



NATIONAL MONSOON AND FLOOD PROJECTION

2025

National Disaster Management Authority, Pakistan

Contents

Acknowledgement

The National Disaster Management Authority (NDMA) is proud to present the ***Proactive Monsoon Guidelines 2025***, developed to support all provinces of Pakistan in their preparedness and response to the increasing challenges posed by heavy rainfall and flooding during the monsoon season. This document reaffirms our steadfast commitment to enhancing resilience against climate-induced disasters, with a focus on protecting human lives, ecosystems, and the broader environment.

This comprehensive guideline is the product of collective dedication and technical expertise, serving as a strategic resource for understanding, managing, and mitigating the impacts of floods. Its development reflects NDMA's integrated and forward-looking approach to disaster risk reduction.

We extend our sincere gratitude to the **Honorable Chairman NDMA**, **Lieutenant General Inam Haider Malik HI (M)**, whose visionary leadership and strategic guidance were instrumental in the successful completion of this critical document.

The Authority also acknowledges the relentless efforts of the NDMA team, particularly from NEOC, NIDM, and the Directorates of Operations and Disaster Risk Reduction (DRR), whose collaboration and commitment played a pivotal role throughout the process.

We are especially grateful to **Director General NEOC, Brigadier Badar Zaman**, **General Manager Tech EW Ms. Zahra Hassan**, **General Manager Risk Assessment Syed Muhammad Tayyab Shah** for there consistent support and insightful contributions. Their invaluable inputs and leadership greatly enriched the quality and utility of this document.

We further extend our heartfelt appreciation to all officers and staff involved in its preparation. It is our earnest hope that these guidelines will serve as a vital reference for government institutions, emergency responders, civil society, and private sector stakeholders in enhancing preparedness, coordinated response, and long-term mitigation strategies. Together, through sustained commitment and collective action, we can build a safer, more resilient Pakistan for future generations.

List of Acronyms

NDMA	**National Disaster Management Authority**
NEOC	**National Emergency Operation Center**
DDMA	**District Disaster Management Authority**
PDMA	**Provincial Disaster Management Authority**
PEOC	**Provincial Emergency Operations Center**
PMD	**Pakistan Meteorological Department**
SID	**Sindh Irrigation Department**
DRR	**Disaster Risk Reduction**
DEOC	**District Emergency Operation Center**
DMA	**Disaster Management Authority**
PCRWR	**Pakistan Council of Research in Water Resources**
FFT	**Flood Forecasting Telemetry System**
KDA	**Karachi Development Authority**
LBOD	**Left Bank Outfall Drain**
RBOD	**Right Bank Outfall Drain**
ERC	**Emergency Relief Cell**
FDP	**Flood Displaced Person**
FFC	**Federal Flood Commission**
FFD	**Flood Forecasting Division**
GHQ	**Army General Headquarters**
HH	**Households**
INGO	**International Non-Governmental Organization**
LBOD	**Left Bank Outfall Drain**
MIRA	**Multi Cluster Initial Rapid Assessment**
RBOD	**Right Bank Outfall Drain**
SASCOF	**South Asian Climate Outlook Forum**
SITREP	**Situation Report**
SUPARCO	**Space and Upper Atmosphere Research Commission**
SOPs	**Standard Operating Procedures**
UN	**United Nations UNICEF UN Children's Fund**
USAR	**Urban Search and Rescue Team**
Wash	**Water, Sanitation and Hygiene WHO World Health Organization**
WMO	**World Meteorological Organization**
NGO	**Non-Governmental Organization**
NHA	**National Highways Authority**
NHEPRN	**National Health Emergency Preparedness and Response Network**
OCHA UN	**Office for the Coordination of Humanitarian Affairs**

1. Executive Summary

Monsoon rains are vital to South Asia, acting as the primary source of freshwater. They replenish surface water reservoirs and recharge aquifers, supporting both ecosystems and human livelihoods. However, when rainfall becomes excessive, it can cause severe flooding and widespread destruction. In 2022, southern Pakistan experienced exceptionally heavy monsoon rains, driven by persistent and overlapping weather systems. In 2022 the provinces of Sindh, Balochistan, and southern Punjab were hardest hit, suffering from riverine, flash, and urban flooding.

NEOC, NDMA in context of policy change from reactive to proactive approach generated 6x months future forecast for effective disaster preparation and mitigation. As per NEOC projections for monsoon 2025, global climate diagnostics such as a neutral El Niño Southern Oscillation (ENSO), a neutral Indian Ocean Dipole (IOD), anomalously warm sea surface temperatures (SSTs) in the Arabian Sea and Bay of Bengal, and evolving phases of the Madden-Julian Oscillation (MJO), lesser snow cover in the northern hemisphere, weakening of subtropical Jetstream, higher pressure gradient around Mascarene high, increased temperature differential between Land Surface Temperature (LST) and Sea Surface Temperature (SST) , northward movement of Intertropical convergence zone (ITCZ), constructive interference of Rossby waves with MJO suggest a season characterized by above-normal rainfall coupled with above average Land Surface Temperature (LST) with regional disparities and heightened extreme event risks. Northeastern, central, southern, and southeastern regions of the country are expected to receive significantly above-normal precipitation. In contrast, northern parts of KP and Gilgit-Baltistan are likely to experience below-normal rainfall. Districts located along the foothills of the Sulaiman and Kirthar Ranges are expected to receive higher-than-average precipitation.

These hydrometeorological indicators signal a heightened risk of Glacial Lake Outburst Floods (GLOFs), landslides in GB and AJK. Flash floods and urban flooding, particularly across northeastern Punjab & its Hill Torrents, southern Sindh, Kirthar Range of Balochistan and parts of KP and AJK. This report presents monsoon and flood projections for 2025, providing a comprehensive overview of Pakistan's flood landscape, exposure patterns, policy recommendations, and anticipatory action guidelines.

2. Overview of Hydro-Meteorological projections

The monsoon season in Pakistan for 2025 is expected to begin on 26–27 June, approximately four days earlier than the normal onset of the southwest monsoon in the country. The season will extend until 15th September. Given the prevailing climatological variables namely, neutral ENSO and IOD conditions, a northward shift of the Intertropical Convergence Zone (ITCZ), reduced snow cover in the Northern Hemisphere, rising temperatures, and increased pressure differentials between the South Asian landmass and the Pacific and Indian Oceans—it is anticipated that the 2025 monsoon will bring overall above-average precipitation and temperatures, with some regional and local anomalies.

The NEOC team, with input from SASCOF and multiple forecast models has developed a consensus-based outlook. It predicts above-normal rainfall coupled with above-normal land surface temperatures, along with localized variability. Northeastern, central, southern, and southeastern regions of the country are expected to receive significantly above-normal precipitation. In contrast, northern parts of KP and Gilgit-Baltistan are likely to experience below-normal rainfall. Districts located along the foothills of the Sulaiman and Kirthar Ranges are expected to receive higher-than-average precipitation.

The most pronounced temperature anomalies are projected for northwestern Pakistan, particularly northern KP and GB. Notable increases in land surface temperatures are also expected in southern Balochistan, central and northeastern Sindh, central and southern Punjab. These above-normal temperatures—especially during the early monsoon phase may accelerate snowmelt in high-altitude northern regions, leading to increased river flows and a heightened risk of flooding particularly in western rivers like Kabul and Indus. Hydrometeorological indicators signal a heightened risk of Glacial Lake Outburst Floods (GLOFs), landslides in GB and AJK. Flash floods and urban flooding, particularly across northeastern Punjab & its Hill Torrents, southern Sindh, Kirthar Range of Balochistan and parts of KP and AJK.

3. Gilgit Baltistan and Azad Jammu and Kashmir

a. Gilgit-Baltistan (GB) Monsoon Projection

The northern mountainous territories of Gilgit-Baltistan are forecasted to receive normal to below normal rainfall. In GB, districts such as Astore, Skardu, Hunza, and Gilgit are likely to experience precipitation in late July and August. This may lead to glacial lake outburst floods (GLOFs) at different locations.

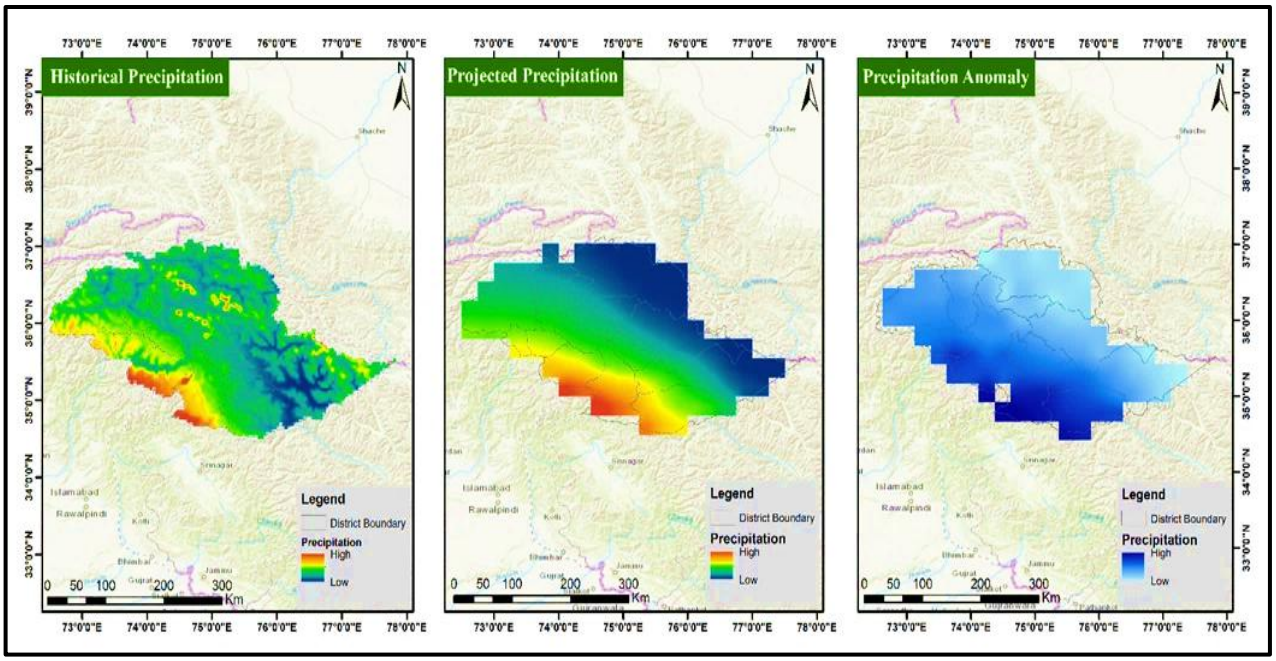


Fig.1 GB Comparative Analysis for Average Precipitation (July, August, September).

b. Flood Projection

Gilgit-Baltistan is expected to experience normal to below-normal rainfall during the 2025 monsoon season, particularly across districts such as Astore, Skardu, Gilgit, and Hunza. However, even moderate rainfall in these high-altitude areas carries considerable hydrological significance due to the presence of snowpacks, glaciers, and glacial lakes. Elevated temperatures, forecasted to remain above normal, will likely accelerate glacier melt. Rainfall events in late July and August, even if infrequent, may act as critical triggers for Glacial Lake Outburst Floods (GLOFs). Valleys downstream of glacial lakes particularly in Hunza, Shigar, and Ghizer remain highly vulnerable to sudden onset floods. Historical patterns, coupled with satellite-derived precipitation anomaly data, reinforce the risk of localized flooding in glaciated basins. The combination of rainfall, temperature anomalies, and glacial lakes makes proactive monitoring indispensable.

c. Snow Cover Projections

Below are the snow projections for the months of March to August 2025. A specific region in northern Pakistan is zoomed in which may be important for hydrological impacts and flood risks.

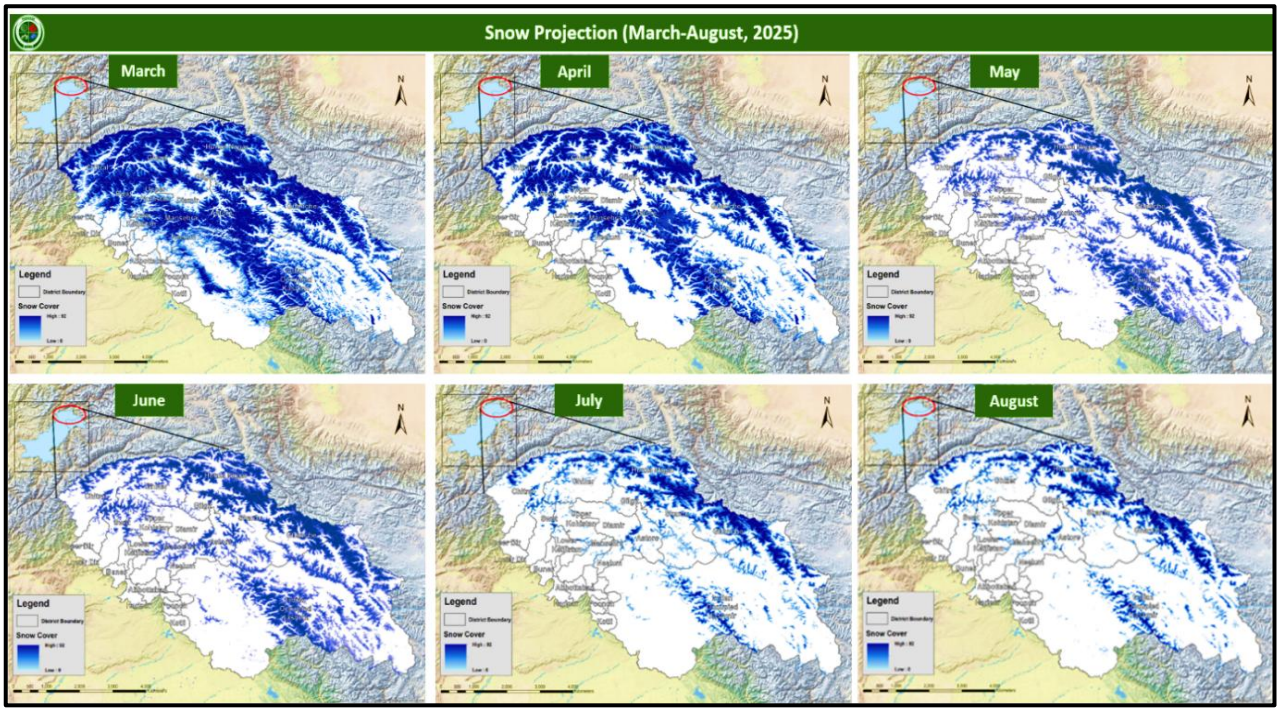


Fig.2 March-August Snow 2025

d. Temperature Projections

The highest projected temperature increases from 28.03°C in January to 45.66°C in June. The lowest temperature remains negative in early months, reaching -13.13°C in January, but gradually rises to 11.66°C in July.

e. Projected Hydro met Risks for 2025

(1) Glacial Lake Outburst Floods (GLOFs). Increasing temperatures and glacial retreat heighten the likelihood of GLOFs, particularly between May and September 2025.

(2) Flash Floods and Landslides. Erratic melting patterns may trigger severe flooding in Sindh, Balochistan, and Punjab, while landslides threaten northern Pakistan.

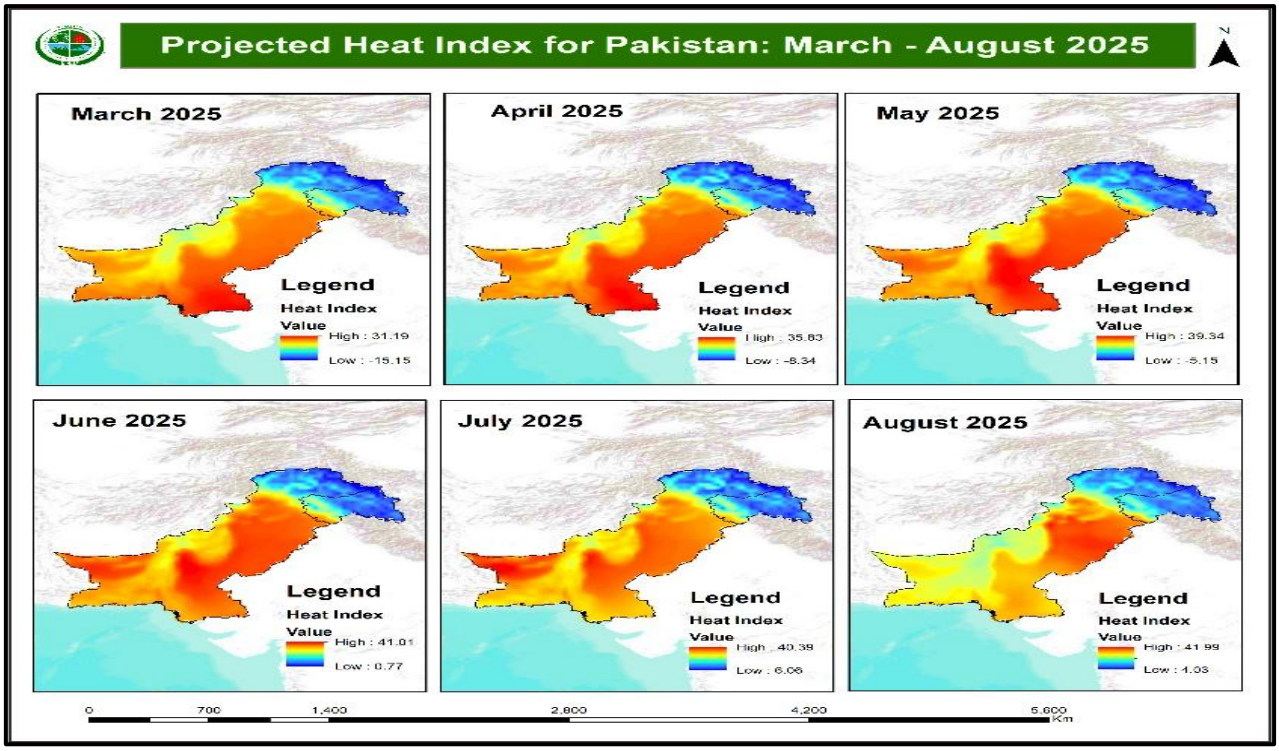


Fig.3 Projected Heat Index (March-August 2025)

f. Azad Jammu & Kashmir (AJK) Monsoon Projection

In AJK, including Muzaffarabad, Neelum Valley, and Rawalakot, isolated heavy rains are forecasted. The rugged terrain and high rainfall intensities pose significant risks of landslides and riverine flooding. These regions also contribute to the upper catchment areas of major rivers, affecting downstream water flows in Punjab.

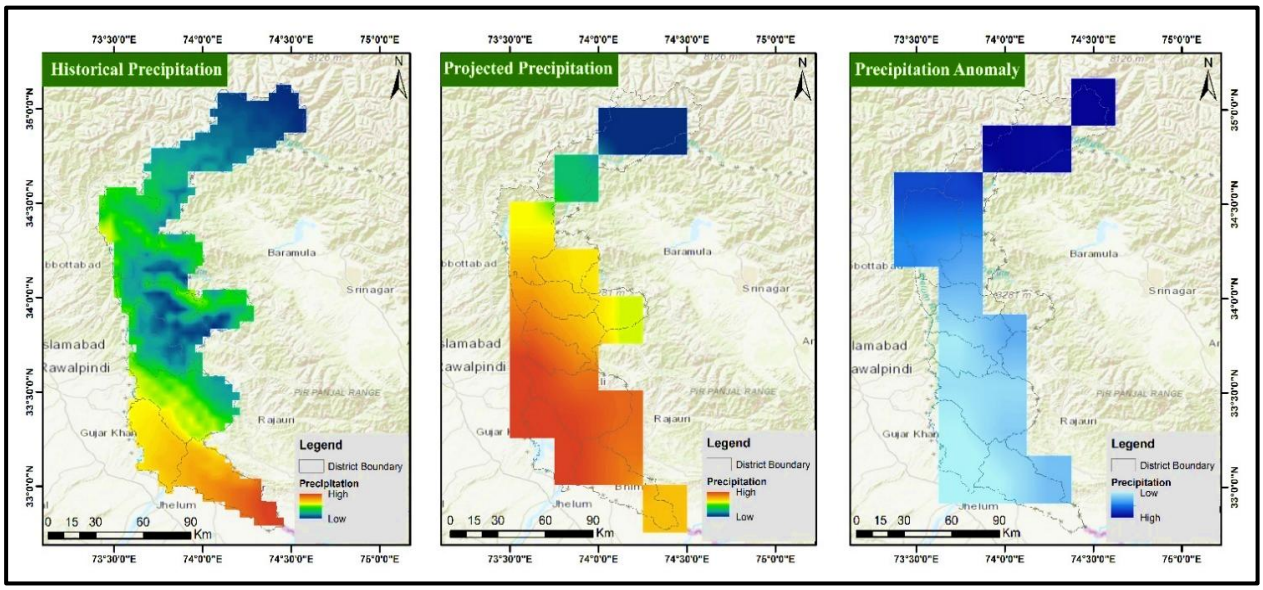


Fig.4 AJK Comparative Analysis for Average Precipitation (July, August, September)

g. AJK Flood Projection

Azad Jammu & Kashmir (AJK) is expected to undergo considerable hydrometeorological activity during the 2025 monsoon season. According to the Monsoon Outlook this region is forecasted to receive isolated heavy rainfall events, particularly during the early part of the monsoon season. Spatial precipitation assessments and anomaly projections indicate a slightly above-normal rainfall trend, especially across the north eastern districts, which include Muzaffarabad, Neelum, Jhelum Valley, Bagh, Haveli, and Poonch. These districts are characterized by steep mountainous terrain, narrow valleys, and an extensive network of rivers and tributaries, including the Neelum (Kishanganga) and Jhelum Rivers. The region's orographic landscape naturally enhances precipitation intensity, making it historically prone to flash floods, riverine flooding, and landslides. In particular, heavy monsoon rains, when combined with glacial meltwater from the upper reaches of the Himalayas, pose a heightened risk of rapid runoff, debris flows, and overflow of riverbanks. The steep topography of AJK accelerates surface water flow, increasing the likelihood of soil erosion, slope failure, and blocked watercourses, which can redirect floodwaters into vulnerable settlements. In addition to the physical risks, infrastructure in many areas such as roads, bridges, and communication lines—remains susceptible to damage or disruption during extreme weather events, thereby complicating emergency response and community access. While the projected rainfall anomaly is only moderately positive, even a slight increase in precipitation can translate into severe hydrological consequences in such a fragile landscape. The combination of above-average temperatures, predicted for the region, may further exacerbate runoff through enhanced snowmelt, contributing to elevated river discharge levels. The steep slopes and fragile geological structure make AJK highly prone to hydrometeorological hazards**,** including:

(1) **Landslides** triggered by intense rainfall on saturated slopes, particularly in Neelum and Poonch valleys.

(2) **Riverine flooding** in the upper Jhelum catchment, potentially impacting water inflows to Mangla Reservoir.

(3) **Flash floods** in small streams and tributaries due to high runoff rates and limited soil absorption capacity.

(h) Flood Susceptibility Zonation

The Jhelum River Basin exhibits widespread vulnerability to flooding, with spatial analysis indicating that areas along the river—from the upper catchments to the downstream low-lying regions—are particularly prone to inundation. According to flood susceptibility mapping, the total area under consideration spans 50,897 square kilometers. Of this, approximately 12% (6,210 sq. km) falls into the low susceptibility category, suggesting a relatively lower likelihood of flood occurrence and minimal expected damage in these zones. However, the moderate susceptibility category comprises the largest share, accounting for 34% (17,548 sq. km) of the total basin area. (https://doi.org/10.1016/j.nhres.2023.11.004)

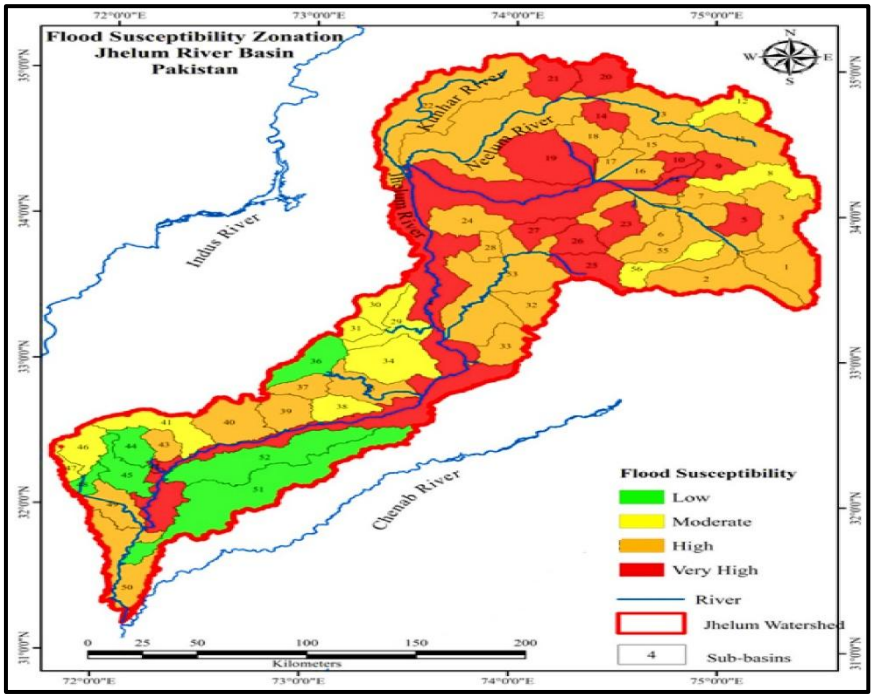


Fig.5 Flood Susceptibility Zonation of Jhelum River Basin.

Flood Susceptibility	*Area (sq.km)*	*Percentage (%)*
Low	6,210	12%
Moderate	17,548	34%
High	14,719	29%
Very High	12,419	24%
Total	50,897	100%

Table.1 Flood Susceptibility Zonation on the Basis of Area.

4. Punjab

a. Monsoon Projection

Punjab is expected to be one of the most impacted provinces, with the northern, northeastern, and central districts likely to experience higher precipitation anomalies. Districts projected to receive rainfall above their climatological averages include Sialkot, Narowal, Gujrat, Lahore, Rawalpindi, Gujranwala, Sargodha, Faisalabad, Jhelum, Chakwal, and Murree.

Similarly, southwestern districts located along the foothills of the Sulaiman Range namely Rajanpur, Dera Ghazi Khan as well as Muzaffargarh, Layyah, and Lodhran are also expected to receive above-normal precipitation this year. These areas are likely to experience persistent monsoon Dera Ghazi Khan and adjacent hill torrent regions may be vulnerable to flash flooding, especially in late July. The overall risk for Punjab includes waterlogging, damage to crops, and infrastructural strain in densely populated cities.

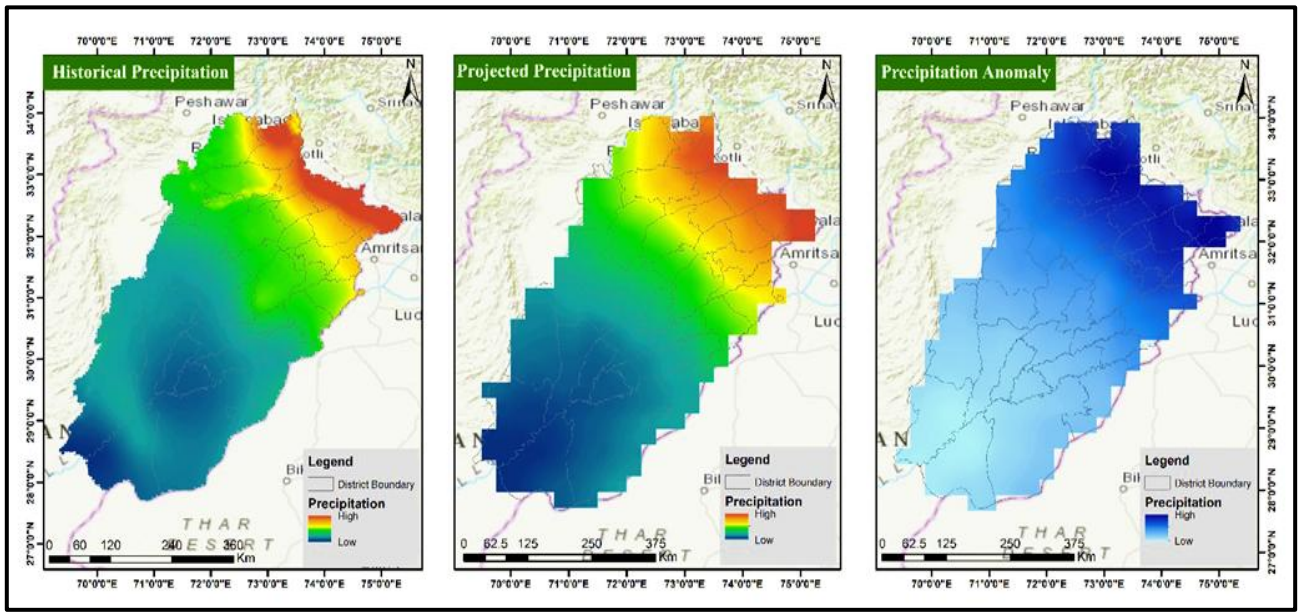
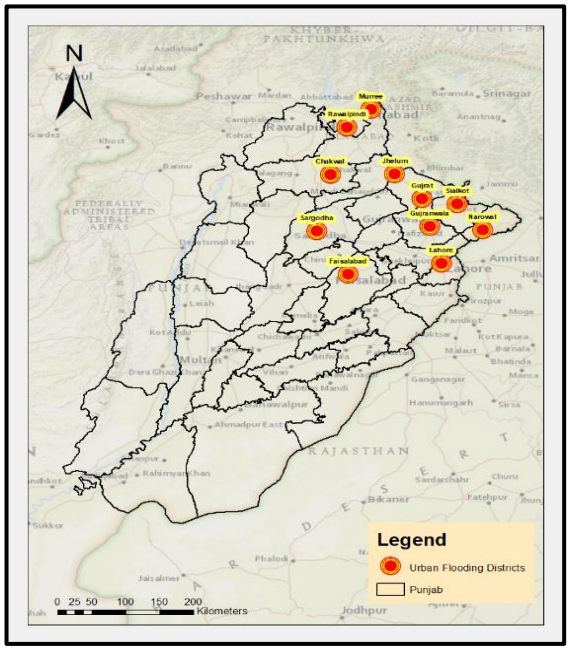


Fig.6 Punjab Comparative Analysis for Average Precipitation (July, August, September)

b. Flood Projection

The increased precipitation is likely to cause rain emergencies in low lying areas, crop damage, and infrastructural strain in densely populated urban centers of northern and central Punjab particularly Gujranwala division and Lahore Division.



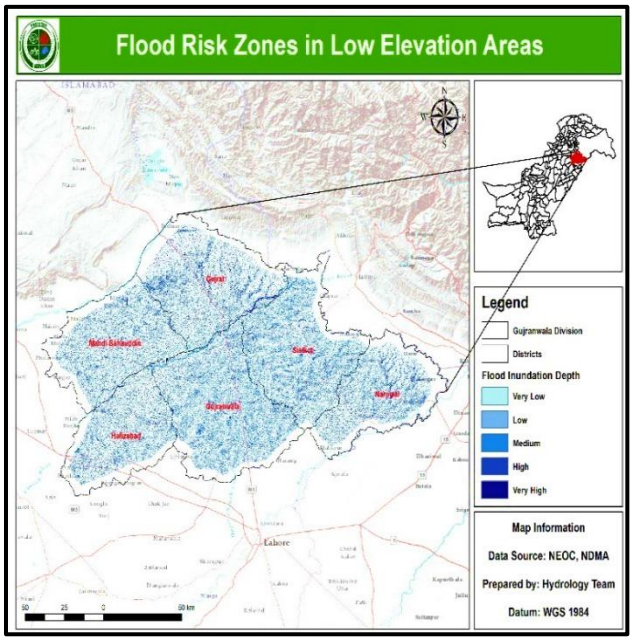


Fig.7 Map showing Vulnerable Districts for Urban Flooding.

Particularly in the North eastern parts of Punjab residing along the **Pir Panjal Range** the Nullah's and Streams are expected to **overflow** because of expected rainfall anomaly in the region.

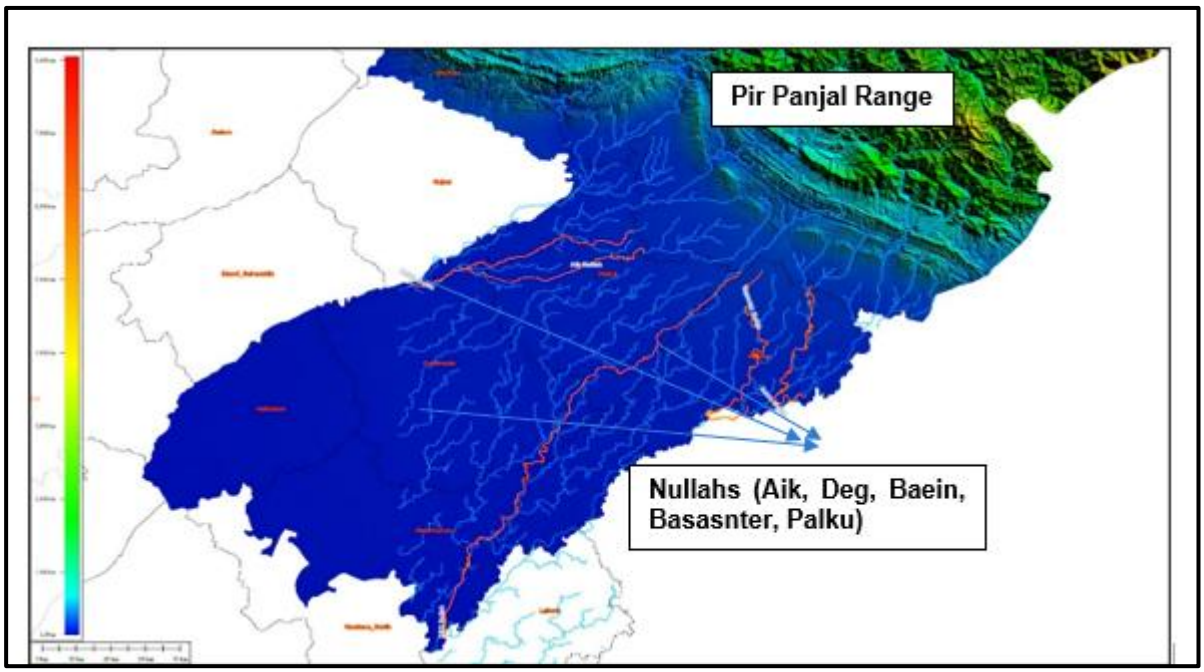


Fig.8 Map showing Vulnerable Districts for Urban Flooding.

NULLAHS LIMITS (In Cusecs)						
NULLAH	LOCATION	LOW	MEDIUM	HIGH	VERY HIGH	EX.HIGH
BEIN	CHAK AMRU	1300	7000	20000	30000	35000 & Above
SHAKARGHAR	*	3000	24000	26000	43000	& Above
AIK	URA	2000	9000	13000	16000	33000 & Above
BASANTAR	JASSAR	4100	4700	7500	11600	17800 & Above
DEG	KINGRA BRIDGE	10000	15000	22000	30000	*
PALKU	WAZIRABAD	2500	3100	5000	25000	26000 & Above

Table.2 Showing Different Nullah's Limit along the Pir Panjal Range

Sr. No.	Hill Torrents	Maximum Flow 2024	Historical Peak
1	Kaura	39,337 cusecs	128,000 (2010)
2	Vehova	28,638 cusecs	110,500 (2010)
3	Sanghar	24,064 cusecs	229,000 cusecs (2010)
4	Sori Lund	51,4460 cusecs	97,710 cusecs (2013)
5	Vadore	-	-
6	Sakhi Sarwar	9,370 cusecs	32,643 cusecs (2010)
7	Mithawan	61,905 cusecs	-

Table.3 Flood Situation in Hill Torrent District DG Khan

Sr No	Hill Torrents	Max Flow 2024	Historical Peak
1	Kaha Hill Torrent	105,276 cusecs	108,941 cusecs (2022)
2	Kala Bagga Khosra Hill Torrent	27,640 cusecs	-
3	Chachar Hill Torrent	63,940 cusecs	75,900 cusecs (2022)
4	Pitock Hill Torrent	14,600 cusecs	-
5	Sori Shumali Hill Torrent	7,250 cusecs	13,000 cusecs (2010)
6	Zangi Hill Torrent	33,600 cusecs	-
7	Sori Janubi Hill Torrent	16,560 cusecs	22,300 cusecs (2012)

Table.4 Flood Situation in Hill Torrent District Rajanpur.

In the southwest, Dera Ghazi Khan and Rajanpur hill torrent regions face a heightened risk of flash flooding in late July & August due to persistent monsoon

activity. The southwestern districts of Punjab, particularly those situated along the foothills of the Sulaiman Range namely Rajanpur and Dera Ghazi Khan are forecasted to receive above-normal precipitation during the 2025 monsoon season. Hence Major Hill Torrents are expected to reach medium to high limits as shown in above table.

The orographic influence of the Sulaiman Range, combined with intensified monsoonal incursions, enhances the likelihood of persistent rainfall episodes. The vulnerable low-lying areas identified by hydraulic modelling are shown in below figure.

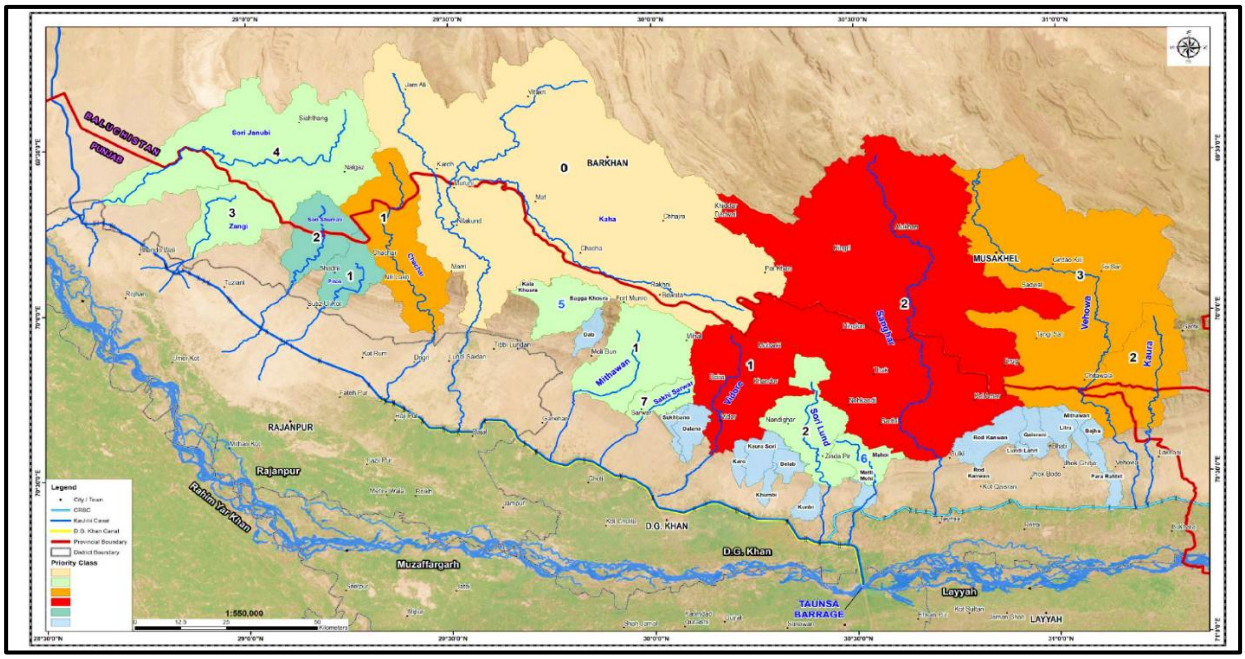


Fig.9 Map showing Vulnerable Low-Lying Areas identified by Hydraulic Modelling.

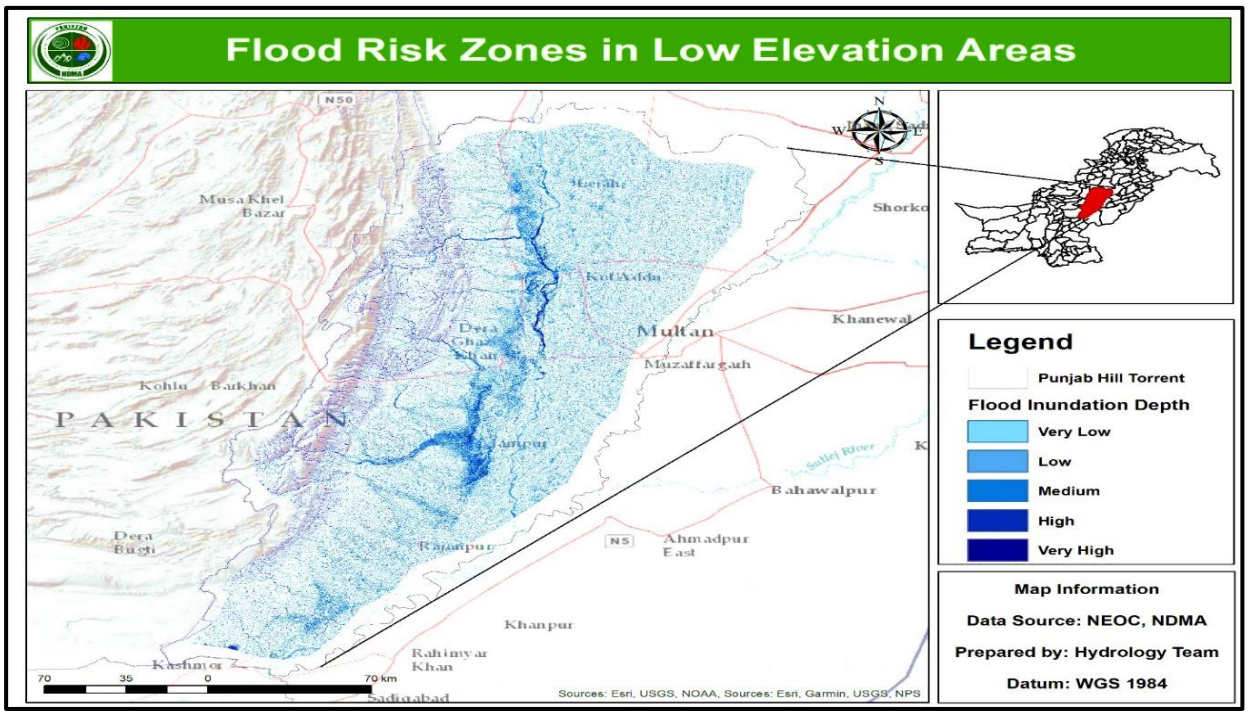


Fig.10 Map showing Vulnerable Low-Lying Areas identified.

c. Hydraulic Structures and Storages in Punjab

Punjab is home to the eastern rivers namely the Jhelum, Chenab, Ravi, and Sutlej as well as the Indus River, which collectively form the backbone of the region's irrigation and water management system. The spatial distribution of barrages, headworks, and reservoirs across Punjab has been strategically planned to optimize water resource utilization, with their design capacities tailored to meet agricultural, industrial, and domestic needs. These critical infrastructures, depicted in the accompanying maps, highlight Punjab's extensive network of water control systems, ensuring efficient distribution and storage to mitigate floods, support irrigation, and sustain water supply throughout the province.

River Indus is expected to flow with medium to high flood levels (3.75 ~ 5.0 lac cusecs) during this monsoon as per the hydrometeorological analysis. River Jhelum and Chenab is expected to remain within High flood limits (1.5 ~ 2.0 lac cusecs). While Ravi and Sutlej rivers are expected to flow within low flood level.

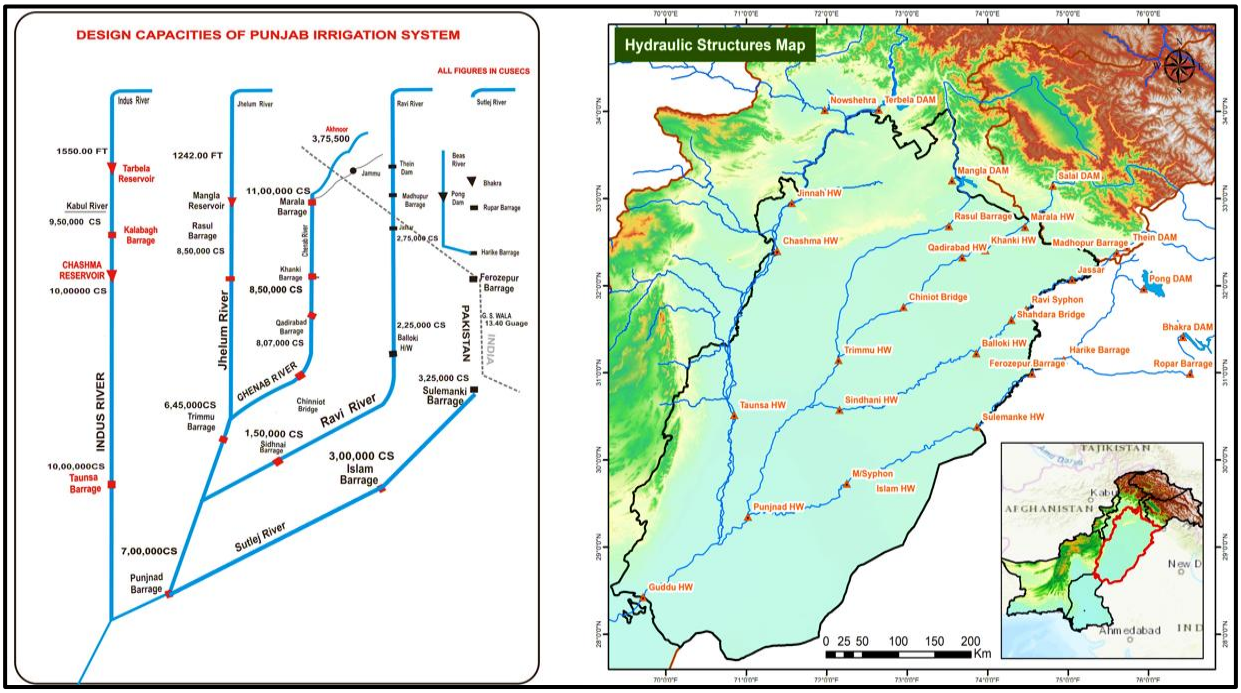


Fig.11 Map showing Hydraulic Structures and storages

d. Transboundary Water Risks

Following the unilateral suspension of the Indus Waters Treaty by India, the absence of bilateral data sharing, particularly on reservoir storage levels and river flow regimes, poses a significant challenge to transboundary flood forecasting and risk mitigation for Pakistan. According to the latest projections from the South Asian Seasonal Climate Outlook Forum (SASCOF) for the JJAS 2025 period, above-normal rainfall and elevated land surface temperatures are anticipated across much parts of

India.

These conditions are likely to accelerate glacial melt in Himalayan-fed River systems, increasing inflows into key Indian reservoirs such as Pong and Bhakra dams, located on the Beas and Sutlej Rivers, respectively. Given the lack of real-time hydrological data and coordinated release protocols, the risk of sudden or unannounced water discharges from these reservoirs into downstream channels remains high. Such releases could result in localized to moderate flooding in vulnerable floodplain communities along the Sutlej River, and potentially impact areas along the Chenab River as well, depending on transboundary inflow patterns and tributary responses.

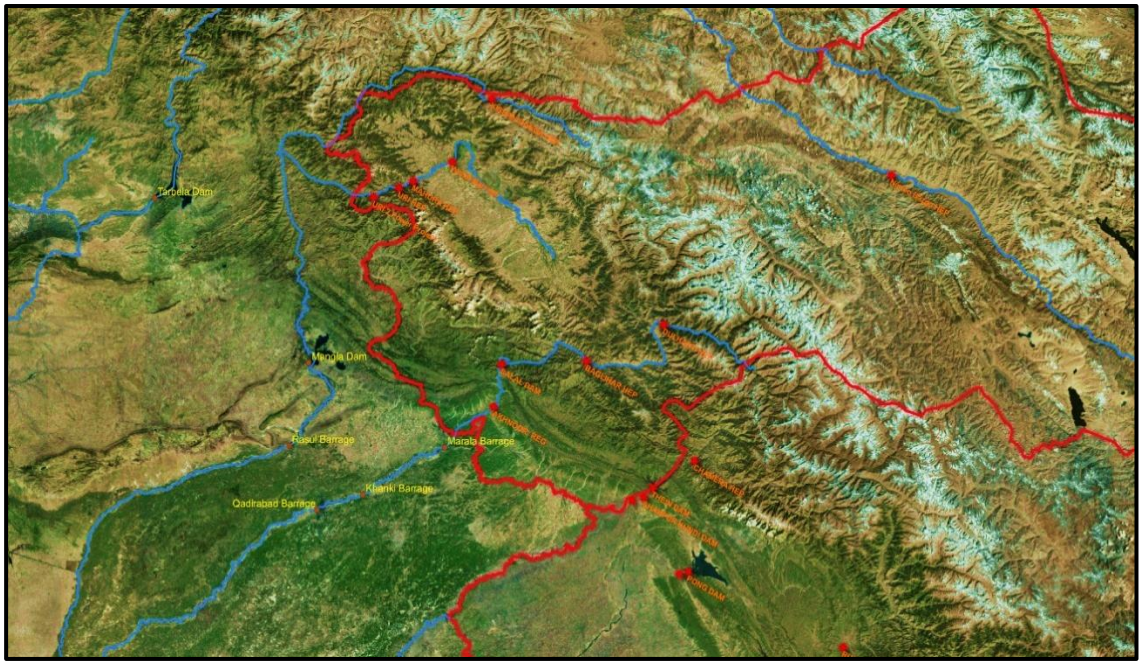


Fig.12 Existing Hydraulic Structures on Trans-Boundary Watersheds

e. Water Availability 2025

As per latest information, the forecast for water availability during the Kharif Season 2025 (April–September) indicates a slight deficit (4.14 MAF) in reservoir storage across Pakistan's major water bodies. Tarbela Reservoir is projected to hold 47.91 MAF, marginally below its normal storage of 50.43 MAF, while Mangla Reservoir is expected to store 14.20 MAF, compared to its normal level of 15.82 MAF. Collectively, the total projected water availability stands at 62.11 MAF, against a normal of 66.25 MAF. This shortfall reflects the impact of reduced winter snowfall and a potentially diminished snowmelt contribution during the early Kharif period. Although above-normal monsoon rainfall is forecasted for 2025, especially during July to September, its benefit to overall water availability may be moderated by the initial

storage deficit and below-average snowpack, necessitating careful water resource planning and management throughout the season.

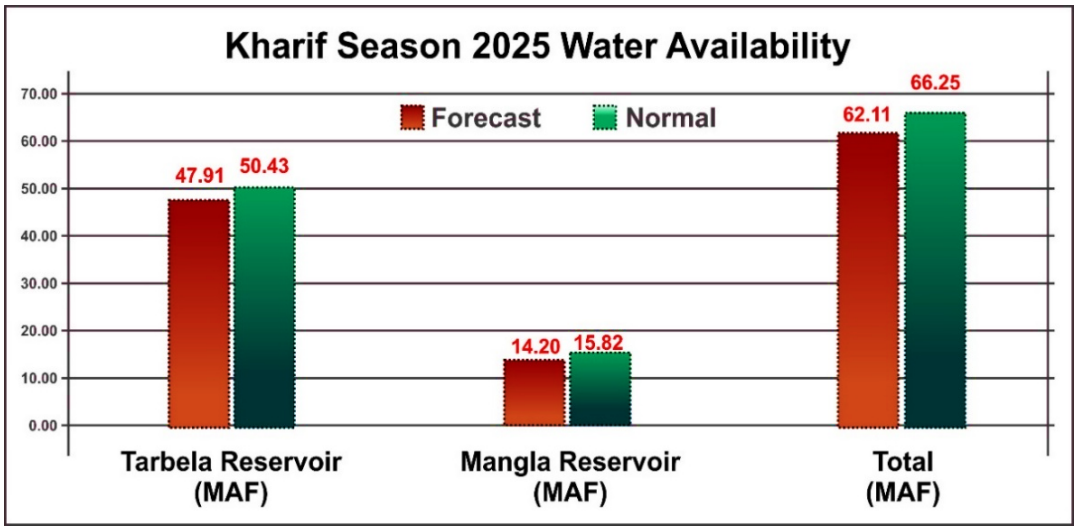


Fig.13 Water Availability for Kharif Season 2025

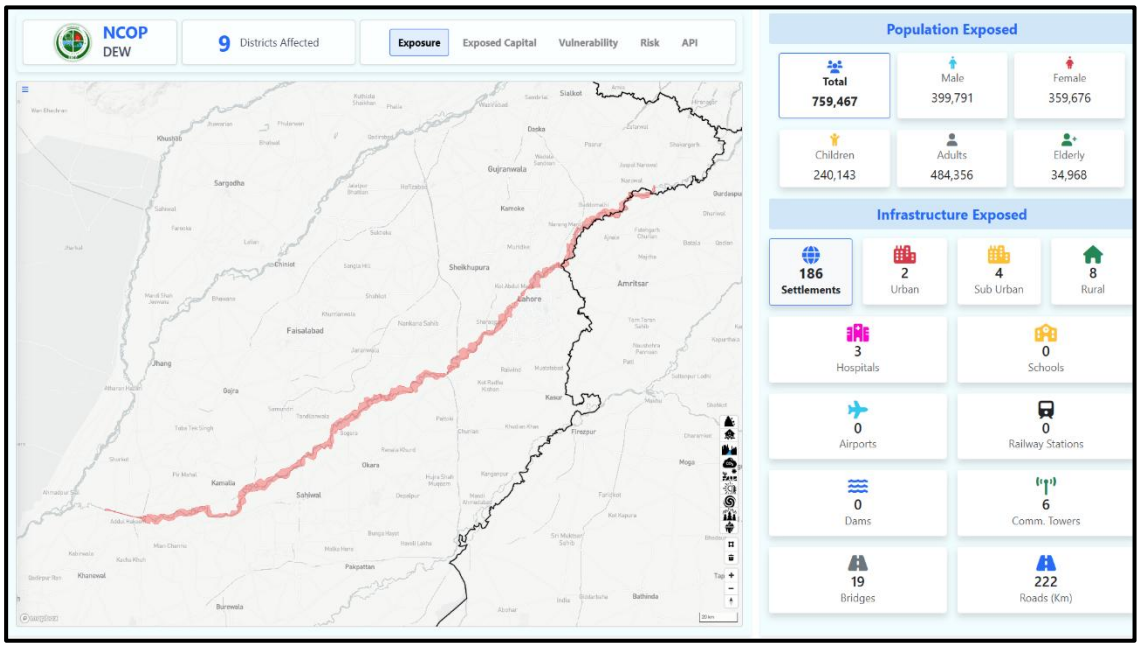


Fig.14 Exposure along Ravi River for Low Flows Scenario

5. Khyber Pakhtunkhwa

a. KP Monsoon Projection

In Khyber Pakhtunkhwa, the northern districts such as Abbottabad, Mansehra, Swat, Dir, and Chitral are expected to receive normal to below-normal rainfall. These areas may face localized flash floods due to intense rainfall combined with steep topography. Central and southern KP, including Peshawar, Mardan, Charsadda, Kohat, and Dera Ismail Khan, will likely experience normal to slightly above normal rainfall during the second half of July. Higher-than-normal temperatures in this region will contribute to rapid snow and glacier melt, particularly in upper KP, leading to increased river discharge. The key risks include landslides, damage to road infrastructure in hilly areas, and overflowing rivers during heavy spells.

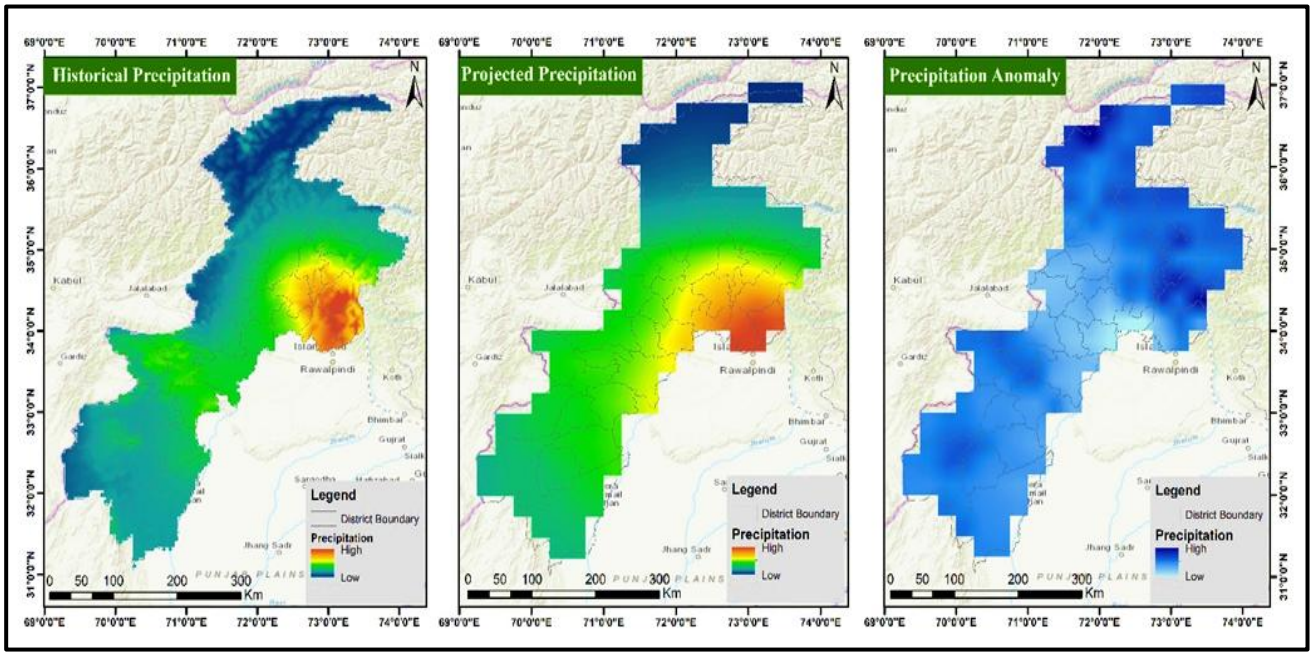


Fig.15 KP Comparative Analysis for Average Precipitation (July, August, September)

b. KP Flood Projection

The technical team conducted a detailed analysis of historical flooding events in Khyber Pakhtunkhwa, employing a comprehensive methodology to identify flood-susceptible zones by considering not only past flood extents but also factors such as elevation, drainage density, soil types, river proximity, land use/land cover, precipitation, and other critical variables.

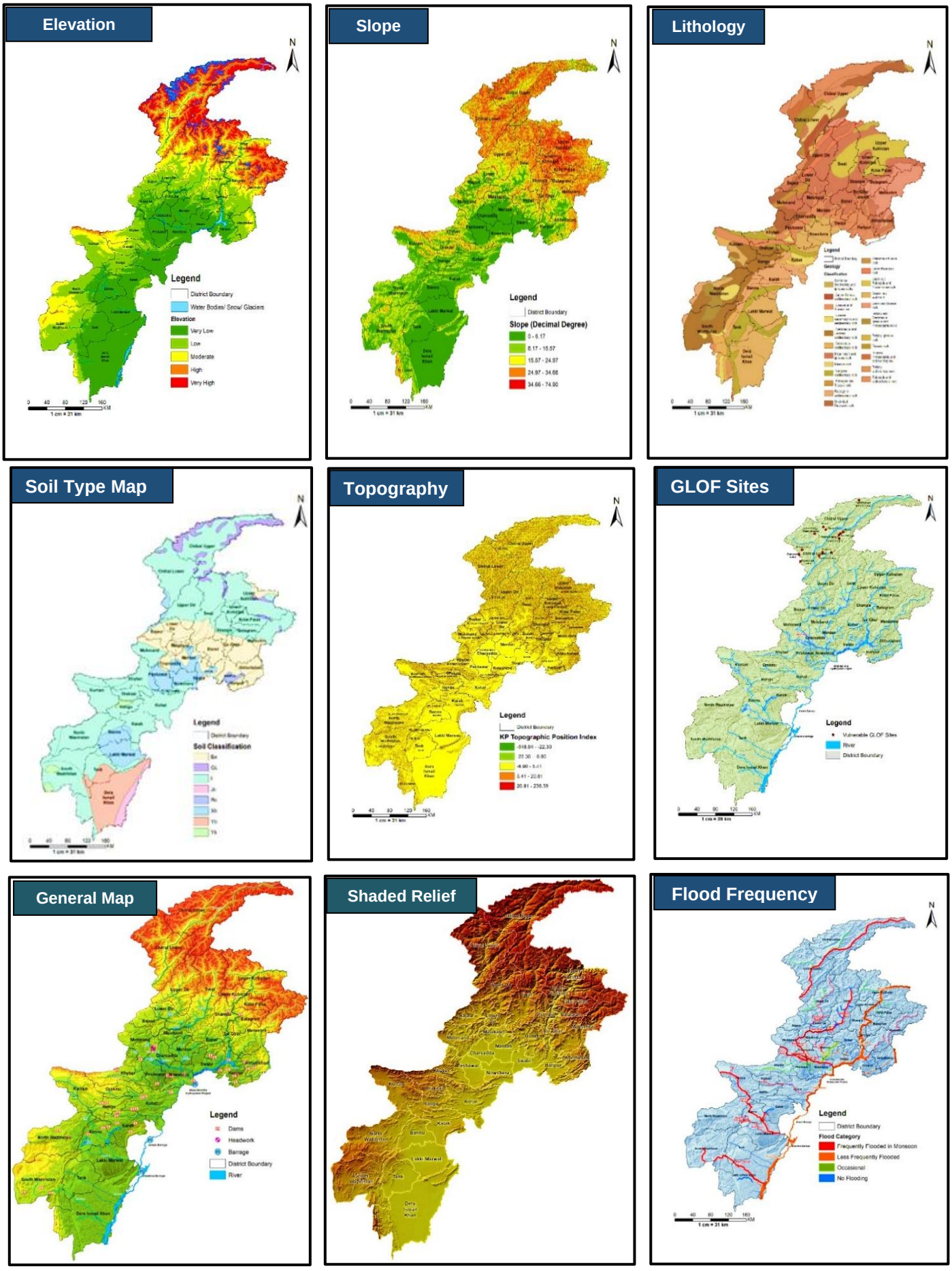


Fig.16 Detailed Maps of Elevation, Slope, Lithology, Soil, Topography and Vulnerable GLOF Sites

General Map highlights topographic variations and key features like rivers and barrages. Shaded Relief Map illustrates terrain elevation and slope to pinpoint low-lying flood-prone areas, and Flood Frequency Map categorizes zones as frequently flooded, less frequently flooded, or not flooded. This multi-faceted approach enhances the precision of identifying vulnerable areas, supporting the development of targeted flood management and mitigation strategies across the province. Based on the multi-criteria decision analysis, Analytical Hierarchy Process the team has identified very high to very low vulnerability zones susceptible to flooding. The technical team employed a Weighted Linear Combination (WLC) approach to identify flood-prone areas within the province. The analysis incorporated the following factors:

(1) Topographic Position Index (TPI): To assess terrain characteristics and identify low-lying areas.

(2) Elevation: To evaluate the influence of altitude on flood susceptibility.

(3) Normalized Difference Vegetation Index (NDVI): To analyze vegetation cover and its role in water retention.

(4) Permanent and Temporary Water Bodies: To account for existing water features contributing to flood risk.

(5) Proximity to Water Bodies: To assess the impact of nearness to water sources on flood vulnerability.

(6) Drainage Density: Additionally, drainage density was calculated to pinpoint low-lying zones prone to floodwater accumulation during flooding events.

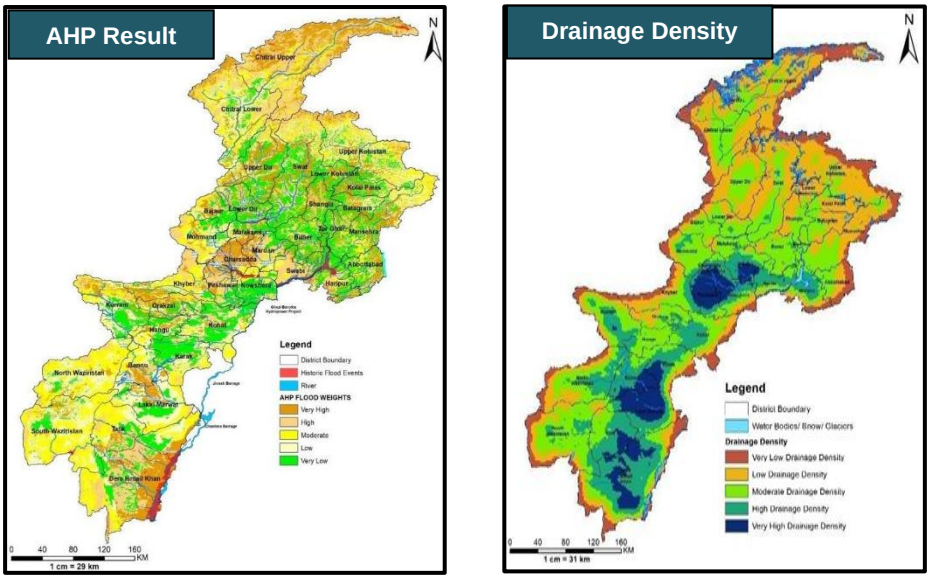


Fig.17 Detailed Maps of AHP Results and Drainage Density

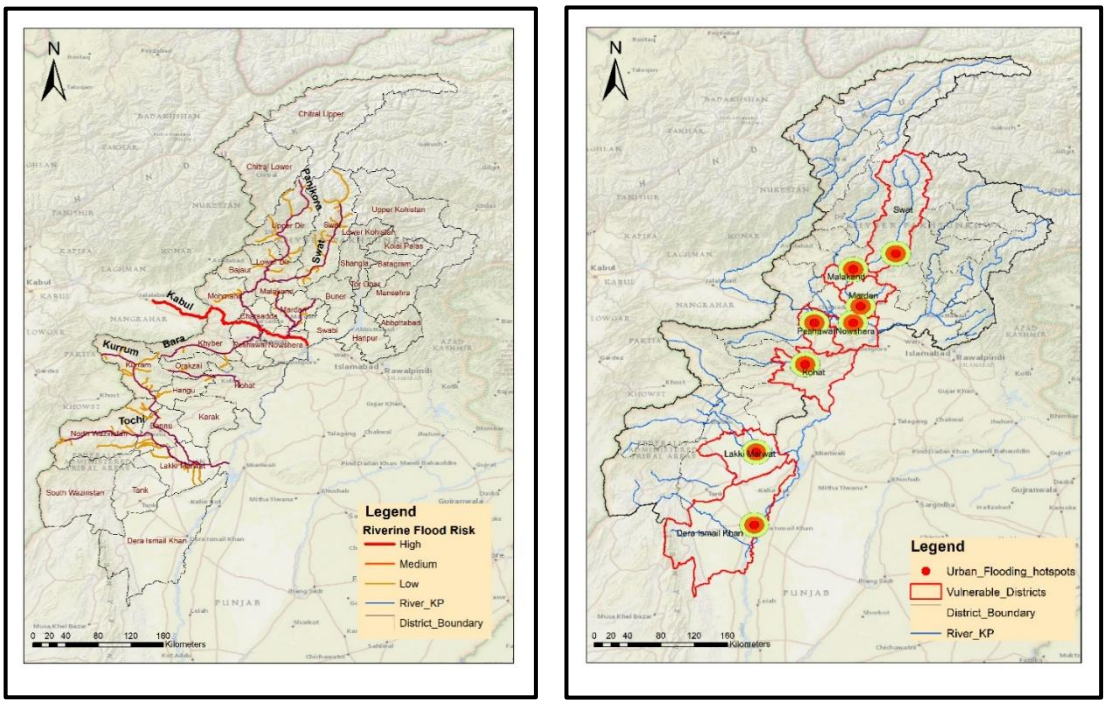


Fig.18 Flood Risk Mapping and Urban Flooding Hotspots

The Flood Risk mapping of vulnerable streams and rivers projected for monsoon 2025 are shown in above figure. The second map identifies urban flooding hotspots and vulnerable districts. Peshawar, Mardan, Charsadda, Kohat, and Dera Ismail Khan marked as high-risk areas due to their proximity to rivers, high drainage density, and historical flood susceptibility. These districts, already classified as vulnerable, are expected to experience normal to slightly above-normal rainfalls, increasing the likelihood of urban flooding.

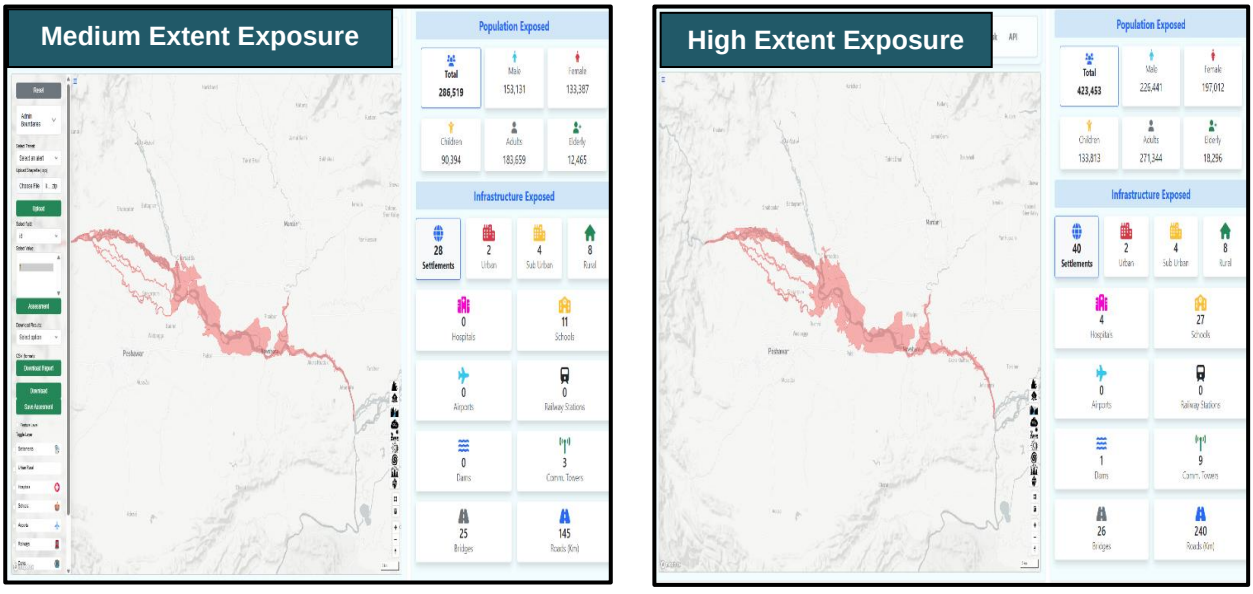


Fig.19 Exposure Along Kabul River for Medium and High Flows Scenarios

6. Sindh

a. Monsoon Projection

Sindh will experience a mixed monsoon pattern. Upper Sindh, including Sukkur, Larkana, Jacobabad, Kashmore, and Dadu, is likely to witness above-normal rainfall, particularly in late July. Lower Sindh, encompassing Karachi, Hyderabad, Thatta, Badin, and Mirpurkhas, is forecasted to see to slightly above-normal rainfall, which may lead to episodes of urban flooding, particularly in urban hotspots Karachi. While the rainfall will bring relief from extended dry spells in some areas, it may also overwhelm the drainage infrastructure in major cities. Heatwaves are another concern for Sindh, especially before the peak monsoon rains begin, further stressing energy and water resources.

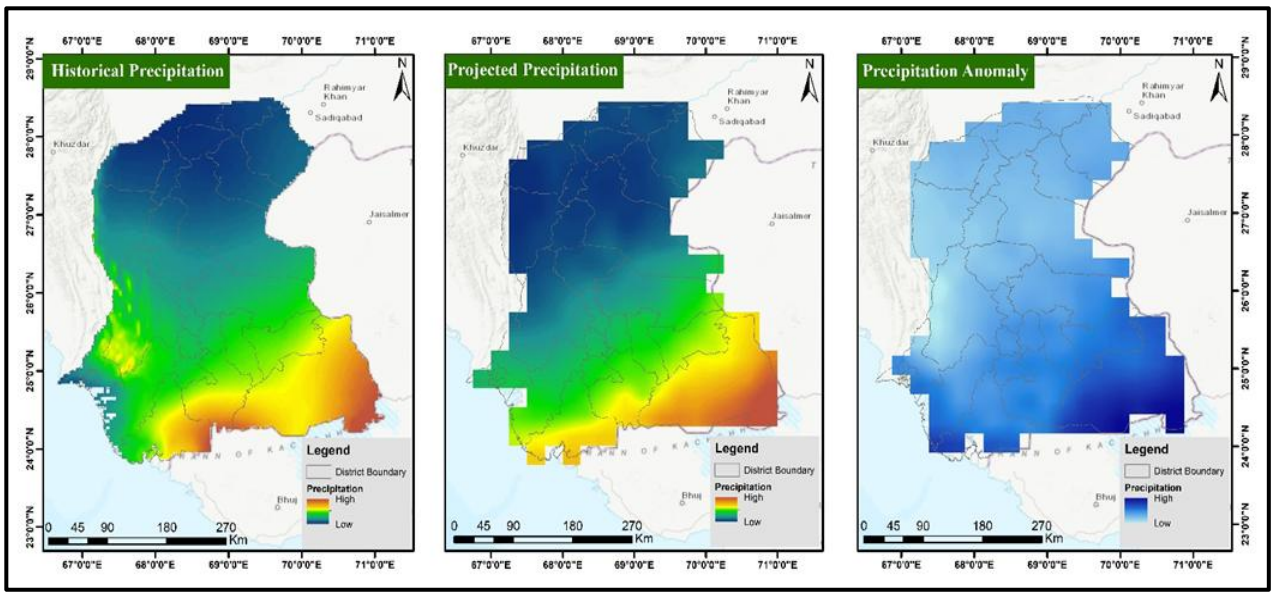


Fig.20 Sindh Comparative Analysis for Average Precipitation (July, August, September)

Sindh typically experiences low to moderate monsoonal rainfall, with coastal and south eastern districts like Karachi, Thatta, and Badin receiving more rain than the arid interior regions such as Jacobabad, Sukkur, and Khairpur. Monsoon 2025 forecasts suggest above-normal rainfall in lower Sindh, while upper Sindh is expected to see near-normal to moderately increased rainfall. Positive anomalies are projected, especially in south eastern Sindh, indicating a modest increase in rainfall that could improve water availability but also raise the risk of urban flooding in low-lying coastal cities.

b. Flood Projection

This projected increase in precipitation may result in localized flooding in low-lying areas and excess surface runoff, particularly where soil infiltration is limited due to arid conditions. The river Indus is expected to flow within medium to High Flood Limits in Sindh Province during Monsoon.

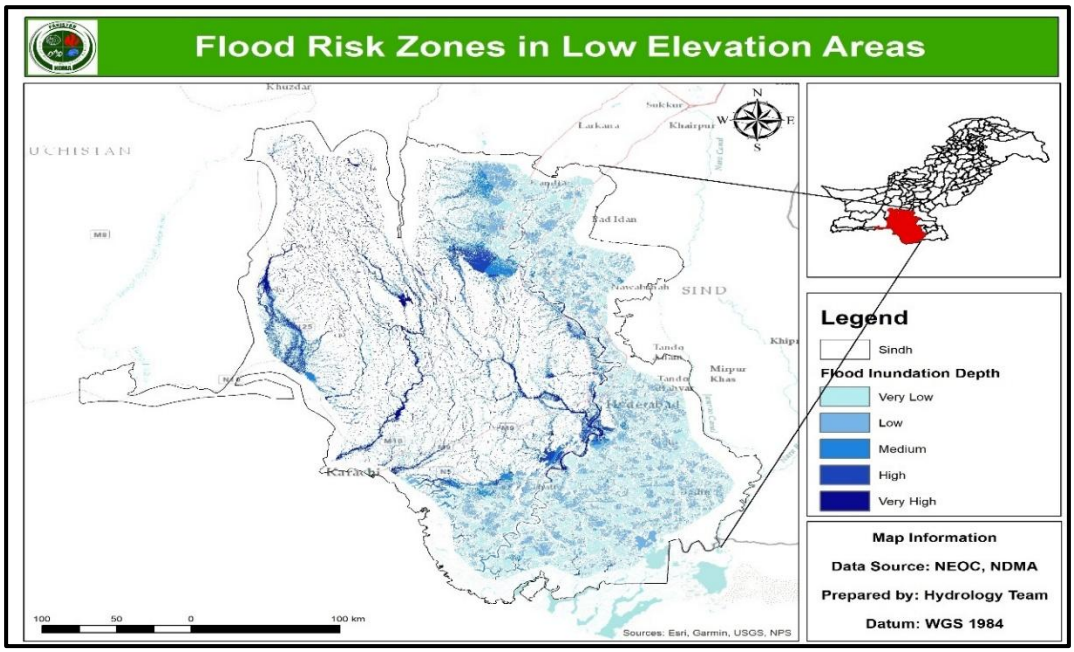


Fig.21 Maps showing Flood Risks Zones in Low Lying Areas of Sindh.

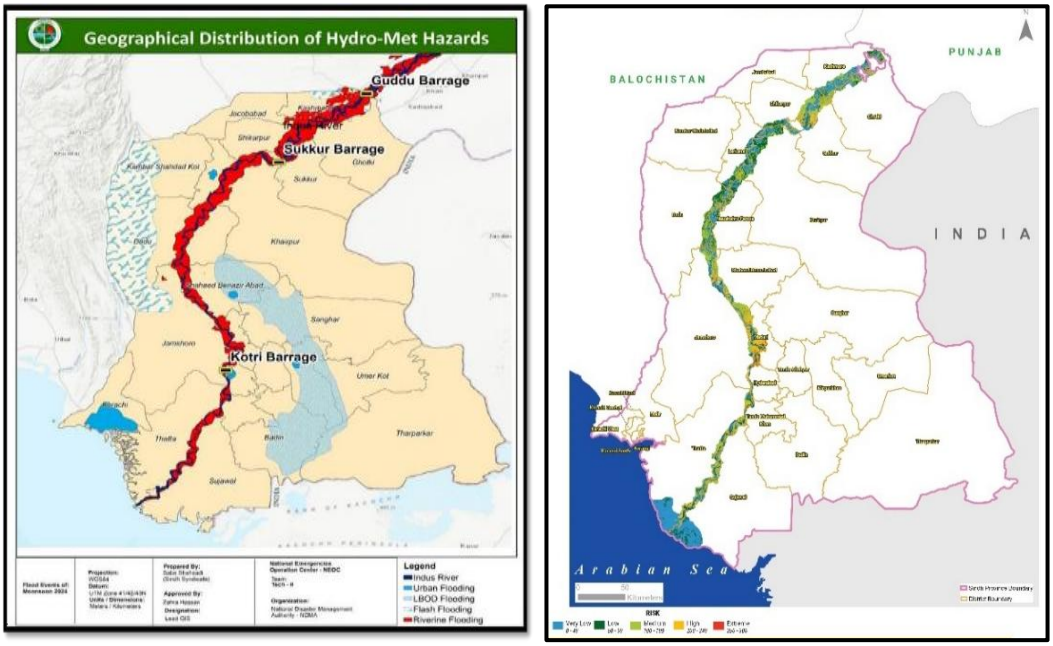


Fig.22 Maps showing Flood Risks Zones in Flood Plain Areas of Sindh.

Sindh province is subject to multiple forms of flooding, including: (a) riverine, (b) LBOD (Left Bank Outfall Drain) system-related, (c) urban, and (d) torrential/flash floods. Above image illustrates the spatial distribution of these hydrometeorological

hazards, as mapped by NDMA. and PDMA. Riverine flooding predominantly affects the floodplains along the Indus River, where seasonal monsoon inflows and upstream releases elevate the risk of inundation. Torrential and flash floods are more common in western districts bordering Balochistan, driven by rapid runoff from the Koh-e-Suleiman Mountain watershed. The accompanying maps also outlines the irrigation & drainage network as well as LULC of Sindh province, which plays a critical role in water management but simultaneously represents a vulnerability during extreme weather events if not maintained or adequately regulated. In Lower Sindh, encompassing Karachi, Hyderabad, Thatta, Badin, and Mirpurkhas, the rainfall outlook suggests slightly above-normal monsoon activity. While this precipitation may alleviate prolonged dry spells and temporarily improve water availability, it poses a serious urban flood risk, especially in Karachi & Hyderabad, due to the city's chronic drainage challenges and high impervious surface coverage. Major urban centers such as Karachi, Hyderabad, and Larkana are increasingly prone to urban flooding, resulting from high-intensity rainfall events compounded by poor drainage infrastructure and encroachment on natural waterways. Additionally, the LBOD system, which services the eastern districts of Sindh, often experiences flooding due to limited drainage capacity and sedimentation, particularly during peak monsoon periods.

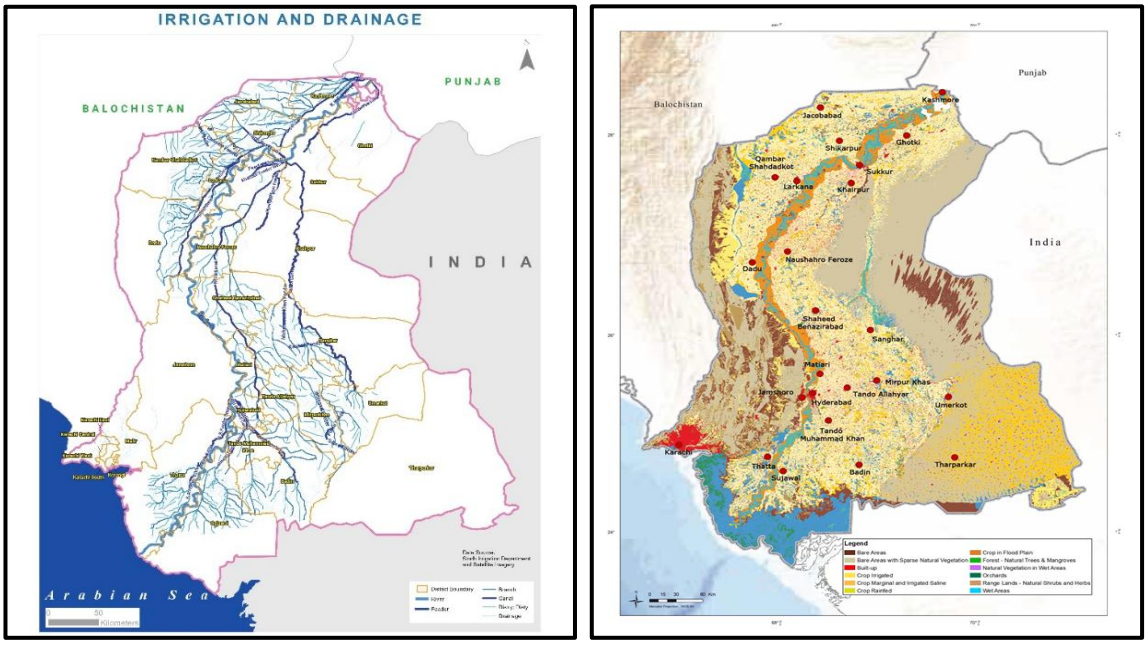


Fig.23 Maps showing Irrigation and Drainage Network of Sindh.

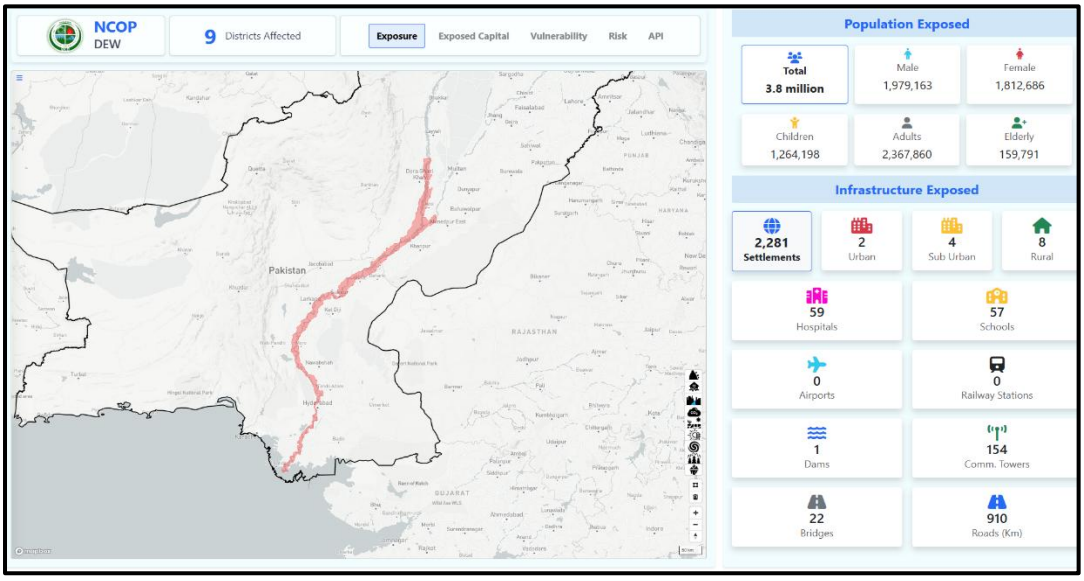


Fig.24 Exposure Along Lower Indus River for High Flows Scenarios

7. Balochistan

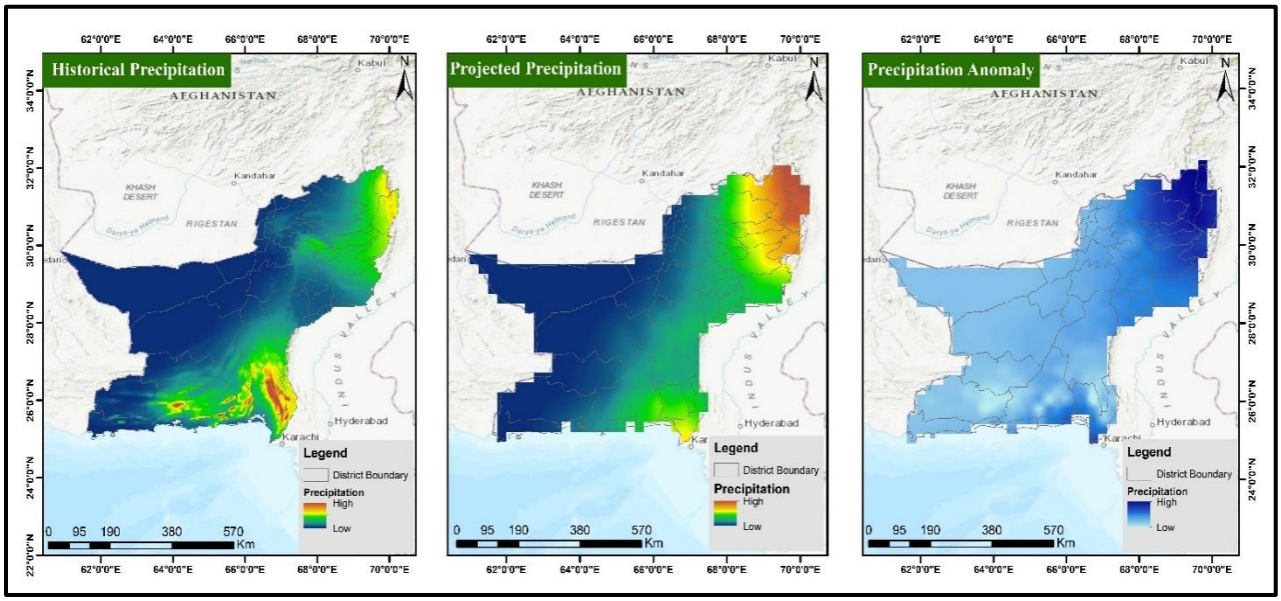
a. Monsoon Projection

Balochistan's rainfall distribution will remain uneven. Eastern and central districts such as Khuzdar, Lasbela, and Washuk are forecasted to receive slightly above-normal rainfall, especially during the latter half of the monsoon. In contrast, western districts like Quetta, Zhob, and Barkhan are likely to experience near-normal to below-normal rainfall. Despite periodic rains, most of Balochistan may continue to experience arid conditions due to long-standing deficits. However, areas that receive sudden bursts of heavy rain will be at risk for localized flash floods.

Fig.25 Balochistan Comparative Analysis for Average Precipitation (July, August, September)

Balochistan has historically received very low monsoon rainfall, especially in central and western districts; slightly higher rainfall is observed in southeastern areas like Lasbela and Khuzdar. Future projections show prominent change, with increases expected in southeastern and northeastern districts. Slight positive anomalies in the southeast suggest a small increase in rainfall, but overall, Balochistan will receive rains

in comparison with historical patterns.



b. Flood Projection

Based on the current meteorological outlook and climatological analyses, Balochistan is expected to undergo a mixed hydrometeorological scenario during the upcoming monsoon season. Projected precipitation patterns suggest a modest yet significant shift. South eastern districts including Lasbela, Khuzdar, and parts of Washuk are anticipated to receive slightly above-normal rainfall during the latter half of the monsoon season. The enhanced rainfall, while beneficial, raises concerns regarding hydrological hazards, particularly in areas characterized by low soil permeability and sparse vegetative cover. Flash flooding remains a key risk, especially in districts prone to convective storm activity and poor drainage conditions. The eastern districts of Balochistan, Pakistan, are indeed highly prone to flooding, primarily due to their topography and location relative to major river systems.

District	Topographical Features	Flood Vulnerability
Jaffarabad	Extremely low-lying; acts as a natural basin for floodwaters from the north and west	Severely impacted in major flood events (2010, 2011, 2012, 2022); high floodwater accumulation risk
Naseerabad	Similar low-lying topography to Jaffarabad	Regularly affected by floods from hill torrents and Indus River overflows
Sibi	Located at the mouth of the Bolan Pass	Prone to intense flash floods from mountainous runoff in the Bolan River basin
Kachhi (Bolan)	Comprises the flat Kachhi Plain, catchment for Bolan River floodwaters	Wide floodwater dispersion due to low gradient; exposed to riverine and hill torrent floods
Jhal Magsi	Downstream location in the Bolan River system	Vulnerable to overflow from Bolan River and its tributaries
Dera Bugti (East)	Low-lying areas bordering Sindh	Susceptible to Indus River overflow and spillovers from adjacent hill torrent channels

Table.5 Most Vulnerable Districts in Balochistan

c. Key Reasons for Flood Vulnerability:

(1) Low-Lying Topography: These districts form part of the vast, flat Indus River plains. They lie at a lower elevation than surrounding areas, acting as natural sinks for floodwaters.

(2) Confluence of Rivers: This region is where major hill torrents and seasonal rivers (like the Bolan, Nari, Mula, Porali) originating from the mountains of central and northern Balochistan converge before draining into the Indus River.

(3) Indus River Proximity: Located on the western bank of the Indus River. During periods of exceptionally high flow in the Indus (often due to heavy rainfall in Punjab, Khyber Pakhtunkhwa, or northern India), the river overflows its banks, inundating these low-lying districts. The Indus often breaches its protective embankments here.

(4) Monsoon Rains: While Balochistan is generally arid, intense monsoon rainfall events (often linked to climate change) can cause flash flooding in the hill torrents draining into these plains. Even moderate rainfall in the catchment areas can cause significant flooding downstream in these flat areas.

(5) Poor Drainage Infrastructure: Natural drainage channels are often insufficient or blocked, and man-made drainage systems are frequently inadequate or poorly maintained.

(6) Hill Torrents: Sudden, intense rainfall in the catchment areas of seasonal rivers leads to powerful flash floods rushing down into these plains with little warning.

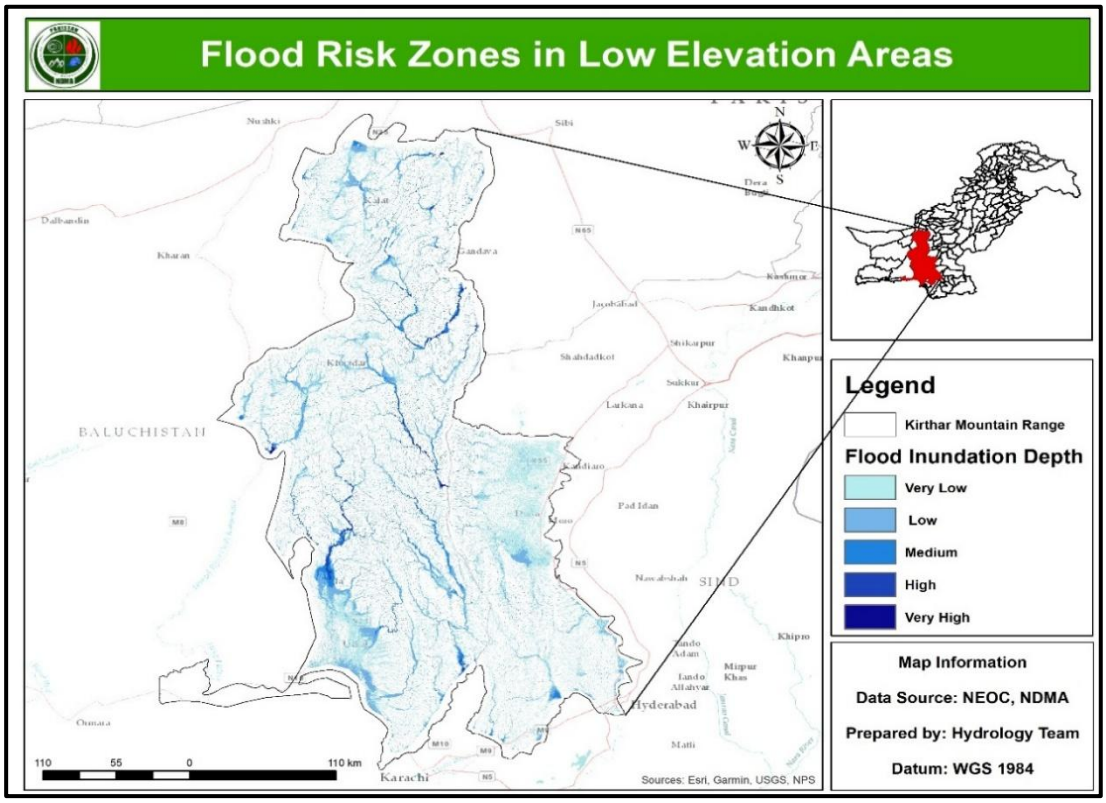


Fig.26 Map showing Flood Risk zones in Low Elevation Areas of Balochistan.

d. Recommendations

(1) All relevant departments should prioritize the completion of all approved and ongoing flood protection projects. Additionally, they must ensure that rehabilitation and flood damage restoration efforts, along with maintenance work on barrages, headworks, bridges, irrigation, drainage, and flood protection infrastructure, are completed well before the onset of the 2025 monsoon season.

(2) Provincial Irrigation Departments (PIDs) and Federal Line Agencies (FLAs) should actively engage with Provincial Authorities to secure the approval and implementation of the River Act for regulating floodplains. This includes the removal of current encroachments and the prevention of new developments within these areas. Progress updates on this initiative should be regularly communicated to the Federal Flood Commission (FFC). PIDs and FLAs must ensure that the River Act is approved and enacted by June 20, 2025.

(3) All relevant departments need to ensure the clearance of encroachments from flood plains and high-risk zones, as well as the waterways of major and minor rivers, including hill torrents and flood flow-generating nullahs, which are at risk from floodwaters and obstruct flood flows. Monthly progress reports should be provided to the FFC until the task is completed. This entire process should be finalized before the start of the 2025 monsoon season.

(4) PIDs should accelerate their efforts to revise the flood limits of the barrages, headworks, and bridges within their jurisdictions, considering the changing ground conditions. This revision process should be completed by June 20, 2025.

(5) PID, GB & AJK should conduct a study on the necessity of existing breaching sections and identify additional critical locations where breaching sections are needed. This study should be conducted on a fast-track basis and completed by June 20, 2025.

(6) Provincial Governments to provide list of encroachments removed along with proper coordinates to NDMA for analysis & verification of encroachments removed from the waterways & flood plains of river.