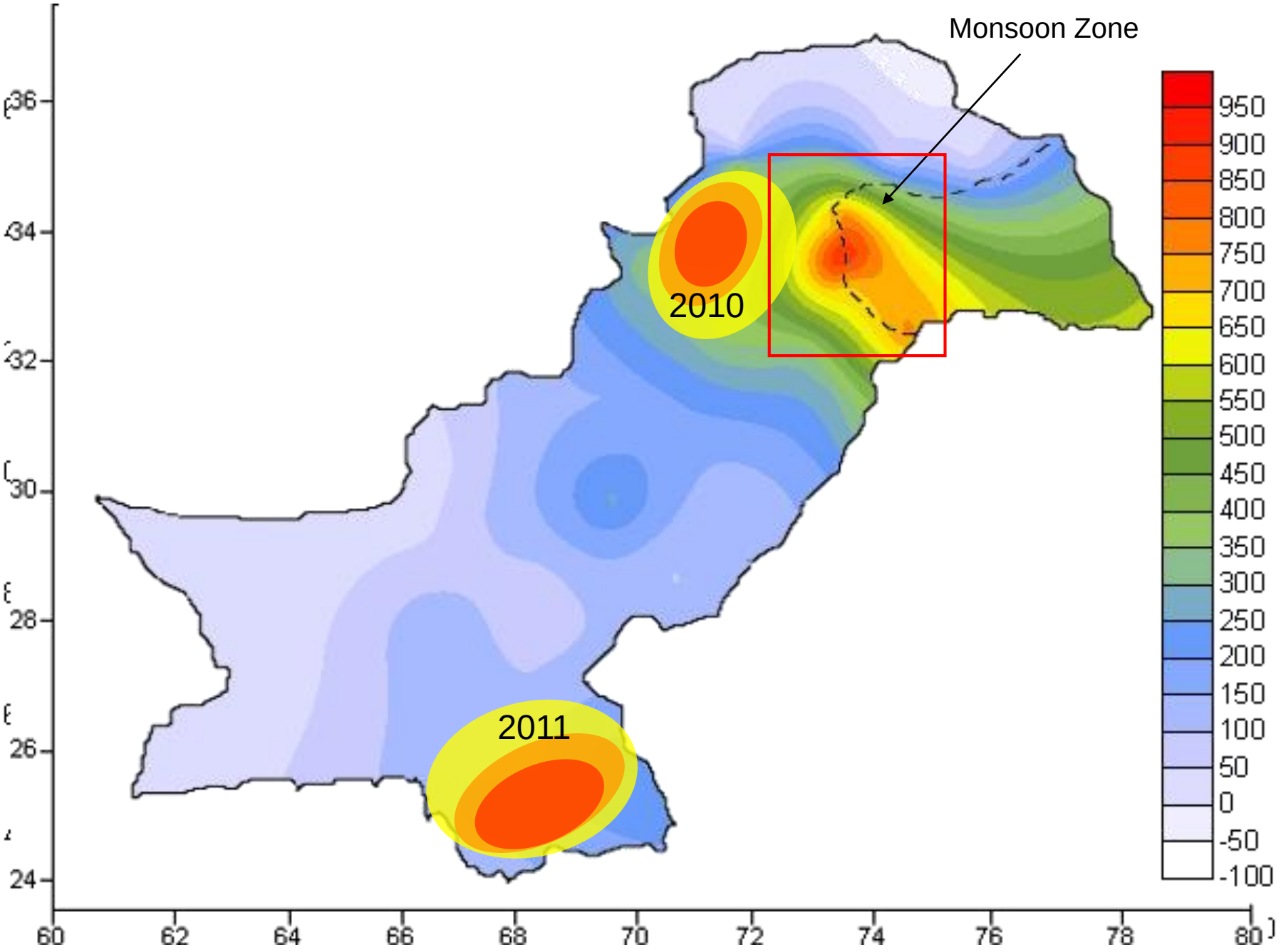
1. **Geographic shifts** – change in area of suitability

2. **Seasonal shifts** – change in (i) yields, (ii) cropping patterns

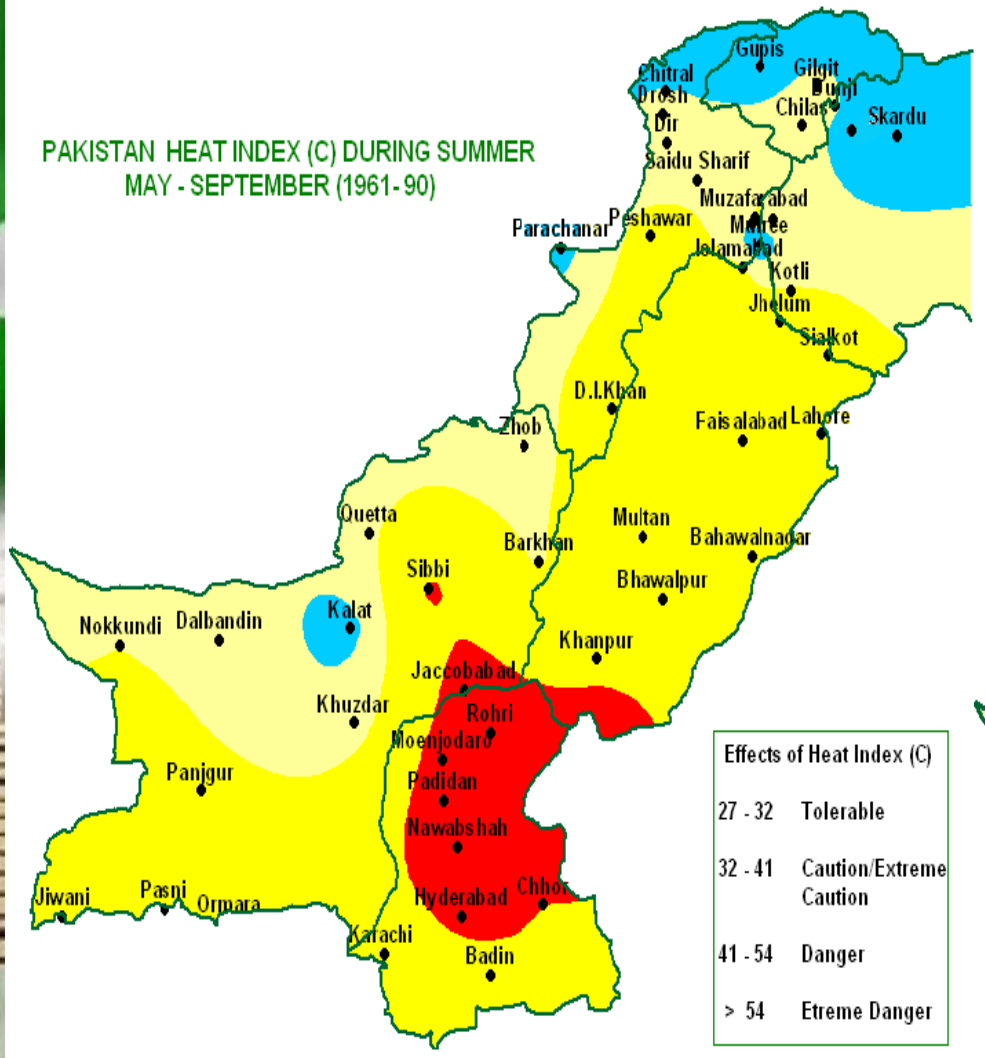
Extreme events

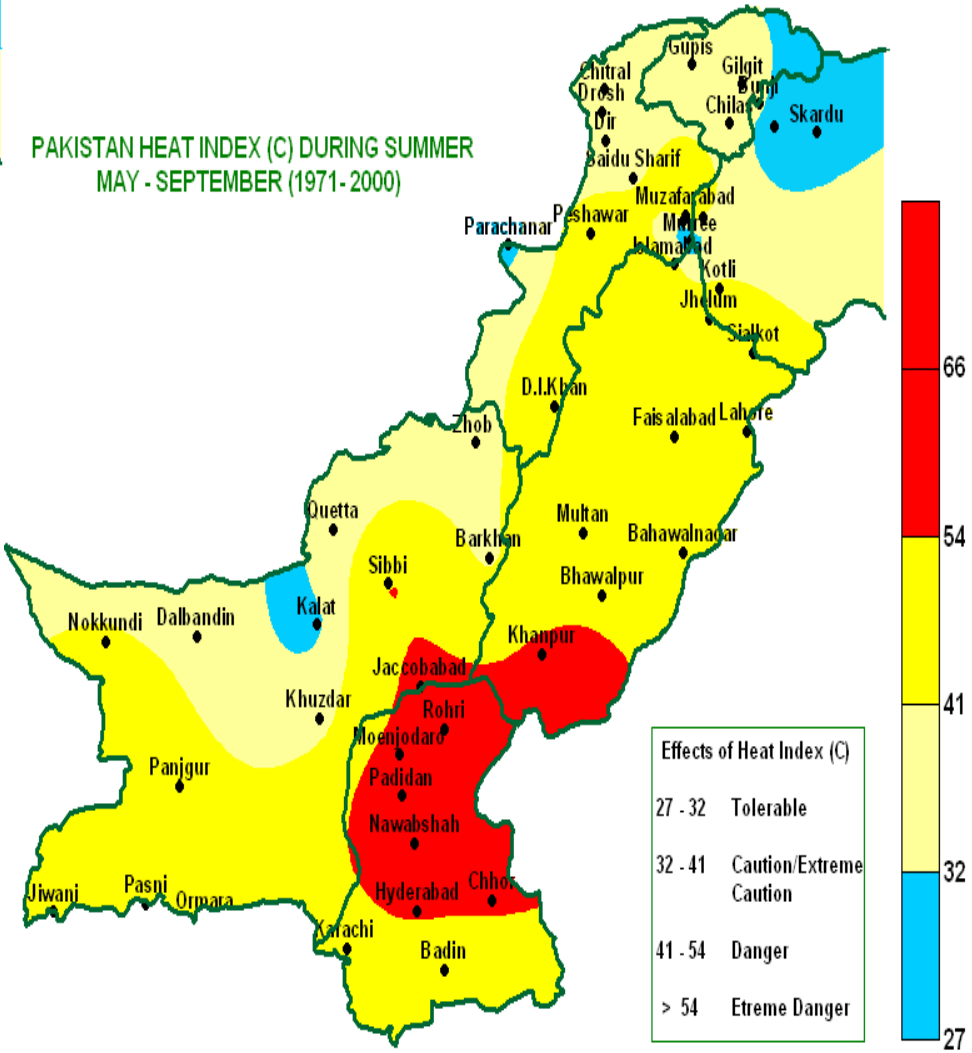
3. **Extreme event shifts**
   - Micro – eg flash flooding and soil loss in uplands
   - Macro – eg saline intrusion in Delta; cyclone landfall

Climate Variability - Monsoonal Belt Changing?



Shift in Heat Index





Climate Change and Mountains

- The mountain regions have warmed considerably over the last century,
- Temperatures are expected to continue rising,
- Projections of precipitation reveal a more differentiated pattern,
- increased exposure to hazards, with extreme events such as GLOFs, avalanches and landslides becoming more common.

Needs / recomendations

- **Adaptation strategies for Agriculture sector be focussed in relation to hydrometeorological changes in the region.**

- **Quantitative Vulnerability assessment of hydro-meteorological resources during next century may be carried out on priority.**

- **Suitable Micro Strategies to promote adaptation in agri-sector to climate change are required.**

- **Climate Change Impact on renewable resources in the region be quantified.**

World hunger again on the rise, driven by conflict and climate change, new UN report says

Hunger and food security

- Overall number of hungry people in the world: 815 million, including:
  - In Asia: 520 million
  - In Africa: 243 million
  - In Latin America and the Caribbean: 42 million

- Share of the global population who are hungry: 11%
  - Asia: 11.7%
  - Africa: 20%
  (in eastern Africa, 33.9%)
  - Latin America and the Caribbean: 6.6%

Malnutrition in all its forms

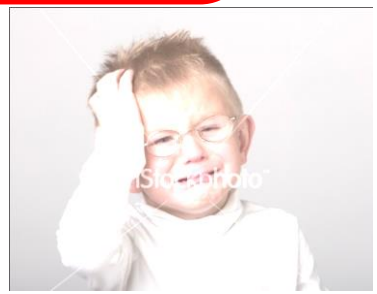
- Number of children under 5 years of age who suffer from stunted growth (height too low for their age): 155 million
    - Number of those living in countries affected by varying levels of conflict: 122 million
- Children under 5 affected by wasting (weight too low given their height): 52 million
- Number of adults who are obese: 641 million (13% of all adults on the planet)
- Children under 5 who are overweight: 41 million
- Number of women of reproductive age affected by anaemia: 613 million (around 33% of the total)

The impact of conflict

- Number of the 815 million hungry people on the planet who live in countries affected by conflict: 489 million
- The prevalence of hunger in countries affected by conflict is 1.4 - 4.4 percentage points higher than in other countries
- In conflict settings compounded by conditions of institutional and environmental fragility, the prevalence is 11 and 18 percentage points higher
- People living in countries affected by protracted crises are nearly 2.5 times more likely to be undernourished than people elsewhere

UNDERSTAND the Climate Risk

COMMUNICATE the Climate Risk



Thank you!