Government of Pakistan
Prime Minister's Office
National Disaster Management Authority (HQ)
Main Murree Road Near ITP Office, Islamabad

Post Winter Report 2024-25

National Disaster Management Authority (NDMA) is the lead agency at the Federal level to deal with the whole spectrum of Disaster Management activities

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Post Winter Report 2024-25

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Acronyms

NDMA	National Disaster Management Authority
PDMA	Provincial Disaster Management Authority
SDMA	State Disaster Management Authority (AJ&K)
GBDMA	Gilgit-Baltistan Disaster Management Authority
ICT	Islamabad Capital Territory
PMD	Pakistan Meteorological Department
MoNHSR&C	Ministry of National Health Services, Regulations & Coordination
NEOC	National Emergencies Operation Centre
SOPs	Standard Operating Procedures
USAR	Urban Search and Rescue
WASA	Water and Sanitation Agency
NHA	National Highway Authority
FWO	Frontier Works Organisation
PCC	Provincial Coordination Cell
IOD	Indian Ocean Dipole
ENSO	El Niño–Southern Oscillation
GLOF	Glacial Lake Outburst Flood
NGO	Non-Governmental Organization
UN	United Nations
e-MHVRA	Electronic Multi-Hazard Vulnerability and Risk Assessment
AJ&K	Azad Jammu & Kashmir
KP	Khyber Pakhtunkhwa
GB	Gilgit Baltistan

POST-WINTER REPORT
1ST DECEMBER 2024 TO 31ST MARCH 2025

Overview

This report presents a comprehensive overview of the winter season in Pakistan from 1st December 2024 to 31st March 2025, with a focus on the key climatic patterns, emerging hazards, and the preparedness and response actions led by the National Disaster Management Authority (NDMA) in coordination with provincial and district-level institutions. It outlines the seasonal weather trends, including below-average precipitation and above-normal temperatures, and assesses their implications for droughts, Glacial Lake Outburst Floods (GLOFs), and other climate-induced disasters.

The document details NDMA's coordinated efforts in contingency planning, early warning dissemination, stakeholder engagement, and relief operations carried out during the winter period. It further includes an analysis of damages and losses, summaries of major incidents.

Introduction

The winter season of 2024–25 in Pakistan brought a range of weather-related challenges, including cold waves, heavy snowfall, floods, droughts, and avalanches. Northern areas like GB and AJ&K experienced extreme cold and snowfall, leading to road blockages and safety risks. At the same time, unseasonal rains triggered flash floods and landslides in KP, damaging homes and infrastructure.

In contrast, Southern regions such as Balochistan and Sindh faced below-normal rainfall, worsening drought conditions and threatening agriculture. Mountainous regions posed increased avalanche risks, including a major incident in Neelam valley that caused life losses.

These diverse threats highlight the need for proactive disaster management. NDMA activated its Winter Contingency Plan, focusing on early warnings, preparedness, and local coordination to reduce risks and protect communities.

Climate Summary December 2024 - March 2025

The winter season of December 2024 to March 2025 in Pakistan was characterized by several notable climate trends. Temperature was a significant factor, with the national mean monthly temperatures warmer than the country averages. This warming trend was consistent across the country, impacting various sectors such as agriculture and public health. Rainfall, on the other hand, was well below average across the country for all four months. This dry spell had profound effects on water availability and agricultural productivity, particularly in arid regions like Balochistan and Sindh. Extreme weather events were also observed, with varied instances of extreme temperature and rainfall recorded across different regions. These events included intense cold snaps in the North and severe heat waves in the South. In terms of global climate drivers, weak La Niña conditions persisted throughout the period, influencing weather patterns globally. Additionally, the Indian Ocean Dipole (IOD) transitioned from a negative phase to a neutral phase by March 2025, which could have implications for future climate variability in the region. Overall, these climate conditions underscore the need for adaptive strategies to mitigate the impacts of such anomalies on Pakistan's climate-sensitive sectors.

Synoptic Data - December 2024

In **December 2024**, Pakistan received significantly below-average rainfall, with a national average of just **1.6 mm** which is **88%** deficit. The heaviest daily rainfall was **25.0 mm** in Mirkhani (KP), and Kalam (KP) recorded the highest monthly total at **33.0 mm**, highlighting the localized and uneven nature of precipitation.

Temperatures were generally cooler than average. The national mean was **12.27 °C**, slightly below the normal of **12.77 °C**. Daytime highs averaged **20.03 °C (−0.22 °C anomaly)**, and nighttime lows were **4.5 °C (−0.35 °C anomaly)**. Gwadar (Balochistan) recorded the hottest day at **33.5 °C**, while Skardu (GB) saw the coldest night at **−13.2 °C.** These temperature extremes reflect the wide climatic variation across Pakistan's diverse geography.

These conditions were influenced by global climate patterns. The **ENSO** had moved into **La Niña**, with Pacific Ocean temperatures at **−0.6 °C** and the **Indian Ocean Dipole** leaned slightly negative, both contributing to drier and cooler weather across much of the country. Such shifts in global climate drivers not only affect monthly weather but also have broader implications for water resources, agriculture, and disaster preparedness in the region.

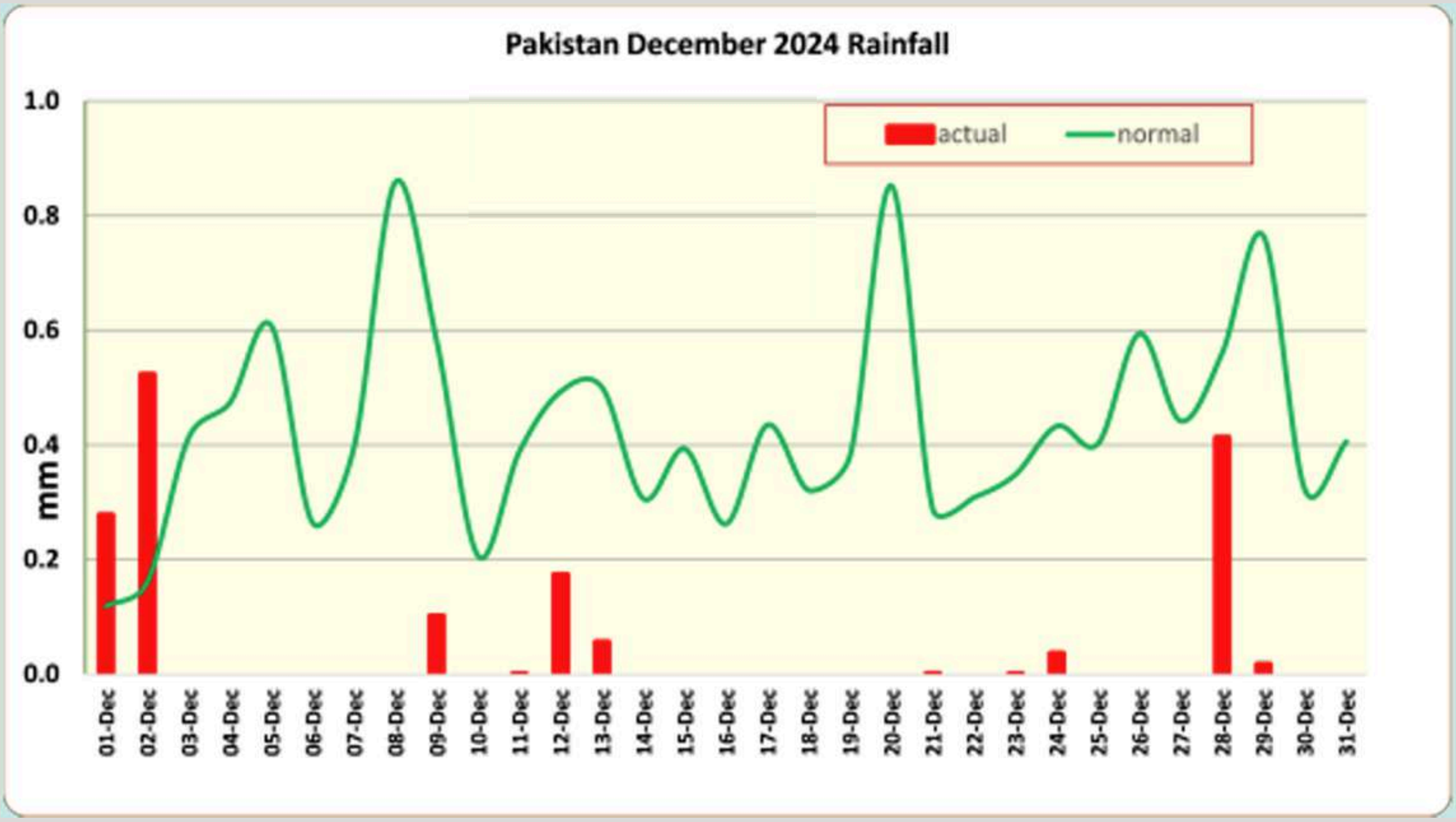


Figure 1: Rainfall Comparison for the month of December 2024

Synoptic Data - January 2025

January 2025 was marked by predominantly dry conditions across Pakistan, with the national area-weighted rainfall recorded at only **8.5 mm**, reflecting a negative **anomaly of -55%. The heaviest one-day rainfall occurred at Chitral (KP) on 14 January 2025, measuring 72.6 mm,** while Chitral also emerged as the wettest location with a monthly total rainfall of **146.9 mm**. Despite the dry spell, dense fog prevailed in Punjab and Sindh, disrupting transportation and daily activities. Several flights were delayed, and road accidents increased due to low visibility. The persistent fog also impacted public health, particularly respiratory conditions in urban centers.

The national mean monthly temperature of **11.92 °C** was slightly warmer than the country average of **11.23 °C (+0.69 °C anomaly).** Daytime maximum temperatures averaged **19.5 °C (+0.5 °C anomaly),** while nighttime minimum temperatures averaged **4.3 °C (+0.3 °C anomaly).** The hottest day was observed in Mithi (Sindh) **on 25 January 2025**, with a maximum temperature of 32.5 °C, while Astore (GB) recorded the coldest night temperature of **-12.0 °C on 31 January 2025**. ENSO conditions remained weakly La Niña, influencing global weather patterns, while the Indian Ocean Dipole (IOD) transitioned toward a neutral phase.

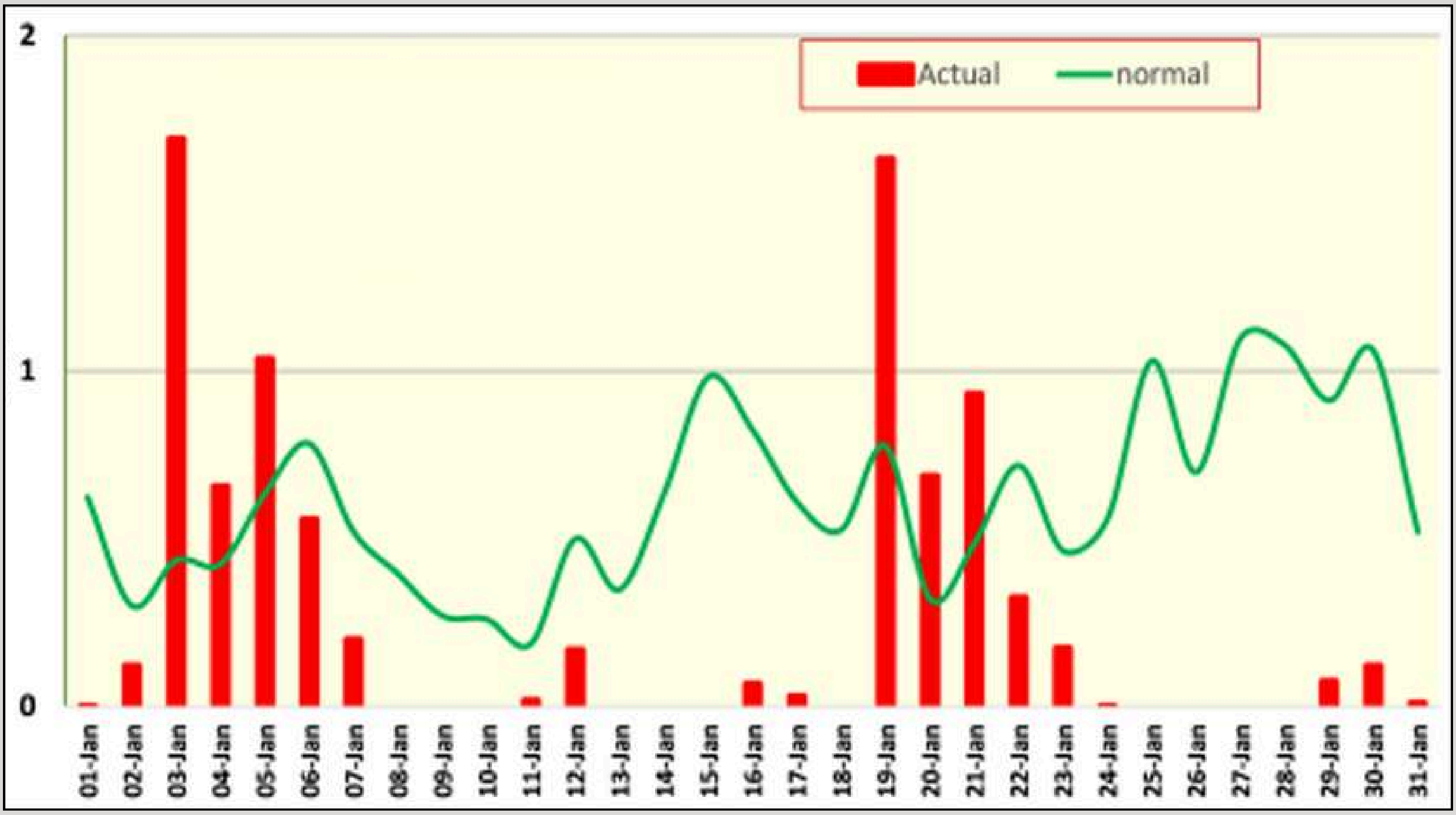


Figure 2: Rainfall Comparison for the month of January 2025

Synoptic Data - February 2025

February 2025 continued the trend of dry conditions, with national area-weighted rainfall recorded at only **11.9 mm,** reflecting a negative anomaly of **-68%.** The heaviest one-day rainfall occurred at Cherat (KP) on **12 February 2025**, measuring **24.0 mm,** while Dir (KP) emerged as the wettest location with a monthly total rainfall of **52.2 mm.** The national mean monthly temperature was recorded at **14.84 °C,** which was warmer than the country average of **13.92 °C (+0.92 °C anomaly).** Daytime maximum temperatures averaged **23.1 °C (+0.7 °C anomaly),** while nighttime minimum temperatures averaged **6.6 °C (+0.4 °C anomaly).** The hottest day was observed in Chhor (Sindh) on **28 February 2025,** with a maximum temperature of 37.5 °C, while Kalam (KP) recorded the coldest night temperature of **-11.0 °C on 15 February 2025.**

Dry conditions persisted across most regions, with little snowfall reported in the Northern mountainous areas. This raised concerns about reduced snowpack and its impact on spring water availability. Farmers in rain-fed areas experienced delays in sowing and lower soil moisture. Urban centers also faced increased dust levels and dry air, contributing to health discomfort. **ENSO conditions remained weakly La Niña,** while the IOD continued its neutral phase, offering little support for moisture-rich weather systems.

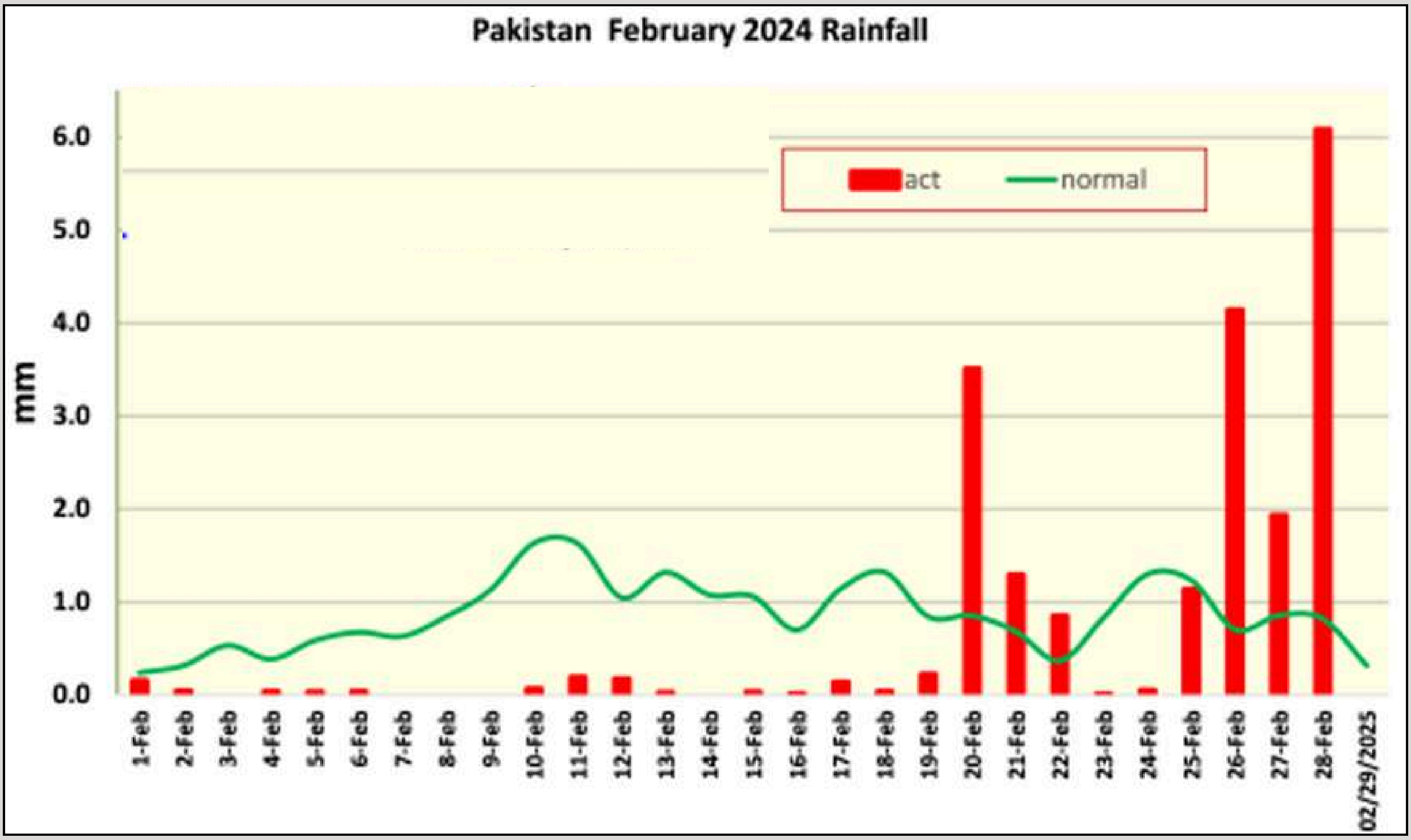


Figure 3: Rainfall Comparison for the month of February 2025

Synoptic March - 2025

March 2025 saw slightly improved rainfall compared to previous months, but it remained below average overall, with national area-weighted rainfall recorded at only **15.1 mm (-50% anomaly)**. The heaviest one-day rainfall occurred at Mirkhani (KP) on **25 March 2025, measuring 86.0 mm,** while Dir (KP) emerged as the wettest location with a monthly total rainfall of **219 mm** due to multiple Western disturbances affecting Northern regions during the month. The national mean monthly temperature climbed to **20.36 °C,** which was significantly warmer than the country average of **18.86 °C (+1.50 °C anomaly).** Daytime maximum temperatures averaged **29.2 °C (+1.8 °C anomaly),** while nighttime minimum temperatures averaged **11.5 °C (+1.2 °C anomaly)**. The hottest day was observed in Mithi (Sindh) on March 30, with a maximum temperature of **42.0 °C,** while Kalam (KP) recorded the coldest night temperature of **-6.0 °C on 10 March 2025.**

Dry and warm conditions intensified in Southern and Central regions, raising concerns about early onset of heat stress. In agricultural zones, the higher-than-usual temperatures accelerated crop development but also increased irrigation demand. Despite some rainfall in the North, drought-like conditions persisted in many other parts of the country.

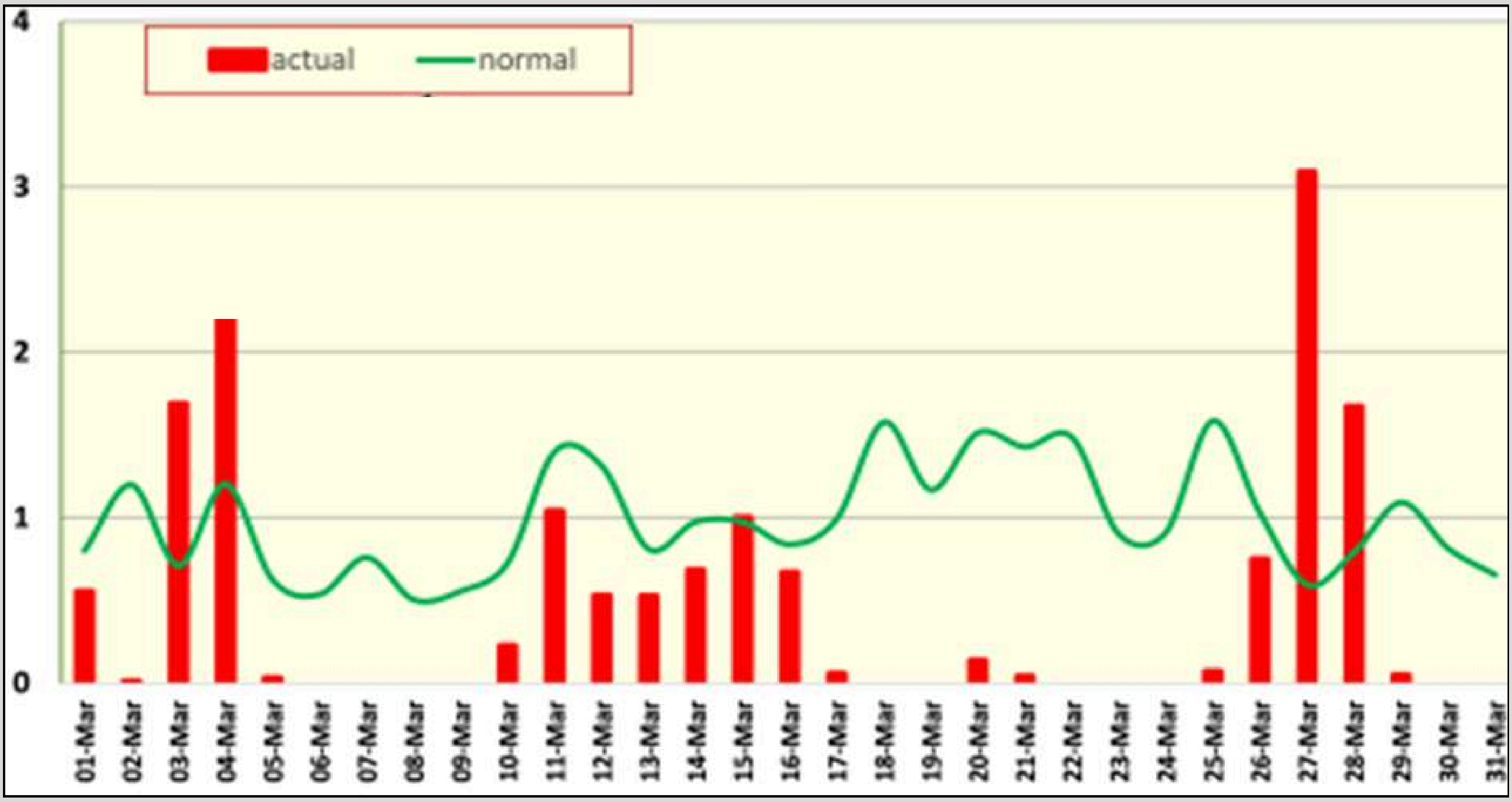


Figure 4: Rainfall Comparison for the month of March 2025

Monthly Synoptic Data Summary from January 2025 to March 2025

- **Rainfall:** Remained significantly below average across Pakistan, exacerbating water stress in arid regions such as Sindh and Balochistan.
- **Temperatures:** Consistently above average for all three months, accelerating crop maturity and impacting agricultural yields.
- **Smog:** Episodes of intense smog in late 2024, particularly in urban centers of Punjab, severely impacted air quality and public health.
- **Delayed Snowfall:** Snowfall occurred later than usual, leading to unstable snowpacks that triggered avalanches and landslides in Northern regions.
- **Global Climate Drivers:**
- **ENSO** remained in weak La Niña conditions.
- **The Indian Ocean Dipole (IOD)** remained in a neutral phase, both climate drivers influenced regional weather patterns but did not bring substantial precipitation to Southern Pakistan.

- **Extreme Weather Events:**
  - Dense fog in January disrupted transportation across multiple regions.
  - Localized heavy rainfall in KP during February and March caused flash flooding in certain areas.

Month	Hottest Day	Coldest Day	Coldest Night	Wettest Day	Wettest Month
December 2024	29.0 °C at Chhor (Sindh)	2.0 °C at Astore (GB)	-13.0 °C at Skardu (GB)	21.0 mm at Parachinar (KP)	41.8 mm at Parachinar (KP)
January 2025	32.5 °C at Mithi (Sindh)	0.5 °C at Astore (GB)	-12.0 °C at Astore (GB)	72.6 mm at Chitral (KP)	146.9 mm at Chitral (KP)
Feburary 2025	37.5 °C at Chhor (Sindh)	-3.5 °C at Kalam (KP)	-11.0 °C at Kalam (KP)	24.0 mm at Cherat (KP)	52.2 mm at Dir (KP)
March 2025	42.0 °C at Mithi (Sindh)	-1.0 °C at Kalam (KP)	-6.0 °C at Kalam (KP)	86.0 mm at Mirkhani (KP)	219.0 mm at Dir (KP)

Table-1: Shows Weather Extreme for the months of Dec 2024 to Mar 2025

During the first quarter of 2025, Pakistan faced significant climate anomalies. Rainfall declined by 41%, leading to water scarcity conditions in areas like Turbat, Jiwani, and Karachi. Temperatures were consistently above average, accelerating snowmelt and impacting crop maturity. Soil moisture deficits were observed in regions such as Potohar, Sialkot, Kashmir, KP, and South-Western Balochistan. Heatwaves intensified toward late March and early April, posing risks to health and agriculture. These conditions highlight the need for adaptive measures to address water scarcity and agricultural challenges.

December 2024 was marked by significantly below-average rainfall, with a national area-weighted total of only **1.6 mm**, reflecting a negative anomaly of **-88%**. The heaviest one-day rainfall occurred at Mirkhani (KP) on **3 December 2024**, measuring **25.0 mm**, while Kalam (KP) emerged as the wettest location with a monthly total of **33.0 mm**. Dry conditions prevailed across most regions, exacerbating soil moisture deficits and drought conditions in arid areas.

Regional Rainfall

- **Punjab:** Experienced extremely below-average rainfall.
- **Sindh:** Recorded minimal rainfall, contributing to severe dry conditions.
- **Balochistan:** Faced significant rainfall deficits.
- **KP:** Received notable rainfall, particularly in Kalam.
- **GB:** Experienced below-average rainfall.
- **AJ&K:** Recorded near-average rainfall conditions.

The national mean temperature was cooler than average at 9.44 °C (-0.49 °C anomaly), with daytime maximum temperatures averaging **20.03 °C (-0.22 °C anomaly)** and night time minimum temperatures at 4.5 °C (-0.35 °C anomaly). Gwadar (Balochistan) recorded the hottest day at **33.5 °C on 5 December 2024**, while Skardu (GB) experienced the coldest night at **-13.2 °C** on **26 December 2024**.

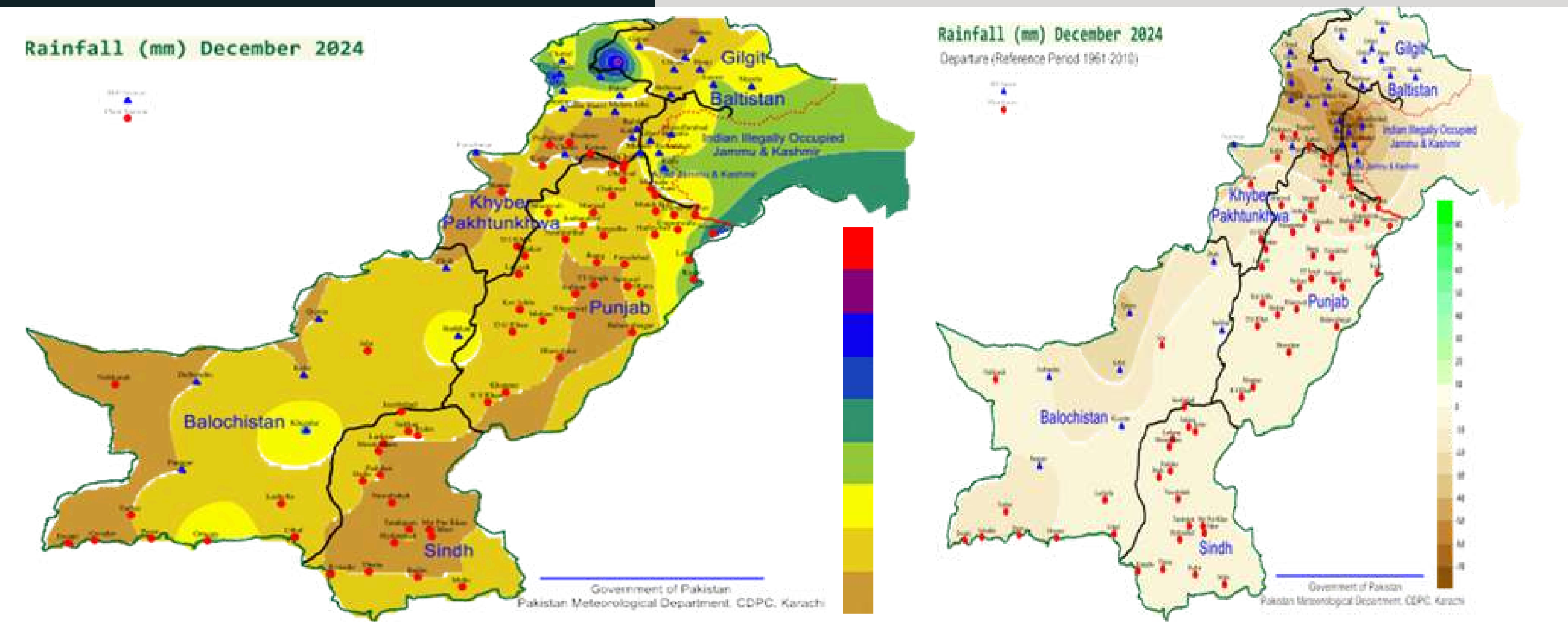


Figure. 5. December-2025 spatial rainfall distribution and departure from normal

Rainfall / Temperature Analysis - January 2025

During the first quarter of 2025, Pakistan faced significant climate variations, particularly in **January 2025**. This month was marked by significantly below-average rainfall, with a national area-weighted total of 8.5 mm, showing a negative **anomaly of -55%.** The heaviest one-day rainfall occurred in Chitral (KP) on **14 January 2025, measuring 72.6 mm,** while Chitral also emerged as the wettest location with a monthly total of **146.9 mm.** Dry conditions persisted across most regions, exacerbating soil moisture deficits and drought conditions in arid areas.

Regional Rainfall

- **Punjab:** Experienced extreme rainfall deficits, recording departures of -92%.
- **Sindh:** Also faced metrological drought conditions with -96% rainfall deficit.
- **KP:** Received significant rainfall, particularly in Chitral.
- **GB:** Recorded below-average rainfall.
- **AJ&K:** Experienced near-average rainfall conditions.

The national mean temperature was slightly warmer than **average at 11.92 °C (+0.69 °C anomaly),** with daytime maximum temperatures averaging **19.5 °C (+0.5 °C anomaly)** and nighttime minimum temperatures at **4.3 °C (+0.3 °C anomaly).** Mithi (Sindh) recorded the hottest day at **32.5 °C on 25 January,** while Astore (GB) experienced the coldest night at **-12.0 °C** on **31 January 2025**.

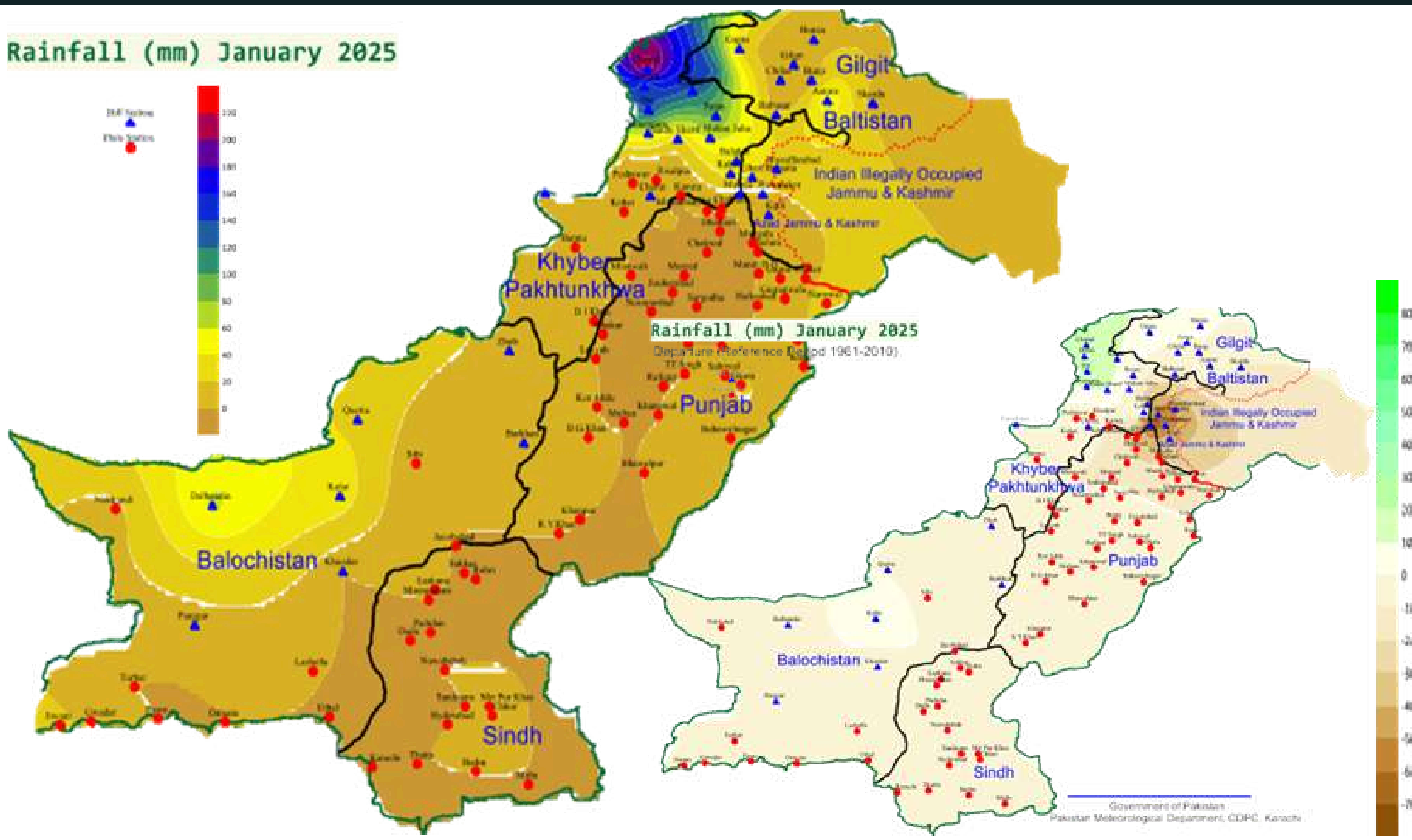


Figure. 6. January-2025 spatial rainfall distribution and departure from normal

Rainfall / Temperature Analysis - February 2025

February 2025 continued the trend of dry weather, with the national area-weighted rainfall totaling only **11.9 mm (-68% anomaly).** The heaviest one-day rainfall occurred in Cherat (KP) on **14 February 2025, measuring 24.0 mm,** while Dir (KP) recorded the **highest monthly total of 52.2 mm.** Soil moisture deficits worsened in Potohar, Sialkot, Kashmir, and South-Western Balochistan, leading to crop stress and water scarcity concerns.

Regional Rainfall

- **Balochistan:** Experienced drought conditions with a significant rainfall deficit.
- **Sindh:** Continued to face dry conditions.
- **Punjab:** Recorded below-average rainfall.
- **KP:** Received notable rainfall, particularly in Dir.
- **GB:** Experienced below-average rainfall.
- The national mean temperature rose to **14.84 °C (+0.92 °C anomaly),** with daytime highs **averaging 23.1 °C (+0.7 °C anomaly)** and nighttime lows at **6.6 °C (+0.4 °C anomaly)**. Chhor (Sindh) recorded the hottest day **at 37.5 °C on 28 February 2025,** while Kalam (KP) experienced the **coldest night at -11.0 °C on 15 February 2025.**

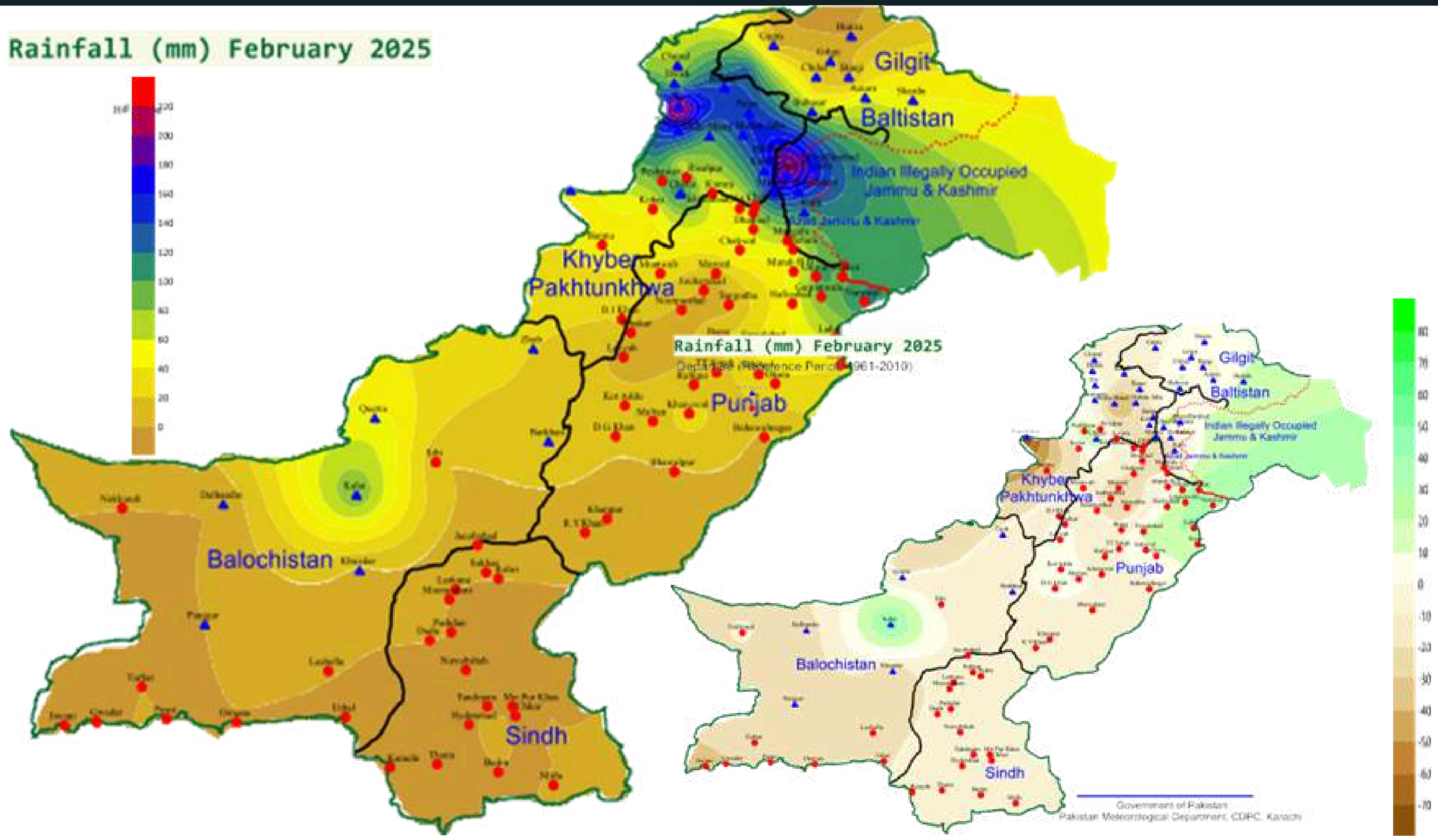


Figure. 7. February-2025 spatial rainfall distribution and departure from normal

Rainfall / Temperature Analysis - March 2025

March 2025 saw slightly improved rainfall compared to previous months but remained well below average overall, with a national **total of 15.1 mm (-50% anomaly).** Regionally, the situation varied significantly.

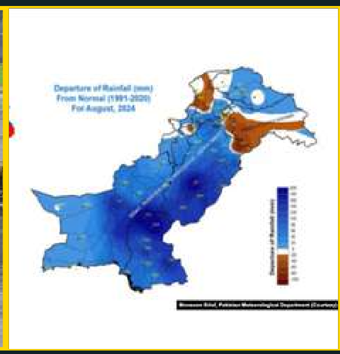
Regional Rainfall

- **Balochistan:** Recorded only **1 mm of rainfall**, making it the second driest **Month in 65 years.**
- **Sindh**: Experienced extremely below-average rainfall with only **0.4 mm.**
- **Punjab:** Recorded **9.9 mm,** which was excessively below **average (-65%).**
- **KP:** Received below-average rainfall at **61.7 mm**.
- **AJ&K:** Recorded near-average rainfall at **96.6 mm**.
- **GB:** Experienced above-average rainfall at **40 mm**.

The heaviest one-day rainfall occurred in Mirkhani (KP) on March 27 with 86 mm, while Dir (KP) was the wettest place with a monthly total of 219 mm. Temperatures continued to rise in March, with the national mean temperature climbing to 20.36 °C (+1.50 °C anomaly). Daytime highs averaged 29.2 °C (+1.8 °C anomaly), while nighttime lows averaged 11.5 °C (+1.2 °C anomaly). Mithi (Sindh) recorded the hottest day at an extreme temperature of 42 °C on March 30, while Kalam (KP) experienced the coldest night at -6 °C on March 10.

Overall Observations for December 2024 to March 2025

- **Rainfall.** The period saw a significant decline in rainfall levels across Pakistan **(-41% overall),** contributing to moderate drought conditions in areas like Turbat, Jiwani, Ormara, Dadu, Mithi, Badin, Thatta, Shaheed Benazirabad, and Karachi.
- **Temperature.** Temperatures were consistently above average across all months, accelerating snowmelt rates in Northern regions and impacting crop maturity in Southern areas.
- **Drought Conditions.** Soil moisture deficits were observed in Potohar region, Sialkot region, Kashmir, parts of KP, and South-Western Balochistan.
- **Extreme Weather.** Heatwaves began intensifying toward late March and early April.
- These climatic anomalies underscore the need for adaptive measures to mitigate water scarcity issues and address agricultural challenges caused by prolonged dry spells and rising temperatures across Pakistan during the first quarter of the year.



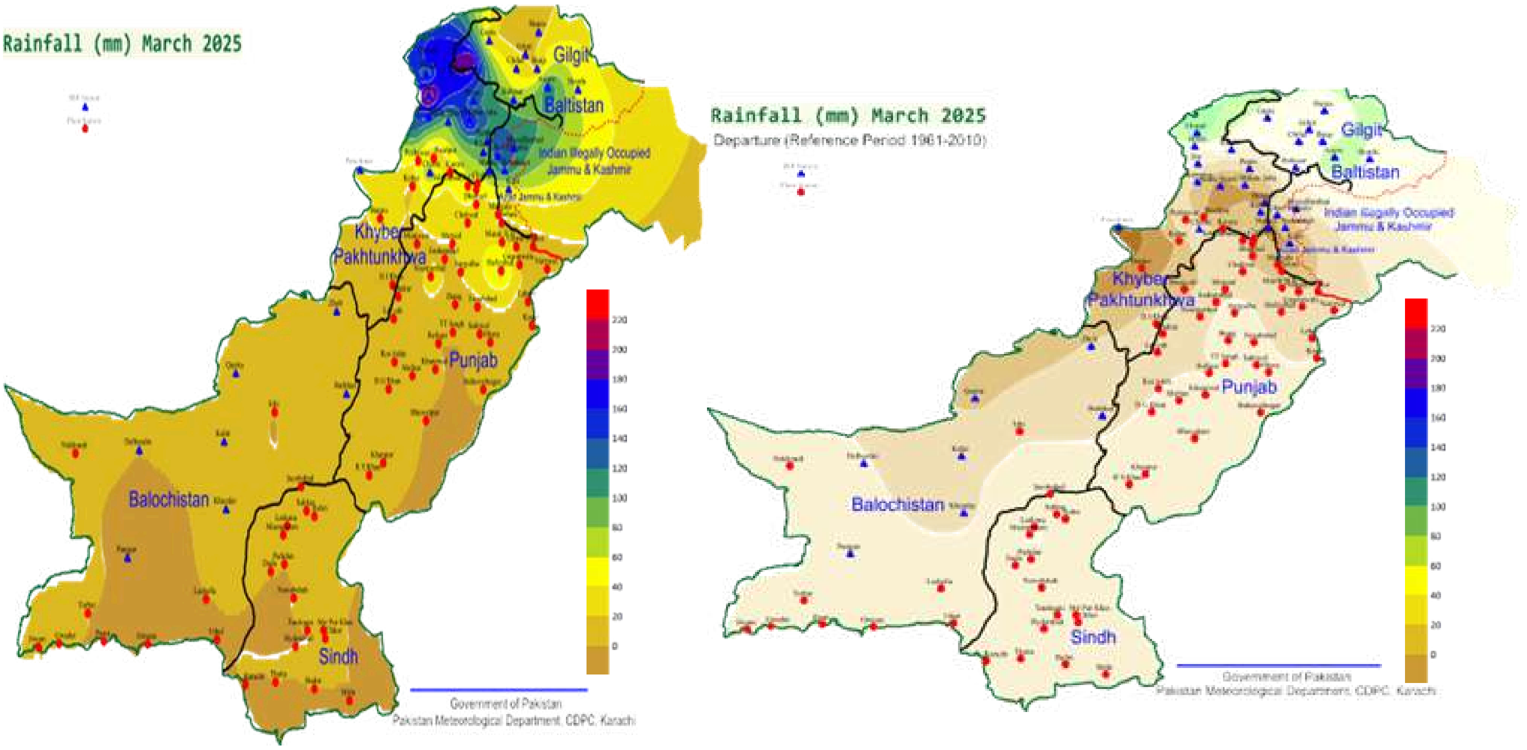


Figure. 8. March-2025 spatial rainfall distribution and departure from normal

Area Average Mean Temperatures

Region	December 2024 Mean Temp (°C) (Anomaly)	January 2025 Mean Temp (°C) (Anomaly)	February 2025 Mean Temp (°C) (Anomaly)	March 2025 Mean Temp (°C) (Anomaly)
Pakistan	9.44 (+1.41)	11.92 (+0.69)	14.84 (+0.92)	20.36 (+1.50)
Azad Jammu & Kashmir	3.67 (+1.49)	6.36 (+1.55)	8.57 (+0.76)	12.34 (+1.12)
Balochistan	10.65 (+1.69)	11.93 (+0.36)	15.19 (+0.72)	20.63 (+1.51)
Gilgit-Baltistan	0.02 (+0.74)	1.94 (+1.09)	3.54 (-0.38)	9.23 (+0.03)
Khyber Pakhtunkhwa	5.17 (+1.49)	9.36 (+1.36)	11.83 (+0.80)	15.94 (+1.50)
Punjab	11.06 (+1.38)	13.44 (+0.79)	16.72 (+1.03)	22.13 (+1.62)
Sindh	16.37 (+1.19)	16.64 (+0.48)	20.58 (+1.02)	26.28 (+1.94)

Table-2: Shows Average Mean Temperature from Dec 2024 to Mar 2025

Impacts and Observations

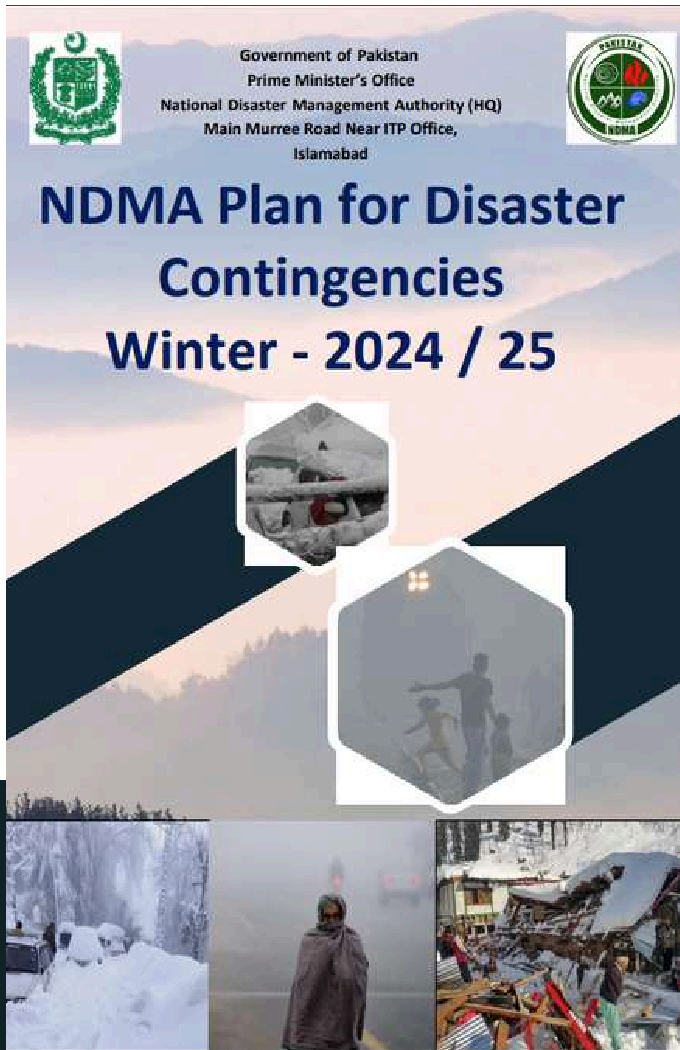
- **Below-average rainfall** lead to water stress, particularly in Balochistan and Sindh.
- **Above-average temperatures** may have influenced crop growth and increased water demand.
- **Fog conditions** in Punjab and Sindh disrupted transportation.

Contingency Planning and Preparedness

NDMA in collaboration with PDMAs and relevant stakeholders, executed a range of strategic initiatives to enhance national readiness for winter-related hazards. These proactive efforts were aimed at minimizing the impact of seasonal threats such as snowstorms, cold waves, fog, smog, avalanches, and landslides. The following key measures were undertaken:

1. **Issuance of the Winter Contingency Plan 2024–25:** NDMA developed and disseminated the Winter Contingency Plan 2024–25, which served as a comprehensive framework for disaster preparedness and response across Pakistan during the winter season. The plan outlined roles and responsibilities for federal, provincial, and district-level stakeholders, integrating a multi-hazard approach to manage winter-specific risks including heavy snowfall, avalanches, fog, smog, cold waves, and rain-induced landslides. Key components of the plan included:

- **Hazard Identification & Vulnerability Assessment:** Mapping of regions prone to snowfall, avalanches, and extreme cold, particularly in GB, KP, and Northern Balochistan. These maps were developed in collaboration with NDMA Tech Team, SUPARCO and PMD.
- **Stockpiling Strategy:** Direction to PDMAs and District Authorities to pre-position food, fuel, medicines, blankets, de-icing material, and emergency rescue kits in high-risk areas before snowfall begins.
- **Interagency Coordination Framework:** Standard Operating Procedures (SOPs) for collaboration between NDMA, PDMAs, Rescue 1122, and the Pakistan Armed Forces for response and recovery. It defines clear communication protocols, joint operational roles, and thresholds for emergency escalation to ensure an integrated and synchronized disaster response mechanism.
- **Community Preparedness and Awareness:** Instructions for launching localized awareness campaigns through media, Mosques, and schools focusing on community-level preparedness, first aid, and safe heating practices.
- **Emergency Communication Plans:** Emphasis on ensuring backup communication systems in case of power outages, including satellite phones and radio operators in remote areas.
- **Logistical Preparedness:** Plans to deploy snow-clearing machinery and mobile health units in inaccessible areas, with the support of National Highway Authority (NHA) and local governments.



Contingency Planning and Preparedness

2. Development and Dissemination of Winter Hazard Guidelines

- To ensure localized and effective preparedness, NDMA issued several season-specific guidelines:
- **Smog Advisory (13 Nov 2024):** Focused on controlling pollution sources, minimizing vehicular emissions, and protecting public health in smog-affected cities, especially in Punjab. These guidelines were circulated among district administrations, media platforms, and public offices for broad outreach.
- **Winter Travel Safety Guidelines (9 Dec 2024):** Offered practical advice to travelers and transport authorities for navigating hazardous winter travel conditions, including black ice, road closures, and visibility issues.
- **Avalanche Guidelines (7 Feb 2025):** Provided step-by-step instructions on identifying avalanche risks, preparing safe zones, and post-avalanche response mechanisms.
- **Snowfall/Rainfall Guidelines (18 Feb 2025):** Detailed safety instructions for people living in high-altitude and mountainous regions to prepare for and respond to heavy snowfall and rain events.

3. Issuance of Smog Management Guidelines (13 Nov 2024):

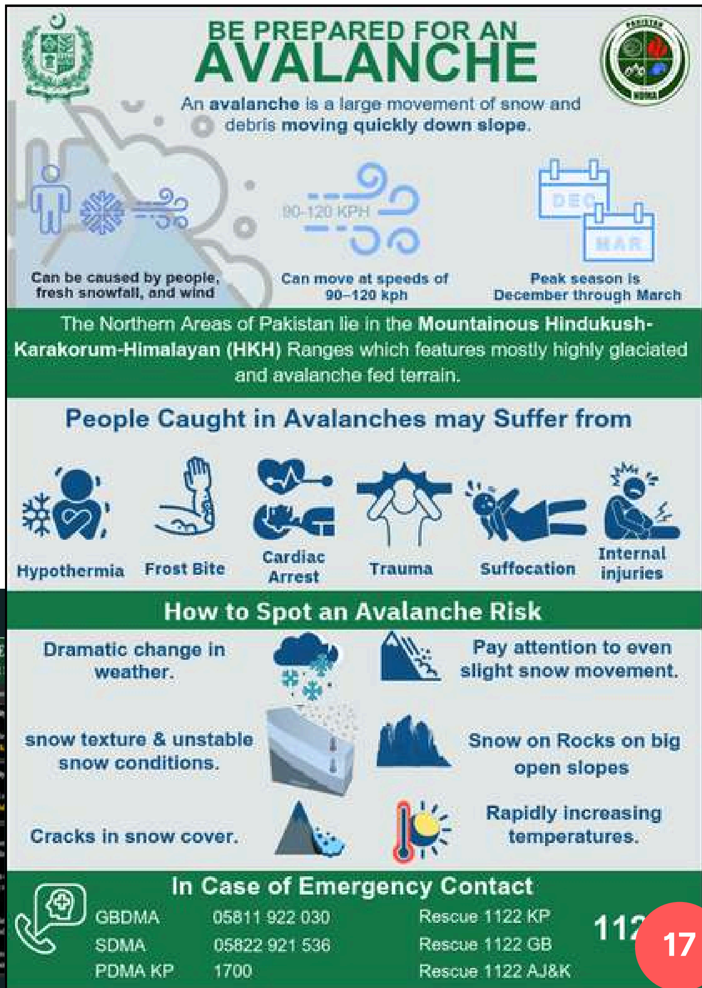
Recognizing the increasing threat of smog—a mix of smoke and fog—during winter months, particularly in urban centers such as Lahore, Faisalabad, and Gujranwala, NDMA issued detailed Smog Management Guidelines. These covered:

- Identification of high-risk areas
- Health advisories for vulnerable groups (children, elderly, respiratory patients)
- Recommendations for vehicular and industrial emission control
- Guidelines for schools and workplaces The guidelines also supported coordination with the Ministry of Climate Change and provincial environment protection departments.

4. Winter Coordination Conference:

Winter Coordination Conference was held on 6 December 2024, this high-level meeting brought together representatives from PDMAs, GBDMA, SDMA (AJ&K), Rescue 1122, PMD, and other national institutions. Key objectives included:

- Reviewing national and provincial readiness levels
- Identifying logistical and operational gaps
- Strengthening coordination mechanisms



Contingency Planning and Preparedness

5. Conducting Simulation Exercises

On 7 December 2024, NDMA conducted a multi-hazard simulation exercise at the National Emergencies Operation Centre (NEOC) to test the national and provincial response framework. The drill simulated:

- Road blockages due to heavy snow
- Emergency rescue of stranded passengers
- Communication between PDMAs and district administrations.

This hands-on exercise helped identify real-time gaps in response coordination and provided critical insights for refining SOPs and contingency plans.

6. Issuance of 13 Winter Hazard Advisories

To ensure public and institutional readiness, NDMA issued 13 targeted advisories addressing:

- Severe weather alerts (snowfall, rainfall, temperature drops)
- Avalanche warnings for GB and KP
- Smog alerts for urban centers
- Cold wave preparedness actions
- Drought monitoring in Southern Pakistan

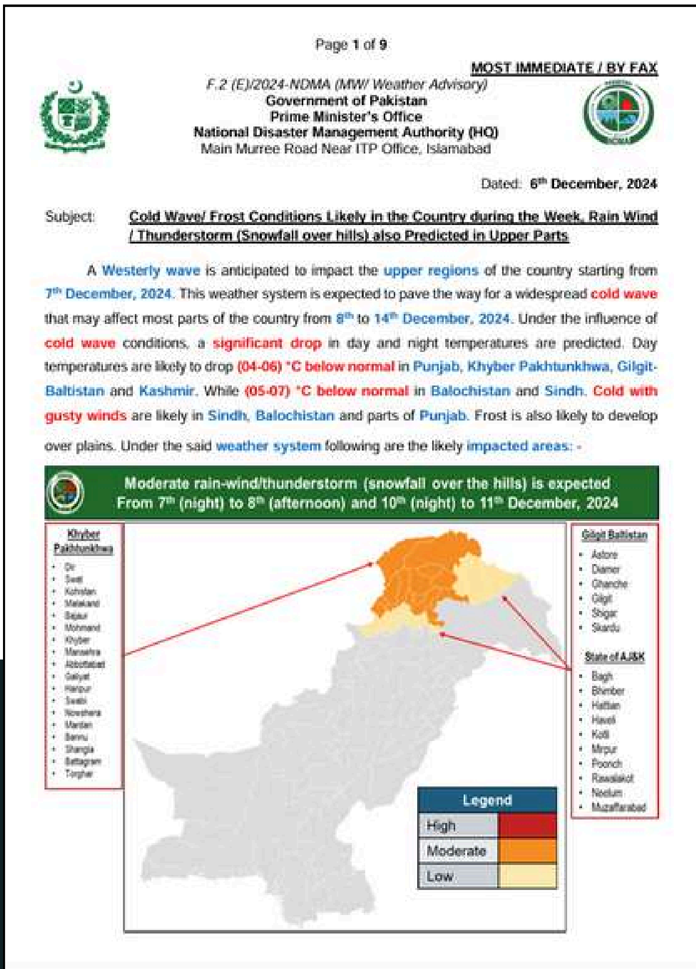
Each advisory included forecast data, recommended actions, and coordination instructions for disaster responders.

7. Hazard Mapping and Risk Profiling

NDMA updated its hazard maps and risk profiles using remote sensing and field data collection in collaboration with Geological Survey of Pakistan, Local Administration and Academia. This included:

- Identifying avalanche-prone slopes in Gilgit-Baltistan and KP
- Pinpointing flood-sensitive valleys and roads
- Assessing landslide risks in Northern Pakistan.
- Updating vulnerability indexes of local populations
- These profiles were integrated into the **e-MHVRA** (electronic Multi-Hazard Vulnerability and Risk Assessment) platform, enhancing decision-making and enabling dynamic resource allocation in vulnerable areas.

8. Strengthening Coordination Channel through Provincial Coordination Cell (PCC): NDMA facilitated the operationalization of Provincial Coordination Cells in all provinces to serve as a central platform for real-time coordination and information sharing between NDMA, PDMAs, line departments, and field-level responders. PCCs are designed to streamline communication flow, ensure timely data collection, enable coordinated resource deployment and act as monitoring hubs during peak hazard periods.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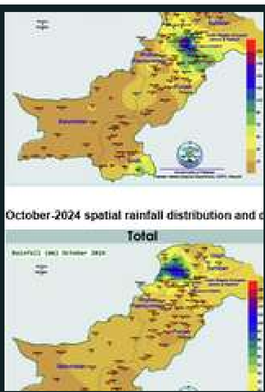
MOST IMMEDIATE / BY FAX

F.2 (E)/2024-NDMA (MW/ Weather Advisory)
Government of Pakistan
Prime Minister's Office
National Disaster Management Authority (HQ)
Main Murree Road Near ITP Office, Islamabad

Dated: **6th December, 2024**

Subject: **Cold Wave/ Frost Conditions Likely in the Country during the Week, Rain Wind / Thunderstorm (Snowfall over hills) also Predicted in Upper Parts**

A Westerly wave is anticipated to impact the upper regions of the country starting from 7th December, 2024. This weather system is expected to pave the way for a widespread cold wave that may affect most parts of the country from 8th to 14th December, 2024. Under the influence of cold wave conditions, a significant drop in day and night temperatures are predicted. Day temperatures are likely to drop (04-06) °C below normal in Punjab, Khyber Pakhtunkhwa, Gilgit-Baltistan and Kashmir. While (05-07) °C below normal in Balochistan and Sindh. Cold with gusty winds are likely in Sindh, Balochistan and parts of Punjab. Frost is also likely to develop over plains. Under the said weather system following are the likely impacted areas: -



Response and Relief Operations

- **Emergency Response:** NDMA activated the Control Room for real-time coordination with provincial authorities, armed forces, and relevant federal ministries. Rapid response teams, including mobilization of firefighting units were mobilized for affected areas.
- **Collaboration with Stakeholders:** NDMA worked in close coordination with Pakistan Army, federal, provincial department, international humanitarian partners such as UN agencies, national NGOs and civil society, to ensure a coordinated and inclusive response.
- **Air Support Operations:** In remote or inaccessible regions cut off by snow or landslides, NDMA coordinated with Pakistan Army Aviation and Pakistan Air Force for aerial reconnaissance and airlifting of relief goods.
- **Road Clearance Operations:** During Winter season 2024-25, multiple landslides, avalanches, and mudslides disrupted road networks in mountainous regions, particularly along the Karakoram Highway (KKH) and connecting roads in Gilgit-Baltistan, AJ&K, and KP. PDMA's, SDMA & GBDMA, in coordination with the National Highway Authority (NHA), Frontier Works Organisation (FWO), and local authorities, carried out extensive clearance operations to restore access. Frequent blockages and re-closures, especially in areas like Kohistan, Diamer, and Skardu, highlighted the ongoing vulnerability of critical routes to extreme weather events.

Muzaffarabad
28-FEB-2025

Kel -Tao But Road
1-MARCH-2025

Neelum
15-JAN-2025

Pehawar
26-OCT-2024

Gilgit Baltistan
11-MARCH-2025

Gilgit Baltistan
04-SEP-2024

Gilgit Baltistan
10-APRIL-2025

Gilgit Baltistan
10-APRIL-2025

Losses and Damages

Losses & Damages Reported by PDMA - KP

Deaths
86

Male	Female	Child
39	22	25

Causes of Deaths

Causes of Deaths	
Structural Collapse	28
Drowning	4
Landsliding	10
Electrocution	22
Lightning	13
Gas Leakages	9

injuries
58

Male	Female	Child
20	09	29

Ser	District	Deaths	Injuries	House Damage	Roads (meters)	Livestock
1	**Khyber**	9	8	5	0	6
2	**Haripur**	3	5	8	0	0
3	**Battagram**	2	4	2	5310	36
4	**Torghar**	1	3	4	2500	31
5	**Kohistan Upper**	2	2	1	2000	0
6	**Swat**	5	1	25	0	51
7	**Dir Upper**	1	2	137	375	8
8	**Hangu**	1	1	7	0	0
9	**Shangla**	1	0	1	0	0
10	**Abbottabad**	1	0	54	0	0
11	**Bajaur**	2	4	14	850	0
12	**Chitral Upper**	3	0	51	2600	45
13	**Kohistan Lower**	6	0	42	2400	15
14	**Mardan**	1	0	2	0	0
15	**Swabi**	0	3	0	0	0
16	**Nowshera**	6	6	33	0	2
17	**Lakki Marwat**	4	3	7	0	0

Losses and Damages

Losses & Damages Reported by PDMA - KP

Ser	District	Deaths	Injuries	House Damage	Roads (meters)	Livestock
18	**Bannu**	38	16	91	0	3
19	**Buner**	0	0	9	0	155
20	**Chitral Lower**	0	0	7	0	0
21	**Dir Lower**	0	0	6	100	42
22	**Malakand**	0	0	1	0	0
23	**Charsada**	0	0	11	0	3
24	**Orakzai**	0	0	2	0	0
24	**Mansehra**	0	0	5	0	0
26	**Mohmand**	0	0	12	0	0
27	**Kolai Pallas**	0	0	2	0	0
Total		**86**	**58**	**539**	**16135**	**397**

Fire Incident - Swat 22-Mar-2025

Flash Flood - Chitral 25-Mar-2025

Rockfall - Dir 29-Jan-2025




Losses and Damages

Losses & Damages Reported by GBDMA

Deaths
05

Male 02 | Female 0 | Child 03

Causes of Deaths

Structural Collapse 01

Land Sliding 02

Gas Leakages 02

injuries
9

Male 06 | Female 03 | Child 0

Ser	District	Deaths	Injuries	House Damaged	Roads (m)
1	Diamar	1	2	0	0
2	Skardu	3	0	1	3000
3	Ghizer	1	7	0	2000
4	Astore	0	0	6	3000
5	Hunza	0	0	0	500


Landslide - Chorbat 28-Feb-2025


Avalanche - KKH 23-March-2025


Landslide - KKH 17-Aug-2025

Losses & Damages Reported by SDMA

Deaths
01

Male 0 | Female 0 | Child 01

Causes of Deaths

Structural Collapse

Land Sliding

Gas Leakages

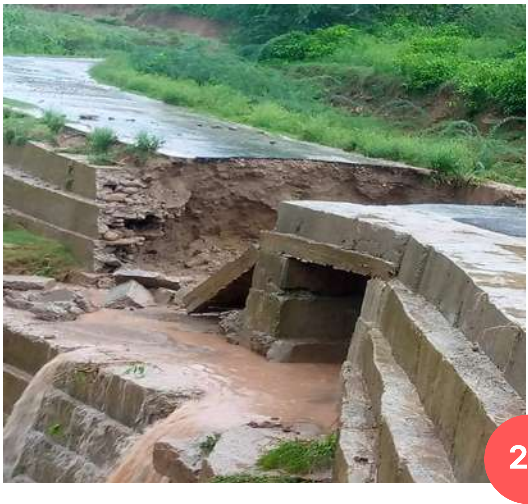
injuries
0

Male 0 | Female 0 | Child 0

Ser	District	Deaths	Injuries	House Damaged	Livestock
1	Neelum	0	0	3	0
2	Jehlum Velley	1	0	0	0
3	Sudhnoti	0	0	1	6
Total		1	0	4	6

Black Ice - Neelum 15-Jan-2025

Provision of Critical Health Item - Neelum 26-Jan-2025



Losses and Damages

Losses & Damages Reported by PDMA - Balochistan

Deaths
03

Male	Female	Child
01	01	01

injuries
03

Male	Female	Child
03	0	0

Causes of Deaths

lightening strike	Flooding
02	01

Ser	District	Deaths	Injuries	House Damaged	Livestock
1	Mastung	1	3	0	0
2	Khuzdar	1	0	0	0
3	Chaghi	1	0	0	0
4	Dera Bugti	0	0	0	63
Total		3	3	0	63


Snowfall - Khojak Top 18-Jan-2025


Snowfall - Chaman 19-Jan-2025


Snowfall - Kahn 19-Jan-2025

Losses and Damages

Losses & Damages Reported by PDMA - Punjab

Deaths
08

Male	Female	Child
04	01	03

Causes of Deaths

Structural Collapse	06
Drowning	01
Landsliding	0
Electrocution	0
Lightning	01
Gas Leakages	0

injuries
14

Male	Female	Child
07	01	06

Ser	District	Deaths	Injuries	House Damage	Roads (meters)	Livestock
1	Kasur	1	4	2	0	0
2	Narowal	0	3	1	0	1
3	Sheikhupura	0	1	1	0	5
4	Sargodha	1	0	1	0	0
5	Faisalabad	2	4	2	0	0
6	Rawalpindi	1	1	0	0	1
7	Lahore	1	1	1	0	0
8	Hafizabad	1	0	0	0	0
9	Jhelum	1	0	1	0	0
Total		8	14	9	0	7

Losses and Damages

Losses & Damages Reported by PDMA - Sindh

Deaths
0

Male	Female	Child
0	0	0

injuries
0

Male	Female	Child
0	0	0

Causes of Deaths

0

Structural Collapse	Land Sliding
0	0

Ser No	District	Deaths	Injuries	House Damaged	Roads(m)	Livestock
1	Nil	Nil	Nil	Nil	Nil	Nil

Communicated Verbally by PMDA Sindh

Relief Provided by PDMA - KP

District	Ration		Tents		Tarpaulins		Blankets		Misc*	
	PDMA	UN / NGO	PDMA	UN / NGO	PDMA	UN / NGO	PDMA	UN / NGO	PDMA	UN / NGO
Abbottabad	0	0	10	0	7	0	9	0	15	0
Charsadda	0	0	4	0	4	0	4	0	4	0
Kohistan Upper	0	900	100	0	0	0	0	720	0	0
Torghar	0	0	7	0	8	0	0	0	0	0
Lakki Marwat	0	0	8	0	10	0	12	0	12	0
Bannu	0	600	200	0	0	0	100	0	80	0
Dir Lower	0	0	11	0	0	0	66	0	35	0
Nowshera	0	0	250	0	247	0	247	0	247	0
Dir Upper	0	500	53	0	119	0	331	1240	893	2088
Battagram	0	0	2	0	2	0	2	0	2	0
Haripur	0	0	10	0	0	0	21	0	25	0
Chitral Upper	6	700	49	0	23	0	69	0	197	250
Khyber	0	0	51	0	94	0	40	0	248	0
Buner	0	600	6	0	12	0	18	0	14	700
Kohistan Lower	100	0	50	0	60	0	350	0	400	0
Bajaur	0	0	44	0	65	0	69	0	272	0
Orakzai	0	0	4	0	4	0	4	0	6	0
Swat	0	600	0	0	0	0	0	800	0	3030
Total	**106**	**3900**	**859**	**0**	**655**	**0**	**1342**	**2760**	**2450**	**6068**

*Mats, Aqua Tabs, Mosquito Nets, Winterization Kit etc.

Relief Provided by PDMA - Punjab

District	Umbrella	Winterized Gloves	Rain Coats	Woolen caps	Socks	Sleeping Bags	Snow Chains	Winterized Shoers	Rescue & Search Suit	Folding Shovel	Chain Saw	Tents
Murree	300	200	200	200	200	400	100	100	100	75	5	25

Conclusion

The winter season of 2024–25 presented Pakistan with a complex array of climatic anomalies, including prolonged dry spells, persistently above-normal temperatures, and extreme weather events such as cold waves, avalanches, smog, and flash floods. These conditions significantly impacted water availability, agriculture, infrastructure, and public health across various regions of the country.

NDMA, in collaboration with federal, provincial, and district-level stakeholders, implemented a comprehensive preparedness and response strategy anchored in its Winter Contingency Plan. The Authority's proactive measures—including early warnings, community awareness, hazard-specific guidelines, simulation exercises, and multi-agency coordination—contributed to minimizing the adverse impacts of these hazards. Despite these efforts, the season highlighted persistent vulnerabilities, especially in remote and hazard-prone areas, and emphasized the urgent need for continued investment in climate adaptation, resilience-building, and localized response capacity.

Looking ahead, it is imperative to integrate lessons learned from the winter season into future planning processes. Enhanced data-driven forecasting, decentralized response mechanisms, and community-based preparedness will be key to managing the increasing frequency and intensity of climate-induced disasters in Pakistan. NDMA remains committed to leading a coordinated national effort in strengthening resilience, protecting lives and livelihoods, and fostering a culture of preparedness across the country.

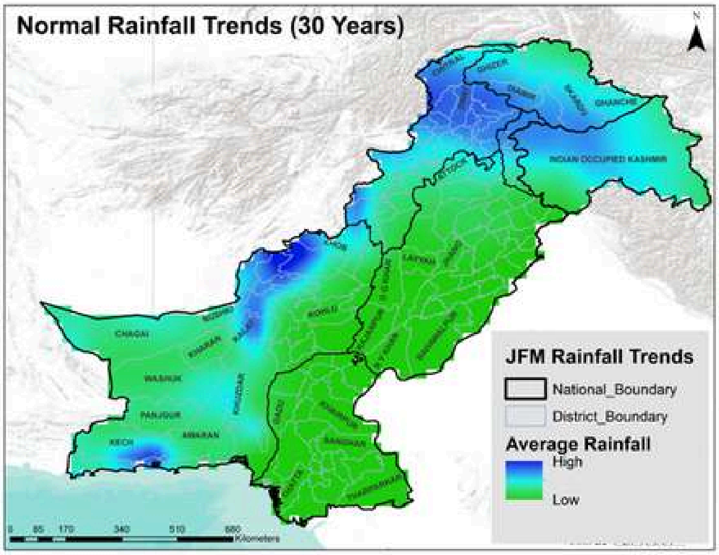
Attachments

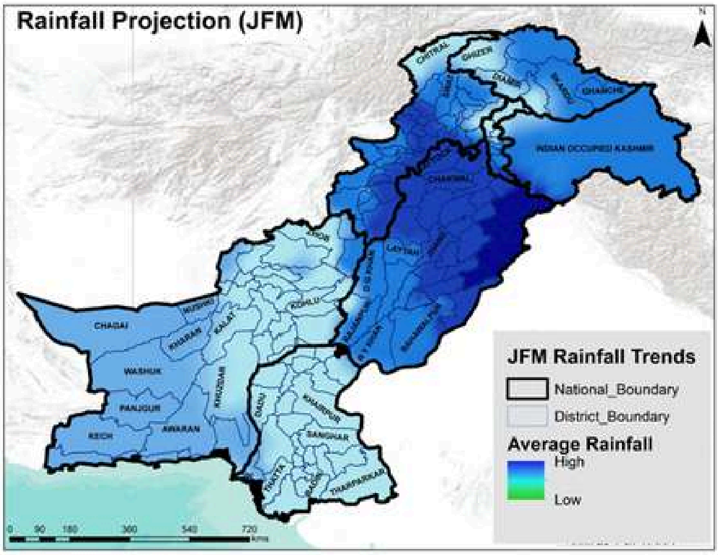
A. NDMA Teach Early Warning Analysis (Annex-A)

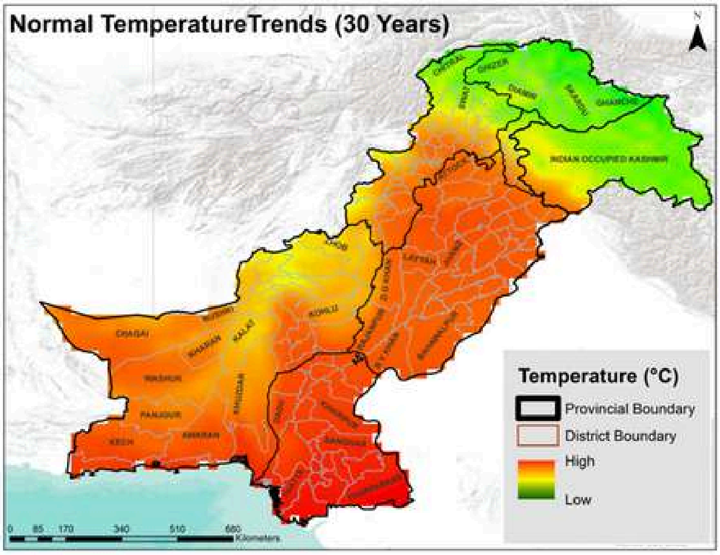
B. National Institute of Disaster Management (NIDM) Reports:

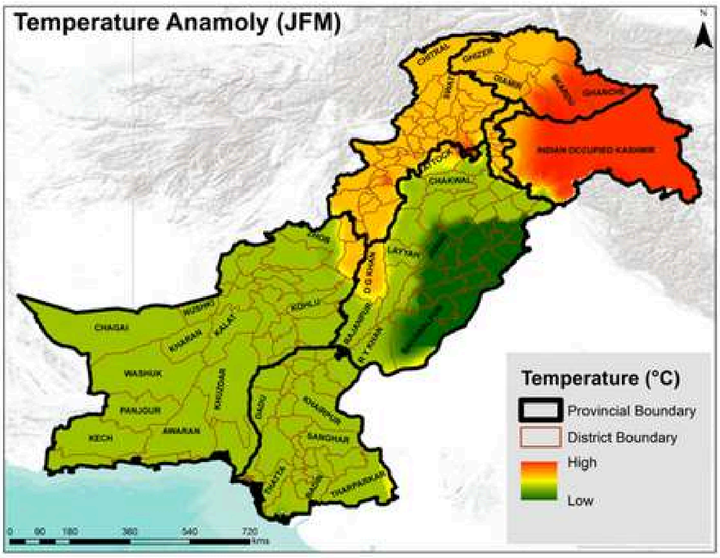
- Shrinking Winters (Trends of Decrease Snowfall and Rainfall in the HKH Regions and its Impact on Pakistan **(Annex-B)**
- Global Climate Surge 2024-25 (Climate Crisis & Pakistan's Vulnerable **(Annex-C)**

Weather Forecasted for January to March-2025









Seasonal Overview

Climate conditions indicate that La Nina is expected to persist through February-April 2025, with a transition to ENSO-neutral likely during March-May 2025. The Indian Ocean Dipole (IOD) is expected to remain in a neutral phase. Below-normal rainfall and prolonged dry spells are anticipated. These conditions, combined with warmer-than-average land surface temperature.

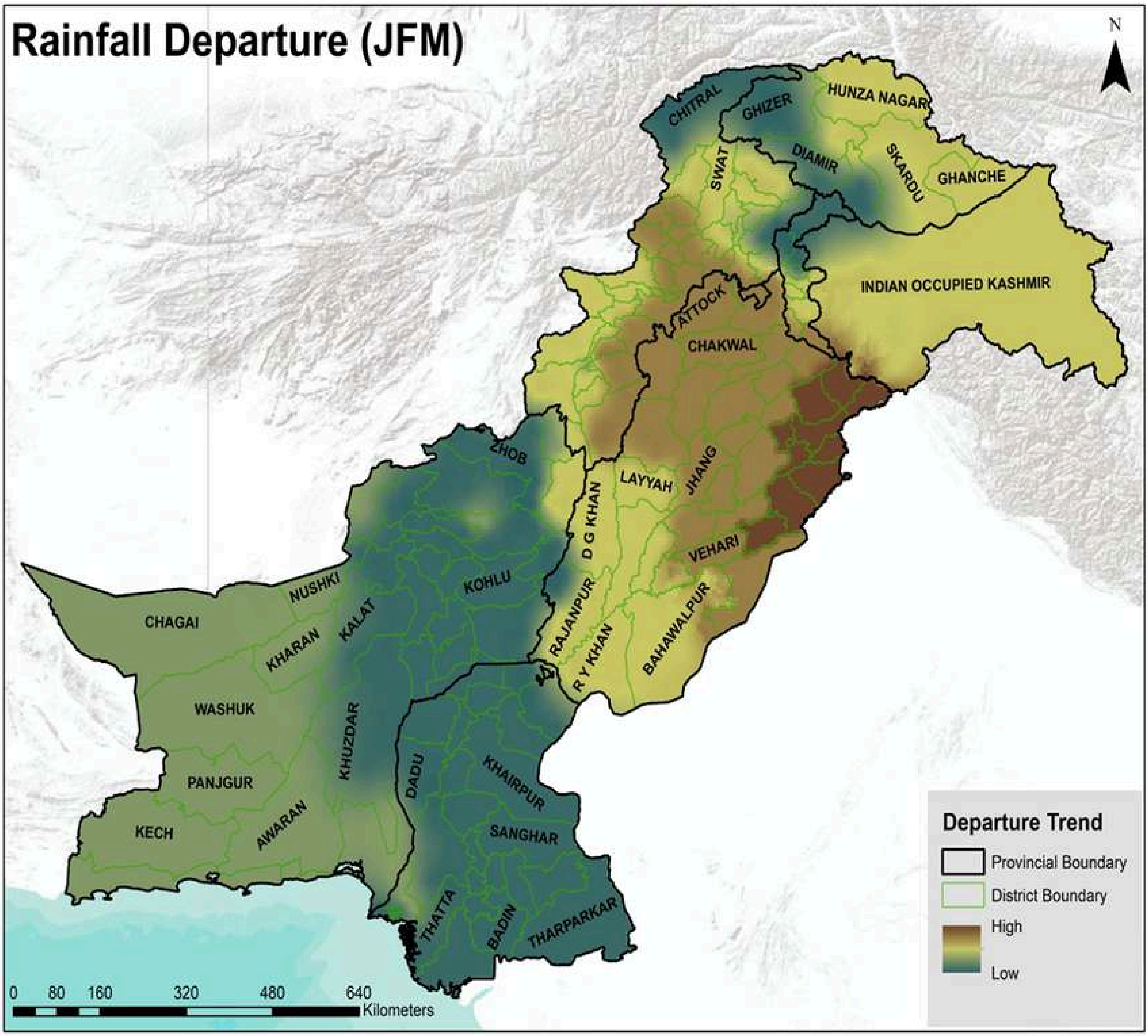
Rainfall Outlook

- Central and Southern Khyber Pakhtunkhwa, AJ&K, North Eastern Punjab are expected to receive **normal to slightly above-normal** rainfall, influenced by Western weather systems.
- Upper Khyber Pakhtunkhwa, Gilgit Baltistan, Hazara, Sindh, and Eastern Balochistan are anticipated to have **near-normal rainfall**.
- Western Balochistan is likely to experience **slightly below/ near normal rainfall**.

Temperature Outlook

- The seasonal temperature outlook predicts above-normal temperatures across most regions of the country.
- Northern areas are expected to experience more significant temperature variations than other regions.
- Warmer-than-usual conditions may impact agriculture, water resources, and energy demand.
- Northern areas could face challenges such as accelerated snowmelt and shifts in seasonal patterns.

January to March-2025 Unfolded

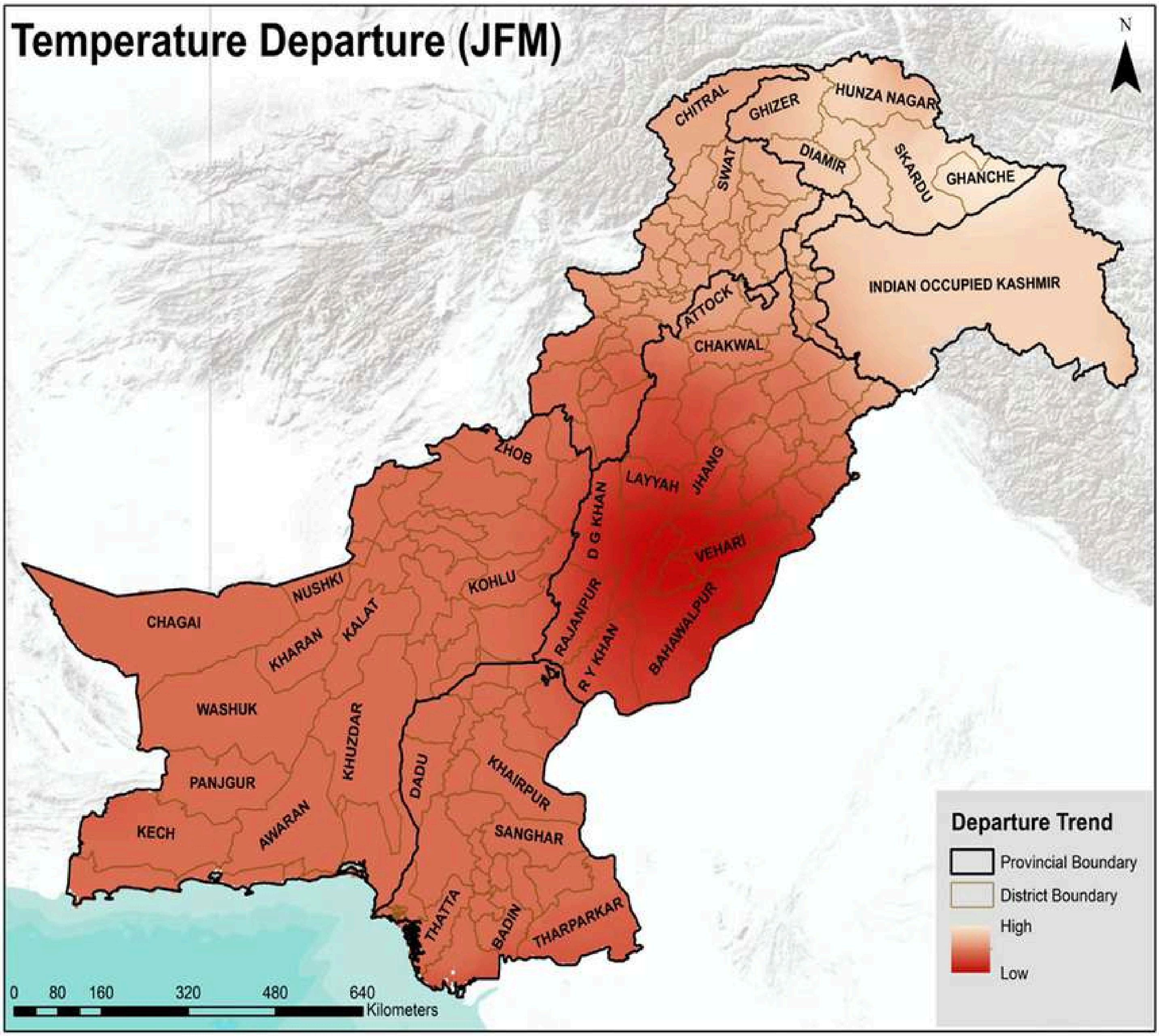


Rainfall Departure

The analysis of historical and projected rainfall patterns shows that certain regions have experienced prominent anomalies:

- Slightly above normal rainfall has been recorded in **KP, Punjab,** and **AJ&K**. These areas are receiving more rainfall compared to the historical average.
- In contrast, lower anomalies, indicating near-normal rainfall, have been observed in **GB, Upper KP, Sindh,** and **Balochistan**. These regions are experiencing rainfall amounts close to or slightly below the usual levels.

January to March-2025 Unfolded



Temperature Departure

Analysis of historical and projected temperature patterns reveals that prominent temperature anomalies:

- Above-normal temperatures, have been recorded in **Sindh, Balochistan**, and Southern Punjab. These regions are experiencing significantly higher temperatures compared to the historical average.
- In contrast, lower anomalies, indicating only slightly above-normal temperatures, are observed in KP, GB, and AJK. These areas show relatively moderate warming compared to the more pronounced increases in other regions.




SHRINKING WINTERS

Trend of decrease Snowfall and Rainfall in the HKH region and its impact on Pakistan

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Editor: Dr. Muhammad Usman, Nasir Chughtai

National Institute of Disaster Management, NDMA

Executive Summary:

The Hindu Kush Himalaya (HKH) region is experiencing a significant decline in snowfall and shifting precipitation patterns due to climate change. This report synthesizes the latest scientific findings on the trends and impacts of low snowfall in the HKH region, with a specific focus on Pakistan. The consequences of these changes pose substantial threats to the country's water security, agriculture, and overall climate resilience.

Pakistan has witnessed a notable increase in mean and maximum temperatures between 1961 and 2025, with the HKH region warming approximately 1.5°C over the past 30 years—nearly twice the rate of other parts of the country. Precipitation patterns have become increasingly erratic, with winter precipitation declining in arid regions while monsoon rainfall has intensified in certain areas. Alarming reductions in snowfall have been observed in recent winters, with precipitation falling by 92% and 80% in December 2023 and January 2024, respectively. Additionally, snow cover persistence in the Indus River basin has declined sharply, registering 23.3% below normal levels as of April 2024, which raises concerns about diminished downstream water availability in early summer.

The cryosphere of the HKH region, encompassing snow and glaciers, is a critical water source for 240 million people within the region and 1.65 billion downstream. Snowmelt contributes approximately 23% of the total annual runoff across the 12 major river basins of the HKH. However, the combination of reduced snowfall and accelerated glacial retreat threatens the long-term sustainability of the Indus River system, which is the backbone of Pakistan's agriculture, supporting over 80% of the sector. The declining reliability of water resources has serious implications for agricultural productivity, particularly for major crops dependent on seasonal meltwater supplies.

Climate projections indicate a continued rise in global temperatures, with an 80% probability of at least one year between 2024 and 2028 exceeding 1.5°C above pre-industrial levels. Pakistan is expected to experience above-average warming, with northern regions facing temperature increases of 3°C–5°C after 2060 under a high-emissions scenario (RCP8.5). While overall precipitation trends remain uncertain, projections suggest an increase in the Upper Indus Basin (UIB) and a decline in the Lower Indus Basin (LIB), particularly during winter.

The declining snowfall and rainfall trends in the HKH region present a critical challenge to Pakistan's water resources, food security, and socio-economic stability. Addressing the challenges requires an urgent, multi-sectoral action, including Integrative climate policies that prioritize both mitigation and adaptation strategies. Proactive and coordinated efforts are essential to reduce the adverse impacts and strengthen long-term climate resilience in the region.

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Introduction:

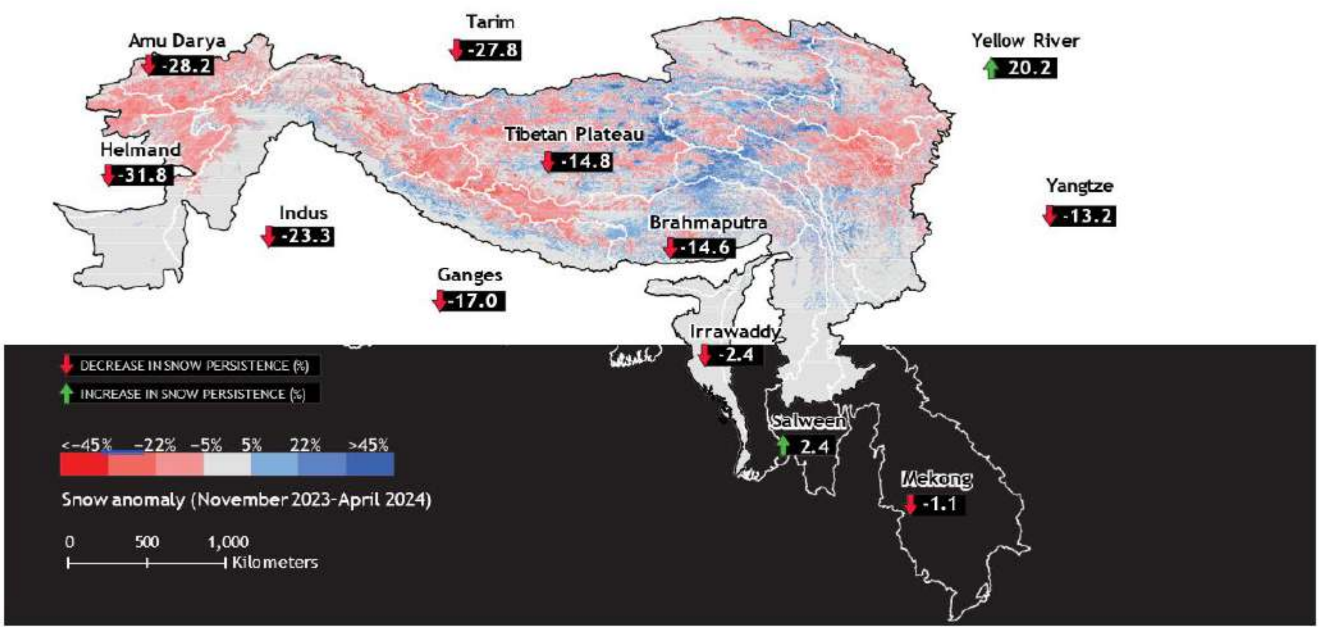
Pakistan is one of the most vulnerable countries to climate change. The country is experiencing a rise in temperature, and precipitation patterns are changing. During 1961–2021 in Pakistan, 0.5 ◦C and 0.8 ◦C increase on average in mean and maximum temperature, have been observed (Ali et al., 2019a; Khan et al., 2022). The Hindu Kush Himalaya (HKH) region is highly dependent on its frozen water resources, known as the cryosphere, which includes snow, permafrost, and ice from glaciers, lakes, and rivers. This frozen water is an essential source of freshwater for about 240 million people living in the region and supports nearly 1.65 billion people further downstream.

Snowfall

Scientific observations and projections indicate that the timing and volume of streamflows in the region are undergoing significant changes. Among these cryospheric components, snow plays a particularly important role in maintaining seasonal water availability, especially at the start of the melt season. Snowmelt is a major contributor to river flows (ICIMOD, 2023). On average, snowmelt provides around 23% of the total annual runoff across the 12 major river basins of the HKH. Notably, its contribution to runoff increases from the eastern to the western parts of the region (ICIMOD, 2023).

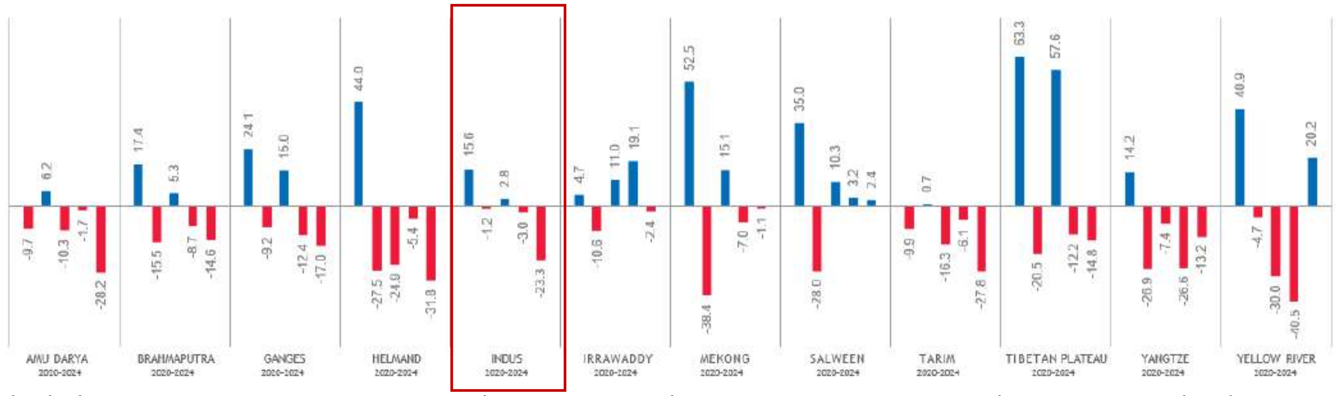
The future's projected increase in temperature is higher than the global on average, particularly, the northern parts located at higher elevations are more probably to experience preeminent surface air temperature (Ali et al., 2015, Khan et al., 2015, Kiani et al., 2021). Precipitation has also become unreliable and unpredictable (IPCC, 2023; Syed et al., 2014). An increase in precipitation during the monsoon season, particularly in some monsoon-dominated regions, and a decrease in winter precipitation in arid regions have been observed (Ahmed et al., 2017b; GOP, 2013).

FIGURE 1: SNOW COVER PERSISTENCE ANOMALY DURING NOV 2003-APRIL 2024 (ICIMOD)



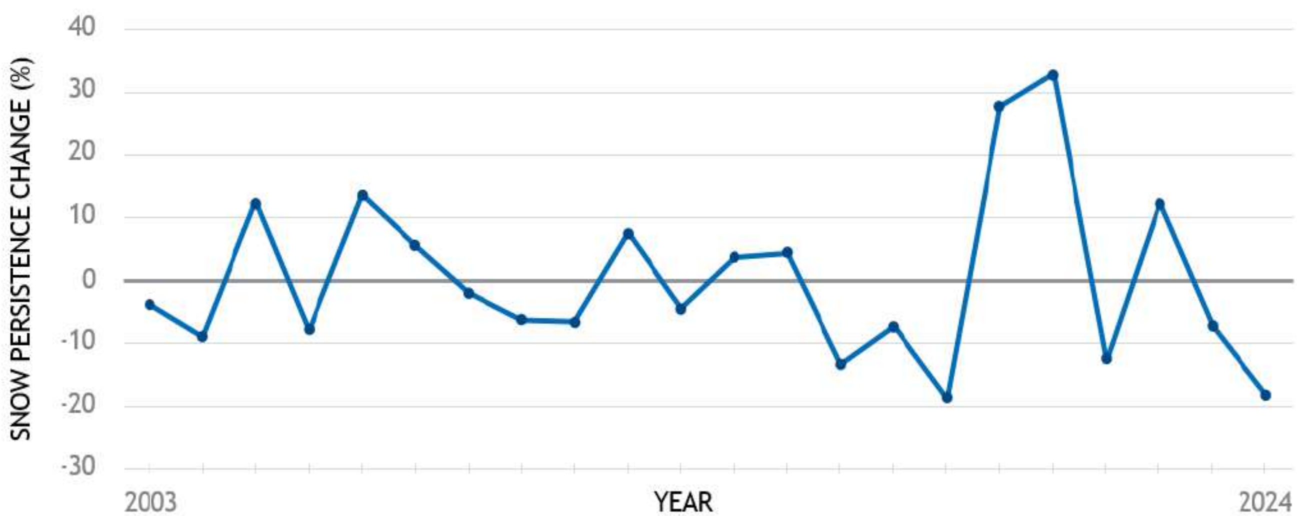
In the Indus River basin, there was a notable decrease in seasonal snow persistence in 2018, with a deviation of 9.4% from the average. In contrast, the highest snow persistence above normal was recorded in 2020 with a value of 15.5%. However, this year, there has been a remarkable decrease in snow persistence, falling 23.3% below normal levels with some positive patterns on the southern sides mostly in the lower altitudes. (ICIMOD)

FIGURE 2: SNOW PERSISTENCE (%) CHANGES BETWEEN 2020 AND 2024 IN MAJOR RIVER BASINS OF THE HKH (COMPARED WITH 2003-2023). THE YEARS ARE FROM LEFT TO RIGHT FOR EACH SUB-BASIN. THE VALUES ON THE BAR ARE THE % CHANGES IN THE YEAR



The below-average snow persistence in the HKH region this winter raises concerns about a potential reduction in downstream water availability during early summer, as shown in figure 3.

FIGURE 3: SEASONAL SNOW COVER PERSISTENCE ANOMALY FOR EACH YEAR BETWEEN 2003 AND 2024 (ICIMOD)

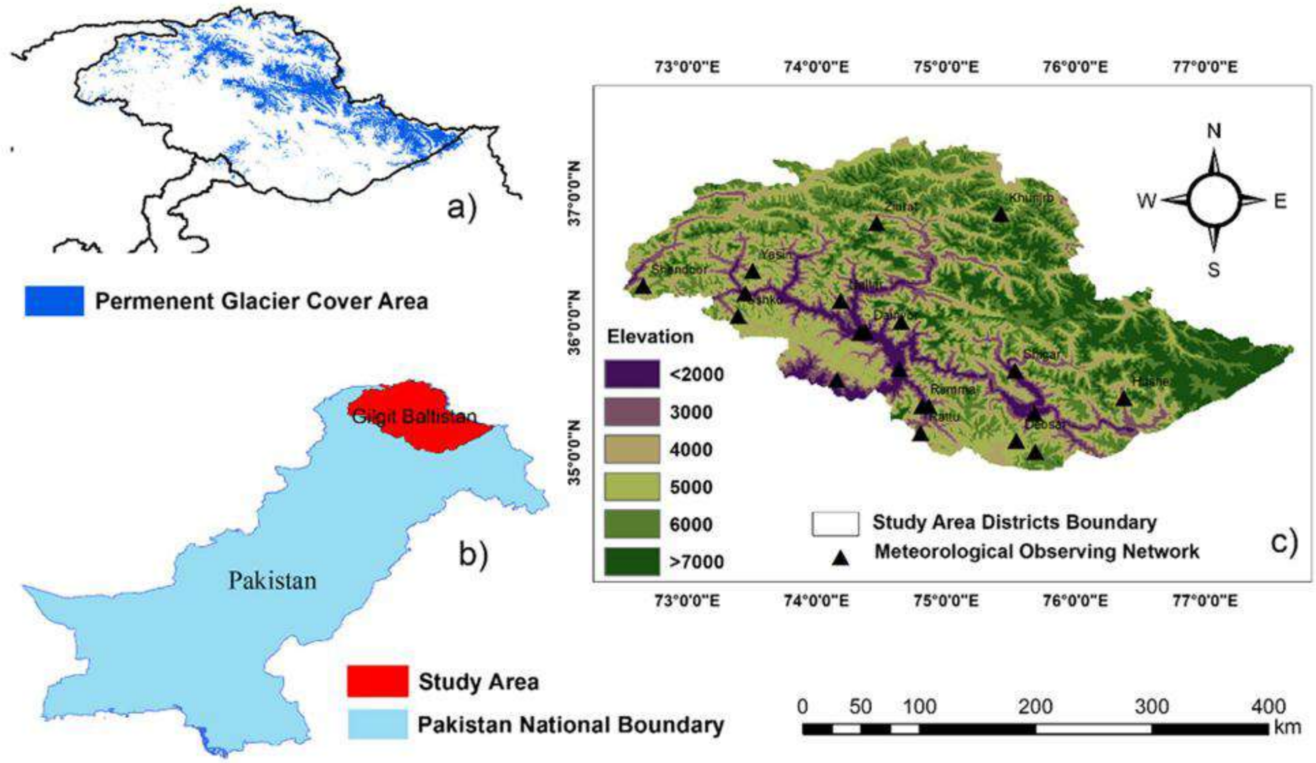


Snowfall trend, LST and Vegetation analysis in Gilgit Baltistan

One of the most active natural elements on the Earth's surface is snow cover, a vital land cover component. Increasing global temperature impacts natural systems such as the atmosphere and oceans have warmed, the amount of snow and ice has decreased, and the sea level has risen (Rosenzweig et al. 2008; Zhang 2021; Robinson et al. 1993; Nicholls and Cazenave 2010). Mountainous basins such as the Upper Indus Basin (UIB) of Gilgit Baltistan (GB) are reliant on seasonal snowmelt and glacier melt (Shafeeque and Luo 2021). The Himalayas are particu larly vulnerable to global warming because they are covered in snow and glaciers (Rees and Collins 2006).

Climate change is a key concern in Hindukush-Karako ram-Himalaya (HKH), and the climate change impacts are most directly or indirectly felt in these mountain ranges; as a result, the behavior of snow cover area (SCA) and glaciers varies throughout time. It has been observed that as temperatures increase, the glaciers in the Himalayas region shrink (Azfar Hussain et al. 2019; Gioli et al. 2014; Khan et al. 2020a, b; Scherler et al. 2011).Monitoring snow cover area is critical for the general hydrology of the Indus Basin and long-term agriculture and hydropower operations. Due to the complicated mountainous terrain, manual snow mapping is potentially dangerous and expensive (Bibi et al. 2019).

FIGURE 4: MAP OF GILGIT BALTISTAN (Satti et al.,2022)



To observe the spatiotemporal distribution of vegetation, snow cover, and LST in the GB, the average value of LST and the Snow Cover Area (SCA) on the elevation bases was analyzed. The average LST variation between (− 23 and 32 ◦C) above 5000 masl, maintains the freezing point for the whole year (Fig. 4a). At mid-range elevation 3000–5000 masl, most of the GB was covered with snow, and high variation was observed in the snow cover area at this range. Above 5000 masl, the total snow-covered area varies in size from 4715 km2 in August to 9745 km2 in March, demonstrating the presence of a permanent glacier in the area. Annual fluctuations in the distribution of land surface vegetation, tempera ture, and snow cover across the study period (2001–2020) were examined as per the seasons in GB such as autumn (September–November) and summer (June–August), spring (March–May), and winter (December–February) (Fig 5).

FIGURE 4: BOX PLOTS REPRESENTING THE DISTRIBUTION OF A LST (ºC). VALUES AT VARIOUS ELEVATIONS OF SNOW COVER AREA (KM2) AND C VEGETATION COVER AREA (KM2) WITHIN GILGIT BALTISTAN. THE HORIZONTAL LINES INSIDE THE BOX REFLECT THE MEAN, WHILE THE RED LINES SHOW THE MEDIAN POINT (SATTI ET AL.,2022)

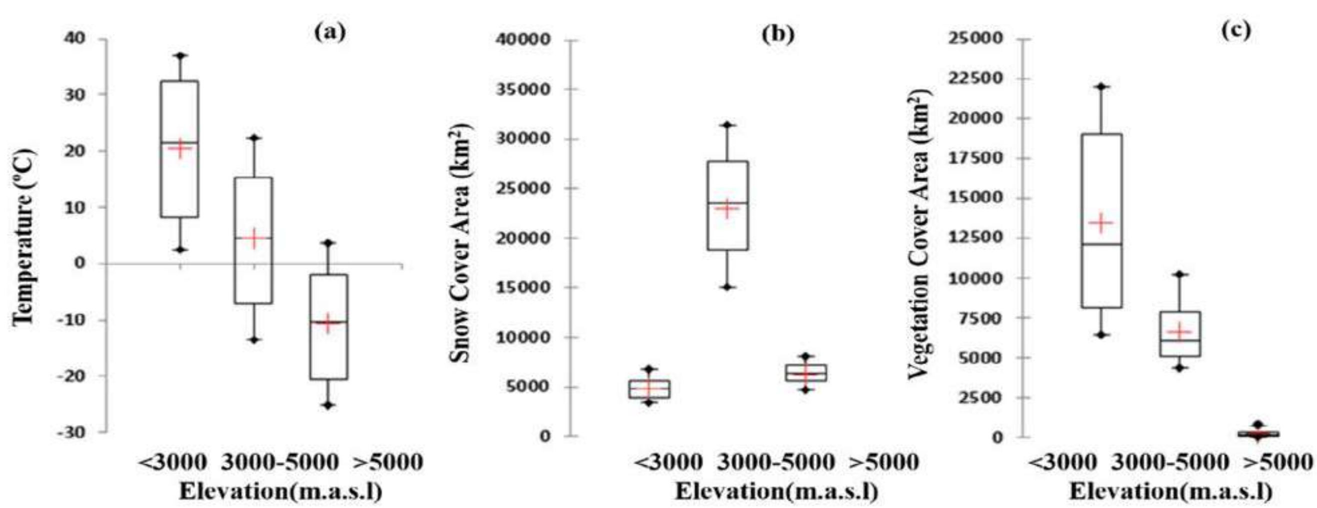
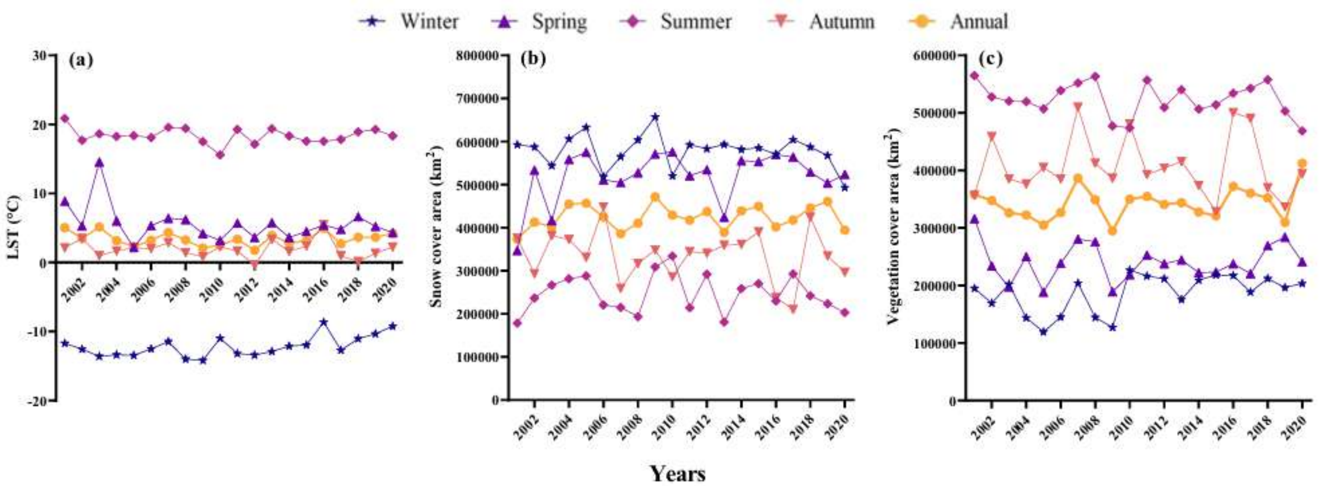


FIGURE 5: LINE CURVES DEPICTING SEASONAL TEMPORAL VARIATIONS IN WINTER, SPRING, SUMMER, AUTUMN, AND ANNUALLY FOR THE RESEARCH PERIOD (2001–2020) INSIDE GB A) AVERAGE LST (ºC), B) SNOW COVER AREA (KM2), AND C) VEGETATION COVER AREA (KM.2) (Satti et al.,2022)

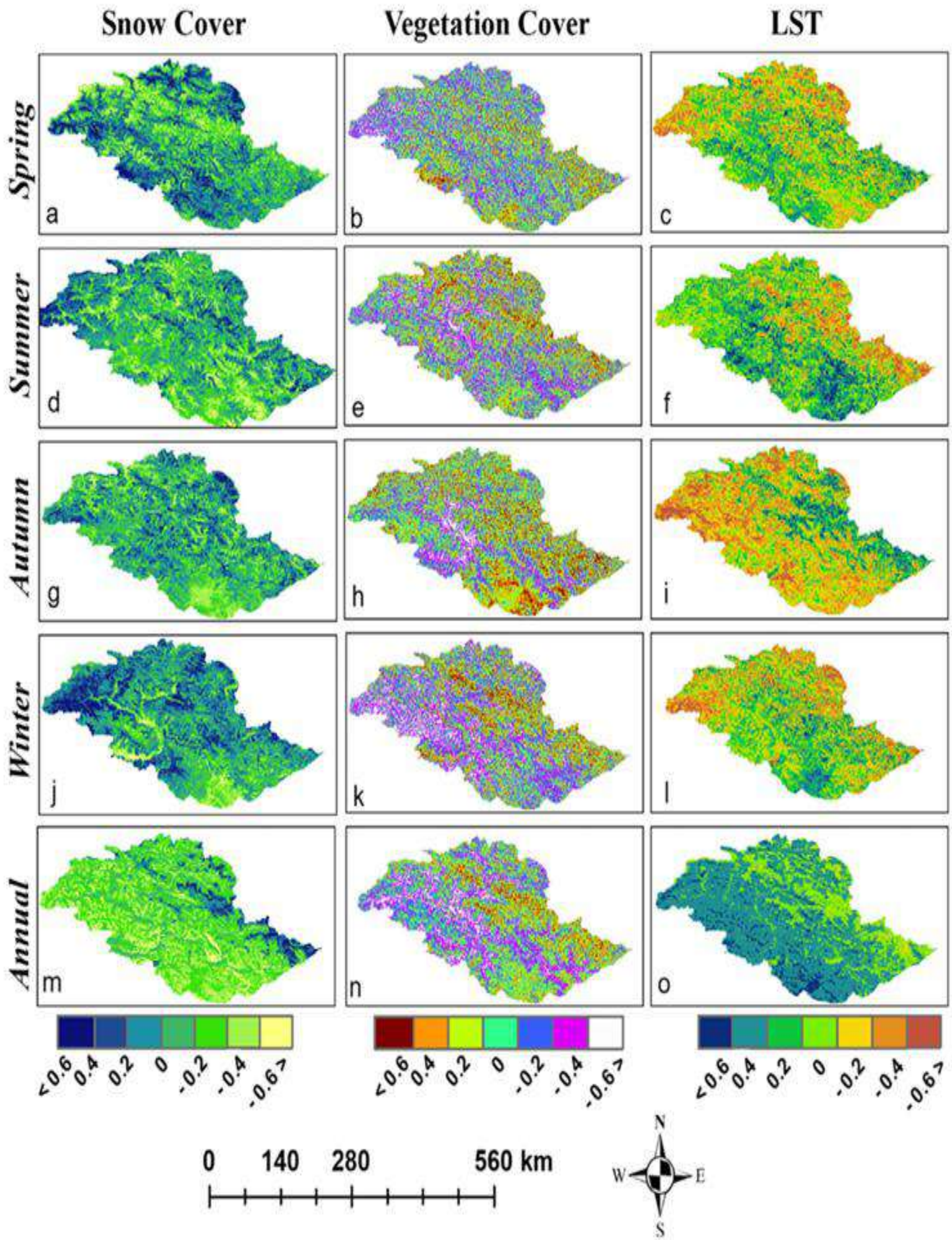


Overall, LST has been increasing annually (Fig. 6o) in GB but increased significantly in June, August, and September throughout the previous two decades. The snow cover area, LST, and vegetation cover area in the study area exhibited strong spatial differentiation on a seasonal and annual basis. Figure 6 shows the seasonal vari ations in all three variables in the GB from 2001 to 2020. Vegetation conditions increased significantly throughout the summer (Fig. 6d) and in February and December (Table 1). According to Fig. 6a and d, SCA decreases significantly in the spring and summer seasons, especially in July and August, and has an increasing trend in January, October, and November (Table 1). During spatial trend analysis, it is observed that the SCA has a decreasing trend at lower eleva tions, specifically 1000–3000 masl, and an increasing trend during the winter season (Fig. 6j) at high elevations 5000 masl. The vegetation cover has a decreasing trend annually, which is sharp in the lower elevation 2000–3000 masl and mid-range 3000–4000 masl elevation zones.

Continuous increases in annual LST trends in the GB, particularly at elevations above 3000 masl, would accelerate the retreat of glaciers at lower elevations. These results indicate the climate change impacts in these elevation ranges, and these opposite trends in precipitation in different seasons at the same elevation could cause extreme disasters like floods and land sliding at lower elevations. This infers that since 2001, snow cover has increased (Fig. 6) at high elevations of the eastern GB and decrease at low elavations. In recent decades, anthropogenic influences have progressively threatened the irreplaceable biodiversity of the HKH region's landscapes. The impact of globalization and climate change on the stability of fragile mountain ecosystems and the way of life of mountain people is grow ing. Protecting high-altitude ecosystems and their interfaces can play an important role in preserving essential services, including water, biodiversity, and carbon sequestration (Satti et al.,2022).

In a nutshell, during midcentury (2021–2060), the precipitation will increase by 1.9% and 11.8% under RCP 4.5 and RCP 8.5, respectively in Gilgit Baltisatn . However, in the latter half of the century (2061–2100) the climatic models showed a decreasing trend of precipitation with 7.2% and 2.39% under RCP 4.5 and RCP 8.5 respectively. To study the climatic variability, it is necessary to use a longer period of data; however, lack of long-period data and adequately spatially distributed meteorological station data is a big hindrance in the mountainous region.

FIGURE 6: MANN-KENDAL TREND DISTRIBUTIONS OF SNOW COVER, VEGETATION COVER, AND LST IN GILGIT BALTISTAN, WAS OBSERVED OVER THE STUDY YEARS (2001-2022) (SATTI ET AL.,2022)



N = 20 Start year = 2001	Land surface temperature			Normalized difference vegetation index			Snow cover		
End year = 2020	Test S	Test Z	Trend	Test S	Test Z	Trend	Test S	Test Z	Trend
January	6	0.11	IS	36	0.24	IS	9	0.13	S
February	8	0.05	IS	40	0.26	S	4	−0.07	IS
March	4	0.7	IS	17	0.11	IS	−9	−0.06	IS
April	7	0.5	IS	30	0.20	IS	−11	−0.12	IS
May	18	0.12	IS	23	0.15	IS	−17	−0.14	IS
June	32	0.21	S	45	0.29	S	−43	−0.35	S
July	21	0.14	IS	51	0.33	S	−31	−0.20	S
August	26	0.47	S	47	0.31	S	−15	−0.11	IS
September	51	0.34	S	67	0.44	S	−7	−0.07	IS
October	15	0.14	IS	−11	−0.07	IS	29	0.32	S
November	21	0.14	IS	6	−0.04	IS	63	0.62	S
December	−6	0.11	IS	51	0.33	S	25	0.16	IS
Annual	23	0.11	IS	59	0.39	S	−7	−0.04	IS
Winter	−4	0.42	IS	47	−0.31	S	43	0.42	S
Spring	15	0.10	IS	31	−0.20	IS	−7	−0.05	IS
Summer	33	0.22	S	65	0.42	S	−35	−0.23	S
Autumn	23	0.15	IS	25	0.16	IS	−29	−0.19	IS

S significant trend, *IS* insignificant trend

TABLE 1: MANN–KENDALL'S TEST RESULTS ESTIMATIONS FOR SNOW COVER, LST, AND NDVI FOR THE ENTIRE GILGIT Baltistan (SATTI ET AL.,2022)

It has been observed that the SCA and the glaciers in the Himalayas are very sensitive to climate change. However, the UIB experienced distinct signatures of climate variability under conditions that contain very low temperatures and stable glaciers. The findings show an increasing trend in snow cover above 5000 masl in winter and spring but a decreasing trend at the same elevation zone in summer.

To address this emerging challenge, it is essential for relevant agencies to take proactive steps. Effective communication is crucial to inform communities about potential droughts and water shortages, while updating water management plans to mitigate water stress. Strengthening collaboration among responsible national agencies will enhance coordinated responses.

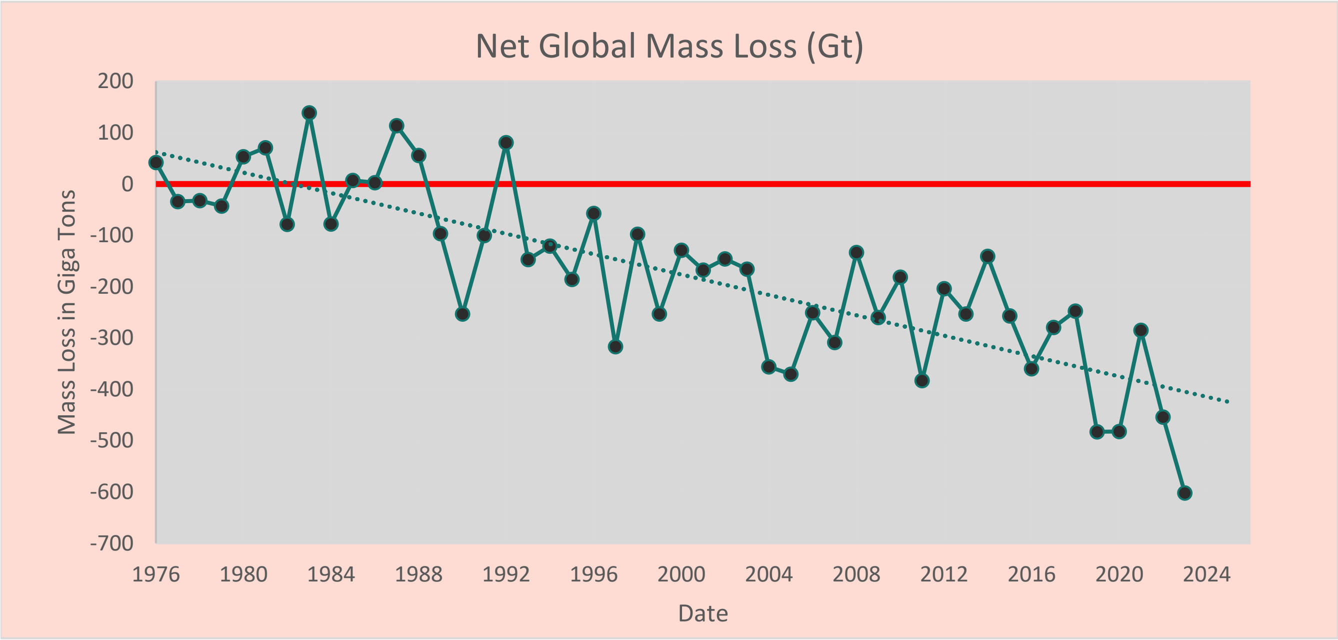
Additionally, implementing drought response strategies is vital for organizing emergency relief efforts and ensuring access to clean water. Encouraging rainwater harvesting from upcoming precipitation can support irrigation and other essential uses. Establishing local water committees can further aid in resource allocation and streamline coordination efforts.While these measures may help alleviate the immediate impacts of below-normal snowfall on water supply in the HKH region, long-term resilience to climate change requires enhanced cooperation among countries that share transboundary rivers. Updating water management policies through regional collaboration will be essential to addressing water shortages in South Asia, where many sectors rely heavily on snowmelt.

In a nutshell, During the winter, snow cover increases, although it declines dramatically between June and July, whereas Gilgit Baltistan has an overall increasing annual LST. This short analysis confirms that snow cover influences vegetation and differs with periods. The way forward for this analysis is necessary to study glaciers in each elevation zone and their impact on different species of vegetation cover, taking into account temperature, precipitation, soil moisture, evapotranspiration, carbon, and anthropogenic activities, also consider other available data of variables affecting vegetation and snow cover. The changes in snow cover area, availability, and changes in water cycling were especially noticeable in low-elevation regions from 2000 to 3000 masl, which were the first to be affected by the impacts of increasing temperatures on vegetation (Satti et al.,2022)

Glacier melting

On a Global scale, according to WGMS (2023) the annual glacier mass is continuously decreasing from 1994-2023. Glaciers, excluding the Greenland and Antarctic Ice Sheets, have contributed approximately 1 mm per year to the global mean sea level rise over the past decade (2014–2023). Preliminary analyses, integrating observational and remote sensing data from 96% of the world's glaciers, reveal that 2023 experienced the largest global glacier ice loss since records began in 1976, contributing an estimated 1.7 mm to the global mean sea level rise. Throughout 2023, glaciers across all regions continued to exhibit accelerated melting, with regional ice thickness losses ranging from 0.5 to 3.0 meters. Western North America experienced the most severe annual mass balance deficits, followed by the European Alps, which suffered a second consecutive year of extreme ice loss, resulting in a cumulative reduction of approximately 10% of their glacier volume. Notably, 2023 marked the second consecutive year in which all glacier regions reported net ice losses (Fig.1)

FIGURE 4: GLOBAL LAND TEMPERATURE. 2023 **(CREDIT: C3S/ECMWF)**

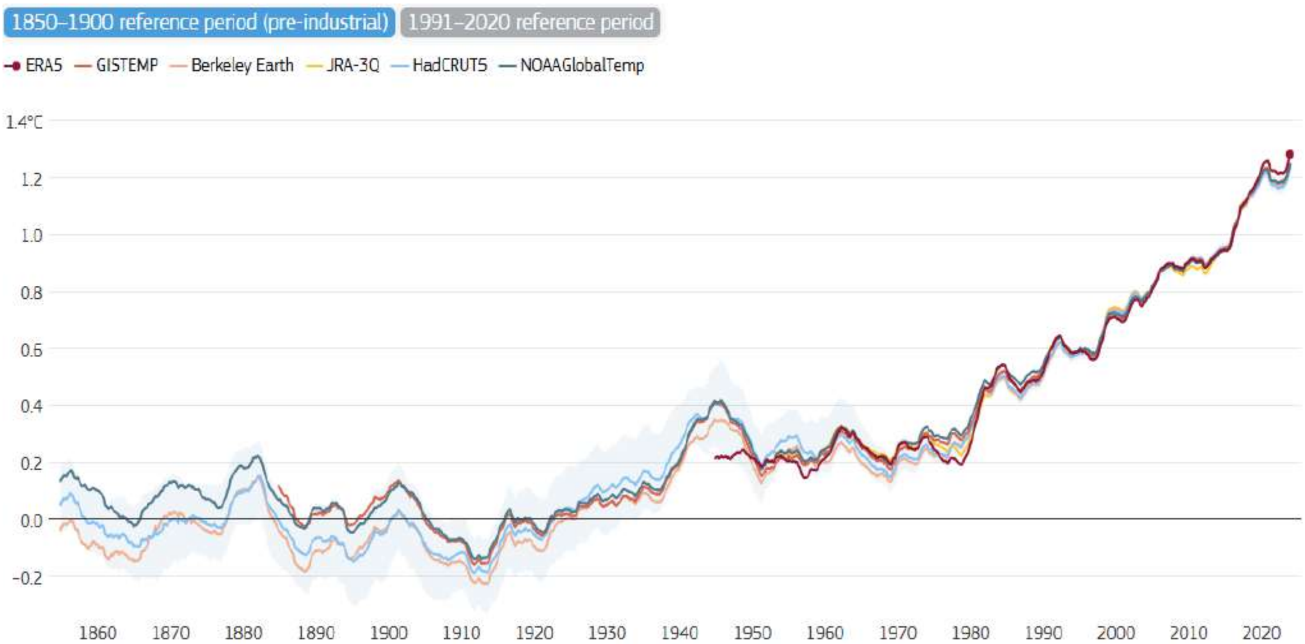


Six widely-used datasets show the latest five-year-average global temperature (2019–2023) to be the highest on record and 2023 to be the warmest year on record. The next warmest years are 2016 and 2020. The lower temperatures in 2021 and 2022 coincided with a prolonged La Niña event. All datasets show that the nine years from 2015 to 2023 are the warmest nine years on record, even if the ranking of some of the individual years differs.

The increase in five-year-average temperatures since the second half of the 19th century is estimated to be 1.2–1.3°C. There has been an average increase of 0.1°C approximately every five years since the mid-1970s, but this rate of warming has not been steady. For example, the five-year averages centered on the years from 2003 to 2012 show hardly any change, then rise sharply due to the record warmth of the years from 2015 onwards. The average rate of temperature increase, according to ERA5, is 0.20°C per decade from 1979 to 2023, with a 95% confidence interval of ±0.03°C.

The average increase in temperature since the 1970s has been around 1.4–1.5°C over all land, compared with around 1.0°C for the global average. According to ERA5, the average rate of increase over land is 0.32 ± 0.03°C per decade from 1979 to 2023. The temperature rise over ice-free seas is about half that over land but nevertheless accounts for about half of the rise in global average temperature, as the area of Earth's surface covered by sea is much larger than the area covered by land. (Fig.5).

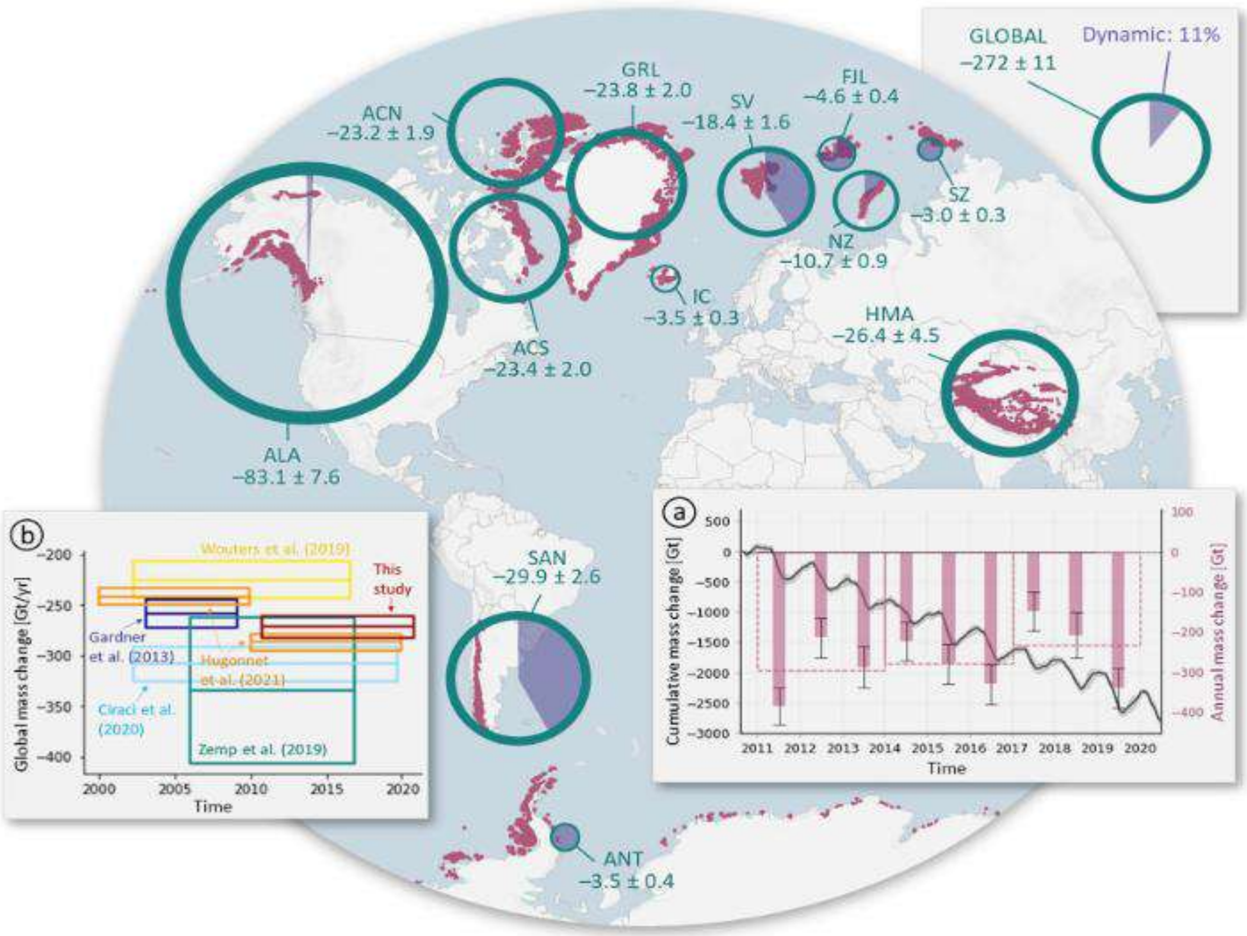
FIGURE 5: GLOBAL LAND TEMPERATURE. 2023 **(CREDIT: C3S/ECMWF)**



Global Facts and Future Projections

- *Global surface air temperature has increased by close to 1.3°C since the pre-industrial era.*
- *The latest five-year averages are the highest, or close to the highest, on record.*
- *The temperature increase has been higher over land than over sea.*
- *80% likelihood of at least one year temporarily exceeding 1.5°C between 2024-2028*
- *Short-term (annual) warming does not equate to a permanent breach of the lower 1.5°C Paris Agreement goal*
- *Pakistan's projected temperature increase is expected to be higher than the global average.*
- *Projected temperature increase in northern parts is expected to be higher than the southern parts of the country.*
- *The frequency of hot days and hot nights is expected to increase significantly.*
- *Pakistan's rainfall projections do not indicate any systematic changing trends.*
- *Major crop yields such as of wheat and rice are expected to decrease significantly.*
- *Water availability per capita is projected to decrease to an alarming level.*
- *An increasing trend in the rainfall over the Upper Indus Basin and decreasing trend in the Lower Indus Basin.*

FIGURE 6: GLACIER MASS LOSS BETWEEN 2010 AND 2020 DOMINATED BY ATMOSPHERIC FORCING



Land-terminating glaciers account for 56% of glacier area and for 65% of the global glaciers mass loss, while marine terminating glaciers account for 35% of global glacier mass loss with contribution from both, enhanced ice discharged and decreasing SMB.

"Key Points:"

- *Glaciers around the globe saw a new record annual mass loss of 1.1 m ice thickness during 2023, with regional ice thickness losses of 0.5–3.0 m.*
- *In 2023, glaciers lost 600 Gt of water. This is the largest annual mass loss in a record going back to 1976, and about 100 Gt larger than any other year on record. It is equivalent to almost five times the amount of ice contained in all the glaciers in central Europe.*
- *Estimates indicate this mass loss contributed 1.7 mm to global mean sea level rise since 1976.*
- *The four years with the largest global glacier mass loss on record have all occurred since 2019.*
- *2022 and 2023 were the first years on record during which all glacier regions reported ice loss.*
- *Glaciers in western North America saw record ice thickness loss of around 3 m. Much-higher-than-average ice loss was also reported in Alaska, central Europe, the Southern Andes, High-Mountain Asia and New Zealand.*

Impacts of Climate Crisis in Pakistan

Due to climate change, the world average surface temperature has increased 0.3-0.6ºC over the past 100 years. The northern belt of Pakistan holds the largest storage of freshwater (ice and snow) after the polar region, and provides water to the downstream population for agriculture plus domestic and hydropower resources. The impacts of climate change on agriculture are shaped by a combination of factors, including extreme weather events and natural disasters linked to fluctuations in global temperature and precipitation patterns. Rising temperatures, heatwaves, snowmelt, flooding, droughts, and sea-level rise have disrupted agricultural systems worldwide. The high mountains of South Asia, encompassing the HKH belt, are often referred to as the "Water Tower of Asia" due to their crucial role in sustaining the major rivers of southern Asia. While most glaciers in the HKH region have been retreating and losing mass since the 1950s, these changes exhibit significant regional variability. According to Rasul and Chaudhry, on the whole, HKH mountain terrain ice and snow coverage is now declining must faster than ever. In the mountain areas global warming effect on the cryosphere is clear in a reduced snow cover period and declines or contracts mountain glaciers. The temperature of the HKH region has warmed by approximately 1.5ºC, which is almost twice the amount in other parts of Pakistan (0.76ºC) in the last 30 years. A significant increase in the temperature of the HKH region is expected to impact snow cover dynamics, which in turn will affect seasonal flow variations. The Hindukush-Karakorum-Himalaya (HKH) is an ensemble of mountain ranges stretching east to west over 2,000 km, containing around 60,000 km2 of glaciers and perennial surface ice in varying climatic regimes. Similarly, unpredictable rainfall and the expansion of diseases and pests toward the poles due to a warming atmosphere have posed substantial challenges to food production. In addition, climate change has led to water scarcity, soil degradation, increased pest infestations, disease outbreaks, and declining crop yields. These adverse effects have significantly undermined rural livelihoods and posed a serious threat to global food security.

It is anticipated that changes in climate have altered the characteristics of droughts in Pakistan. However, due to the high diversity of climates and varying patterns of climate changes across regions and seasons, the impact of climate change on droughts differs across different parts of the country. Furthermore, the influence of climate on droughts can vary over time. Assessing the impact of climate change on droughts during the cropping season is particularly important, as droughts during this time are found to be more destructive. Climate changes across temporal and spatial scales, and the physical mechanisms responsible for these changes, have been a prominent topic among climate scientists, environmentalists, meteorologists, and ecologists for the last three decades of the previous century. (Ahmed et al., 2018).

The agriculture sector of Pakistan, due to its significant dependence on climate patterns and water availability, is highly vulnerable to changing climate patterns. Pakistan has a diversified economic base with the agriculture sector, contributing 24 percent in GDP and 37.4 percent in employment. Therefore, the changing climate patterns may adversely affect the agriculture and livelihood of the country.



Future Projections:

There is an 80 percent likelihood that the annual average global temperature will temporarily exceed 1.5°C above pre-industrial levels for at least one of the next five years, according to a new report from the World Meteorological Organization (WMO). This is a stark warning that we are getting ever closer to the goals set in the Paris Agreement on climate change, which refers to long-term temperature increases over decades, not over one to five years. The global near-surface temperature for each year between 2024 and 2028 is predicted to be between 1.1°C and 1.9°C higher than the 1850-1900 baseline. (WMO, 2023).

The Global Change Impact Study Centre (2007) utilized a General Circulation Model (GCM) to project future climate change, focusing on annual temperature and precipitation changes for the years 2020, 2050, and 2080 under two emissions scenarios: A2 and A1B. According to the model, by 2080, the temperature in Pakistan is projected to increase by as much as 4.38°C. The study further identified regional variations in annual temperature changes, noting that (i) the temperature increases in both summer and winter is more pronounced in northern Pakistan compared to southern Pakistan, and (ii) the temperature increases are greater in winter than in summer for both regions. In terms of precipitation, no significant overall change is projected. However, the model indicates a slight increase in summer precipitation and a decrease in winter precipitation in southern Pakistan (Chaudry et al., 2015). The PMD conducted another significant study that computed temperature and precipitation change for different regions of Pakistan from 2011 to 2050. The climate models show a maximum rise in the northern areas of Pakistan, central and south Punjab, and lower parts of Khyber Pakhtunkhwa Province. However, mixed trends are projected for precipitation over different regions of Pakistan. (Table 2)

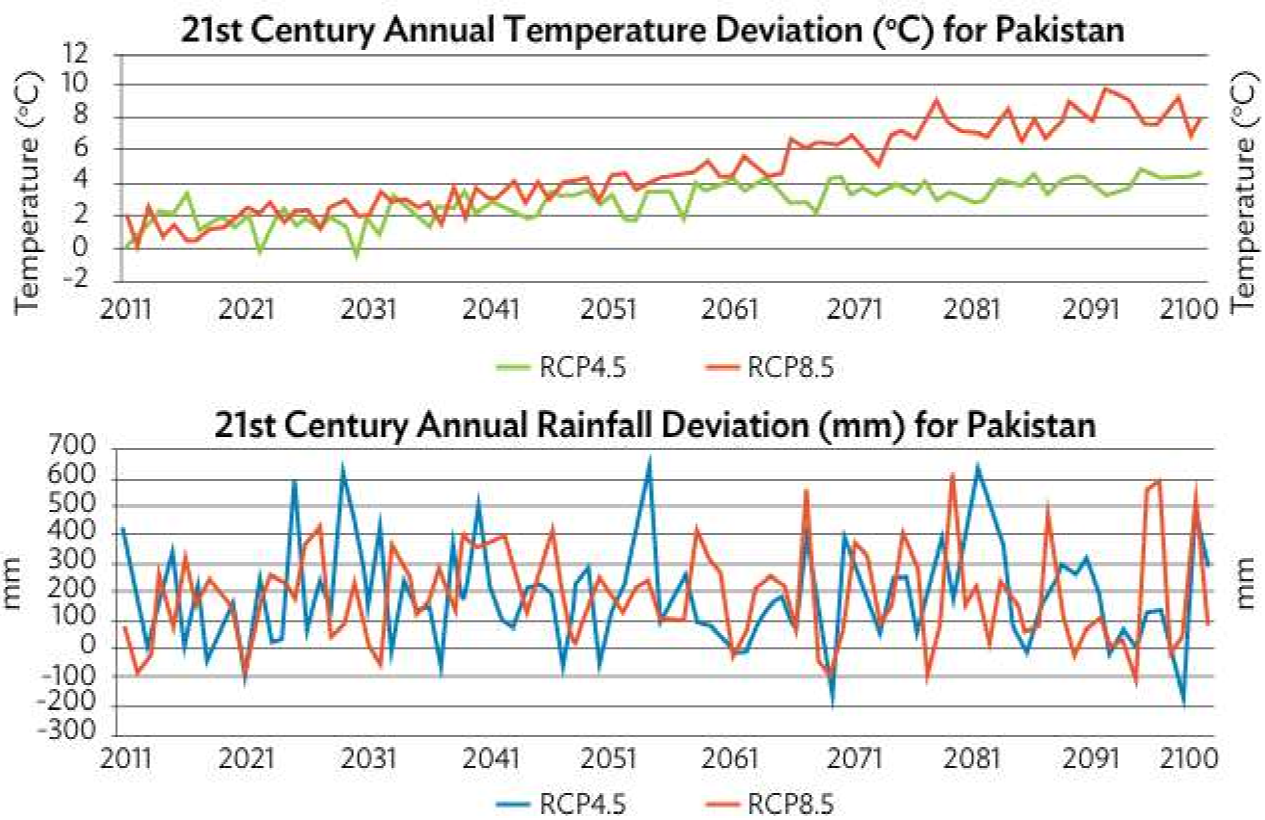
The Indus Basin is a critical hydrological region that is highly sensitive to climate change. This study evaluates projected variations in temperature and precipitation within the basin, focusing on the Upper Indus Basin (UIB) and Lower Indus Basin (LIB). Model simulations indicate a differential response in precipitation patterns and temperature trends across the region. The findings highlight significant increases in temperature, with spatially and temporally variable precipitation patterns, emphasizing potential implications for hydrological resources and water availability in the basin.

Model projections suggest a near-uniform distribution of rainfall over the entire Indus Basin. However, distinct variations emerge at subregional levels. The UIB is expected to experience an increasing trend in precipitation, whereas the LIB will likely see a decline, with minimal changes in the border zone between these subregions. Notably, winter precipitation is projected to decrease, particularly in the southern part of the basin, due to pronounced winter warming.

Furthermore, while the total number of rainy days over the basin is projected to rise, a contrasting trend emerges in the transition zone between the UIB and LIB. Here, models indicate a decrease in rainy days but an increase in rainfall intensity, suggesting heightened risks of extreme precipitation events. These projections highlight the potential for intensified hydrological extremes, including both floods and droughts, with implications for water resource management.

The downscaled projections indicate significant warming across the Indus Basin. Under the RCP4.5 scenario, mean temperature is expected to rise by 3°C–5°C, whereas RCP8.5 projects a more pronounced increase of 4°C–6°C by the end of the century, with an accelerated warming trend post-2050.

FIGURE 7: Pakistan's Mean Annual Temperature and Precipitation Deviation Projections During 21st Century (PMD)



Spatially, temperature increases exhibit notable heterogeneity. Northern, snow-covered regions of Pakistan, particularly in the UIB, are projected to experience a greater temperature rise compared to central and southern regions. Under RCP8.5, temperature increases of 10°C–12°C are anticipated in northern Pakistan after 2060, while RCP4.5 suggests a less intense warming of 5°C–6°C. These findings indicate a substantial risk of glacial retreat and changes in snowmelt patterns, directly affecting river flow and downstream water availability.

	Precipitation (mm/decade)			Temperature (°C/decade)		
Region	A2	A1B	B1	A2	A1B	B1
Pakistan	+1.73	+1.26	-0.89	+0.51	+0.41	+0.24
Northern areas	+4.6	+2.9	-1.3	0.76	0.63	0.39
Potohar and upper NWFP	+6.1	+3.8	-0.5	0.01	-0.34	-0.01
Central/southern Punjab and lower NWFP	-2.98	-1.78	-3.5	+0.63	+0.71	+0.05
High Balochistan	+1.48	+0.92	-0.57	+0.15	+0.26	+0.03
Southeastern Sindh	+5.1	+3.0	-0.1	0.00	-0.1	+0.01
Sindh and lower Balochistan	-1.8	-0.98	-0.05	+0.5	+0.27	+0.01

mm = millimeter, NWFP = Northwest Frontier Province and current Khyber Pakhtunkhwa.

Notes: A2 shows business as usual, A1B shows balanced scenarios, and B1 shows Ideal World (SRES Report IPCC 2001) based on greenhouse gas emissions likely in the 21st century.

TABLE 2: MAN REGION-WISE CLIMATE PROJECTION OF PAKISTAN 2011-2025

Conclusion:

Pakistan has experienced an unprecedented decline in winter snowfall, significantly impacting its hydrology, agriculture, and tourism. In December 2023 and January 2024, Pakistan recorded a 92% and 80% reduction in precipitation, respectively, compared to previous years (IIPS, 2024). This decline is attributed to shifting weather patterns influenced by climate change and variations in westerly disturbances. The reduced snowpack in the northern high-altitude regions, particularly in the Hindu Kush, Karakoram, and Himalayas, poses a severe threat to the country's water availability, as snowmelt contributes significantly to the Indus River system, which supports over 80% of Pakistan's agriculture (WAPDA, 2023). Furthermore, experts warn that prolonged reductions in snowfall may exacerbate glacial retreat, increasing the risk of water shortages, desertification, and extreme climate events such as heatwaves and droughts (APP, 2024). Urgent climate adaptation measures, including afforestation, sustainable water management, and improved climate monitoring, are necessary to mitigate the long-term consequences of reduced snowfall in Pakistan.

Way Forward

Considering the challenges posed by climate change, a set of targeted recommendations is essential for effective mitigation and adaptation.

- Governments must prioritize the development of comprehensive climate policies that are integrative, inclusive, and forward-looking. These policies should encompass both mitigation strategies, like transitioning to renewable energy, and adaptation measures, such as infrastructure resilience and sustainable agricultural practices.
- Effective climate action requires collaboration across various sectors. This includes partnerships between government agencies, private sectors, non-governmental organizations, and local communities. Collaborative efforts should aim to share knowledge, pool resources, and align strategies for a unified approach to climate change.
- Increased investment in climate science, innovative technologies, and best practices is essential to understand and combat climate change effectively. This includes research in renewable energy, climate-resilient crops, and advanced forecasting technologies.
- Infrastructure development should incorporate climate resilience as a core principle. This involves designing and constructing buildings, roads, and other infrastructure elements that can withstand extreme weather conditions and climatic shifts.
- Climate change is a global challenge that requires international collaboration. Sharing knowledge, experiences, and resources at the international level can facilitate the implementation of effective climate solutions and foster global solidarity in climate action.
- Supporting sustainable agricultural practices that are resilient to climate change is essential for food security. This includes promoting water-efficient irrigation, organic farming, and the use of climate-resilient crop varieties.
- Economic development strategies should align with environmental sustainability. This involves promoting green industries, sustainable tourism, and eco-friendly practices that contribute to economic growth while conserving the environment.
- Raising public awareness about the impacts of climate change and the importance of sustainable practices is fundamental. Educational programs and campaigns should aim to inform and engage the public, fostering a culture of environmental stewardship and collective responsibility.
- Strengthening early warning systems for better prediction and timely response to climate-related disasters is vital. Additionally, regular disaster preparedness drills and emergency response training should be conducted to ensure community readiness.

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NATIONAL DISASTER MANAGEMENT AUTHORITY

Pakistan

Global Climate Surge Report
2024-2025

CLIMATE CRISIS & PAKISTAN'S VULNERABILITY

By
NATIONAL INSTITUTE OF DISASTER MANAGEMENT (NIDM)
National Think Tank

NATIONAL DISASTER MANAGEMENT AUTHORITY

ACKNOWLEDGEMENT

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NDMA remains committed to fostering research and knowledge-sharing to strengthen Pakistan's resilience against climate-induced disasters. We hope this report serves as a valuable resource for policymakers, researchers, and practitioners in addressing climate challenges effectively.

National Disaster Management Authority (NDMA)
Government of Pakistan

Acronyms

AJ&K	Azad Jammu & Kashmir
CCA	Climate Change adaptation
DDMA	District Disaster Management Authority Disaster
DM	Disaster Management
DRM	Disaster Risk Management
FFC	Federal Flood Commission
FFD	Flood Forecasting Division
GB	Gilgit-Baltistan
GBDMA	Gilgit-Baltistan Disaster Management Authority
INGO	International Non-Governmental Organization
JCMC	Joint Crises Management Cell
KP	Khyber Pakhtunkhwa
MoCC	Ministry of Climate Change
NDMA	National Disaster Management Authority
NDCs	Nationally Determined Contributions
NEOC	National Emergency Operation Center
NASA	National Aeronautics and Space Administration
NIDM	National Institute of Disaster Management
PDMA	Provincial Disaster Management Authority
PMD	Meteorological Department
SDGs	Sustainable development Goals
UN	United Nation

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Executive Summary

The Climate SURGE 2024-2025 report provides a comprehensive analysis of the escalating global climate crisis and its far-reaching impacts, with a particular emphasis on Pakistan's increased vulnerability. The report highlights unprecedented global temperature records, rising sea levels, and a surge in extreme weather events throughout 2024, underscoring the critical need for immediate and coordinated climate action. It stresses the importance of transitioning away from fossil fuels and advocates for enhanced financial support to developing nations, along with substantial improvements in early warning systems. Pakistan ranked as the 5th most vulnerable country to climate change. This report outlines the key challenges Pakistan faces due to climate change and recommends actionable strategies for integrating Climate Change Adaptation (CCA), anticipatory actions, and Disaster Risk Reduction (DRR) across multiple sectors. By adopting global best practices, these strategies aim to effectively mitigate the impacts of climate change and build resilience in the face of growing environmental threats. The year 2024 has seen an alarming increase in climate-related disasters, emphasizing the urgency for global intervention. The Global Climate Surge 2024-25 report offers a detailed assessment of these escalating climate trends, their socio-economic ramifications, and the policy measures needed to mitigate climate risks effectively. The unexpected return of winter in March 2025, driven by a western disturbance, brought heavy rainfall and snowfall to Pakistan, significantly impacting the agricultural sector. This climatic anomaly disrupted crop cycles, delayed planting seasons, and affected the growth of seasonal crops, particularly those sensitive to temperature fluctuations. The unseasonal weather patterns further underscored the vulnerability of Pakistan's agriculture to the unpredictable shifts in climate, potentially leading to reduced yields and financial losses for farmers, while amplifying the need for adaptive strategies to mitigate such disruptions.

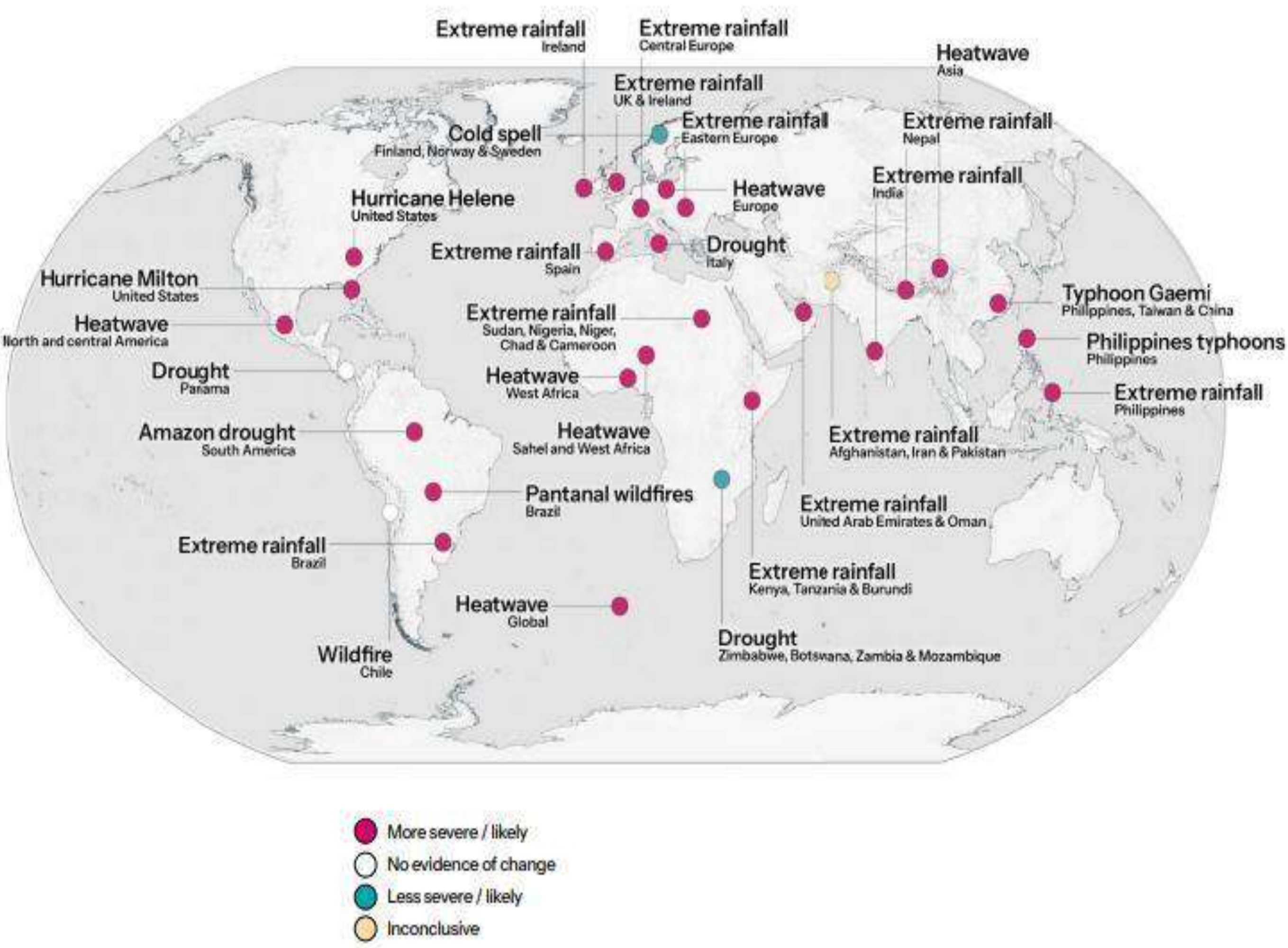
Introduction

This section offers a concise overview of key findings, highlighting global climate trends, major disaster events occurring in 2024-2025, and the specific impacts of climate change on Pakistan, presented as a case study. It further outlines recommended strategies and policy actions for addressing climate challenges in 2025, emphasizing the adoption of global best practices to strengthen resilience and mitigate negative impacts.

Record-Breaking Temperatures

Global average temperatures have surpassed **1.5°C** above pre-industrial levels, resulting in a surge of heatwaves across Europe, North America, and Asia. Additionally, the frequency and intensity of extreme weather events, including typhoons, extreme rainfall, wildfires and floods, have markedly increased. These events have caused significant displacement of populations and substantial economic losses worldwide.

World Weather Attribution studies 2024



Glacial and Ice Sheet Melting

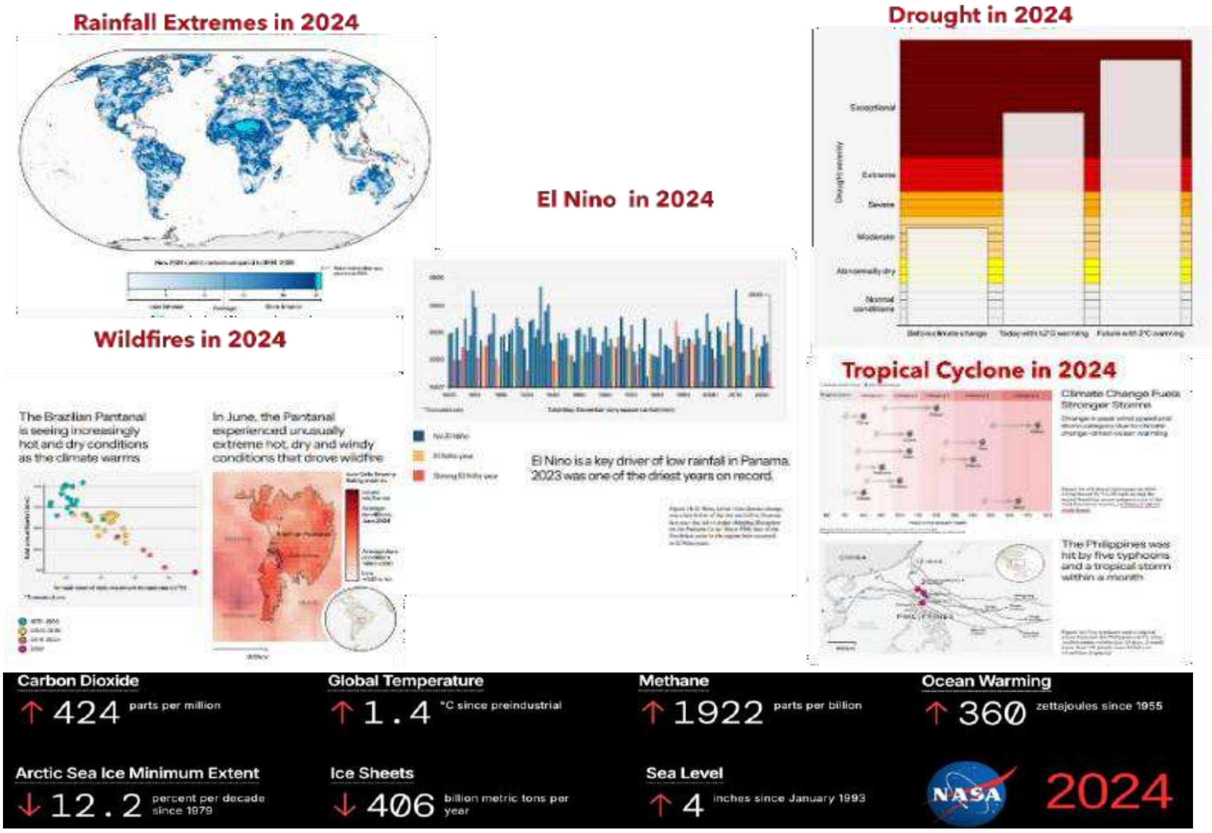
The rapid melting of ice in Greenland and Antarctica has significantly contributed to rising sea levels, posing a severe threat to coastal communities worldwide.

Biodiversity Loss and Ecosystem

Habitat destruction and shifting climate zones have placed immense stress on species survival, leading to an alarming rate of biodiversity loss.

Global Climate Surge 2024-205

The Global Climate Surge 2024-25 report highlights the accelerating pace of climate change, surpassing previous projections and underscoring the urgent need for immediate, large-scale mitigation efforts to safeguard future generations. The report provides a comprehensive analysis of climate-related disasters, including statistical data on their frequency and regional distribution. For instance, heatwaves accounted for 84 recorded events, with 31 occurring in Africa. Additionally, the report details specific disaster events, their geographic locations, and associated human and economic losses.



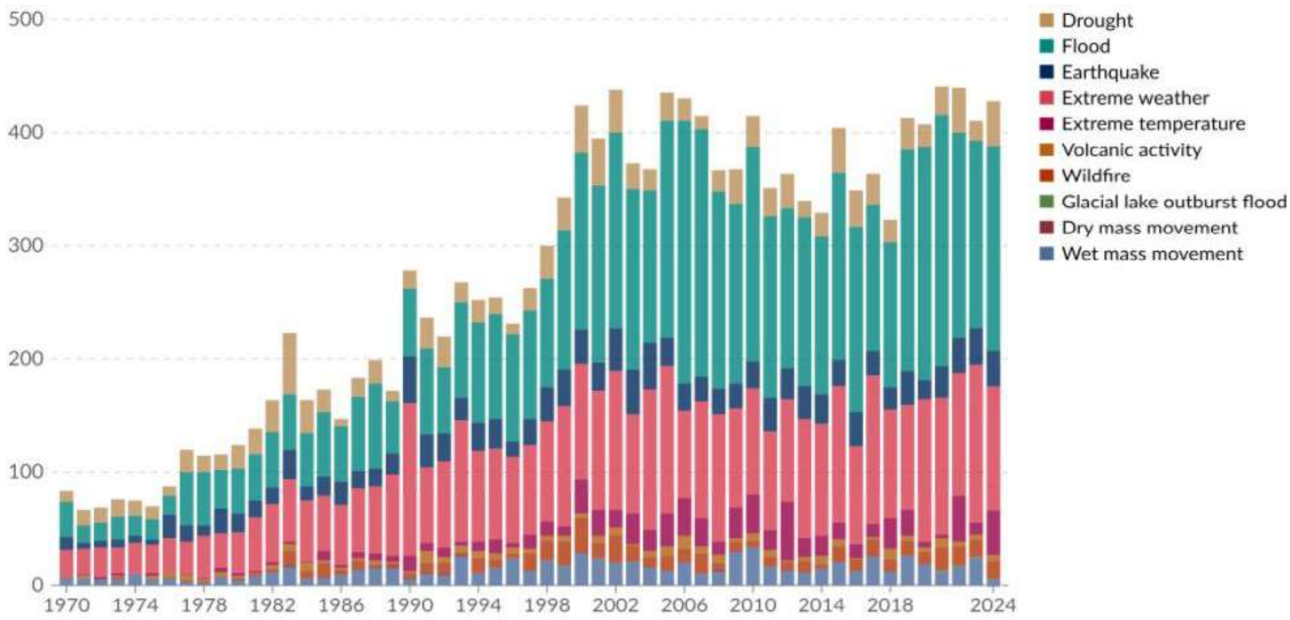
Global Natural Disasters 2024

Months	Disaster in Countries	Economic Losses
Jan	Earthquake in Japan	$50–70 billion
	Floods in Germany	$15–20 billion
	Cyclone Belal in France	$10–15 billion
	Storm in Mauritius	$1–2 billion
Feb	Wildfire in Chile	$3–5 billion
	Urban Flooding in Australia	$8–12 billion
Mar	Wildfire in Texas, USA	$5–7 billion
Apr	Earthquake in Taiwan	$20–30 billion
	Floods in Dubai, UAE	$5–7 billion
	Floods in Oman	$2–3 billion
	Floods in Kenya	$1–2 billion
	Floods in China	$30–40 billion
	Floods in Saudi Arabia	$4–6 billion
May	Floods in Brazil	$10–15 billion
	Floods in Afghanistan	$0.5–1 billion
	Mudslide in Indonesia	$2–3 billion
	Wildfire in Canada	$10–15 billion
Aug	Floods in Bangladesh and India	$20–30 billion
Sep	Hurricane Helene in Florida, USA	$50–70 billion
	Floods in Nepal	$1–2 billion
Oct	Hurricane in Florida, USA	$40–60 billion
	Flood in Thailand	$5–7 billion
Nov	Canada's Wildfire	$15–20 billion
	Spain floods	$5-7 billion
	Indonesia Landslide	$1–2 billion
	Monsoon in Asian Countries	$30-40 billion
	Malaysia Flood	$3-5 billion
Dec	Cyclone in Mayotte	$0.5-1 billion
	Earthquake Vanuatu	$0.5-1 billion
	Australia Bushfire	$10–15 billion

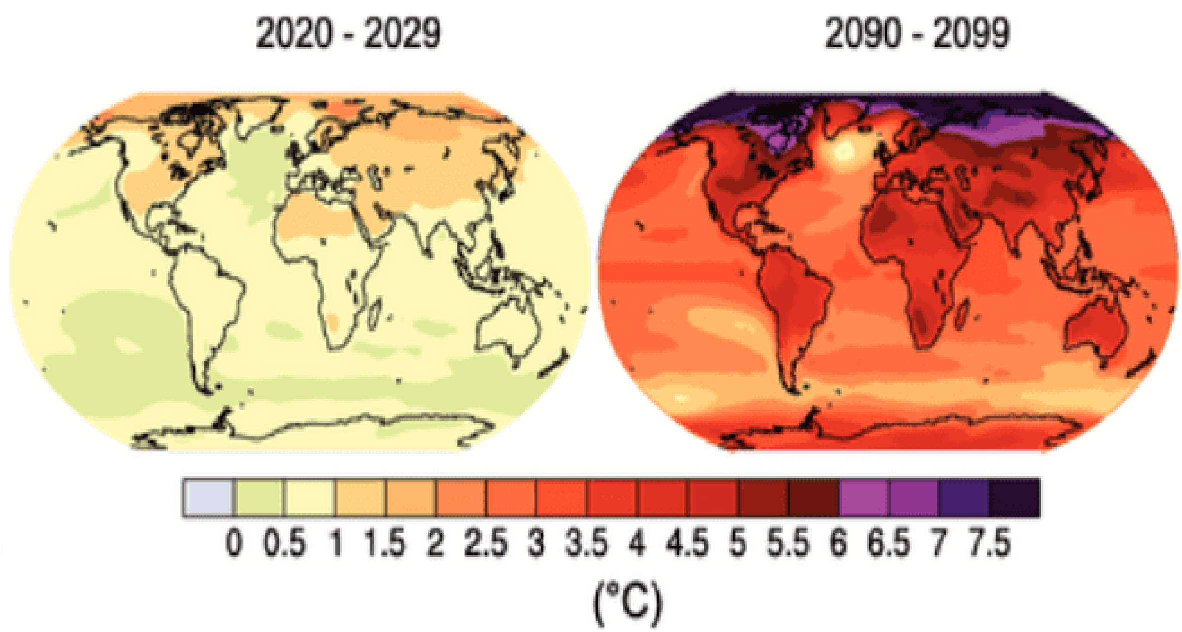
Global Natural Disasters 2025

Disaster	Location	Description	Estimated Economic Losses in USD
Winter Storm	Northeastern USA	Severe blizzard disrupts transportation and damages infrastructure.	$20 billion
Floods	Malaysia, Thailand	Monsoon rains cause flash floods and destroyed agricultural land.	$15 billion
Earthquake	Japan	Magnitude 7.2 earthquake damages buildings and disrupts manufacturing hubs in Osaka region.	$40 billion
Wildfire	Los Angeles	Caused major property and capital losses	$95 to $164 billion
Heatwave	Southern Africa	Unseasonably high temperatures lead to drought conditions, impacting agriculture and water supply.	$8 billion
Tornado	Southern USA	Series of EF3 tornadoes destroys homes, schools, and businesses across multiple states.	$12 billion
Wildfires	Australia (Victoria)	Prolonged heatwave and dry conditions fuel wildfires, burning hectares of land.	$18 billion
Landslides	Peru	Heavy rainfall triggers landslides, destroying villages and blocking major highways.	$7 billion
Storm Surge	Philippines	Typhoon-induced storm surge floods coastal areas, damaging homes and fishing industries.	$14 billion

Global Natural Disasters 1970 to 2024



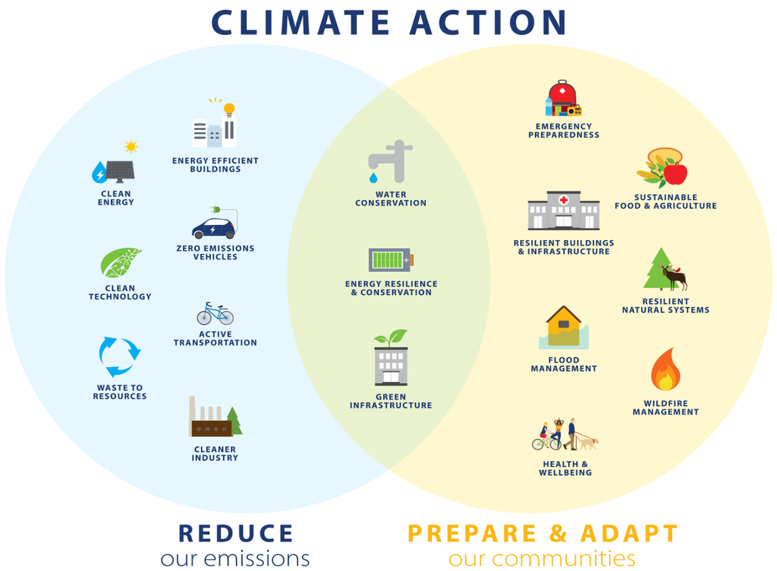
The future of climate change is a continuation of global warming and more severe weather events, according to NASA.



Future of climate change (NASA 2024)

Global Response

The global response to climate surge has intensified in recent years, driven by the urgent need to address the escalating impacts of climate change on ecosystems, economies, and communities. International agreements such as the Paris Agreement have established frameworks for countries to commit to reducing greenhouse gas emissions and limiting global warming to well below 2 degrees Celsius above pre-industrial levels. Nations are increasingly adopting national climate action plans, known as Nationally Determined Contributions (NDCs), which outline specific targets and strategies for mitigating climate change. Additionally, global initiatives such as the United Nations Sustainable Development Goals (SDGs) emphasize the importance of climate action in achieving sustainable development and resilience against climate-related disasters.



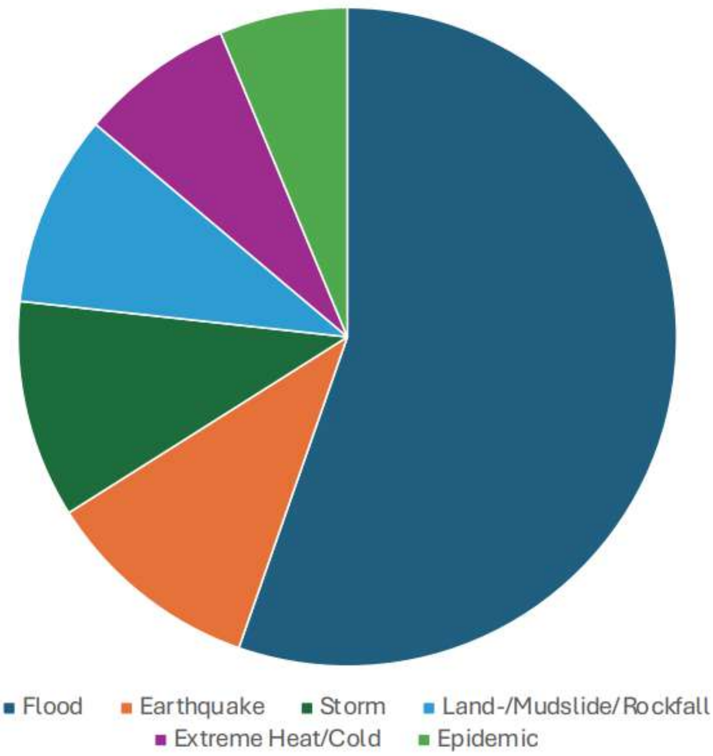
Government of British Columbia

Transition to a low-carbon economy, enhancing resilience to climate impacts, and provision of support to the most vulnerable countries

In parallel, there has been a surge in funding and investment aimed at enhancing climate resilience and adaptation efforts worldwide. Financial mechanisms, including the Green Climate Fund, provide support to developing countries for projects that address climate vulnerabilities and promote sustainable practices. Collaborative efforts among governments, non-governmental organizations, and the private sector are fostering innovation in renewable energy technologies, sustainable agriculture, and disaster risk reduction strategies. Furthermore, grassroots movements and community-led initiatives are gaining momentum, advocating for climate justice and equitable solutions that empower vulnerable populations. This multifaceted global response reflects a growing recognition of the need for collective action to combat climate surge.

Pakistan Climate Surge 2024-2025

Pakistan is ranked **5th most climate vulnerable** country in the Global Climate Risk Index. Pakistan is experiencing a **significant climate surge**, marked by rising temperatures, changing precipitation patterns, and increased frequency of extreme weather events. This surge is exacerbating challenges such as droughts, floods, and heatwaves, which have profound impacts on agriculture, water resources, and public health. The country's vulnerability to climate change is heightened by its geographical location, with the Himalayan region experiencing rapid glacier melting and the coastal areas facing threats from sea-level rise and seawater intrusion. As a result, Pakistan is witnessing more frequent and intense natural disasters, including cyclones and floods, which strain the country's infrastructure and economic resources. Addressing these climate-related challenges requires a comprehensive approach that includes sustainable development strategies, climate-resilient infrastructure, and enhanced disaster preparedness and response mechanisms.



Natural Disasters in Pakistan (2000-2024)

Climate change has significantly altered weather patterns, leading to increased environmental hazards such as cyclones, extreme heat, shifting precipitation trends, rising sea levels, and warming sea temperatures. These changes pose serious threats to coastal infrastructure, agriculture, public health, and ecosystems. More frequent and intense cyclones are causing widespread devastation, while rising temperatures intensify heatwaves, wildfires, and glacial melt. Unpredictable rainfall patterns contribute to both flooding and drought, exacerbating water scarcity and disease outbreaks. Additionally, sea-level rise and ocean warming further endanger coastal communities and marine ecosystems. Urgent adaptive measures and disaster preparedness strategies are essential to mitigate these growing risks.

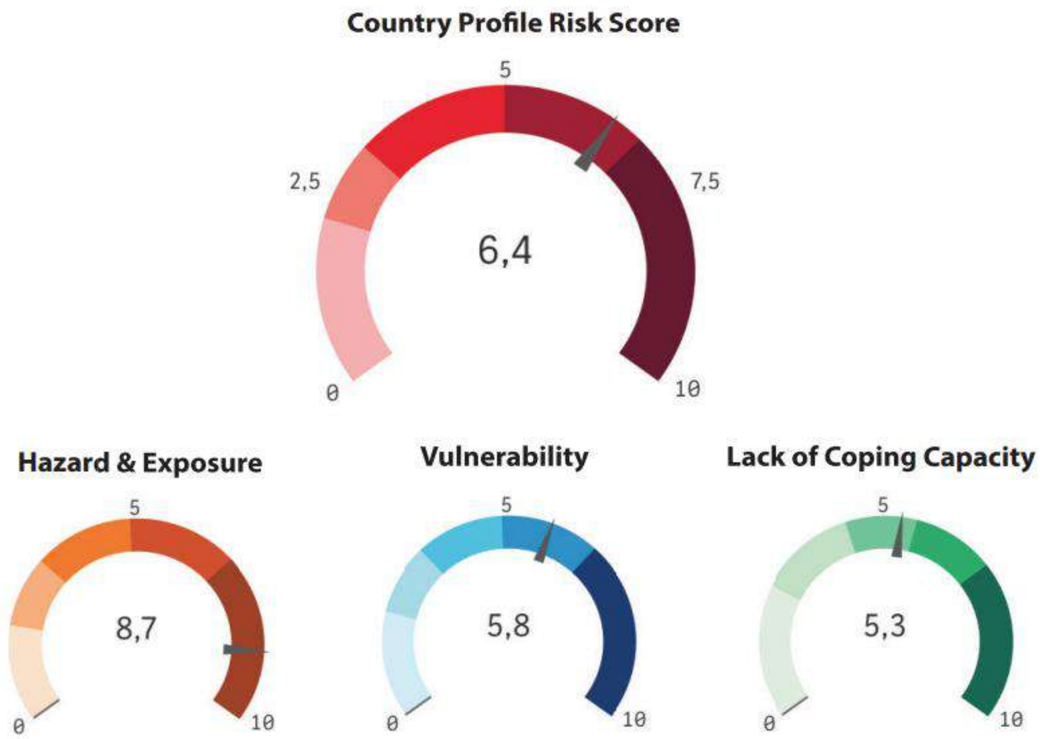
Between 1900 and 2025, seven tropical cyclones affected 2.8 million people, with increasing frequency and intensity due to climate change. Future cyclones will be more severe, causing greater damage to coastal infrastructure and livelihoods, particularly for fishing and farming communities. Urgent measures are needed to enhance disaster preparedness and resilience.

Temperatures have risen by 0.63°C in the past century, with projections of up to 6.0°C by 2090. Extreme heat days (above 35°C) are increasing, worsening heatwaves, water demand, and agricultural losses. Rising temperatures also intensify wildfires, disease spread, and glacial melt, heightening disaster risks. Climate adaptation is essential.

Rainfall has increased by 25% since 1901, with more extreme events since 1960. While coastal areas face declining rainfall, other regions see increases. Changing patterns heighten flood and drought risks, disrupt agriculture, and spread waterborne diseases. Improved water management and flood control are critical.

The Indus Delta faces a projected sea level rise of 30–80 cm by 2024, causing salinization, coastal erosion, and displacement of low-lying communities. Intensified storm surges will increase flood risks. Coastal resilience measures, flood defenses, and sustainable planning are urgently needed.

The Arabian Sea has warmed by 2°C in two years, fueling stronger, more frequent cyclones with higher wind speeds and heavier rainfall. This threatens coastal infrastructure and marine ecosystems, affecting fisheries. Enhanced disaster preparedness and early warning systems are crucial to mitigate impacts.



Inform risk index Pakistan 2025

Disaster Risk = (Hazard × Vulnerability) / Capacity

Classification	World Risk Index	Exposure	Vulnerability	Susceptibility	Lack of Coping Capacities	Lack of Adaptive Capacities
very low	0.00 - 1.84	0.00 - 0.17	0.00 - 9.90	0.00 - 7.17	0.00 - 3.47	0.00 - 25.28
low	1.85 - 3.20	0.18 - 0.56	9.91 - 15.87	7.18 - 11.85	3.48 - 10.01	25.29 - 37.47
medium	3.21 - 5.87	0.57 - 1.76	15.88 - 24.43	11.86 - 19.31	10.02 - 12.64	37.48 - 48.04
high	5.88 - 12.88	1.77 - 7.78	24.44 - 33.01	19.32 - 34.16	12.65 - 39.05	48.05 - 59.00
very high	12.89 - 100.00	7.79 - 100.00	33.02 - 100.00	34.17 - 100.00	39.06 - 100.00	59.01 - 100.00

World Risk Report Classification Matrix

The Lack of Adaptive Capacity score, Pakistan (64.18) and Afghanistan (69.60) score well above Bangladesh (48.54), India (50.49) and Iran (12.17) in a reflection of failures to undertake long-term strategies and processes to anticipate and mitigate future negative impacts.

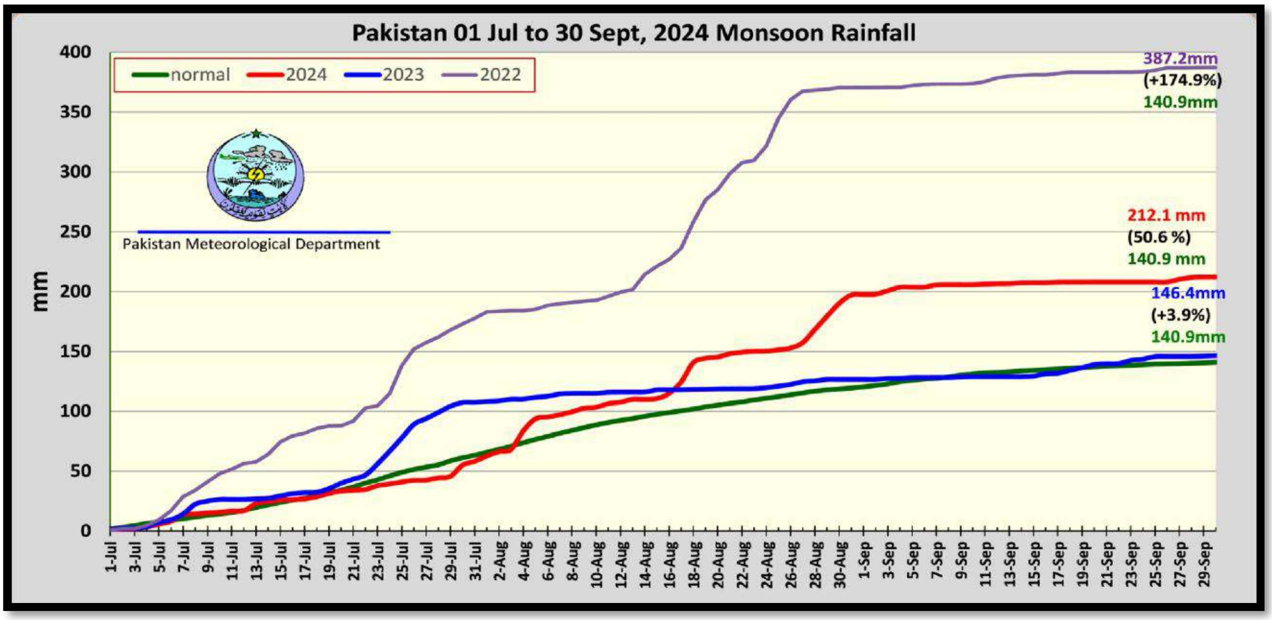
Disasters in Pakistan 2024-2025

Heavy rains and strong winds began on 27 February 2024. The heavy weather affected Gwadar and other areas of Balochistan Province. The downpour caused flooding, particularly in Gwadar, Jewani, and Ormara, where high waters damaged infrastructure, displaced residents, and prompted emergency responses from government and military teams. Heavy rains continued through March and April, and there were reports of floods, landslides, and hailstorms across KP, Balochistan, Punjab, and Gilgit Baltistan. Over 5,800 homes and 464 schools were damaged alongside widespread infrastructure destruction. At least 117 people died, and 139 people were injured. Relief efforts, including evacuation, rescue, and water decontamination, were organized by PDMAs and NDMA. Long-term impacts include disrupted education, loss of livestock, and widespread displacement affecting 1.5 million people, with flood risks persisting.

	01 Jul to 30 Sept, 2024 Rainfall		
	normal (mm)	actual (mm)	Deviation (%)
Pakistan	140.9	212.1	+51
Azad J&K	389.5	306.5	-21
Balochistan	58.3	122.9	+111
Gilgit-B	39.7	40.5	+2
Khyber-PK	256.3	242.6	-5
Punjab	231.9	344.0	+48
Sindh	133.7	278.4	+108

Monsoon 2024 Rainfall (mm)

The 2024 monsoon season in Pakistan began on June 29, slightly ahead of its usual start date of July 1. Rainfall in July and September was somewhat below average. However, August witnessed an exceptionally high volume of rain, offsetting the earlier deficit. Rainfall in August not only compensated for months of July and September but pushed the total monsoon season rainfall above the seasonal average. Post Monsoon Report 2024 To sum it up, Pakistan experienced excessively above-average rainfall during the entire monsoon season with a +51% deviation from the normal and ranked 8th wettest monsoon rainfall during the past 64 years (record is 387.8mm in 2022). On a regional scale, Balochistan and Sindh had excessively above-average rainfall (+111% & 108% respectively), while Punjab had also above-average rainfall (+48%). The Khyber Pakhtunkhwa (KP) and Gilgit Baltistan (GB) (with -5% & +2% respectively) received nearaverage rainfall, whereas, Azad Jammu and Kashmir (AJ&K) (with -21%) was the only region to receive below-average rainfall. Figure shows the spatial distribution seasonal (JAS) rainfall and gives the comparison of cumulative monsoon rains this year and the previous two years.



Pakistan 01 Jul to Sept,2024 Monsoon Rainfall

Key Challenges

Resource Limitations:

The demand for additional rescue equipment and personnel was evident, especially in hard-to-reach areas. Limited resources strained the capacity to conduct timely rescues across all affected regions.

Communication Barriers:

In flood-hit districts, damaged infrastructure and network failures hindered effective communication between rescue teams, local authorities and affected populations. This delayed the coordination of efforts and the dissemination of emergency information.

Accessibility and Terrain Challenges:

Flooding created significant accessibility challenges in remote areas, particularly at higher altitudes where landslides posed an ongoing threat. Landslides had blocked roads and the limited availability of heavy machinery delayed deployment to affected areas. Blocked or submerged routes had hindered rescue teams from reaching certain communities promptly, necessitating the use of air and river-based resources for timely assistance.

Data and Coordination Gaps:

Limited access to real-time data made it challenging to track flood progression and predict high-risk zones accurately. This slowed coordination efforts among various agencies, affecting the deployment of resources and planning for evacuations.

Preparedness and Community Awareness:

In some districts, a lack of disaster preparedness and community awareness on flood response measures led to delays in evacuations, putting more people at risk. Increased efforts in pre-emptive community education and preparedness drills could mitigate this in future events.

Misinformation and Fake News:

The rapid spread of misinformation and fake news on social media created additional challenges during the monsoon season. False information regarding flood severity, evacuation orders and available resources led to confusion among affected communities, complicating rescue operations. This diverted critical resources and delayed response efforts, emphasizing the need for effective communication strategies and reliable information channels to combat misinformation during future crises.

Climate Induced Disasters Initiatives Pakistan

National Disaster Management Authority (NDMA)

Pakistan is increasingly vulnerable to climate-induced disasters, including floods, heatwaves, droughts, and glacial melt events. In response, the National Disaster Management Authority (NDMA) continues to lead initiatives to mitigate the challenges posed by climate change. Through proactive disaster preparedness measures, NDMA is enhancing response capabilities to address floods, cyclones, and heatwaves while fostering climate resilience across the country.

NDMA's Proactive Approach to Climate Disaster Management

NDMA is focusing on developing advanced early warning systems and collaborating with provincial governments to implement climate-resilient infrastructure projects. These initiatives include the construction of flood-resistant housing and green infrastructure projects aimed at reducing environmental vulnerabilities. Additionally, NDMA is promoting Community-Based Disaster Risk Reduction (CBDRR) programs to equip local communities with essential skills for disaster preparedness and response planning.

To further strengthen Pakistan's climate resilience, NDMA is actively engaging with international partners to secure technical assistance, scientific expertise, and research support for climate-related projects. These efforts reflect NDMA's commitment to developing a comprehensive disaster risk reduction (DRR) strategy aligned with global best practices.

National Emergency Operations Centre (NEOC) – A Strategic Initiative

The National Emergency Operations Centre (NEOC) is a pioneering initiative of NDMA, established to transition Pakistan's disaster management approach from reactive to proactive, NEOC stands as a model of innovation and preparedness.

Equipped with state-of-the-art facilities and real-time satellite feeds, NEOC has the capability to anticipate disasters up to three months in advance. A multidisciplinary team of experts employs Geographic Information Systems (GIS), Remote Sensing, Climatology, Meteorology, Seismology, Hydrology, and Data Sciences to monitor and analyze global and local hazards. This enables early detection of emerging disaster patterns and trends, ensuring timely interventions and effective response strategies.

NDMA's Role in Disaster Response

The timely activation of NEOC significantly strengthens Pakistan's resilience against monsoon floods by enhancing coordination, response efficiency, and community preparedness. The key roles NDMA in disaster risk management include:

Centralized Coordination

NEOC serves as a hub for coordination among government agencies, NGOs, and local authorities, facilitating real-time communication and information sharing.

Risk Assessment

The center employs advanced early warning systems to monitor weather patterns and assess flood risks, enabling timely alerts to vulnerable communities.

Resource Mobilization

Early activation allows for the pre-deployment of essential resources, ensuring rapid logistical support to affected areas.

Community Preparedness

NDMA organizes public awareness campaigns and training programs for local disaster management committees to enhance community readiness for potential disasters.

Emergency Response

NDMA coordinates the activation of rapid response teams and integrates health, rescue, and relief services, minimizing response times and mitigating disaster impacts.

Data Collection and Analysis

The center gathers and analysis data during and after flooding events to improve future preparedness and response strategies.

International Collaboration

NDMA fosters partnerships with international agencies to secure additional resources and funding, enhancing overall disaster response capabilities.

Integration of Global Best Practices and Anticipatory Action

NDMA is committed to integrating climate change adaptation strategies and anticipatory action into disaster risk reduction. By aligning with international frameworks such as the Sendai Framework for Disaster Risk Reduction and the Sustainable Development Goals (SDGs), NEOC aims to strengthen preparedness at all levels. Additionally, NDMA conducts trainings under the International Search and Rescue Advisory Group (INSARAG) and organizes simulation exercises (SimEx) to enhance response efficiency. NEOC represents a transformative step in Pakistan's disaster management landscape. By leveraging cutting-edge technologies, fostering community engagement, and strengthening international collaboration, NEOC are proactively addressing climate-induced disasters. These efforts are instrumental in safeguarding lives, minimizing economic losses, and building a resilient Pakistan capable of withstanding future climate challenges. NEOC invite collaboration with national and international stakeholders to further bolster disaster preparedness and response efforts, ensuring a safer and more secure future for all.

Key initiatives included:

- Ministry of Climate Change, Government of Pakistan, National Adaptation Plan (NAP), Islamabad, Pakistan, 2023.
- Government of Pakistan, Pakistan Climate Change Act, Islamabad, Pakistan, 2017.
- National Disaster Management Authority (NDMA), National Disaster Risk Reduction Policy (NDRRP), Islamabad, Pakistan, 2013.
- United Nations Development Programme (UNDP), Glacial Lake Outburst Floods (GLOF) Project: Mitigating Climate Risks in Northern Pakistan, Islamabad, Pakistan, 2022.
- Ministry of Climate Change, Government of Pakistan, Billion Tree Tsunami Project: Reforestation for Climate Resilience, Islamabad, Pakistan, 2021.
- National Emergency Operations Center (NEOC), Strengthening Early Warning Systems for Climate Resilience, Islamabad, Pakistan, 2023.
- Pakistan Urban and Infrastructure Development Authority, Climate-Resilient Infrastructure Development Strategies, Islamabad, Pakistan, 2023.

Way Forward

Moving forward, Pakistan needs to adopt a multi-faceted approach to address the challenges posed by climate surge. This includes strengthening its policy framework to integrate climate resilience into all sectors, particularly agriculture and water management. Investing in climate-resilient infrastructure, such as flood-resistant housing and green infrastructure, will be crucial for mitigating the impacts of extreme weather events. Additionally, enhancing early warning systems for floods, cyclones, and heatwaves will help in timely evacuations and emergency responses. Collaboration with international organizations can provide access to advanced technologies and funding for climate-related projects, further bolstering Pakistan's resilience against climate change.

Future Perspective

Future research in Pakistan should focus on developing more accurate climate models that can predict extreme weather events with greater precision. This will enable better planning and preparedness for climate-related disasters. Studies on climate-resilient agricultural practices and efficient irrigation systems can help improve crop yields and reduce water stress. Moreover, research into innovative technologies for renewable energy and green infrastructure can support Pakistan's transition towards a more sustainable and climate-resilient economy. Community-based research initiatives can also help understand local perceptions and adaptation strategies, ensuring that climate policies are tailored to meet the needs of vulnerable communities. By pursuing these research directions, Pakistan can develop effective solutions to mitigate the impacts of climate surge and ensure sustainable development for future generations:

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