POST MONSOON 2024

SITUATIONAL REPORT

Provincial Disaster Management Authority, Punjab

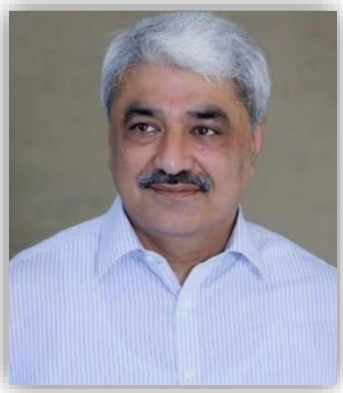
Chief Minister, Punjab

Maryam Nawaz Sharif

As we confront the growing challenges of climate change, the Punjab Government's vision for a resilient Punjab aims to ensure the safety and well-being of every citizen in the face of any eventuality. The monsoon 2024 has been a testament to the enhanced coordination and preparedness of PDMA, which worked closely with relevant stakeholders to mitigate the impacts of floods. Despite facing multiple threats such as riverine floods, urban flooding, and hill torrents, Punjab Government's proactive approach ensured a timely response, minimized damages, and safeguarded lives. Through real-time monitoring, early warning systems, and coordinated efforts with District Disaster Management Authorities, PDMA was able to evacuate vulnerable communities promptly, delivered relief at their doorstep, and swiftly coordinated recovery efforts. This integrated response underscores the vital role of PDMA while highlighting the collaborative efforts of other key line departments working together on disaster mitigation and preparedness within the province. Given Pakistan's vulnerability to climate impacts, it remains crucial for strengthening/improving preparedness towards sustainable and permanent solutions for all types of flooding to ensure informed decisions making to mitigate risks for public safety in Punjab.

Minister for Disaster Management, Punjab

Khawaja Salman Rafique



As the effects of climate change continue to escalate the frequency and intensity of natural disasters such as floods, hill torrents and heatwaves are becoming more pronounced. It is imperative for us to be more proactive, innovative, and resilient in our approach toward disaster management. This year, Punjab has witnessed moderate to severe weather patterns during the monsoon season. However, the PDMA has taken on this challenge with exemplary dedication and successfully mitigated the impacts of these natural calamities. By leveraging cutting-edge technology and improved communication systems, PDMA has coordinated swift evacuation and relief operations, safeguarded vulnerable communities and minimized damages. The Government of Punjab remains steadfast in its commitment to reducing disaster risks through enhanced preparedness and response mechanisms.

Chief Secretary, Punjab

Zahid Akhtar Zaman

Considering the escalating impacts of climate change, the imperative for a robust and comprehensive disaster management strategy is more pressing than ever. Through the integration of real-time data and effective interdepartmental coordination, the Government has successfully safeguarded vulnerable communities and has been able to minimize the adverse effects of floods and monsoon 2024 by optimizing early warning systems, executing well-coordinated evacuation protocols, and ensuring the timely mobilization of resources. The Government of Punjab remains resolute in its commitment to disaster risk reduction, continuously enhancing our preparedness and response capabilities to address the evolving threats posed by climate change.

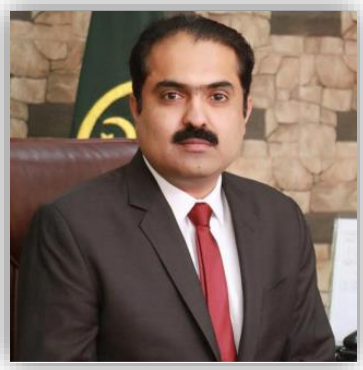
Senior Member Board of Revenue, Punjab

Nabeel Javed

Punjab is increasingly vulnerable to a wide range of hazards including floods, heatwaves and smog, all exacerbated by the growing impacts of climate change. The PDMA has played a leading coordinating role in managing these challenges. During the monsoon season 2024, proactive strategies, early warning systems and enhanced flood preparedness played an instrumental role in reducing the risks to lives and properties of vulnerable communities. The seamless coordination between departments and the use of advanced technologies for risk assessment further enabled us to limit the damage from natural hazards. As we face a future of greater climate uncertainties, our continued focus will be on building resilience and ensuring that Punjab remains equipped to handle disasters effectively.

Director General, PDMA Punjab

Irfan Ali Khan Kathia



As Director General of the PDMA, I take immense pride in the significant strides, our teams have made in elevating disaster preparedness and response level during the 2024 monsoon season. Utilizing MHVRA data and Flood Simulation Models, PDMA made critical, data-driven and informed decisions that enabled timely resource allocation and efficient mobilization to address emerging emergencies. Our swift and effective response, in collaboration with District Disaster Management Authorities, line departments, stakeholders, and humanitarian partners, ensured the protection of vulnerable communities and minimized damages. The success of our efforts this season underscores the importance of maintaining a strong focus on operational readiness, inter-agency coordination, and resilience building to confront the growing challenges posed by climate change. Moving forward, PDMA remains committed to refining its strategies and capabilities to safeguard the province against future climate-related risks.

Acknowledgements

PDMA Punjab has taken a leading role in coordinating a comprehensive emergency response to mitigate human and material losses during crises. This year's flood season demonstrated the effectiveness of PDMA's proactive and coordinated efforts in collaboration with DDMAs. The authority worked tirelessly alongside provincial and district-level government departments, humanitarian partners, and all relevant stakeholders. Through the collective efforts of provincial departments such as the Irrigation Department, Local Government Department, Housing Department, WASAs, and Punjab Emergency Services Department (Rescue 1122), along with federal agencies like NDMA, FFC, PMD, and the Pakistan Army, PDMA successfully minimized the impacts of riverine floods, urban flooding, and hill torrents, ensuring the protection of vulnerable communities across Punjab. The contributions of humanitarian partners such as WHH, UNICEF, GIZ, IOM and local organizations were also crucial in achieving the desired resilience targets.

Under the astute leadership of **Mr. Irfan Ali Kathia (Director General), PDMA** facilitated seamless cooperation between various departments, focusing on risk assessment, mitigation strategies, rescue operations, and the delivery of relief to affected areas. This comprehensive, multi-stakeholder approach demonstrates PDMA's unwavering commitment to safeguard the province against both natural and human-induced disasters. We extend deep appreciation to all line departments, humanitarian partners, and other key stakeholders whose dedication and expertise were vital to the successful execution of PDMA's flood response efforts.

This report has been shaped under the esteemed guidance and leadership of **Mr. Nabeel Javed, Senior Member Board of Revenue/Relief Commissioner Punjab**, whose support has been instrumental in achieving its goals. Special thanks to **Mr. Amir Raza (Director, PDMA), Mr. Zaheer Liaquat Baig (Director, Admin & Coordination), Mr. Hameed Ullah Malik (Director IT)** for their significant contributions during Monsoon Season 2024.

The Post Monsoon 2024 – Situational Analysis Report was successfully conceived, designed, and executed under the expert supervision of **Mr. Nisar Ahmed Sani (Director, Operations).** His foresight and hands-on guidance were essential to the initiative's achievement, ensuring a comprehensive and impactful outcome. We would also like to acknowledge the pivotal roles played by **Ms. Rabia Pervez (Incharge PEOC), Ms. Iqra Basit (Assistant NGO/GIS), Ms. Yusra Mazhar (Assistant GIS),** and **Ms. Fizza Hafeez (Assistant GIS)** in drafting the report, analyzing data, preparing figures, tables, and charts, and composing the final document.

Acronyms

PDMA	Provincial Disaster Management Authority
DDMAs	District Disaster Management Authorities
DRF	Disaster Response Force
EWS	Early Warning System
FSM	Flood Simulation Model
DEOCs	Disaster Emergency Operations Centers
PEOC	Provincial Emergency Operations Center
NDMA	National Disaster Management Authority
MHVRA	Multi-Hazard Vulnerability and Risk Assessment
PMD	Pakistan Meteorological Department
CCDM	Cabinet Committee on Disaster Management
FFC	Flood Forecasting Commission
WASA	Water and Sanitation Agency

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CHAPTER 1
MONSOON 2024 UNFOLD

1. Monsoon 2024 - Unfold

The monsoon season, typically spanning from mid-June to late September, is a critical period for Pakistan, bringing both essential rainfall for agriculture and the risk of devastating floods. In recent years, the effects of climate change have intensified the monsoon's impact, leading to more erratic weather patterns, prolonged rainfalls, frequent cloud bursts and increased flooding risks. To cope with the disasters, the PDMA plays a leading role in mitigating the effects of these natural disasters. Through comprehensive preparedness, Early Warning Systems (EWS), Resource Mobilization and close coordination with government line departments i.e. District Disaster Management Authorities (DDMAs), Humanitarian Partners, Disaster Response Force (DRF) and local communities, PDMA ensures timely and effective response to protect lives and livelihood of vulnerable communities.

1.1 Monsoon Outlook 2024

The Monsoon Outlook for 2024 highlighted a significant shift in precipitation patterns for Punjab. According to the SASCOF-28 Outlook Map (Figure 1.1) and the Multi Model Ensemble Forecast (Figure 1.2), the province experienced an above-normal monsoon season. Specifically, Upper Punjab was projected to see a 25% increase in rainfall. Lower Punjab, which typically received less rainfall, was forecasted to experience a substantial 36% increase, with total precipitation reaching around 118 mm (Table 1.1). These forecasts suggested an unprecedented level of rainfall for the region, which potentially escalated into a disaster situation as the heavy rains led to flooding and other related issues. It was crucial to prepare for and mitigate the impacts of such extreme weather conditions to ensure the safety and resilience of the communities in Punjab.

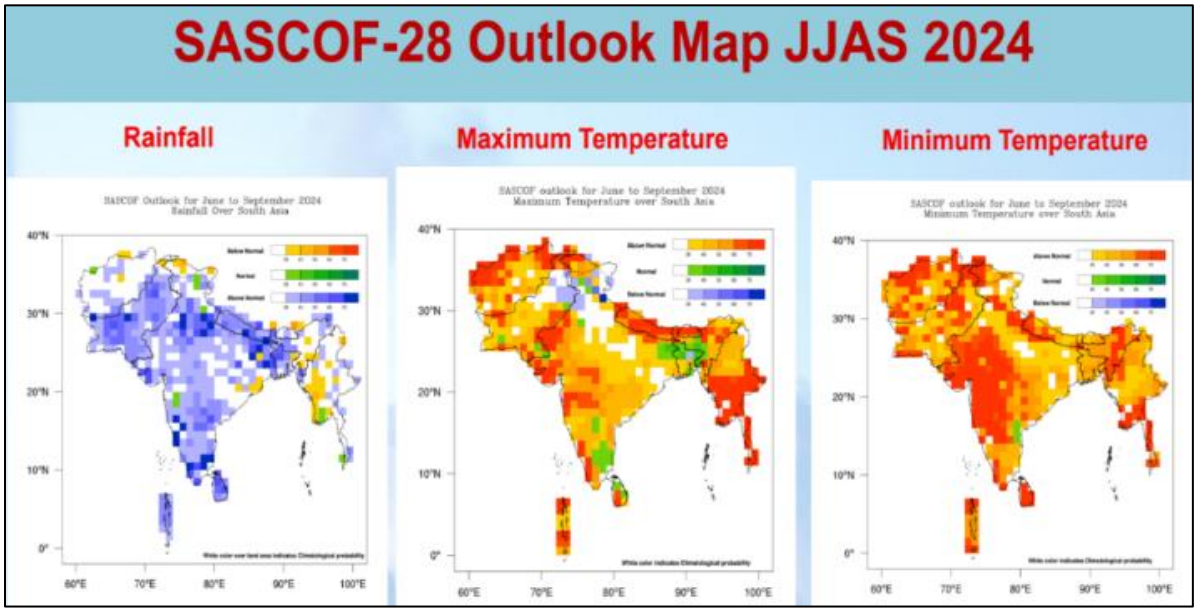


Figure 1.1 Monsoon Outlook Maps. **(***Source: SASCOF***)**

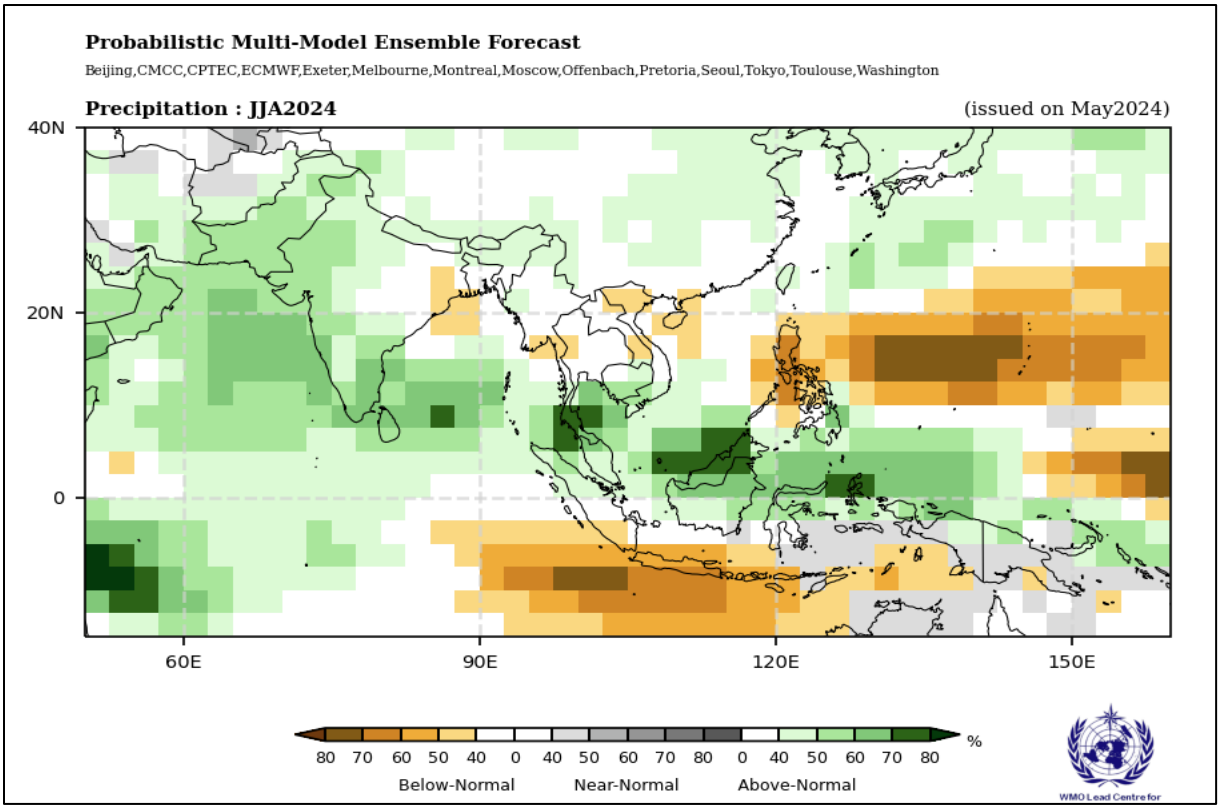


Figure 1.2 Probabilistic Multi-Model Ensemble Forecast for Precipitation JJA, 2024. (*Source: WMO*)

Region	Normal Rainfall (mm)	Monsoon 2024(%)	Remarks
Pakistan	188	+30	Above Normal
Gilgit-Baltistan (GB)	60	-5	Near Normal
Khyber Pakhtunkhwa (KP)	269	+18	Above Normal
Upper Punjab and Azad Kashmir	517	+25	Above Normal
Lower Punjab	118	+36	Above Normal
Sindh	116	+55	Above normal
Baluchistan	52	+39	Above normal

Table 1.1 Monsoon 2024 Rainfall Outlook by Region. (*Source: PMD, Lahore*)

The rainfall in 2024 has revealed that several districts across the Punjab have experienced above-normal precipitation, exceeding the 517 mm threshold identified in the (Table 1.1) for Upper Punjab and Azad Kashmir. This above-normal rainfall raised concerns about flooding and potential damage to infrastructure, agriculture, and communities, necessitating prompt mitigation measures by local authorities to prevent widespread disruption, particularly in densely populated urban areas. The districts such as Rawalpindi, Jhelum, Gujrat, Sialkot, Gujranwala, Sargodha, Faisalabad, Lahore, and Multan have been the most affected, experiencing frequent urban flooding that has impacted infrastructure, residential areas, and commercial zones. However, in Monsoon season 2024, Urban centers like Lahore, Rawalpindi, Sialkot, Gujrat and Multan experienced unprecedented rainfall which caused significant urban flooding in the month of August and September.

The monsoon season 2024 posed significant challenges, particularly due to the rising water levels in the Indus River and its tributaries, which were amplified by the combined flows from the Kabul and Indus rivers. Maximum water flow was observed in Chashma, Kalabagh, and Taunsa, severely impacting five districts: Mianwali, Rajanpur, Kot Addu, Dera Ghazi Khan, and Rahim Yar Khan. Sheet flooding had been exacerbated by the overflowing of several critical nullahs, including Nullah Aik and Nullah Deg in Sialkot, Nullah Bein in Narowal, and Nullah Basanter in Narowal, contributing to severe waterlogging in adjacent areas. Hill torrents originating from the Suleiman Range, particularly in Dera Ghazi Khan and Rajanpur districts, continued to pose a significant threat. The rise in both riverine and urban flooding, compounded by the unpredictable behavior of hill torrents, underscores the need for enhanced preparedness, real-time monitoring, and robust interagency coordination to safeguard Punjab against the increasingly volatile impacts of the monsoon season.

CHAPTER 2

Preparedness – Monsoon/Flood 2024

2. Preparedness - Monsoon/Flood 2024

The PDMA, Punjab is dedicated to saving lives and livelihoods through preparedness to minimize the risk of disasters across the province. Drawing from past experiences and utilizing MHVRA data and the Flood Simulation Model, PDMA effectively prepared for the 2024 monsoon season using a multi-pronged approach that emphasizes timely response, risk reduction, and effective management. To ensure effective preparedness and mitigation measures, the following activity calendar was rigorously adhered to throughout the season:

Sr. #	ACTIVITIES	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Responsibility
1.1	District Flood Contingency Plans		30th March											DCs
1.2	Departmental Flood Contingency Plans		30th April											All Secretaries
1.3	Provincial Flood Contingency Plan				15th May									PDMA
2.1	1st Mock Exercises					May								PDMA, DCs, DRFs
	2nd Mock Exercises						June							PDMA, DCs, DRFs
2.2	DDMA Meetings													DCs
2.3	Third Party Validation (TPV), Readiness Certificates and Pre-positioning of Equipment						15th June							Commissioners, PDMA, DDMAs, DRFs
2.4	Inspection of Flood Protection Bunds (Survey by Army, irrigation, DDMAs)			March till 10th May										Army, PID, DCs
2.5	Army Survey Board (Inspection of Flood fighting Equipment Available with Pak Army)		Feb till 30th April											PDMA, PID, All Corps
2.6					Circulated to all DCs, DDMAs for Compliance									HUD, PHED & LGs
2.7	De-Silting of Nullahs, Water Channels, Bridges etc.			Mar to 15th June										DDMAs, WASAs, MCs
2.8	Removal of Encroachments (Water Ways, Zamindara Bunds)					30th May								DDMAs, PID, Police
2.9	Pre-Qualification of Firms/Vendors				15th June									PDMA, DDMAs
3.1	Operationalization of Control Rooms/DEOCs						15th June to 15th October							PDMA, DDMAs
3.21	Establishment of Flood Forecasting Center						15th June to 15th October							PDMA, PID, MET

Table 2.1 Annual Flood Preparedness and Response Activity Calendar. (*Source: PDMA, Punjab*)

2.1 Disaster Preparedness

2.1.1 Top Tier Ownership

The Chief Minister conducted multiple visits to PDMA Headquarters and flood-prone districts along with Ministers concerned, Chief Secretary, SMBR / Relief Commissioner Punjab and DG PDMA, reviewing preparedness and response to the vulnerable communities. In these visits and meetings critical decisions were made regarding resource allocation, fund distribution, and disaster response strategies.

Figure 2.1 Chief Minister, Punjab Visited to PDMA and Rajanpur (Hill Torrents affected area).

Furthermore, the cabinet committee on disaster management remained very effective and proactive in overall supervision of this season and provided an efficient forum for thorough deliberations review and early decisions making regarding preparedness, rescue, relief etc.

Figure 2.2 Cabinet Committee for Disaster Management (CCDM) Meetings

Figure 2.3 Minister, SMBR and Army Visit to PDMA

Figure 2.4 British High Commission's Team Visit to PDMA

2.1.2 Collaboration with Humanitarian Partners

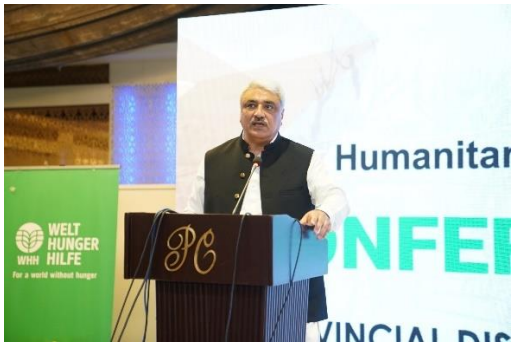
○ Humanitarian Stakeholders Monsoon Conference - 2024

With Punjab increasingly vulnerable to floods, urban inundations, and heavy rains, the PDMA, in collaboration with Welthungerhilfe, organized a Monsoon / Pre-Flood 2024 Preparedness Conference on July 23, 2024. The conference aimed to develop forward-thinking contingency plans, coordinate stakeholders effectively, and mobilize resources for a swift and efficient response to potential disasters.

Key participants included government departments such as Deputy Commissioners, Commissioners of all vulnerable districts, the Pakistan Meteorological Department and the Punjab Emergency Services Department (Rescue 1122). International organizations like GIZ, USAID, WFF, WFP, the Pakistan Red Crescent, Muslim Hands, Save the Children, Care International, Tear Fund, WaterAid and UN Agencies such as UNOCHA, UNICEF, UN UNICEF, WHO, UNIOM,

District Disaster Management Authorities (DDMAs), and various non-governmental organizations (NGOs) also attended.

During the conference, participants shared expertise and experiences in disaster management and response. They further established communication channels for effective coordination and information sharing and committed to mobilizing resources and providing support to affected communities. This conference served as a crucial platform for fostering collaboration, building resilience, and ensuring that Punjab is well-prepared to face the challenges of the upcoming monsoon season.



Minister Disaster Management Punjab giving Opening Remark

Senior Member Board of Revenue, Punjab giving Welcome Remark

Director General PDMA giving presentation and remarks on PDMA's Working and Collaboration with all stakeholders

US Consulate General Kristen K. Hawkins highlighting importance of collaboration of all departments to mitigate disaster related risks.

The Senior Member Board of revenue in his address to all participants and heads of departments.

DG PDMA and Country Dorector Welthungerhilfe Pakistan presenting shield to US Consul. General.

DG PDMA, Country Dorector Welthungerhilfe Pakistan and Director Operations present shield to Minister Disaster Management, Punjab.

Figure 2.5 Humanitarian Stakeholders Monsoon Conference Highlights

○ Provincial Workshop Organized with the Collaboration of UNICEF

PDMA in collaboration with UNICEF organized a workshop on "Provincial Workshop on Accountability to affected people (AAP) & Social and Behavior Change in Emergencies (SBiCE). The primary objective of this workshop was to enhance understanding and ensuring the effective implementation of AAP and community feedback mechanisms among key partners.

DG PDMA highhlighting the importance of Accountability to Affected people and how PDMA with collaboration of UN Agencies can work effectively in this area.

Group discussion on effective planning and response to affected people in hazard prone areas.

Figure 2.6 Highlights of UNICEF Conference on Accountability to Affected People

○ Exchange of Flood Preparedness Knowledge with Nigerian Delegation

On June 27, 2024, a high-level Nigerian delegation, including governors from three states, visited PDMA Punjab. They engaged with PDMA officials to learn about Punjab's disaster management system and toured the control room. Director General Irfan Ali Kathia explained PDMA's 24-hour communication network and its readiness for various challenges such as floods, COVID-19, and heat waves. The delegation was particularly impressed with the flood simulation model and emergency response capabilities. They valued the insights gained and plan to incorporate similar strategies in Nigeria to enhance their disaster management efforts.

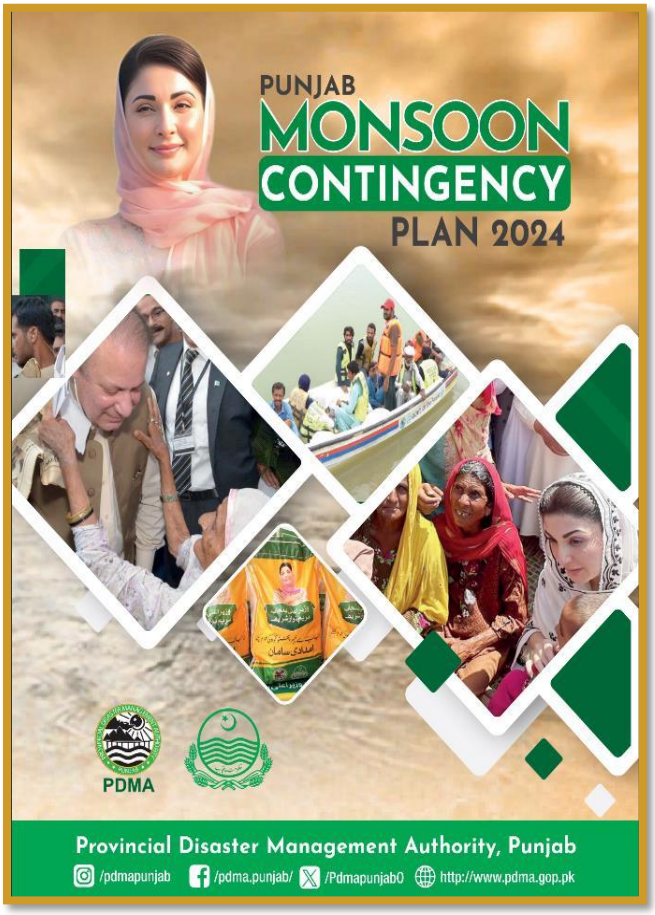
Figure 2.7 Nigerian Delegation Visit to PDMA

2.1.3 Monsoon Contingency Plan

The Monsoon Contingency Plan is an important element of preparedness, designed to assess allocate resources, and responsibilities. The primary goals are to diminish the impact of monsoon-related disasters on the population, safeguarding lives and likelihood. It addresses the risks of riverine, flash, and urban flooding through detailed assessments of vulnerable areas and populations. Strategies within the plan include enhancing early warning systems, elevating public awareness and education, positioning relief supplies in advance, setting up emergency shelters, and fostering robust coordination among all relevant stakeholders.

Main Contours:

- Stakeholders Engagement
- Disaster Risk Management Action Plan
- Flood Simulation
- Early Warning System
- Contingency and Evacuation Plan
- Strategy for Community Awareness
- Resource Mobilization
- Emergency Response
- Inventory of Rescue Relief Equipment



2.1.4 Identification of Evacuation / Relief Camps

PDMA has strategically selected and established Evacuation / Relief camps at vulnerable locations in the province as part of its comprehensive flood relief efforts. The site selection process was carefully planned, considering factors such as proximity to flood-prone areas, accessibility for affected communities and rescue teams, and the availability of essential infrastructure.

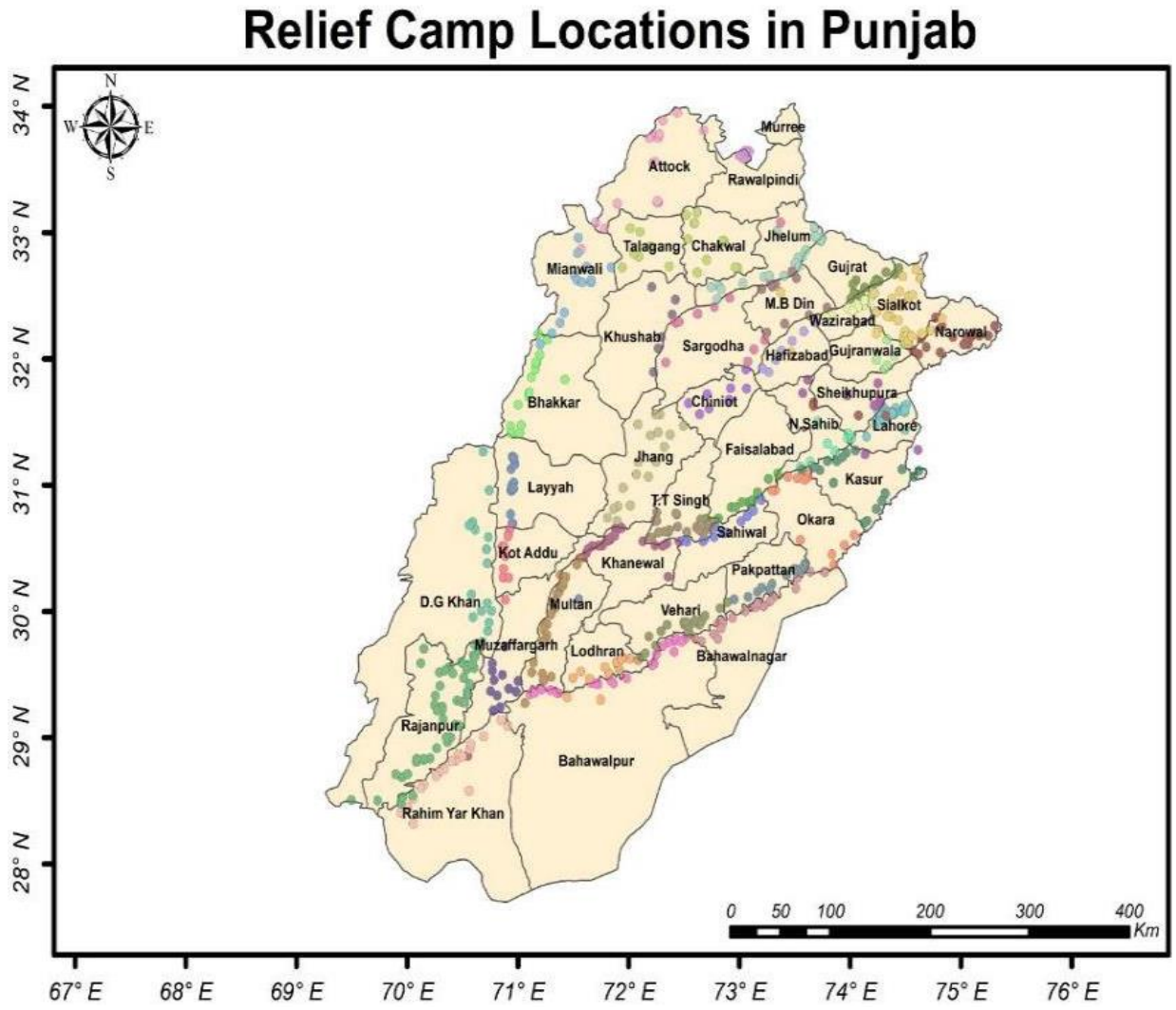


Figure 2.8 Relief Camp Locations in Punjab (Source: GIS Team, PDMA, Punjab)

2.1.5 De-silting Campaign

Under the direction of the Honorable Chief Minister, PDMA has initiated a large-scale de-silting campaign in collaboration with concerned line departments / agencies i.e. Irrigation Department, Housing Department, WASAs, LG & CD, and Cantonments Board. This initiative aimed to mitigate the effects of both urban and riverine flooding. As special desilting is the prime focus of PDMA, this campaign involved comprehensive cleaning of all drains and nullahs and places particular emphasis on the dredging and maintenance of major canals, drainage systems,

and waterways across the province. This proactive effort was a crucial step toward reducing the risks posed by both hill torrents and monsoon-induced flooding in Punjab.

Figure 2.9 Desilting Efforts in Nullah Lai (Rawalpindi) and other flooding prone districts of Punjab.

2.1.6 Mock Exercises

PDMA, in collaboration with DDMAs, Disaster Response Force (Rescue 1122), Pak Army, and local authorities, conducted full-fledge mock exercises to assess and enhance flood preparedness. These simulations were aimed at testing the readiness of response teams, evaluating the effectiveness of evacuation and relief plans, and fine-tuning operational protocols.

Figure 2.10 PDMA's collaborative effort with DDMAs, Pak Army, and local authorities, Rescue 1122 teams participated in full-scale mock exercises

2.1.7 Funds to Districts

At the start of the 2024 monsoon season, PDMA took proactive measures by transferring PKR 10 million to each district across the province for relief and rescue efforts. This financial support was aimed at ensuring that districts had immediate access to the necessary funds for emergency response, allowing them to address potential monsoon-related disasters such as flooding, infrastructure damage, and the needs of displaced populations. The districts were empowered to utilize the allocated amount for various activities, including rescue operations, provision of temporary shelters, medical assistance, and rehabilitation of affected areas. Furthermore, the districts were assured that the allocated funds could be recouped upon request, ensuring a continuous flow of resources as needed throughout the monsoon season. This initiative demonstrated PDMA's commitment to minimizing the impact of the monsoon on lives and property, and to fostering efficient disaster management at the district level.

2.1.8 Awareness through Media

Comprehensive media campaigns were launched to inform and educate the public about precautionary measures during the monsoon season. The campaigns utilized print, electronic, and social media platforms to disseminate vital information, such as flood alerts, instructions for evacuation, safety measures to avoid waterborne diseases, and emergency helplines.

Figure 2.11 PDMA Media Awareness Campaign

2.1.9 Distribution of Equipment to Pakistan Army and Rescue 1122

In anticipation of monsoon-related disasters, PDMA facilitated the distribution of rescue equipment to key response units. This included the Pakistan Army and Rescue 1122, who received boats, life jackets, medical supplies, and other essential equipment.

○ Flood Fighting Equipment (FFE) Handed Over to Pak Army

Sr.	Item Name	Quantity
1.	OBMs (40 HP)	20
2.	OBMs (15 HP)	10
3.	Boats (10 ft)	10
4.	Life Rings	200
5.	Life Jackets	200
6.	Tents	10

Table 2.2 List of Flood Fighting Equipment (FFE) Handed Over to Pak Army (*Source: PDMA, Punjab*)

○ Additional Flood Fighting Equipment Handed Over to Rescue 1122

Sr.	Item Name	Quantity
1.	Air Compressors	15
2.	Boats (19 ft)	13
3.	Boats (24 ft)	12
4.	OBM (15 HP)	14
5.	Boats (10 ft)	14
6.	Endoscopic Fiber Optic Camera	10
7.	Chipping Hammer Drill Machine	10
8.	Rotary Hammer Drill Machine	10
9.	Angular Grinder	10
10.	Manual Hydraulic Rubber Cutter	10

Table 2.3 List of Flood Fighting Equipment (FFE) Handed Over to Rescue 1122 (*Source: PDMA,Punjab*)

Figure 2.12 Flood Fighting Equipment (FFE) Handed Over to Rescue 1122 and Pak Army (On right Portable Air Compressor and on left Angular Grinder)

2.1.10 Deployment of Resources

As the monsoon season approached, PDMA took proactive measures by deploying resources to strategically vulnerable locations and mobilizing the necessary human resources to ensure a timely and effective response to any potential emergencies. These resources included essential items such as rescue boats, medical supplies, food hampers, drinking water, and shelter materials, all aimed at mitigating the impact of floods or other monsoon-related disasters. Rescue 1122 teams and local authorities were placed on high alert, ready to respond swiftly to any crisis.

(a) (b)

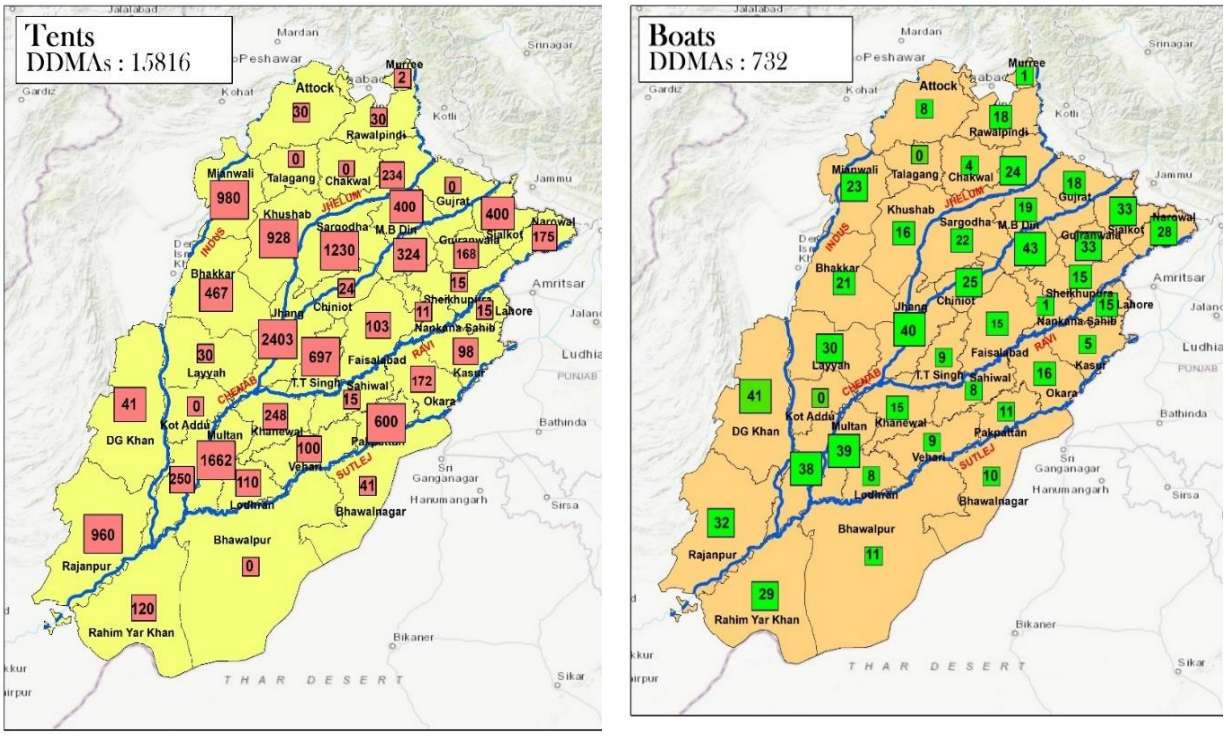


Figure 2.13 Maps of (a) Tents (b) Boats deployed in all the districts of Punjab. (*Source: GIS Team, PDMA, Punjab*)

2.1.11 Early Warning

The Provincial Emergency Operations Center (PEOC) at PDMA Punjab serves as a central hub for disaster management activities, particularly during the monsoon season and flooding events. The PEOC coordinates with various departments, such as the Flood Forecasting Center (FFC), District Emergency Operations Centers (DEOCs), and the National Emergency Operations Center (NEOC), to ensure the timely dissemination of early warnings and effective response to flood risks. Equipped with advanced technology and communication tools, the PEOC monitors real-time data on weather conditions, river levels, and flood risks to make informed decisions. It also connects with key agencies like the Pakistan Meteorological Department (MET), National Disaster Management Authority (NDMA), and local district administrations, facilitating a streamlined response to emergencies.

The DEOCs, established at the district level, play a crucial role in executing the directives from the PEOC by engaging local authorities and resources. These centers provide real-time situational reports and communicate the needs and actions required at the district level to mitigate the impact of disasters. DEOCs also ensure that early warnings issued by the PEOC reach vulnerable communities through multiple communication channels such as WhatsApp, telephone hotlines (like the 1129 helpline), and social and electronic media. This decentralization of operations enables timely and localized responses, ensuring a swift and coordinated approach to disaster management.

Figure 2.14 Working of PEOC and DEOC, PDMA

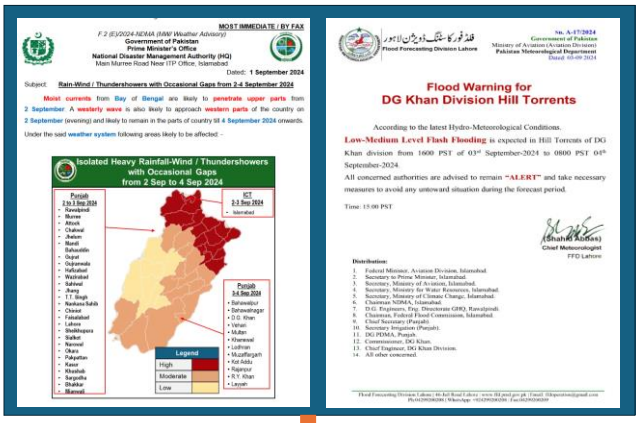
The Flood Forecasting Center (FFC) provides critical input to both the PEOC and DEOCs by monitoring hydrological data and forecasting potential flooding scenarios. Using advanced forecasting models and satellite data, the FFC helps predict riverine floods and other hydro-meteorological risks, giving ample lead time to issue early warnings. During the monsoon season,

FFC's data plays an instrumental role in identifying at-risk areas, allowing for targeted actions such as evacuations, infrastructure fortification, and resource mobilization. Through this collaboration between PEOC, DEOCs, and the FFC, the province ensures a robust flood management system, mitigating the adverse effects of heavy rainfall and floods.

Throughout the monsoon season, PDMA ensured the continuous dissemination of early warnings, working in close collaboration with National Disaster Management Authority (NDMA), Pakistan Meteorological Department (PMD), and other stakeholders. Weather updates, flood warnings, and evacuation alerts were broadcasted via multiple channels including SMS, radio, television, and social media. Real-time monitoring of river discharges and rainfall data was conducted, enabling timely alerts for at-risk communities.

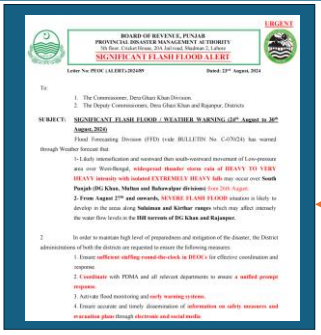
- The Provincial Emergency Operations Center (PEOC) at PDMA Punjab receives early warnings, alerts, and advisories about weather conditions such as rain, thunderstorms, and floods from NDMA and PMD.
- The PEOC cross-verifies this information using various weather models, including the Windy weather forecasting service and the Ventusky weather visualization platform developed by companies in the Czech Republic.
- The initial forecasts from NDMA and PMD come through WhatsApp, emails, and fax.
- After confirming the information through these diverse weather models, the PEOC of PDMA issues the necessary weather or flood alerts and advisories to the administrations of the affected districts.
- These alerts are also disseminated via social media platforms (Twitter, Instagram, official PDMA WhatsApp groups), the official website (www.pdma.gop.pk), and SMS to the vulnerable populations.
- Public awareness campaigns are further supported through announcements in mosques and distribution of printed pamphlets, ensuring the community remains informed and prepared to act.

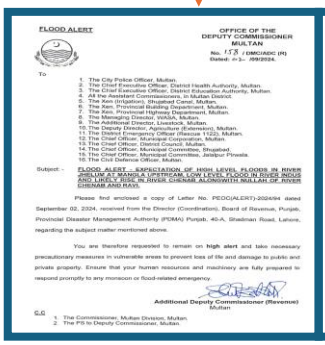
Weather alert/advisory from NDMA / PMD



PEOC (PDMA) issues the weather or flood alerts/advisories to respective (vulnerable/concerned) districts' administrations.

Published and issued on social media (Twitter, Instagram, official PDMA whatsapp groups) and official website (www.pdma.gop.pk)





District administration forwards the alert/advisory to concerned departments

Announcements through mosques

Establishment of relief and medical camps (if required)

Info/alert banners

2.1.12 MHVRA and Flood Simulation Model (FSM)

The Multi-Hazard Vulnerability Risk Assessment (MHVRA) conducted by the PDMA Punjab serves as a scientific basis for disaster planning and risk management. The MHVRA data was utilized for emergency preparedness, and risk reduction, offering a detailed understanding of hazard exposure and the communities at risk. One of the notable outputs of the MHVRA study was the district-level vulnerability assessments, which provide a complete risk profile for 20 districts of Punjab. The MHVRA continues to serve as a key resource for provincial and district authorities, enhancing disaster preparedness and resilience across the Punjab. Additionally, PDMA developed a Flood Simulation Model to better predict flood impacts and plan mitigation efforts.

Figure 2.15 Flood Simulation Model Dashboard

CHAPTER 3
Impact Analysis – Monsoon/Flood 2024

3. Impact Analysis – Monsoon/Flood 2024

During the 2024 monsoon season, cities like Lahore, Rawalpindi, Sialkot, Gujrat and Multan faced severe flooding due to unprecedented rainfall. The bar chart depicting the accumulated rainfall for June, July, and August 2024 highlights significant variations across different stations in Punjab. Lahore recorded the highest rainfall at 944 mm, followed by Chaklala Airbase with 766 mm, and Islamabad with 755 mm. Sialkot received 586 mm, while Multan experienced 349 mm of accumulated rainfall exceeding usual normal levels. The overall monsoon season experienced Punjab receiving 30% above normal rainfall and Lower Punjab, where Multan is located, witnessing a 36% increase over normal rainfall levels (Figure 3.1).

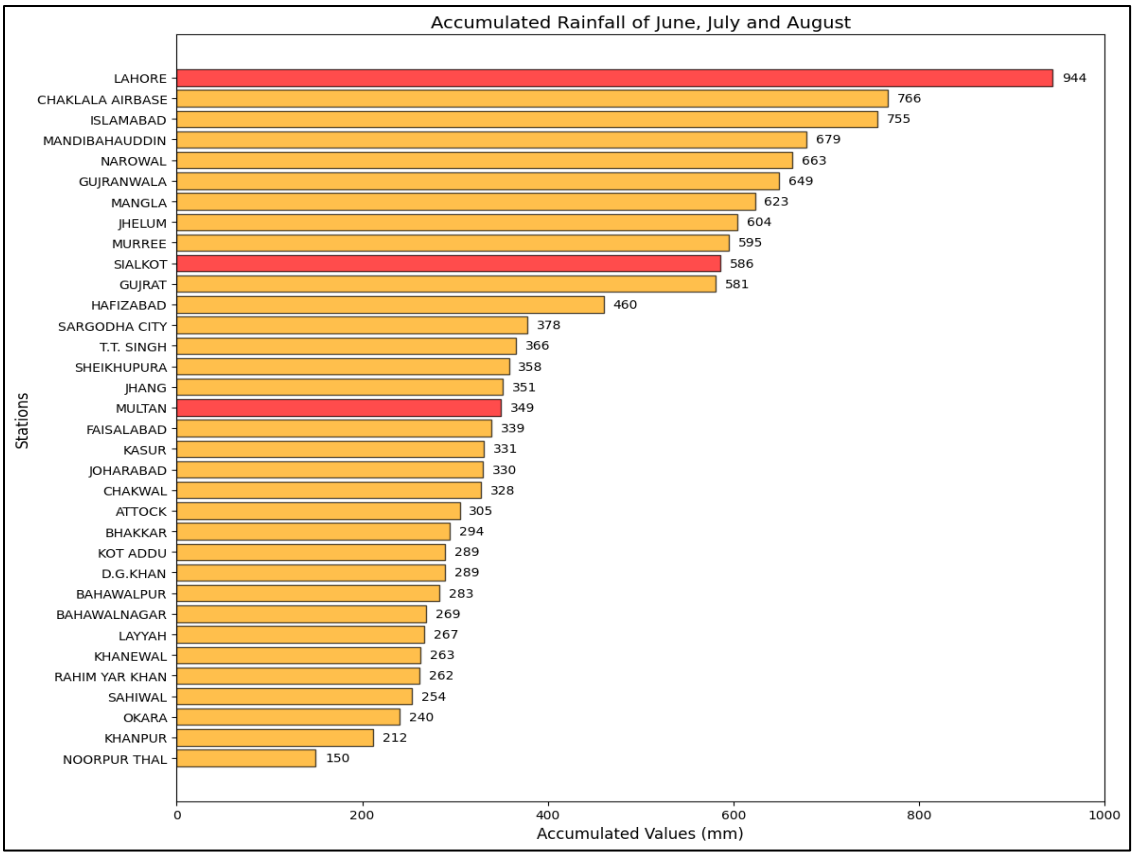


Figure 3.1 Seasonal Accumulative Rainfall in Major Cities, 2024 Monsoon. (*Source: PMD, Lahore*)

Drawing from historical data, PDMA has divided floods into three categories i.e. Riverine, Urban, and Flash Flooding in Hill Torrents and Nullahs. Additionally, districts were further categorized according to the intensity and scale of vulnerability for better planning, preparedness, and response. By classifying these flood types, PDMA with support of DDMAs adopted a targeted approach to address the specific challenges and risks associated with each type, ensuring a more efficient and effective flood management. This categorization was also crucial for better resource allocation, EWS, and disaster response. The types of floods that cause damage in Punjab are mentioned below:

3.1 Riverine Flooding

Spatial categorization of Riverine flood prone districts and intensity of vulnerability are shown in Figure 3.2

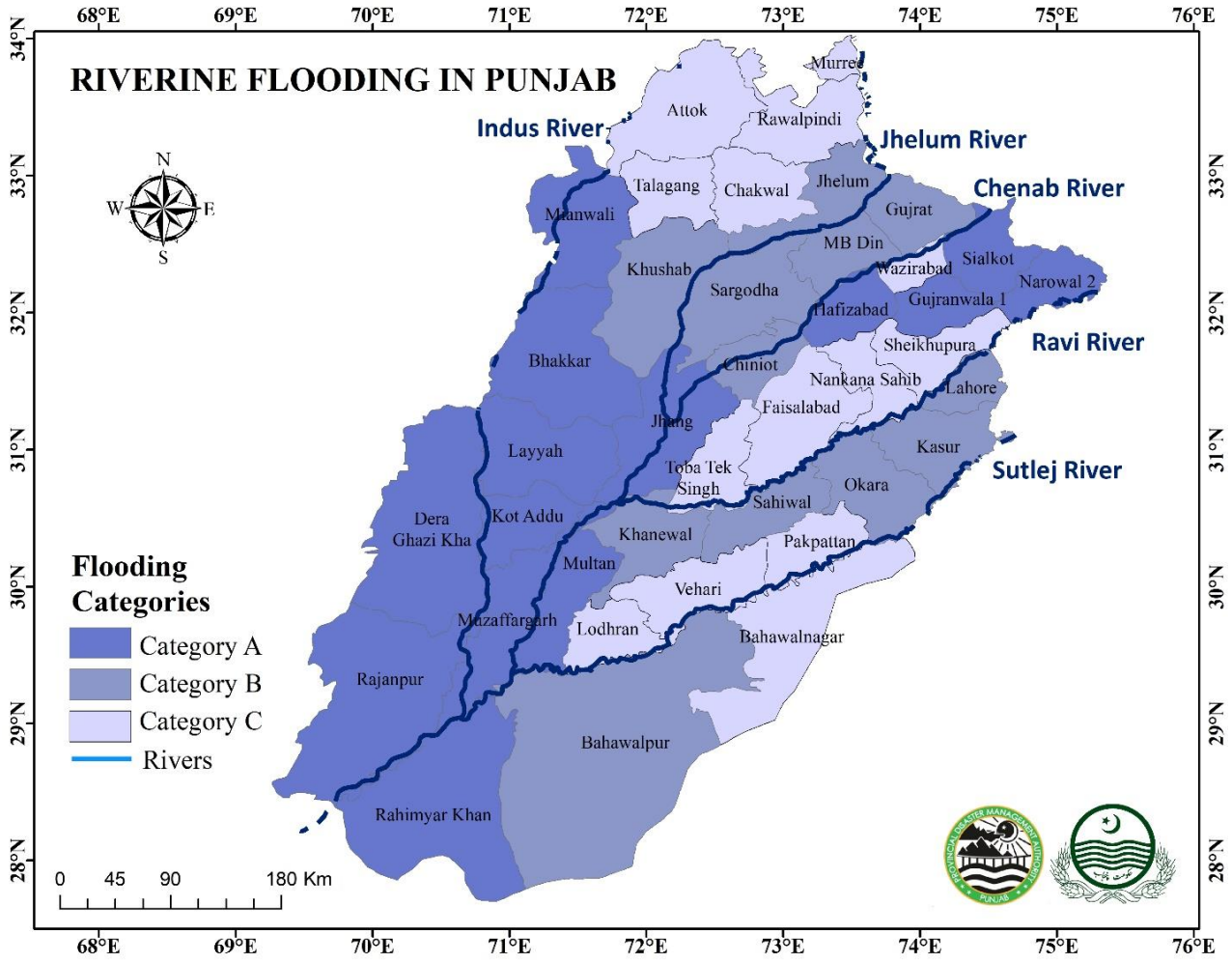


Figure 3.2 Riverine Flooding Prone Districts in Punjab (*Source: GIS Team, PDMA, Punjab*)

The Indus River, which receives combined flows from the Kabul and Indus rivers, poses another major challenge. The highest water flow levels in the Indus River were recorded sequentially at Chashma, Kalabagh and Taunsa, as depicted in Figure 3.3. Consequently, due to these elevated water levels. Five districts experienced impacts: Mianwali, Kot Addu, Rajanpur, DG Khan and Rahim Yar Khan.

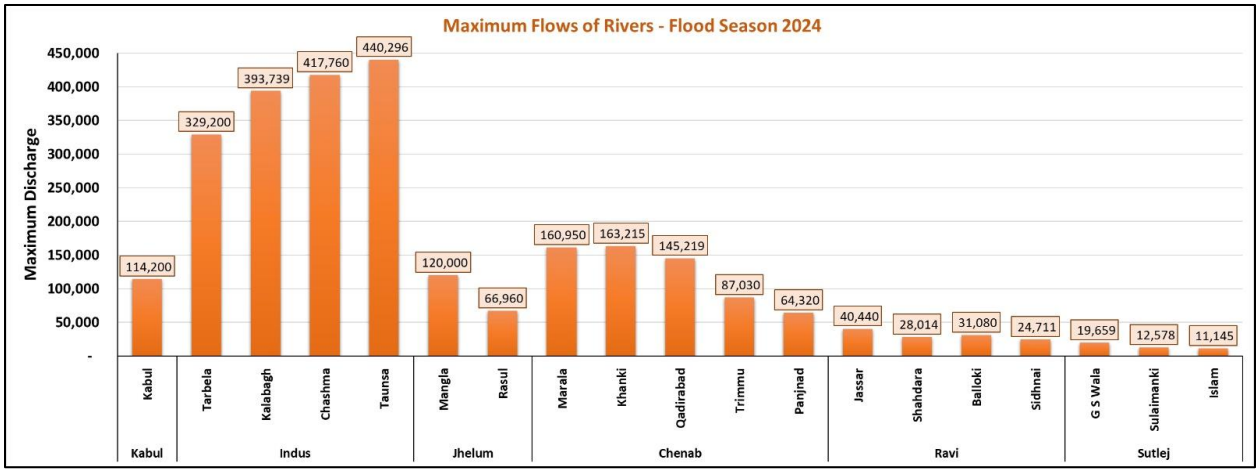


Figure 3.3 Maximum Discharge Flows of Rivers – Flood Season 2024 (*Source: PMD, Lahore*)

3.1.1 Impact and Response to Riverine Flooding

Due to riverine flooding at the Indus River, the bund in Kot Addu was damaged (Figure 3.4). However, PDMA responded swiftly to the situation by coordinating repair efforts and deploying resources to mitigate further damage.

Figure 3.4 J- Head Spur RD 34+000 Magasan Flood Bund on River Indus D/S Taunsa Barrage (*Source: Irrigation Department, Lahore*)

Heavy riverine flows caused inundation of following mauzas falling within flood plain in various districts, which were responded by PDMA/DDMAs promptly.

Districts	Villages/Mauzas	Persons Affected	Rescued / Evacuated	Relief Camps
Layyah	56	2208	492	21
Mianwali	10	73	49	6
DG Khan	3	250	0	14
Kot addu	3	1800	1700	2
Rajanpur	2	0	179	9
Total	74	4331	2420	52

Table 3.1 Rescue and Relief Data for Riverine Flooding Affectees.

3.2 Urban flooding

Urban flooding in Punjab is a complex and growing problem that requires a comprehensive approach to mitigate its effects. The increasing intensity of urban floods is largely due to inadequate infrastructure, inefficient land use, concretization of cities, encroachments on natural drainage routes, rapid urbanization, and poor waste management. Spatial categorization of Urban flood prone districts and intensity of vulnerability are shown in Figure 3.5.

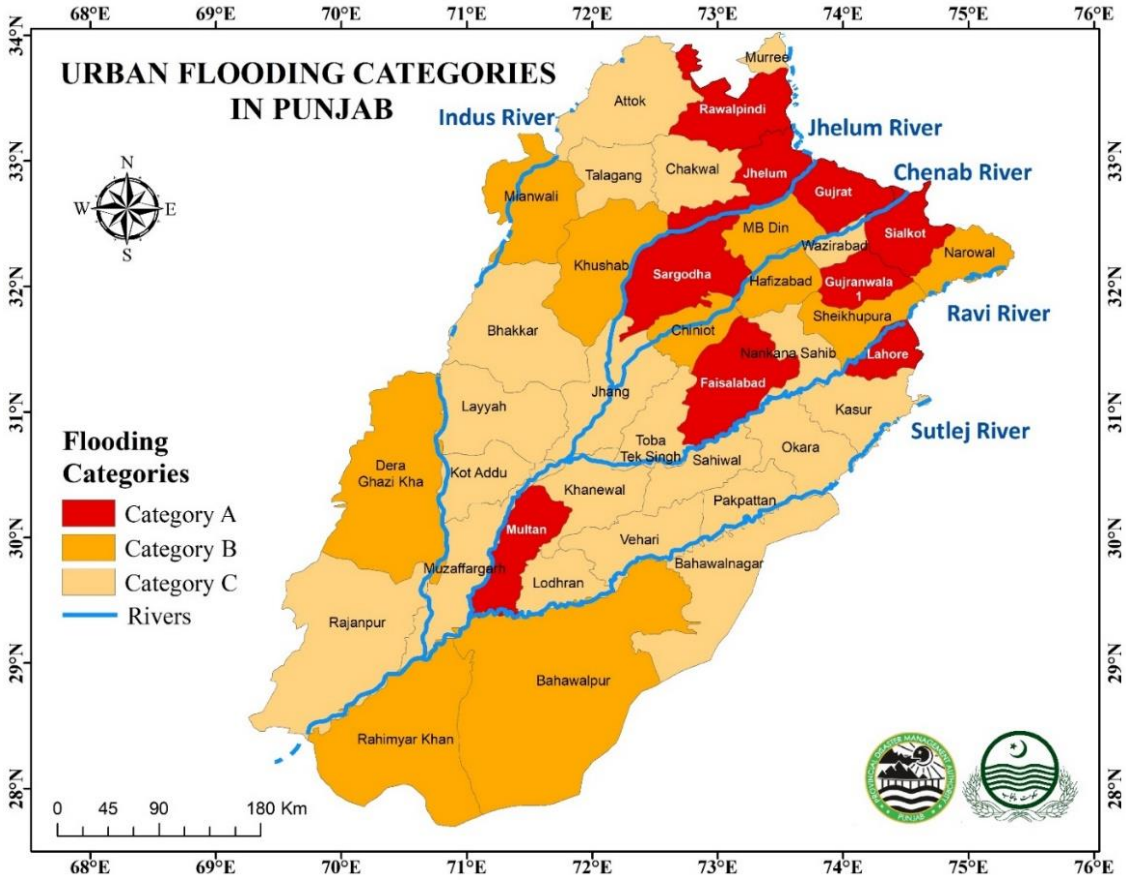


Figure 3.5 Urban Flooding Prone Districts in Punjab (*Source: GIS Team, PDMA, Punjab*)

The affected regions, as identified by recent flood maps, include Rawalpindi, Jhelum, Gujrat, Sialkot, Gujranwala, Sargodha, Faisalabad, Lahore, and Multan. These districts regularly experience frequent and intense urban flooding, which negatively impacts infrastructure, residential areas, and commercial zones. The varying discharge capacities of local nullahs, such as Nullah Aik and Nullah Deg, underscore their critical role in these flooding events as shown in Figure 3.6. During heavy rainfall, these watercourses often overflow, causing significant damage to the adjacent urban areas. The unprecedented rains during the 2024 monsoon season in cities such as Lahore, Rawalpindi, Sialkot, Gujrat and Multan caused widespread disruptions, with urban flooding emerging as a critical challenge. In Lahore, rainfall reached an astonishing 944 mm, nearly double the typical seasonal levels. This extreme precipitation caused overflow of city's

drainage systems, leading to severe urban flooding. The heaviest one-day rainfall was recorded on August 1st at Lahore Airport, with a staggering 337.0 mm, making it the wettest location with a monthly total of 603.0 mm.

Sialkot also faced significant challenges, receiving 586 mm of rainfall. The city's flooding was further exacerbated by the overflow of local nullahs, which frequently flood during heavy rainfall events. Key nullahs like Nullah Aik, which exhibited the highest water flow, and Nullah Deg, which ranked third in terms of maximum discharge, played a critical role in the urban flooding. Other nullahs, such as Nullah Bein in Narowal and Nullah Basanter, also contributed to the elevated water levels and subsequent flooding in surrounding areas.

While Multan experienced lower rainfall at 349 mm than expected, it still exceeded normal levels, leading to significant waterlogging and localized urban flooding. The combination of above-normal rainfall and insufficient drainage infrastructure resulted in severe disruptions in parts of the city.

This pattern of extreme rainfall and urban flooding highlights the urgent need for a proactive event-based disaster management strategy. Enhanced urban planning, improved flood forecasting systems, and more efficient drainage infrastructure are essential components in mitigating the risks posed by heavy rainfall and climate-induced weather events in these vulnerable urban areas.

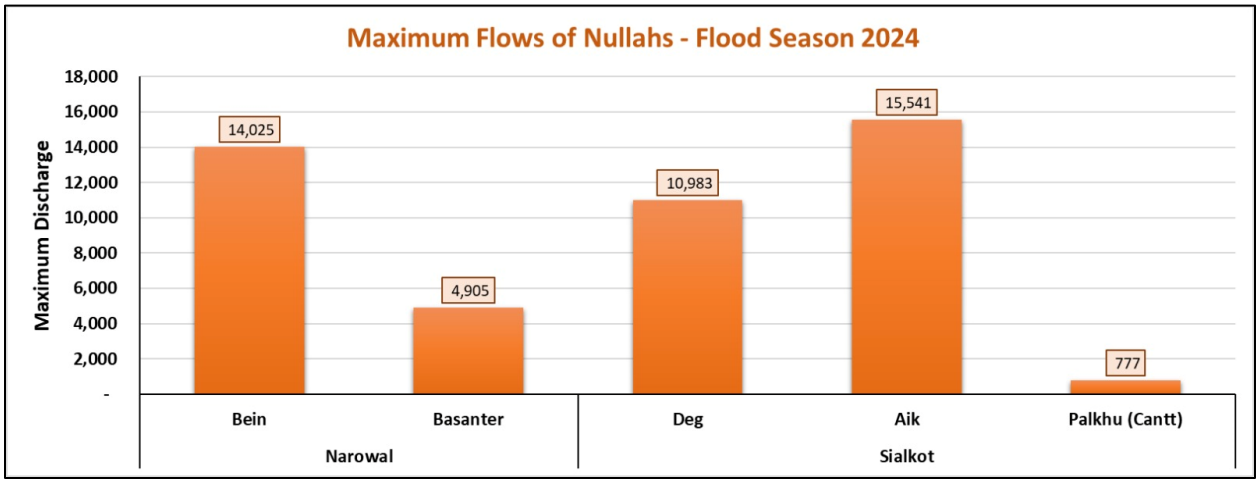


Figure 3.6 Maximum Flows of Nullahs – Flood Season 2024 (*Source: PMD, Lahore*)

3.2.1 Impacts and Response to Urban Flooding

During monsoon season, PDMA implemented an effective urban flood response through strategic coordination, resource mobilization, and proactive awareness campaigns. In collaboration with WASAs and Local Governments, PDMA optimized drainage systems in key districts like Lahore, Sialkot, and Multan to manage unprecedented rainfall. During urban flooding, emergency teams coordinated with WASAs in affected areas to manage standing water on the roads. They deployed dewatering sets and sucker machines to facilitate efficient drainage, effectively minimizing disruptions and reducing potential damage (Figure 3.7). This proactive approach helped restore normalcy in affected areas as quickly as possible. Comprehensive awareness efforts

through media and digital platforms educated the public on flood safety, significantly reducing casualties and losses.

Figure 3.7 Before and after monsoon rain in Multan: Efficient efforts of WASA and PDMA minimized the impacts of flooding and quickly restored normalcy.

Due to PDMA's proactive measures, particularly the special desilting efforts made before and during the monsoon season, Punjab effectively managed the challenges posed by heavy rains. The strategic pre-positioning of resources and timely alerts further contributed to minimizing losses throughout the season. Despite the challenges, no significant casualties were reported from flooding. The proactive approach also reduced damage to crops and riverbanks, and potential flooding was swiftly controlled. Isolated incidents of structural collapses, sky lightning, drowning and electrocution caused fatalities, but immediate compensation was provided to the affected families, underscoring the success of PDMA's pre-monsoon strategies.

In the aftermath of the floods, PDMA conducted thorough assessments of losses, focusing on houses and livestock ensuring compensation for affected farmers and residents. This coordinated response highlighted PDMA's preparedness and ability to mitigate the monsoon's impact.

Sr. No.	Districts	Deaths	Injuries	House Damages	Cattles Perished
1	Muzaffargarh	3	11	5	-
2	Bhakkar	1	9	5	-
3	Lodhran	5	1	2	-
4	Sheikhupura	10	50	20	-
5	Sargodha	2	20	10	-
6	Chakwal	3	1	1	27
7	Rajanpur	8	14	146	-
8	Bahawalpur	4	11	4	-
9	Multan	12	30	17	-
10	Toba Tek Singh	-	-	-	-
11	Sialkot	9	14	9	1
12	Sahiwal	1	7	6	-

13	Rahim Yar Khan	11	6	4	-
14	Bahawalnagar	6	22	10	-
15	Dera Ghazi Khan	6	3	3	-
16	Faisalabad	16	56	25	5
17	Chiniot	1	3	1	17
18	Jhang	2	11	3	-
19	Gujranwala	6	35	19	2
20	Gujrat	4	16	12	-
21	Hafizabad	-	-	-	-
22	Mandi Bahauddin		2	2	-
23	Narowal	3	11	6	-
24	Lahore	13	33	7	-
25	Kasur	10	19	11	-
26	Nankana Sahib	-	14	5	-
27	Khushab	5	2	-	-
28	Khanewal	2	13	4	18
29	Vehari	3	12	5	-
30	Rawalpindi	11	1	7	-
31	Jhelum	4	2	1	17
32	Attock	4	2	1	-
33	Pakpattan	1	4	1	-
34	Okara	3	4	1	-
35	Mianwali	-	-	2	-
36	Layyah	1	9	2	36
37	Murree	1	1	1	-
38	Wazirabad	2	1	2	-
39	Kot Addu	5	5	3	-
40	Talagang	1	--	1	-
Total		179	455	364	123

Table 3.2 Count of deaths, injuries and House damaged due to roof collapse in all districts of Punjab (*Source: DEOCs*)

Khushab

Sheikhupura

Rahim Yar Khan

Multan

Sialkot

Daska - Sialkot

Figure 3.8 Distribution of Compensation Cheques

3.3 Flash Floods in Hill-torrent

Map of Hill Torrents in Punjab highlights the areas prone to flash floods caused by rapid water accumulation from surrounding hills, particularly in Dera Ghazi Khan, Rajanpur, Mianwali, and Khushab districts. These regions, adjacent to the Suleiman Mountain Range, were vulnerable to high-velocity floodwaters during heavy rainfall, causing significant damage.

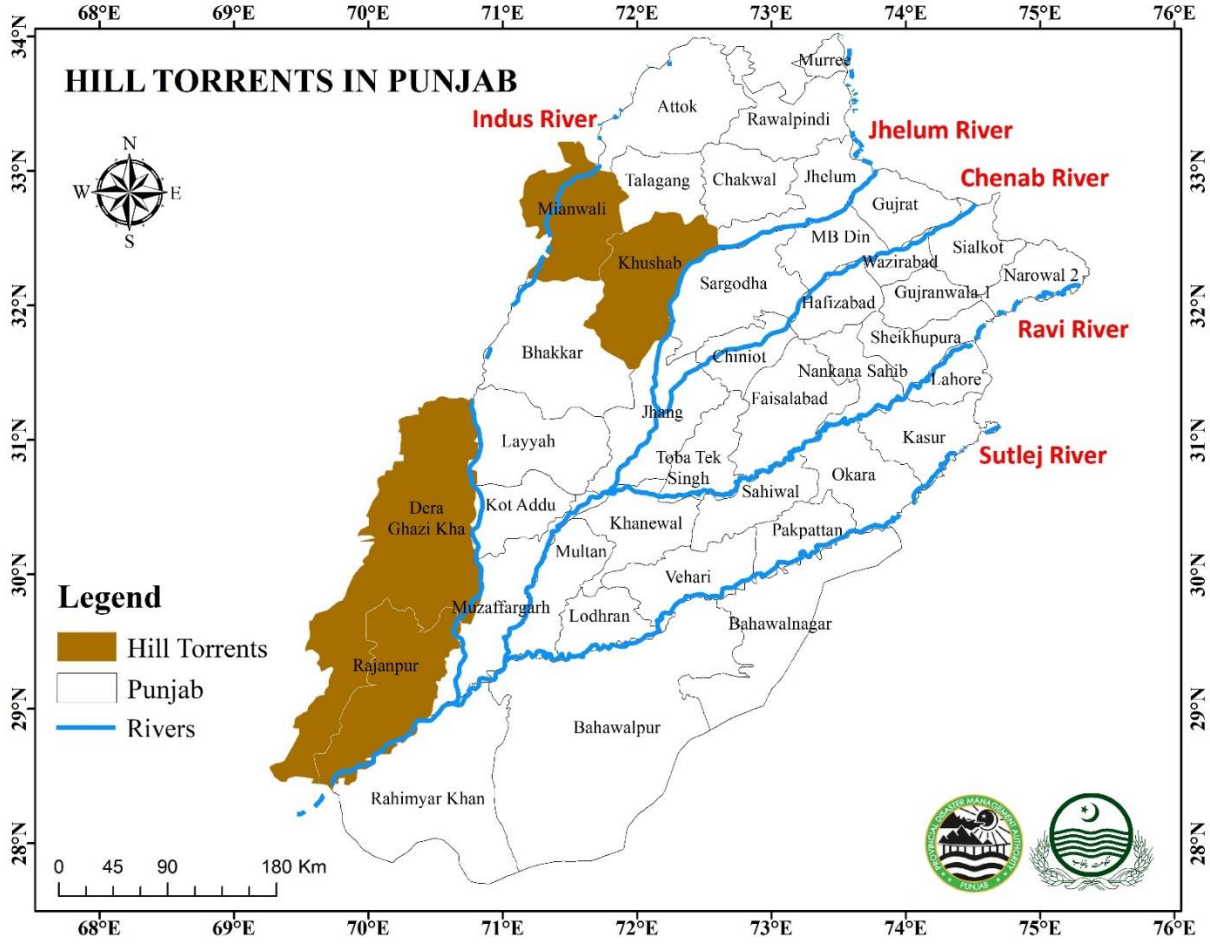


Figure 3.9 Hill Torrents Districts of Punjab (*Source: GIS Team, PDMA, Punjab*)

In Punjab, over 200 hill torrents originate from the Suleiman Range, with 14 of these being major, evenly divided between the Dera Ghazi Khan and Rajanpur districts. These torrents generate high-velocity floodwaters that pose a serious threat to public and private infrastructure.

The flood water from these torrents spread into the Pachad area and, after passing through the cross-drainage networks (cause ways) of the Kachhi and D.G. Khan canals, eventually drain into the Indus River. Hill torrents prone districts are shown in Figure 3.9. Pitok and Zangi in Rajanpur show a consistent and notable rise in flow over time (Table 3.3). Pitok increased from its historic peak of 5,000 Cs in 2010 and 2022 to 14,600 Cs in 2024, indicating a substantial rise in water flow over recent years. Similarly, Zangi's flow jumped from 3,310 Cs in 2010, to 9000Cs in 2022 surge to 33,600 Cs in 2024, a significant surge that underscores increasing water volumes in

the torrent. In contrast, the remaining hill torrents like Kaura, Vehova, and others, exhibit fluctuations with no consistent pattern of increase. Some torrents, such as Vidore and Kaha, reached high flow levels in 2022 but decreased slightly in 2024.

Among the hill torrents in Rajanpur, the highest flow is observed in the Kaha, followed by Kala Bagga Khosra and Sori Janobi. These hill torrents, with their substantial water flow, can lead to severe flooding and infrastructural damage in the downstream areas. In the DG Khan region, Vadore hill torrent shows the highest flow, followed by Vehova. These hill torrents are critical in flood management due to their significant discharge capacities, which can contribute to flooding in surrounding areas when they overflow.

Hill Torrent	Historic Peak (Cs)	2024	Districts
Kaura	140000 (2015)	23747 Cs	DG Khan
Vehova	149405 (2015)	41364 Cs	
Sanghar	229000 (2010)	47403 Cs	
Sori Lund	97710 (2013)	39758 Cs	
Vidore	145101 (2012)	75589 Cs	
Sakhi Sarwar	32643 (2010)	29701 Cs	
Mithawan	61905 (2010)	26615 Cs	
Kaha	96000 (2013)	105276 Cs	Rajanpur
Kala Bagga	27640 (2024)	27640 Cs	
Chachar	65000 (2013)	63940 Cs	
Pitok	5000 (2010)	14600 Cs	
Suri Shumali	7150 (2010)	5845 Cs	
Zangi	3310 (2010)	33600 Cs	
Suri Junubi	4320 (2013)	16560 Cs	
Chichali	10500 (2016)	5115	Mianwali
Adwala	7000 (2022)	9350	
Baroch	20000 (2022)	8634	

Table 3.3 Trends in Peak Water Flow of Major Hill Torrents in D.G. Khan and Rajanpur, 2022 & 2024.
(Source: Irrigation Department, Punjab)

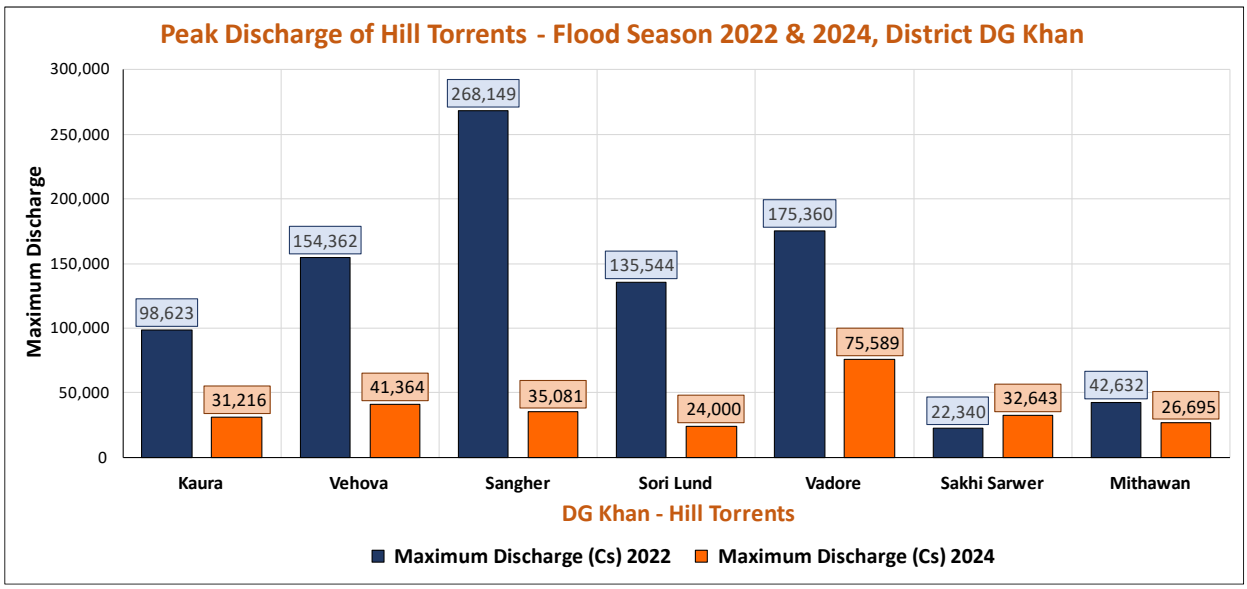


Figure 3.10 Figure showing comparison of Maximum Discharge flows of Hill torrents in DG Khan in years 2022 and 2024. (*Source: PMD, Lahore*)

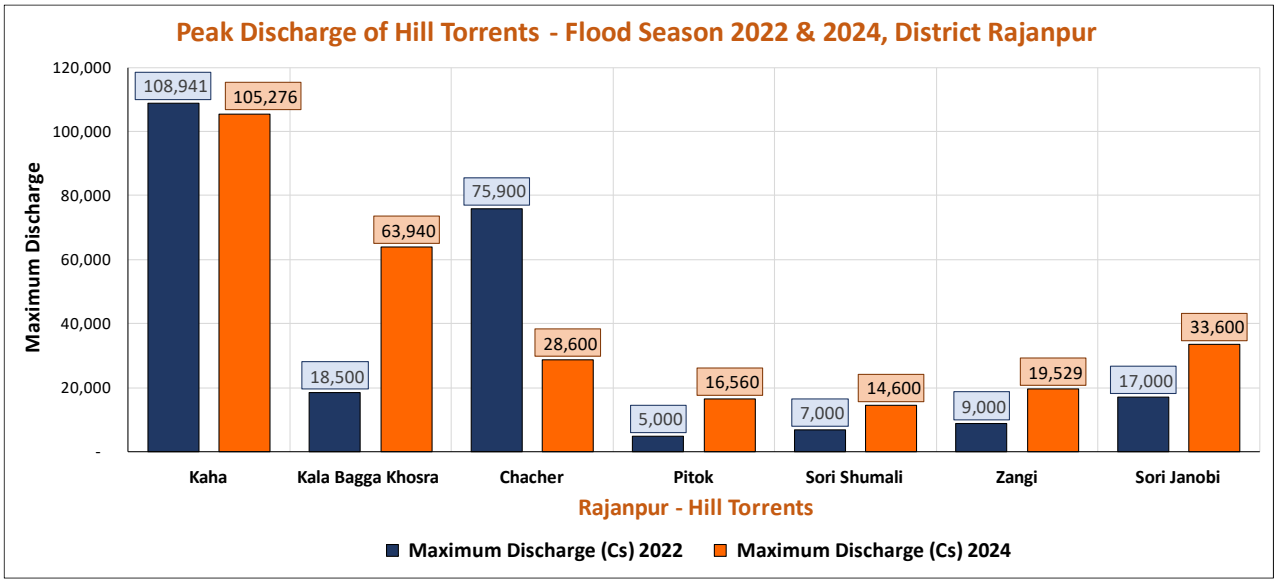


Figure 3.11 Figure showing comparison of Maximum Discharge flows of Hill torrents in Rajanpur in years 2022 and 2024. (*Source: PMD, Lahore*)

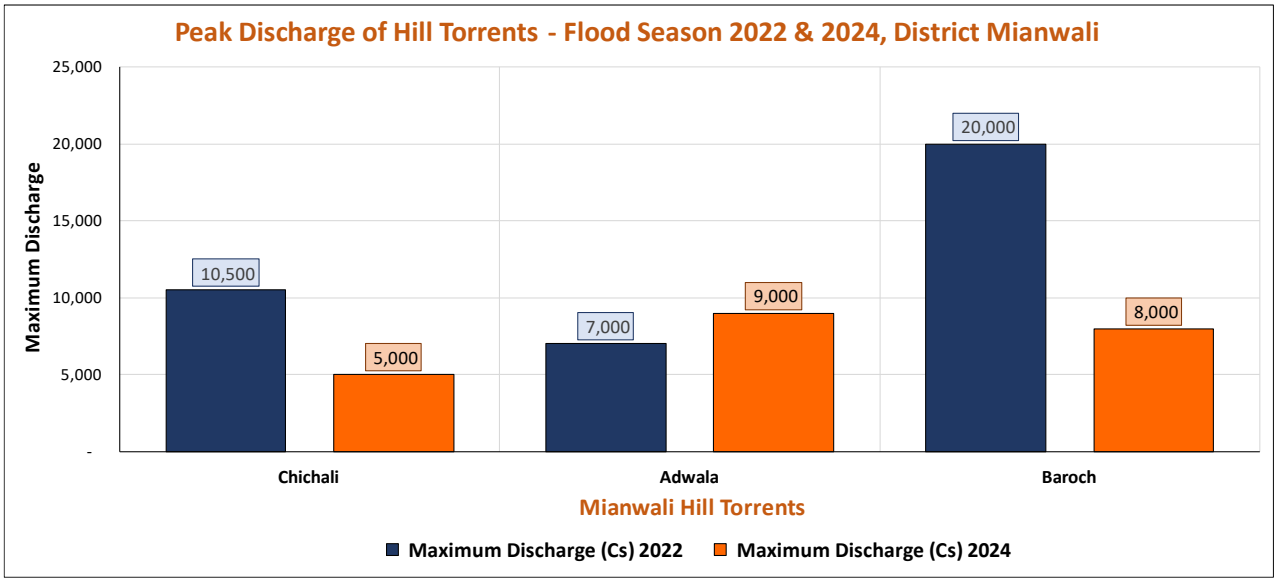


Figure 3.12 Figure showing comparison of Maximum Discharge flows of Hill torrents in Mianwali in years 2022 and 2024. (*Source: PMD, Lahore*)

3.3.1 Impacts and Response to Hill Torrents

During Hill torrent, The Minister of Disaster Management, accompanied by the DG PDMA, conducted several field and monitoring visits to vulnerable districts. During these visits, they assessed the condition of flood barriers, embankments, and evacuation routes, ensuring all protective measures were in place ahead of the monsoon season. Similarly, the Chief Minister and DG PDMA engaged with local authorities, reviewed the on-ground implementation of contingency plans, and addressed any gaps in preparedness in Rajanpur, which is particularly prone to flooding. These field visits highlighted the government's commitment to safeguarding vulnerable communities, while reinforcing coordination between provincial and district-level disaster management teams.

Enhancing the capacity of the Musharaf Drain and the drains of Vidore hill torrents, such as Old Manka, Drain-1, and Kapper, will ensure the safe and timely passage of floodwaters, reducing the risk of flooding around vulnerable cities like Rojhan.

Figure 3.13 Minister Disaster Management and DG PDMA Visit to Rajanpur District

Districts	Hill Torrents	Tehsils	No. of Relief Camps	Total Number of persons evacuated	Total Number of Rescued persons	No. of Affected Mauzas
DG Khan	Kaura	Taunsa Sharif	3	0	0	0
	Vihova		2	0	0	0
	Sanghar		3	0	0	0
	Sori Lund	DG Khan	4	0	0	0
	Vidore		5	0	0	0
	Sakhi Sarwar	Kot Chutta	5	0	0	5
	Mithawan					
TOTAL			**22**	**0**	**0**	**5**
Rajanpur	Kaha	Jampur	5	55	690	65
	Kala bagha khosra					
	Chachar	Rajanpur	5	2266		39
	Sori Janubi					
	Sori Shumali					
	Pitoke	Rojhan	6	2063		24
	Zangi					
TOTAL			**16**	**4384**	**690**	**128**
Mianwali	Chichali	Isa Khel	2	0	0	13
	Adwala		1	26	26	
	Baroch		3			
TOTAL			**6**	**26**	**26**	**13**

Table 3.4 Rescue and Relief Data of Hill Torrents Affectees

3.4 Media Alerts during Monsoon - 2024

PDMA reinforced its efforts with ongoing media campaigns to keep the public informed about the evolving situation. These campaigns provided regular updates on potential flood threats, safety measures, and actions to take during evacuation. Local media outlets were leveraged to ensure maximum reach, especially in remote areas.

Figure 3.14 PDMA Media Alerts for Early Warning Dissemination

CHAPTER 4

Lessons Learnt

4. Lessons Learnt

4.1 Strengthening of EWS and Upscaling of MHVRA

The effectiveness of the PDMA's early warning system and risk assessment is significantly compromised due to outdated MHVRA data and the lack of modernized EWS. Since the last MHVRA conducted in 2018, no updates have been made, rendering the risk assessment inadequate for disaster planning and management. Furthermore, the EWS struggles with key challenges, including insufficient information on household locations for data dissemination and outdated communication methods. This makes it difficult to deliver timely and widespread warnings to communities at risk. There is a pressing need to develop rapid, efficient systems and channels for delivering warnings through modern platforms, including automated notifications, community networks, and integrated public notification systems.

Following solutions aim to upgrade data for risk assessment, strengthening EWS, and build community resilience against future disasters.

- Upgrading and Operationalization of Existing MHVRA
- Strengthening the data center of PDMA to ensure a more responsive system
- Risk Assessment and mapping of disaster events such as urban flooding, Hill Torrents, Riverine flooding etc
- Real-Time Tracking of Boats, Flood-Fighting Machinery, and Equipment by using of satellite-based tracking system
- Development and Implementation of Digital Modules for effective Dissemination of Information and Early Warning
- Sensitization of Vulnerable Communities through imparting multi-layered training programs, Distribution of disaster related literature in local language, Issuance of guidelines for construction of houses/buildings on built-back-better policies.
- Capacity Building of PDMA’s PEOC and DEOCs through provision of technical resources and modern tools/gadgets for long term sustainability

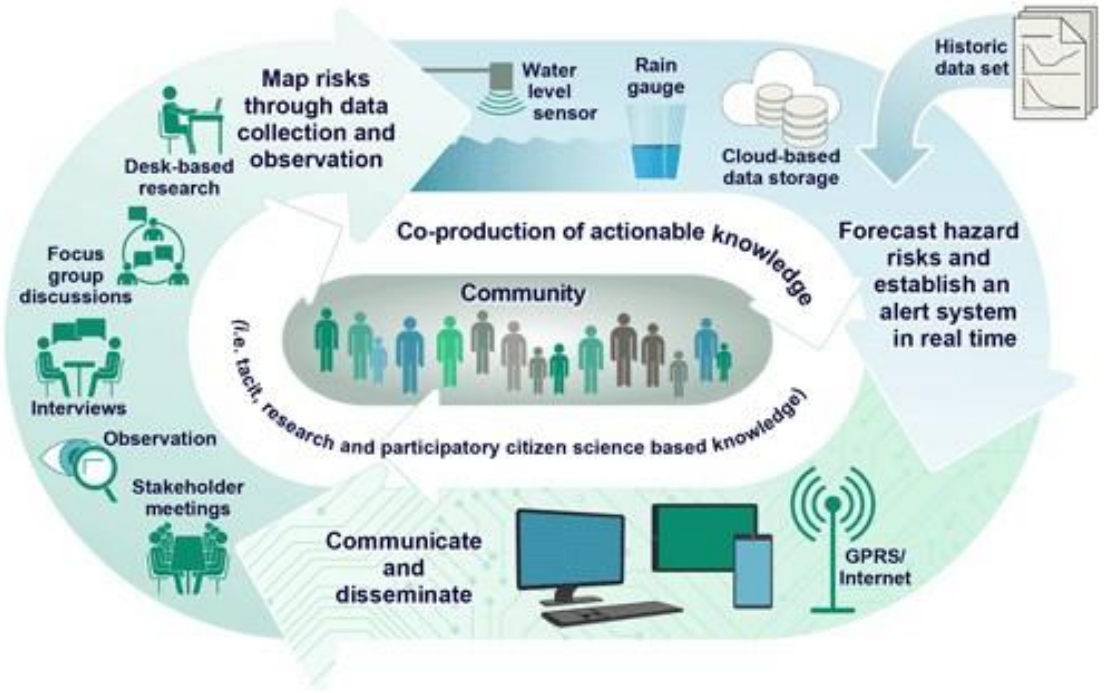


Figure 4.1 A Framework for Real-Time Risk Mapping, Forecasting, and Communication to Strengthen Disaster Resilience and Response Capabilities

4.2 Digitization of Rain Measuring Gauges

Punjab faces significant challenges in effective rainfall monitoring, which is crucial for disaster mitigation, preparedness and risk reduction. PDMA currently relies on a traditional network of rain gauge data gathered from the PMD and the Irrigation Department. This data is often inconsistent and inaccurate due to several factors, including insufficient gauge coverage and variability in the maintenance and calibration of the instruments. These issues lead to delayed data collection and reporting, impairing PDMA's ability to make timely, informed decisions during extreme weather events such as floods, and weakening its capacity to provide early warnings to vulnerable communities.

To address these challenges, digitizing rain measuring gauges in Punjab is a crucial step toward enhancing the accuracy and availability of rainfall data across the province.

Key strategies for achieving this include:

- Replacing traditional gauges with automated digital gauges that feature real-time data logging and transmission capabilities.
- Establishing a comprehensive network of gauges at different locations in Punjab particularly in remote and underserved areas, to ensure adequate data representation.
- Developing standardized procedures for the regular maintenance and calibration of all monitoring instruments to ensure consistent data quality.

The digitization of rain measuring gauges will enable PDMA to make data-driven decisions for improved disaster management, enhancing EWS and reducing risks to communities.

Figure 4.2 Rain Measuring Gauges.

4.3 Real-Time Monitoring of Hydrological Gauges across Barrages and River through digitization

Fourteen manual hydrological gauges have been deployed across barrages and rivers in Punjab, collecting inaccurate and inconsistent data due to human errors and telecommunication issues, particularly in remote areas and in times of disasters. This hinders PDMA's ability to respond effectively in such critical situations when timely data is necessary for effective response and management.

To overcome these challenges, the digitization of hydrological gauges is essential for real-time monitoring. Key strategies for digitizing hydrological gauges include:

- Transitioning from manual gauges to advanced digital gauges that provide real-time data
- Implementing a centralized data management system that consolidates information from all digital gauges, enabling comprehensive monitoring and analysis.
- Improving telecommunication systems to ensure reliable data transmission, to facilitate timely updates during emergencies

By digitizing rainfall gauges, PDMA can enhance its ability to make informed decisions and effectively manage flood risks, ensuring better protection for communities across Punjab.

Figure 4.3 Transitioning to Digital Hydrological Gauges for Real-Time Flood Monitoring

4.4 Protection of Local Abadees from River Erosive Action

Local abadees have been constructed within floodplains, which exposes these communities to significant risks during flood events. The strategic placement of these settlements in low-lying areas, has resulted in increased vulnerability to flooding and erosion. As riverbanks erode and floodwaters rise, local abadees face threats to their infrastructure, livelihoods, and safety. The impact is particularly severe on households with limited resources to recover from disasters, leading to prolonged displacement and economic hardship

With the struggle of PDMA and Irrigation Department, eleven erosion action schemes have been approved in few districts that are designed to protect the lives and livelihoods of local settlements. To overcome the problem of erosion, it is essential to develop additional schemes and conduct in-depth indemnity and feasibility studies across all major rivers for long term resilience. These studies will assess future erosion risks, ensuring that the implemented measures remain effective in the face of evolving environmental conditions and climate change impacts.

Figure 4.4 Erosive Action Scheme in District Hafizabad (Left) and Chiniot (Right).

4.5 Sustainable Measures for Urban Flooding

To address the recurring issue of urban flooding in Punjab, PDMA has emphasized the need for long-term, sustainable strategies that go beyond short-term measures. A key solution identified is the implementation of rainwater harvesting systems to capture and store excess rainfall, reducing pressure on urban drainage networks during heavy downpours. When integrated into rooftops, parks, and public spaces, these systems can store water for non-potable uses like irrigation and cleaning or recharge local groundwater, benefiting both flood mitigation and resource conservation. In addition, PDMA has highlighted the importance of strict enforcement of building codes to ensure proper drainage and flood-resistant construction. Establishing recharge wells in open spaces and depressions, as well as constructing underground storage tanks in flood-prone hotspots, are essential measures that can significantly mitigate urban flooding risks.

Key strategies include:

- Strict enforcement of building By-Laws and Regulations
- Zoning of land use for water detention & recharge
- Detailed survey of urban centers by using Digital Elevation Model to Identify the natural gradient
- Fixation of plinth level & finish road level in particular local streets
- Development of depressed areas like greenbelts, public parks, grounds, open spaces etc.
- Regulation of Rain-Water detention/harvesting in Industrial areas and housing societies
- Introduction of Sponge city concept
- Public Awareness to create green spaces in courtyards, rooftops and introduction of Kitchen Gardening
- Massive Forestation

Figure 4.5 Rainwater Harvesting, Green Infrastructure, and Zoning for Long-Term Flood-Resilient Cities in Punjab