INFRASTRUCTURE GUIDELINE

FOR MONSOON 2025

NATIONAL DISASTER MANAGEMENT AUTHORITY

INFRASTRUCTURE ADVISORY & PROJECT DEVELOPMENT WING

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1 Monsoon Flooding: From Rain to Ruin

Pakistan is particularly vulnerable to flooding due to a combination of natural geographic conditions and human-induced factors, which together heighten the risk and severity of such events. The geographical location of the country in an area that is characterized by severe weather conditions plays an important role in its vulnerability to floods. Pakistan lies in a monsoon region and the seasonal southwest monsoon keeps the country in never-ending rainfall especially June to September every year. These rains are most times severe and prolonged causing an overall flooding due to the poor drainage capacities of the drainage systems and the infrastructure to handle them. Also, there is a huge system of rivers in Pakistan, one of which the Indus River, in combination with the tributaries may massively overflow in the event of heavy rains, contributing to the dangers of flooding. The flash floods are particularly susceptible especially in the spring and summer months with temperatures causing enhanced melting of the snow-capped mountains and glaciers found in the Northern parts of the country that will result in Glacial Lake Outburst Floods (GLOFs).

Besides geographical and climatic variables related to Pakistan, the effectiveness of anthropogenic factors that increased flood vulnerability is observed. The natural flood mitigation capacity has been highly undermined by urbanization in flood zones, deforestation and uncontrolled settlement creeping on the flood plains. The fast growth of urban area especially big cities like Karachi and Lahore, has resulted in wetlands and riverbed encroachment resultantly decimating the natural ability of these wetlands and riverbeds to absorb floods. Moreover, the inability of unproductive urban planning and poor drainage system has contributed to vulnerability of urban areas to waterlogging and floods during heavy precipitations. The impact of floods is also increased through the reduction of soil retention capacity because of de-forestation in the catchment of the major rivers, which increases the vulnerability of the land to the force of erosion and sedimentation. Climate change comes in to make the situation in Pakistan very sensitive since the rate, at which weather changes were increasing has contributed to the weather being unpredictable with the occurrence of more intense and erratic monsoons making the flood even more frequent and severe. The hilly nature of the country which experience landslides and the urban areas developed by the river side increases the chances of flash floods and urban flooding in case of extreme weather conditions.

Sindh was the most heavily affected, with 1,885,029 houses damaged and the destruction of 8,389 kilometers of roads and 165 bridges. Key districts such as Dadu, Larkana, Khairpur and Thatta experienced widespread devastation, hampering relief and recovery operations and stalling economic activities. Similarly, KPK experienced significant infrastructure damage, with 91,464 houses destroyed and 1,575 kilometers of roads and 107 bridges either severely damaged or completely destroyed. The mountainous regions of Swat, Dir, Chitral and Nowshera were particularly vulnerable to flash floods and landslides.

Punjab also faced considerable destruction, with 67,981 homes damaged and 877 kilometers of roads and 15 bridges disrupted. The southern districts of Punjab, including DG Khan, Rajanpur and Muzaffargarh, sustained extensive damage. Balochistan, too, witnessed widespread devastation, with 241,659 homes damaged and more than 2,000 kilometers of roads and numerous bridges destroyed, particularly in the southern and central districts, where inadequate infrastructure and challenging terrain compounded the severity of the floods.

Although AJ&K and GB experienced relatively fewer damages in terms of the number of homes destroyed, both regions suffered significant disruptions. AJ&K reported 555 houses damaged, along with 19 kilometers of roads and 33 bridges affected. Flash floods and landslides, particularly in Muzaffarabad and Bagh, worsened the challenges in these areas. In GB, 1,793 houses were damaged and 33 kilometers of roads and 61 bridges were destroyed, with districts such as Ghizer, Hunza, Skardu and Diamer being particularly vulnerable to Glacial Lake Outburst Floods (GLOFs) and flash floods, given the region's susceptibility to rapidly melting glaciers and unstable slopes.

The 2022 floods also highlighted serious weaknesses in Pakistan infrastructure and disaster preparedness. Such incidents were eye openers to the necessity to take long-term precautionary actions to increase resilience to future floods. The ways to reduce the effects of such disasters include making sure that Pakistan invests in climate-resistant infrastructure, enhanced early warning systems and enhancement of flood plain management practices as we go into the 2025 monsoon season and beyond.

2 Districts Most Prone to Infrastructure Damages Against Floods

The Infrastructure Risk Atlas (2025), developed by the Infrastructure Advisory and Project Development (IA&PD) division of the National Disaster Management Authority (NDMA), serves as a critical tool for understanding and addressing the vulnerabilities within Pakistan's infrastructure landscape. This comprehensive resource offers a detailed spatial and structural analysis of the country's built environment, highlighting regions at elevated risk from natural disasters such as floods and earthquakes. One of the key features of the Atlas is its classification of residential buildings according to construction type ranging from mud and adobe structures to reinforced concrete and hybrid forms. This classification enables planners, engineers and disaster managers to assess the relative susceptibility of different housing typologies to structural failure during high-impact events.

The Atlas also offers a district-level resilience assessment, incorporating factors like population density, historical hazard exposure, and critical infrastructure distribution to provide insights into local capacity for disaster response and recovery, enabling targeted planning for reconstruction, retrofitting, and preparedness. The Infrastructure Risk Atlas (2025) strengthens Pakistan's institutional ability to anticipate infrastructure failures and prioritize interventions in the most at-risk areas, ultimately contributing to a more resilient and risk-informed development pathway. The following maps illustrate districts across various provinces that are most susceptible to severe infrastructure damage caused by flooding. These maps serve as a powerful visual tool, helping to clearly identify regions at higher risk, thus enabling effective and efficient disaster preparedness strategies. The aim of mapping out these flood-prone areas is not only to informs but also to enhances decision-making processes at both the policy and operational levels. Based on the Infrastructure Risk Atlas, following districts have been classified as "Most at Risk" against flood hazards in each province:

2.1 Punjab

- DG Khan, Rajanpur, Muzaffargarh, Kot Addu, Taunsa, Gujrat, Wazirabad, Gujranwala, Sheikhupura, Narowal, Sialkot, Jhang, Layyah and Rahim Yar Khan

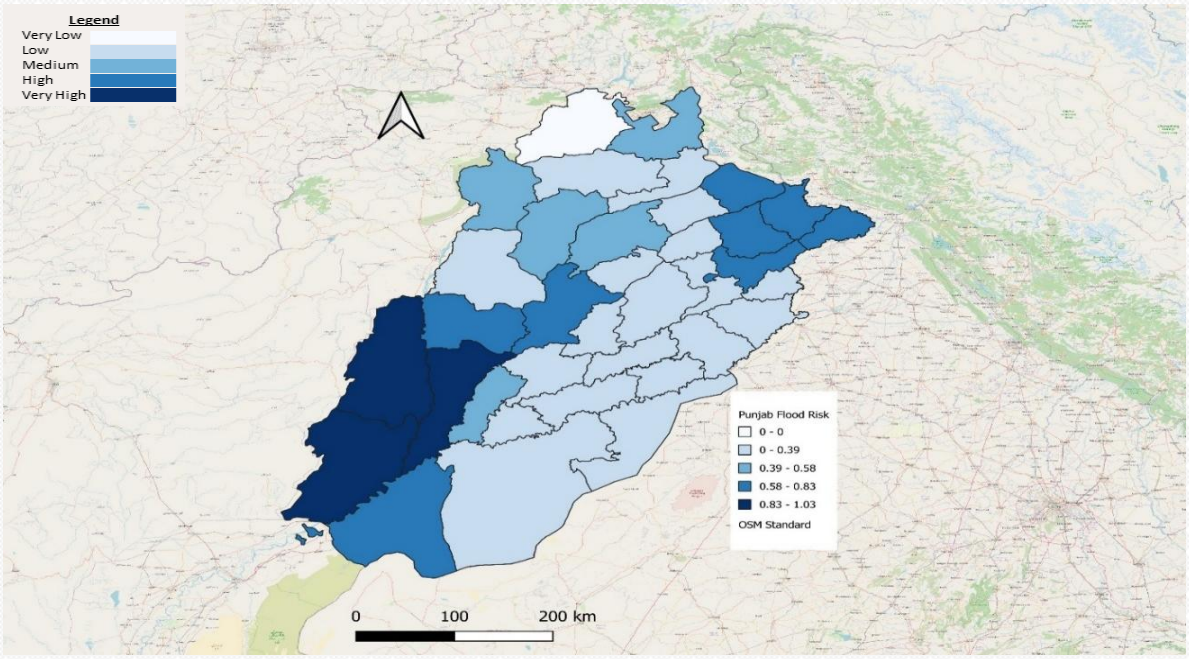

Figure 1: Regions of Punjab Most Prone to Infrastructure Damages During Floods

2.2 Sindh

- Larkana, Shikarpur, Kashmore, Jacobabad, Shahadkot, Dadu, Naushahro Feroze, Shaheed Benazirabad, Khairpur, Mirpur Khas, Hyderabad, Tando Muhammad Khan andBadin

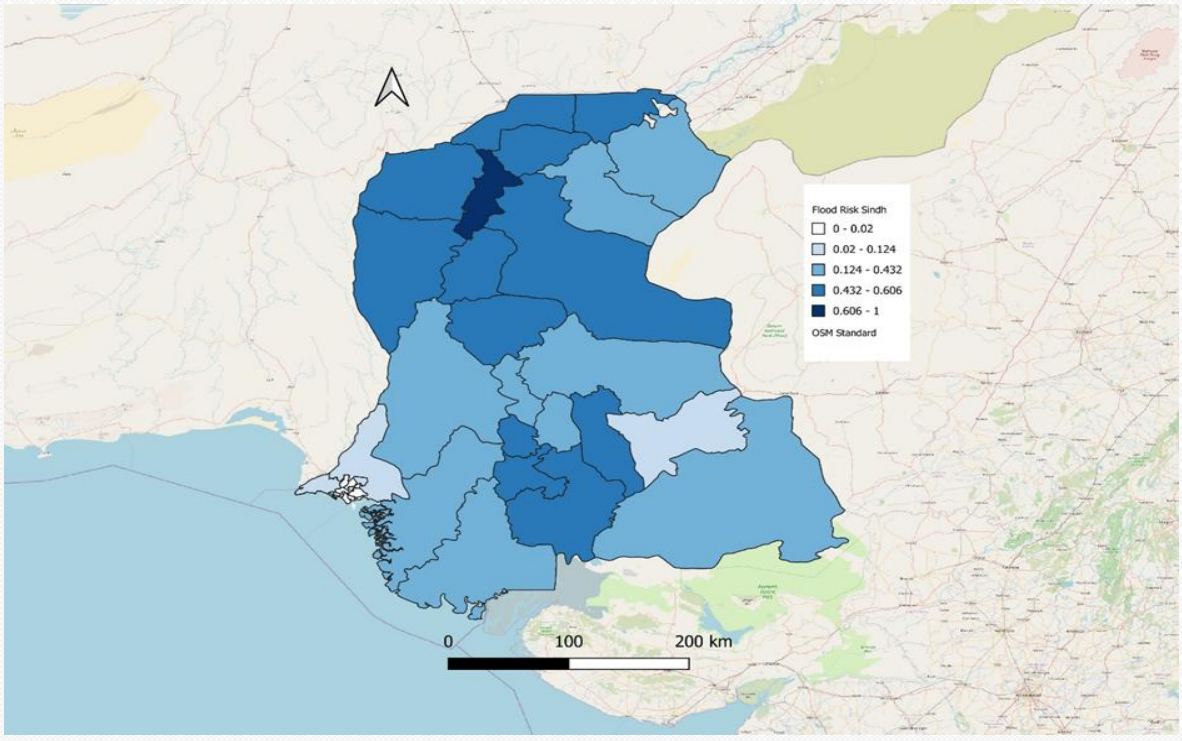

Figure 2: Regions of Sindh Most Prone to Infrastructure Damages During Floods

2.3 Khyber Pakhtunkhwa

- Chitral, Swat, Shangla, Buner, Torghar, Khyber, Peshawar, Charsadda, Nowshera, DI Khan and Tank

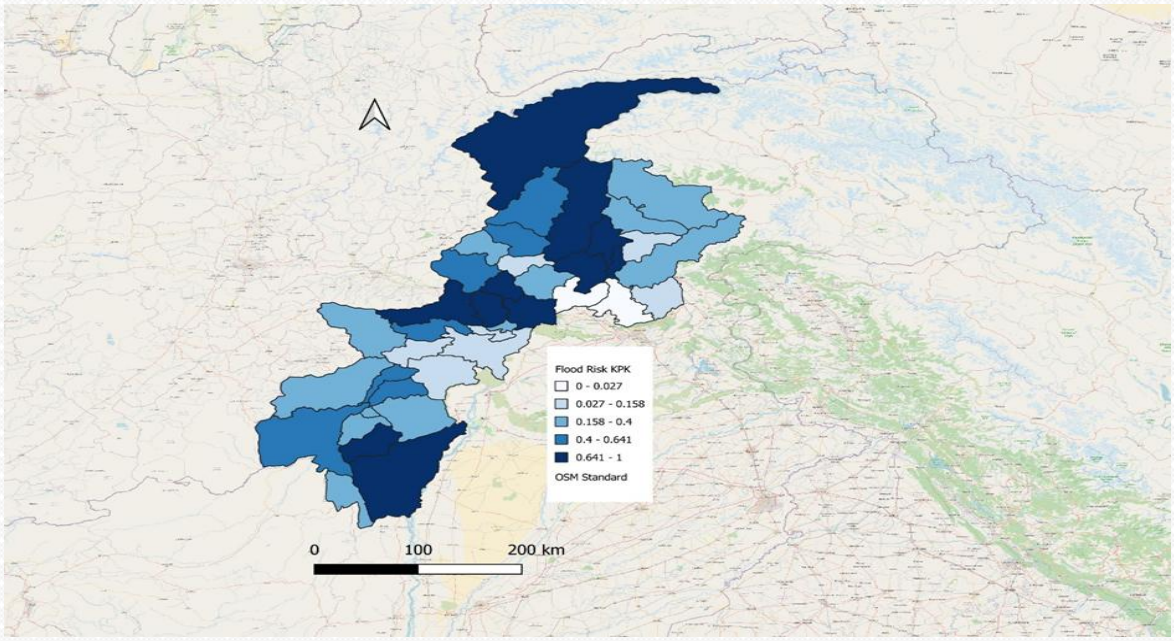

Figure 3: Regions of KPK Most Prone to Infrastructure Damages During Floods

2.4 Balochistan

- Nasirabad, Jafarabad, Usta Muhammad, Qilla Saifullah, Pishin, Karezat, Harnai, Jhal Magsi, Qalat and Shaheed Sikandarabad

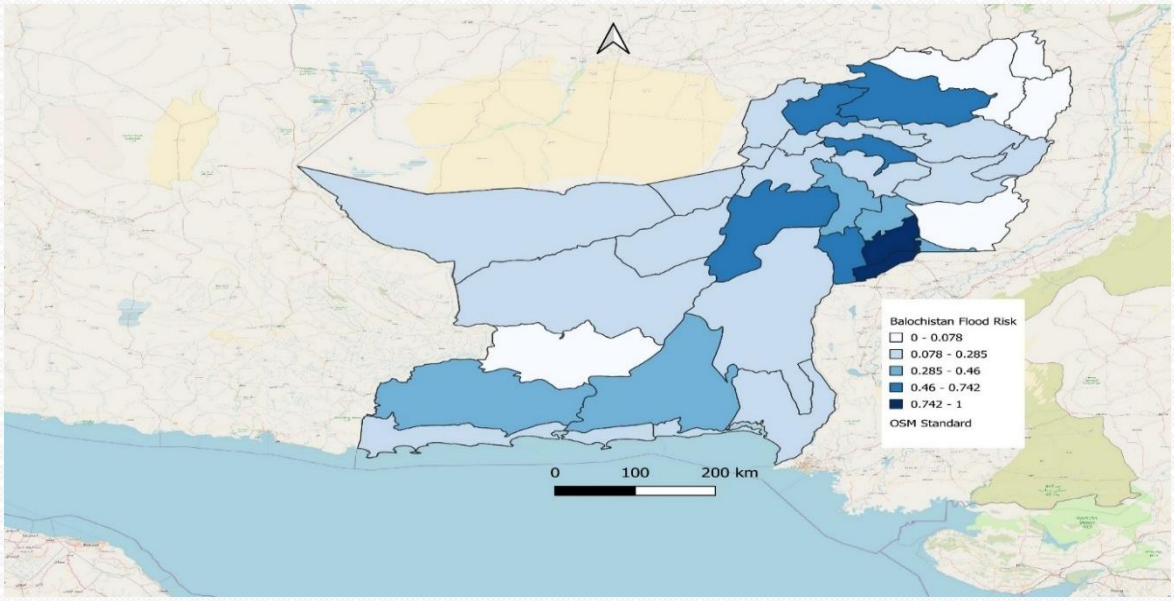

Figure 4: Regions of Balochistan Most Prone to Infrastructure Damages During Floods

3 Projection of Monsoon 2025 Rain Patterns

The technical team of the National Disaster Management Authority (NDMA) has conducted an extensive analysis to develop forecasts for rainfall patterns during the monsoon season of 2025. These projections identify regions that are likely to experience the heaviest rainfall, with a high probability of monsoon-induced flooding. As a result, these areas will require prioritized attention and targeted interventions throughout the 2025 monsoon phase to mitigate potential risks and impacts.

3.1 Punjab

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

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

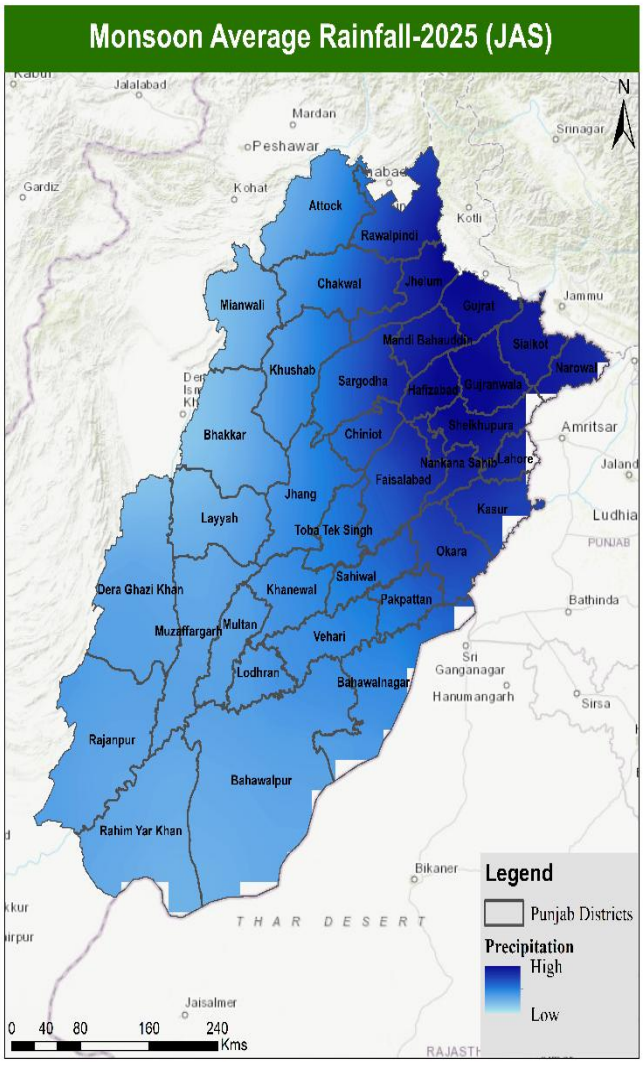

Figure 5: Average Monsoon Rainfall for Punjab (2025)

3.2 Sindh

Sindh will experience a mixed monsoon pattern. Upper Sindh, including Sukkur, Larkana, Jacobabad, Kashmor and Dadu, is likely to witness above-normal rainfall, particularly in late July. Lower Sindh, encompassing Karachi, Hyderabad, Thatta, Badin and Mirpurkhas, is forecasted to see to slightly above-normal rainfall, which may lead to episodes of urban flooding, particularly in urban hotspots Karachi. While the rainfall will bring relief from extended dry spells in some areas, it may also overwhelm the drainage infrastructure in major cities.

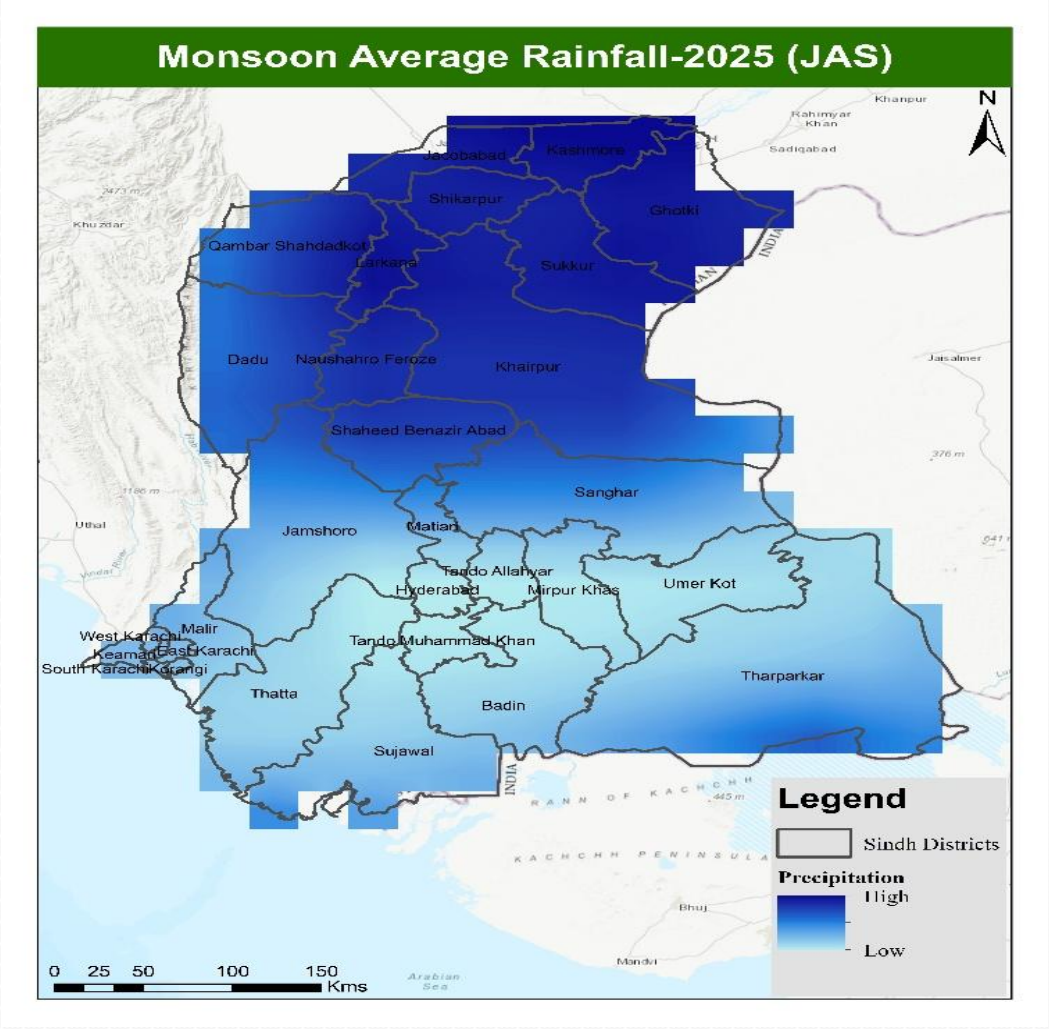

Figure 6: Average Monsoon Rainfall for Sindh (2025)

3.3 Khyber Pakhtunkhwa

In Khyber Pakhtunkhwa, the northern districts such as Abbottabad, Mansehra, Swat, Dir and Chitral are expected to receive normal to below-normal rainfall. These areas may face localized flash floods due to intense rainfall combined with steep

topography. Central and southern KP, including Peshawar, Mardan, Charsadda, Kohat and Dera Ismail Khan, will likely experience normal to slightly above normal rainfall during the second half of July.

Higher-than-normal temperatures in this region will contribute to rapid snow and glacier melt, particularly in upper KP, leading to increased river discharge. The key risks include landslides, damage to road infrastructure in hilly areas and overflowing rivers during heavy spells.

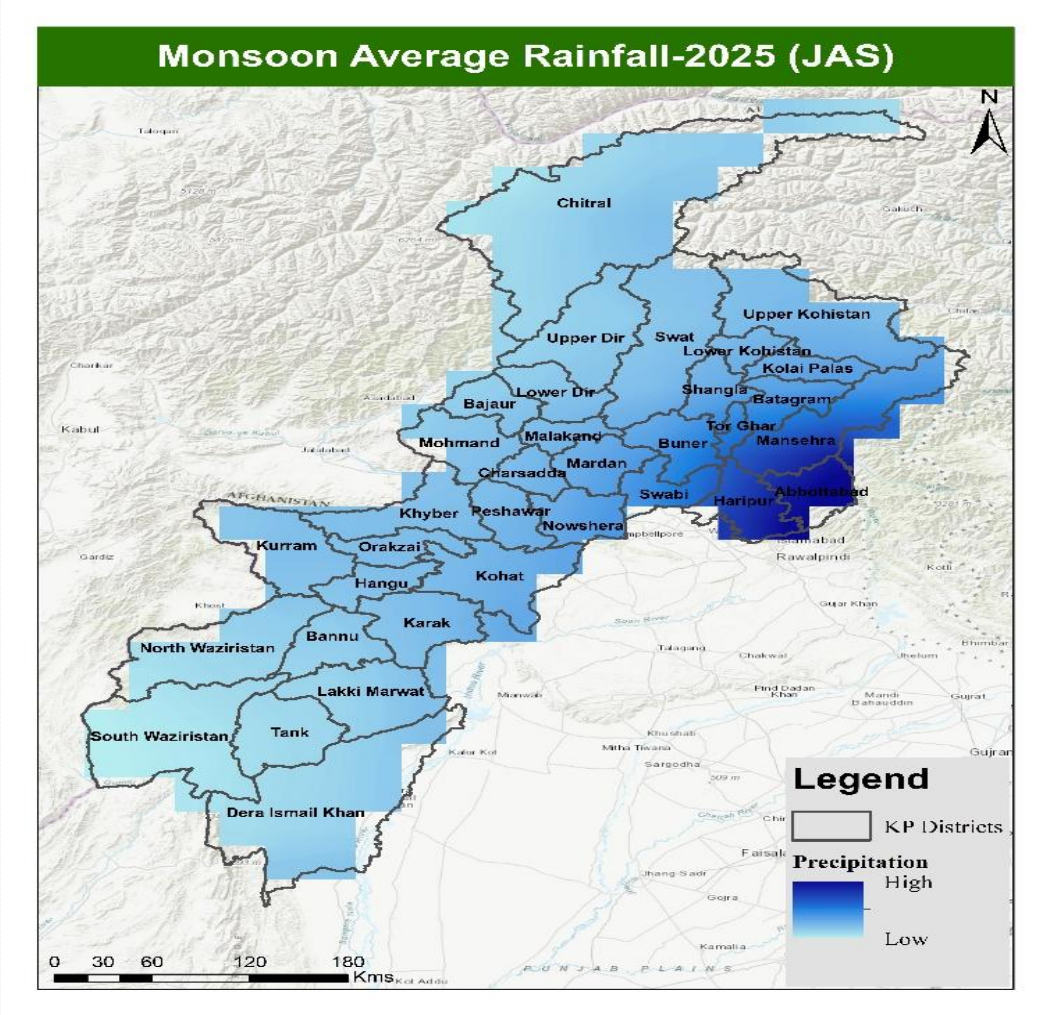

Figure 7: Average Monsoon Rainfall for Khyber Pakhtunkhwa (2025)

3.4 Balochistan

Balochistan's rainfall distribution will remain uneven. Eastern and central districts such as Khuzdar, Lasbela and Washuk are forecasted to receive slightly above-normal rainfall, especially during the latter half of the monsoon. In contrast,

western districts like Quetta, Zhob and Barkhan are likely to experience near-normal to below-normal rainfall.

Despite periodic rains, most of Balochistan may continue to experience arid conditions due to long-standing deficits. However, areas that receive sudden bursts of heavy rain will be at risk for localized flash floods due to low soil absorption and minimal vegetation.

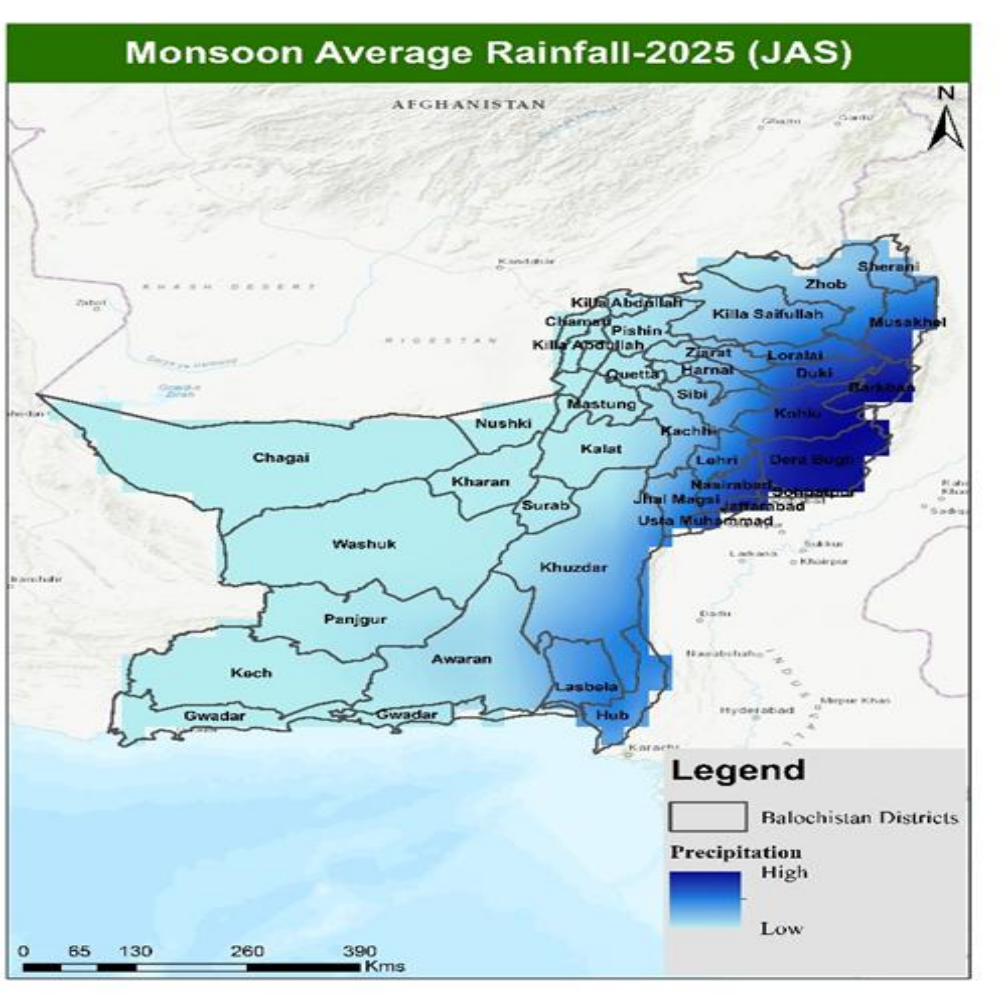

Figure 8: Average Monsoon Rainfall for Balochistan (2025)

3.5 Gilgit-Baltistan

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

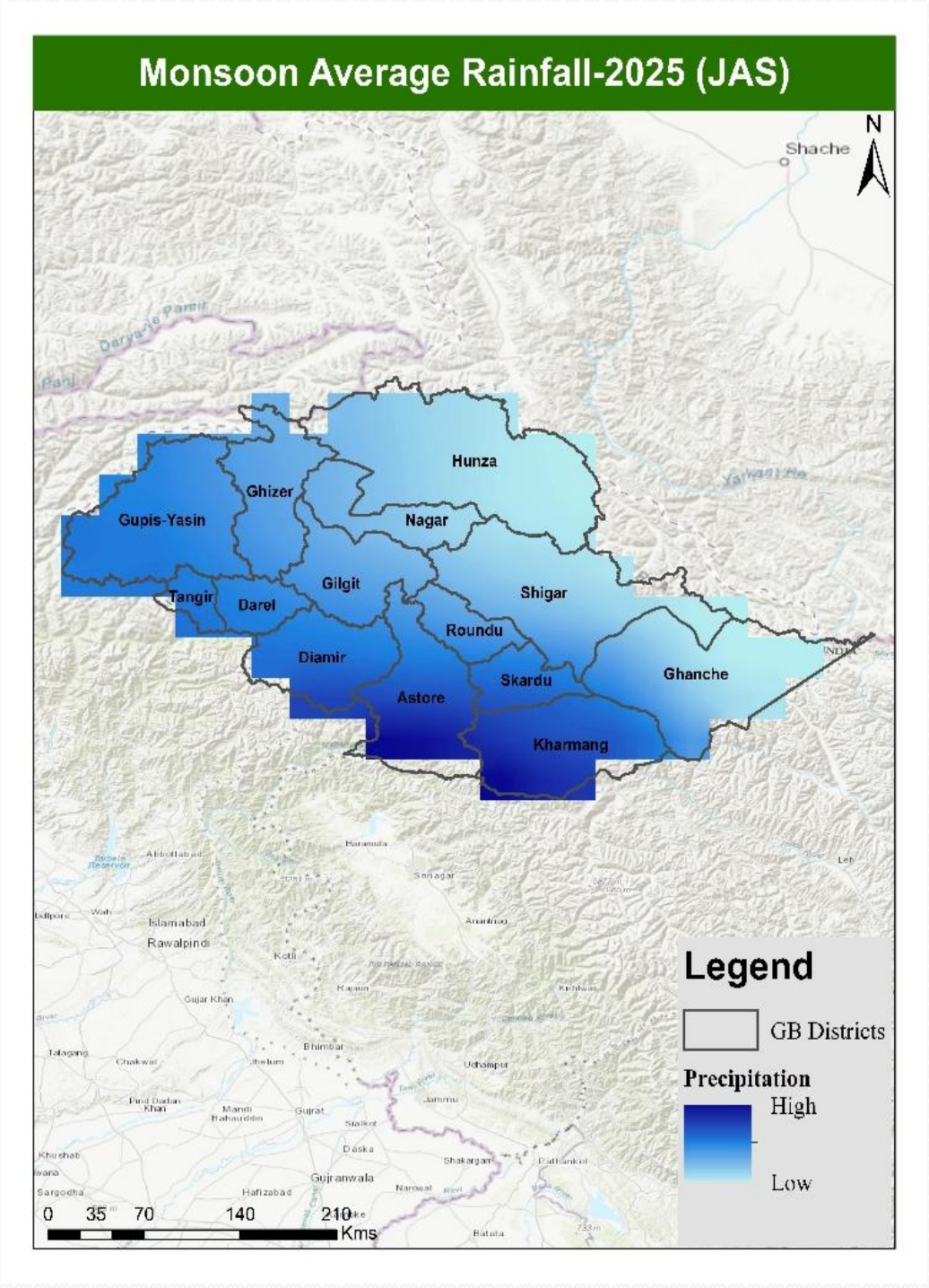

Figure 9: Average Monsoon Rainfall for Gilgit-Baltistan (2025)

3.6 Azad Jammu and Kashmir

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

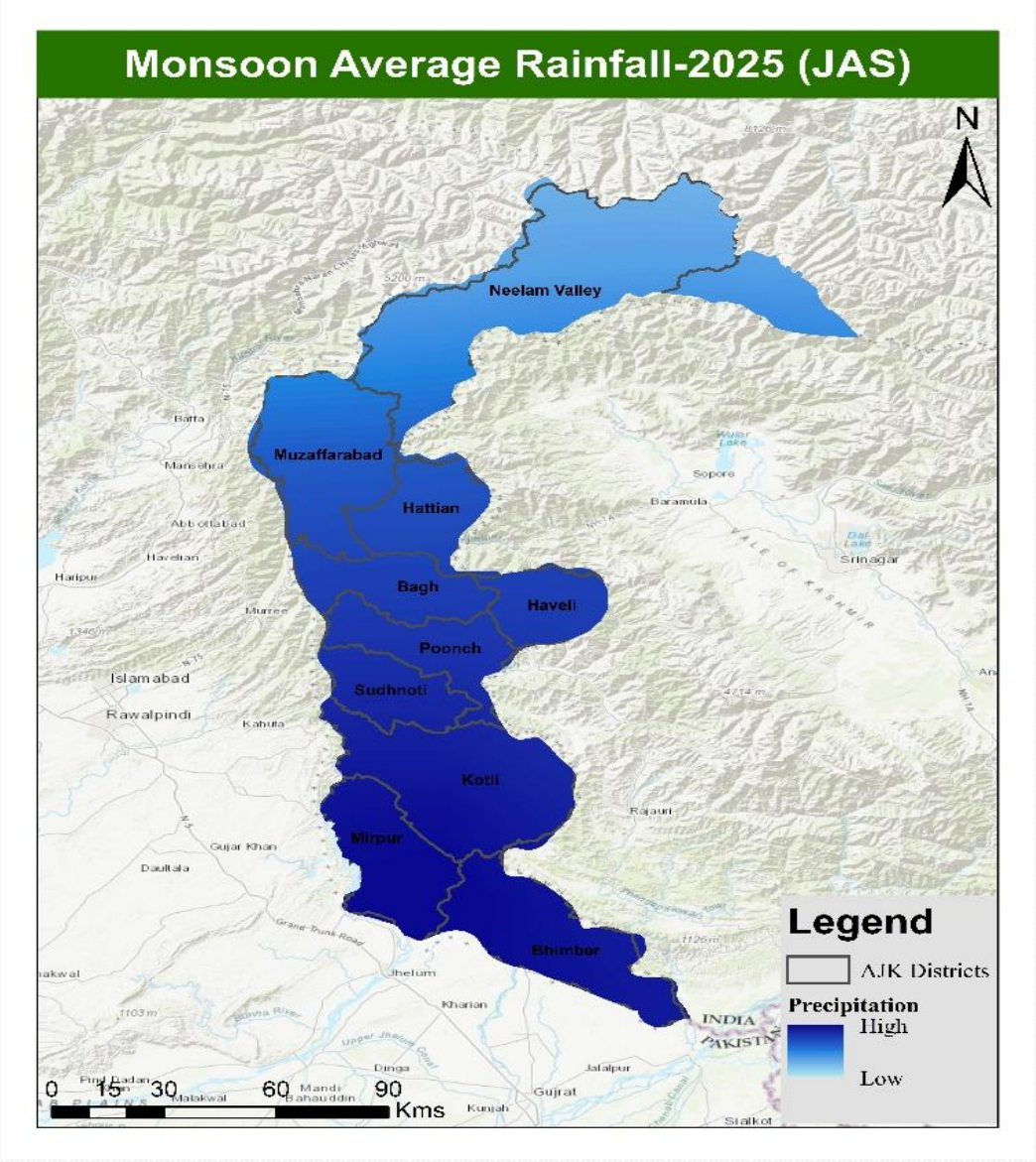

Figure 10: Average Monsoon Rainfall for Azad Jammu and Kashmir (2025)

4 Recommendations and Mitigation Strategies

4.1 Residential and Public Infrastructure

The monsoon season in Pakistan poses significant risks to residential and public infrastructure, especially in flood-prone areas. In response, a range of strategic recommendations and mitigation measures as shown in Table 1 are essential to reduce the impact of flooding and other monsoon-related damages on communities.

Table 1: Recommendations and Mitigation Strategies for Building Infrastructure

Sr.	Action	Objective	Implementation Tools	Expected Outcome
1	Identify and ***map Kacha (mud) houses*** and estimate residents at risk.	Assess vulnerability and plan for evacuation and shelter.	GIS mapping, mobile data tools, volunteer networks, NDMA/PDMA data integration.	District-wise risk profile to support emergency planning and response.
2	***Elevate plinths*** using RCC/bricks and reinforce roofs with wooden/metal trusses.	Reduce flood damage to Kacha houses and prevent roof collapse.	Brick ballast, RCC fill, metal/wood trusses, trained local masons.	Enhanced structural stability and flood resilience of adobe houses.
3	Apply ***waterproof coatings*** (bitumen, lime-cement, sealants) up to 1.5m on walls.	Prevent erosion, damp and wall degradation during floods.	Bituminous paint, lime-cement plaster, community training workshops.	Longer lifespan and better flood protection of mud structures.
4	Place ***sandbags*** around house perimeters before flooding.	Provide immediate, temporary flood barriers to protect houses.	Sandbag stockpiles, community training, TMA support.	Delayed water entry and protection of house foundations.
5	***Reinforce riverbanks*** with gabions, riprap and geotextiles.	Prevent riverbank breaches and protect low-lying communities.	Gabion walls, riprap, geotextile mats, coordination with Irrigation Depts.	Stabilized riverbanks and reduced flooding in adjacent areas.
6	Install ***rainwater harvesting systems*** (rooftop collection and storage tanks).	Reduce surface runoff and manage rainfall at source.	PVC guttering, storage tanks, inclusion in building bylaws.	Improved floodwater management and increased water availability.
7	***Retrofit*** public buildings (schools, hospitals) for flood resilience.	Ensure uninterrupted services during floods.	Elevated utilities, waterproof coatings, reinforced structural elements.	Functioning critical infrastructure during and after floods.

8	Add ***shear walls, diagonal bracing, or steel*** reinforcement in buildings.	Strengthen resistance against hydrostatic/lateral flood forces.	Structural retrofitting, steel/concrete reinforcement, updated building codes.	Improved structural integrity and fewer building failures.
9	Install ***cross-bracing*** in timber-framed walls.	Enhance structural rigidity and lateral flood resistance.	Wooden planks, steel rods, trained carpenters, anchoring techniques.	Strengthened timber buildings, reduced collapse risk in floods.

4.2 Industrial Infrastructure

Table 2 describes the key recommendations and strategies for Industrial Infrastructure.

Table 2: Recommendations and Mitigation Strategies for Industrial Infrastructure

Sr.	Action	Objective	Implementation Tools	Expected Outcome
1	Establish ***clear evacuation routes*** and protocols for all employees.	Ensure safe and orderly evacuation during flooding events.	Evacuation maps, signage, drills, staff training.	Minimized injury and confusion; enhanced emergency preparedness.
2	Ensure that all drainage systems are ***clear of debris*** and fully operational.	Prevent waterlogging and interior flooding of the facility.	Manual clearing, maintenance logs, CCTV inspections, sump pumps.	Uninterrupted site access and protection of operational areas.
3	***Elevate critical machinery*** and electrical installations above potential flood levels; waterproof equipment.	Prevent electrical failure and damage to machinery during inundation.	RCC platforms, waterproof covers, elevation retrofitting, sealed conduits.	Continuity of operations and reduced equipment damage.

4	Set up ***reliable communication systems*** for receiving real-time flood alerts.	Enable timely decision-making and proactive evacuation.	SMS alert systems, NDMA apps, satellite phones, VHF radios.	Improved coordination and rapid response to flood warnings.
5	***Digitize and back up critical records*** and documents off-site or on the cloud.	Preserve essential data and ensure continuity of operations post-flood.	Cloud storage, hard-drive backups, data security protocols.	Data security and faster recovery after flood disruption.
6	Establish ***direct communication*** with local disaster management authorities.	Facilitate coordinated emergency response and resource access.	Dedicated focal persons, MoUs, direct contact lists.	Strong institutional coordination
7	***Secure hazardous materials*** to prevent flood-related contamination.	Avoid environmental and safety hazards.	Chemical lockers, elevated containment units, hazard-proof labelling.	Prevented spills, compliance with environmental standards.
8	***Install automatic circuit breakers, fire extinguishers*** and train staff in firefighting and shutdowns.	Mitigate fire risks due to electrical faults during flooding.	ACBs, extinguishers, staff training sessions, fire drills.	Quick fire response and safer electrical shutdown practices.
9	Conduct ***pre-monsoon structural integrity assessments*** and retrofit weak points.	Ensure facility can withstand prolonged exposure to flood conditions.	Civil engineering surveys, retrofitting works, roof and wall strengthening.	Safer industrial premises and reduced structural damage risk.
10	***Follow flood alert advisories*** from NDMA and local authorities.	Ensure compliance with national early warning and response systems.	Subscription to alerts, SOP alignment with advisories, real-time tracking.	Proactive decision-making aligned with national flood response.

4.3 Hydraulic Infrastructures

Table 3 describes the important recommendations for hydraulic infrastructure.

Table 3: Recommendations and Mitigation Strategies for Hydraulic Infrastructure

Sr.	Action	Objective	Implementation Tools	Expected Outcome
Dams				
1	Conduct ***immediate evaluations*** of dam embankments, spillways and foundations.	Identify structural vulnerabilities before monsoon to prevent failures.	Engineering inspections, geotechnical surveys, structural assessment tools.	Early detection of weaknesses and prioritization of reinforcements.
2	***Expedite sediment removal*** and clear debris from reservoirs, culverts and spillways.	Maximize water storage capacity and ensure unobstructed flow.	Dredgers, excavators, sediment traps, debris clearance teams.	Improved water retention and reduced risk of overflow or blockage.
3	***Strengthen spillways*** and install automated water release systems.	Enable efficient discharge during peak inflow to prevent overtopping.	RCC reinforcement, SCADA systems, automated control gates.	Controlled outflow, reduced flood pressure and safer dam operation.
4	Deploy ***temporary flood barriers*** and improve downstream access roads.	Enhance emergency readiness and evacuation capability.	Modular barriers, road gravelling, mobile repair units, stockpiles.	Quick response to flood risks and protection of downstream populations.
5	***Train local authorities*** and communities on emergency flood protocols.	Strengthen local response capacity in high-risk zones.	Workshops, drills, flood response manuals, simulation exercises.	Informed and prepared local teams, minimizing casualties and damage.
6	***Retrofit floodgates*** and locks with automated control systems.	Facilitate real-time water regulation during flood events.	Actuators, sensors, SCADA/PLC systems, power interface kits.	Improved operational efficiency and rapid response to rising water.

7	Install ***backup power supplies*** and manual controls for gates and locks.	Ensure uninterrupted gate operation during power outages or failures.	Diesel generators, solar backups, manual override levers.	Continuous control of water levels regardless of system failure.
8	Establish ***scheduled maintenance/testing*** for floodgate mechanisms.	Maintain system reliability and reduce malfunction risk.	Monthly inspection checklists, seal replacement kits, control system audits.	Optimal floodgate performance and reduced risk of system failure.
9	***Stabilize road slopes*** in hilly areas using landslide and erosion control methods.	Prevent road collapses and ensure safety in mountainous terrain.	Retaining walls, gabion structures, catch drains, check dams.	Landslide risk reduction and protection of hill roads.
10	Install ***flood barriers*** around critical roads and bridges in urban centres.	Protect key communication routes from inundation.	Modular flood barriers, HESCO baskets, sandbags, levees.	Uninterrupted access to vital infrastructure during flood events.
11	Reinforce and ***ensure visibility of road signs*** and flood warning markers.	Guide safe navigation and improve traffic safety during low visibility.	High-reflective signage, solar-powered lights, elevated signposts.	Enhanced driver awareness and reduced traffic accidents during floods.
Barrages and Headworks				
1	Conduct ***comprehensive assessments*** of barrage and headwork structures.	Identify structural weaknesses and prioritize essential upgrades before monsoon onset.	Structural audits, condition surveys, underwater inspection equipment, drone surveillance.	Enhanced structural reliability and reduced risk of failure during high flow conditions.
2	***Clear debris***, sediment and blockages from intake channels, gates and canals.	Maintain efficient water flow and avoid operational disruptions during heavy rainfall.	Mechanical dredgers, desilting crews, trash racks, regular maintenance schedules.	Uninterrupted operations and minimized flood-induced mechanical stress.
3	Install or upgrade ***surge protection mechanisms*** (e.g., pressure relief valves, automated gates).	Manage abrupt water level increases and protect systems from mechanical failure.	Automated control systems, SCADA-linked gates, hydraulic pressure relief valves.	Improved control and resilience against rapid water surges.

4	Strengthen surrounding embankments and levees with ***erosion-resistant materials.***	Prevent structural failure due to erosion from strong currents and protect nearby infrastructure.	Riprap, reinforced concrete, gabion structures, geotextile linings.	Long-term stabilization of surrounding infrastructure and reduced flood vulnerability.
5	Establish ***rapid-response teams*** and stockpile emergency materials.	Enable swift on-site response during flood emergencies or infrastructure damage.	Emergency toolkits, pre-positioned sandbags, reinforcement materials, mobile units.	Faster repairs, reduced downtime and minimized damages during flood events.
6	Enhance communication systems ***using flood monitoring technologies*** with real-time data.	Improve early warning capabilities and ensure timely coordination with local authorities.	IoT-based sensors, telemetry stations, real-time dashboards, radio/alert systems.	Quicker decision-making and timely response to flood threats, reducing overflow risk.
Canals				
1	Conduct ***inspections of canal embankments*** and linings to detect structural deficiencies or erosion.	Ensure embankment integrity and continuous water delivery during monsoon conditions.	Visual inspections, drone surveys, structural testing kits, engineering assessments.	Timely identification and repair of risks, reduced breach probability.
2	Establish and follow a ***regular maintenance*** schedule for clearing sediment and debris from canal networks.	Prevent flow blockages and maintain operational efficiency during peak rainfall.	Desilting machines, manual clearing crews, debris nets, scheduled maintenance logs.	Uninterrupted water flow and reduced risk of overflow or backflow.
3	Install ***silt traps*** and ***sedimentation basins*** along canals.	Capture sediment and reduce accumulation to preserve hydraulic efficiency.	Stone or concrete sediment basins, gravel silt traps, site-specific hydrological planning.	Improved water quality and sustained flow capacity in high-rainfall periods.
4	Reinforce canal drainage and integrate ***additional diversion*** features.	Manage excess water effectively, prevent waterlogging in adjacent fields and minimize localized flooding.	Overflow channels, lined drains, diversion pipes, floodway extensions.	Reduced flood impact on agricultural zones and improved stormwater dispersion.

5	Deploy ***automated monitoring systems*** in critical canal sections.	Enable real-time tracking of water levels and early detection of potential issues.	Flow sensors, telemetry units, SCADA dashboards, alert systems.	Faster, informed response to canal stress, ensuring flood mitigation.
6	Integrate ***adjustable gates*** and ***weirs*** to regulate flow.	Provide flexibility for water diversion and flood volume management during extreme rainfall.	Motorized gates, manual/automated weirs, hydraulic regulators.	Enhanced control over canal water, reducing downstream flood pressure and optimizing operations.
Weirs				
1	Install ***debris deflectors*** or booms upstream of weirs using local materials.	Prevent debris accumulation and ensure continuous water flow during floods.	Steel/timber booms, anchored floating barriers, upstream debris nets.	Reduced blockage risk, improved hydraulic efficiency and operational reliability.
2	Construct ***sedimentation ponds or basins*** upstream to capture suspended silt and debris.	Minimize sediment load reaching the weir and downstream systems.	Stone or RCC sedimentation ponds, manual desilting tools, scheduled maintenance plans.	Prolonged structural performance and improved sediment management.
3	***Fortify weir crests*** with erosion-resistant materials (e.g., riprap, concrete).	Protect structural integrity from erosion caused by high-velocity flow.	Locally sourced riprap, concrete overlays, geotextile underlays.	Enhanced durability of the weir and resistance to flow-induced damage.
4	Install ***low-cost flow monitoring*** systems (e.g., sensors, gauges).	Enable real-time monitoring of water levels for flood response and planning.	Ultrasonic or radar level sensors, water gauges, telemetry systems.	Accurate flow data collection, enabling proactive flood management.
5	***Retrofit spillways*** with increased discharge capacity using simple engineering upgrades.	Prevent overtopping and enable the weir to safely handle higher water volumes.	Concrete slab extensions, stepped spillway retrofits, masonry overflow channels.	Enhanced discharge capacity and reduced overtopping risks during flood events.

Dykes and Levees				
1	***Fortify existing dykes and levees*** using erosion-resistant materials like riprap, RCC, or geotextile fabric.	Enhance structural integrity to withstand high-velocity floodwaters and prevent failure.	Riprap rock placement, RCC panels, geotextile mats, slope stabilization equipment.	Increased resilience of embankments during peak flow, reduced breach risk.
2	Implement ***periodic inspection and maintenance*** using non-destructive testing methods.	Detect and address microfractures and hidden weaknesses before structural failure occurs.	Ultrasonic testing devices, radar surveys, GIS-based inspection logs, repair kits.	Timely identification and repair of defects, ensuring long-term safety.
3	Deploy ***engineered vegetation*** (e.g., deep-rooted grasses/shrubs) on embankment surfaces.	Prevent surface erosion and improve soil cohesion naturally.	Bioengineering designs, native plant selection, erosion-resistant seeding protocols.	Eco-friendly reinforcement, reduced maintenance needs and long-term slope stability.
4	Construct ***overflow channels or relief valves*** at strategic points.	Divert excess water safely and reduce the risk of overtopping or breach.	Spillways, overflow culverts, flap gates, trench drains.	Controlled pressure release, minimizing catastrophic failure during extreme flood events.
5	Establish ***flood monitoring and early warning systems*** near embankments.	Enable real-time tracking of water levels and proactive flood mitigation.	Remote sensors, telemetry stations, sirens, visual alert systems, mobile apps.	Faster response times, community safetyand reduced flood impact.

4.4 Communication Infrastructure

Table 4 illustrates the important recommendations for communication infrastructure.

Table 4: Recommendations and Mitigation Strategies for Communication Infrastructure

Sr.	Action	Objective	Implementation Tools	Expected Outcome
1	Conduct ***pre-monsoon inspections*** of roads, bridges and drainage structures.	Identify vulnerabilities and ensure systems are clear and functional.	Structural inspections, debris removal equipment, coordination with Highway & Municipal Departments.	Reduced blockages, better floodwater flow and minimized infrastructure failure.
2	***Strengthen*** critical roads, bridges and flood-prone infrastructure using durable materials.	Improve structural resilience to withstand floods and reduce repair costs.	Reinforced concrete, steel supports, flood-resistant construction techniques.	Enhanced durability and reduced infrastructure damage from flood events.
3	Establish ***rapid-response repair teams*** for emergency interventions.	Enable swift restoration of damaged infrastructure during/after floods.	Emergency toolkits, mobile repair units, trained technical teams.	Minimized transport disruption and faster resumption of essential mobility.
4	Construct ***emergency access roads or bypasses*** in vulnerable zones.	Maintain uninterrupted access and evacuation routes during floods.	Pre-identified detour plans, temporary road matting, elevated causeways.	Continuity of emergency movement and reduced isolation of flood-hit areas.
5	Develop SOPs and ***contingency traffic rerouting plans***.	Ensure organized traffic flow and reduce chaos during infrastructure closures.	Pre-approved detour maps, coordination with traffic police, public awareness campaigns.	Smooth vehicular flow and minimized traffic disruption during flooding.
6	Install ***scour protection*** (gabions, riprap, concrete aprons) at bridges.	Prevent erosion around piers and abutments during high flow.	Gabion baskets, riprap, concrete slabs, geotextiles.	Increased bridge stability and reduced failure risk from scouring.

7	***Retrofit*** bridge decks and ***anchor*** them securely.	Prevent displacement or structural collapse from flood forces.	Deck anchorage systems, retrofitting bolts, hydrodynamic resistance designs.	Safer bridge performance and reduced post-flood rehabilitation costs.
8	Improve ***urban drainage capacity*** through upgrades and regular maintenance.	Manage floodwater effectively in dense urban zones.	Large-diameter stormwater pipes, retention tanks, scheduled desilting programs.	Reduced urban flooding and surface water stagnation.
9	***Stabilize road slopes*** in hilly areas using landslide and erosion control methods.	Prevent road collapses and ensure safety in mountainous terrain.	Retaining walls, gabion structures, catch drains, check dams.	Landslide risk reduction and protection of hill roads.
10	Install ***flood barriers*** around critical roads and bridges in urban centers.	Protect key communication routes from inundation.	Modular flood barriers, HESCO baskets, sandbags, levees.	Uninterrupted access to vital infrastructure during flood events.
11	Reinforce and ***ensure visibility of road signs*** and flood warning markers.	Guide safe navigation and improve traffic safety during low visibility.	High-reflective signage, solar-powered lights, elevated signposts.	Enhanced driver awareness and reduced traffic accidents during floods.

4.5 Guidelines for Metropolitan Areas

Important recommendations for Metropolitan Areas are shown in Table 5.

Table 5: Recommendations and Mitigation Strategies for Metropolitan Areas

Sr.	Action	Objective	Implementation Tools	Expected Outcome
1	Conduct proactive assessments to ***identify Kacha*** (mud) houses and their inhabitants.	Determine vulnerability and prepare for timely evacuation and sheltering.	Field surveys, GIS mapping, mobile data tools, community engagement.	Accurate data for targeted emergency planning and shelter provision.
2	***Reinforce riverbanks*** using	Prevent breaches and	Gabions, riprap lining, geotextile	Stabilized banks and reduced risk of

	retaining walls, riprap and geotextiles.	flooding in low-lying urban and peri-urban areas.	fabric, coordination with Irrigation Dept.	flooding in adjacent zones.
3	Install ***rainwater harvesting*** systems in public and residential buildings.	Manage excess rainwater, reduce surface runoff and enhance water conservation.	Rooftop collection systems, storage tanks, plumbing kits, building bylaw amendments.	Decreased urban runoff and increased water availability.
4	***Upgrade urban drainage*** systems, including stormwater drains and green infrastructure.	Handle increased water volumes, reduce urban flooding and improve absorption.	Larger capacity sewers, bioswales, rain gardens, stormwater master plans.	Improved drainage capacity and flood mitigation in urban zones.
5	Implement ***smart flood control*** technologies in urban centres.	Enable real-time flood monitoring and faster response.	IoT sensors, automated gates, data dashboards, early warning systems.	Enhanced flood forecasting, timely alerts and efficient water management.
6	Enforce stricter ***flood-resilient building codes*** for new constructions.	Ensure structural safety and durability of new buildings against flooding.	Revised urban building codes, compliance checks, penalties for violations.	Safer, flood-resistant urban building stock.
7	Develop ***community flood shelters*** in high-risk urban areas.	Provide safe refuge and essential services during flood events.	Multi-use elevated structures, provisioning for food/water/medical care.	Life safety, organized displacement management and reduced panic.
8	Create and enhance ***urban green spaces*** in flood-prone areas.	Absorb rainwater, reduce runoff and act as natural flood buffers.	Parks, wetlands, bioswales, green belts, zoning policy integration.	Increased resilience and improved urban liveability.

9	Promote ***underground water storage*** systems in high-density areas.	Capture excess rainwater and reduce drainage load.	Recharge wells, underground tanks, retention pits.	Mitigated surface runoff and sustainable water management.
10	***Retrofit*** public buildings with structural and waterproof enhancements.	Ensure continuity of essential services and protection of public assets.	Steel/concrete reinforcement, elevated utilities, waterproof coatings (bitumen/lime-cement).	Flood-resilient critical infrastructure and reduced downtime.
11	Place ***sandbags*** around homes as temporary flood barriers.	Prevent floodwater entry and protect structural foundations.	Community sandbag stockpiles, awareness campaigns.	Immediate low-cost defence against flooding.
12	Launch ***housing improvement*** programs in slums/informal settlements.	Reduce vulnerability of marginalized populations to flood risks.	Financial subsidies, technical assistance, low-cost flood protection materials.	Safer housing and empowered, flood-aware communities.
13	Incorporate ***bracing, shear walls, or steel*** reinforcement in flood zones.	Prevent structural collapse under hydrostatic or lateral loads.	Structural retrofitting guidelines, technical assistance, PBC integration.	Safer buildings in high-risk zones.
14	***Upgrade utility networks*** (power, water, gas) to be flood-resilient.	Ensure uninterrupted utility services during floods.	Elevated equipment, waterproof enclosures, utility retrofits.	Sustained functionality of essential services during flood events.

POST MONSOON RECONSTRUCTION

5 Post Monsoon Reconstruction Recommendations

The Post-Monsoon Reconstruction and Rehabilitation Plan presents a comprehensive and context-specific framework tailored to the unique challenges Pakistan faces following seasonal monsoon flooding. With a history of recurring flood events that disproportionately impact low-lying, rural and urban fringe areas, the plan seeks to guide the systematic restoration of damaged infrastructure and essential public services while prioritizing the protection of vulnerable communities. It addresses not only immediate recovery needs but also long-term resilience, ensuring that the reconstruction efforts contribute to reducing future disaster risks and promoting social and economic stability across affected regions.

At its core, the plan emphasizes disaster risk reduction (DRR) and climate-resilient development, recognizing the growing frequency and intensity of monsoon-related disasters in Pakistan due to climate change and poor land-use planning. By incorporating adaptive strategies across critical sectors such as housing, transportation, irrigation, energy and public health facilities, it promotes the use of flood-resistant construction materials, improved drainage systems, elevated infrastructure platforms and enhanced early warning mechanisms. Special attention is given to informal settlements, industrial zones and agricultural lands, where flood impacts can severely disrupt livelihoods, public health, food security and access to basic services.

Ultimately, the plan aims to foster a more sustainable and inclusive recovery process by embedding resilience into every phase of reconstruction—from damage assessments and resource allocation to stakeholder coordination and policy alignment. Through a multi-tiered approach involving federal, provincial and district-level authorities, along with technical agencies, development partners and civil society, this plan positions Pakistan to not only rebuild safer infrastructure after floods but also to institutionalize resilience in planning systems. It advocates for investment in long-term mitigation measures, capacity-building of frontline institution sand community engagement to enhance national preparedness and reduce the human and economic costs of future disasters.

Table 6: Post Monsoon Reconstruction Recommendations and Strategies

Sr.	Category	Action	Objective	Implementation Tools & Materials	Methodology	Expected Outcome
Residential Infrastructure						
1	Mud (Kacha) Houses	Replace or retrofit with brick/RCC elevated plinths and reinforced roofing.	Reduce future vulnerability to flooding.	RCC, masonry, bracing materials, subsidy programs.	Community surveys, prioritization based on damage, phased reconstruction.	Safer, flood-resilient rural housing stock.
2	Informal Settlements	Launch housing improvement schemes with technical and financial support.	Enable low-income families to build flood-resilient homes.	Low-cost designs, micro-finance, NGOs.	Engage local contractors, offer standard resilient models	Upgraded living conditions and reduced flood mortality.
Public Buildings (Schools, Hospitals, Offices)						
1	Schools & Health Centres	Retrofit structural elements, elevate utilities, waterproof walls.	Ensure continuity of essential services during floods.	RCC, waterproofing materials, utility elevation designs.	Conduct rapid vulnerability assessments, select retrofitting package.	Functionality maintained during future emergencies.
2	Government Buildings	Install flood-resistant equipment, digitize records, train staff.	Enhance institutional capacity to manage disasters.	Cloud storage, solar backup, DRR training modules.	Align department contingency plans with monsoon risks.	Disaster-ready governance infrastructure.

Communication Infrastructure						
1	Roads & Bridges	Elevate road sections, construct bypasses, install scour protection.	Ensure uninterrupted access and logistics during flooding.	Gabions, riprap, culverts, emergency bypass designs.	Risk-based prioritization, engineering design audits.	Resilient transport connectivity during peak rainfall.
2	Urban Drainage	Upgrade and maintain drainage, integrate green infrastructure.	Reduce urban flooding and ensure road usability.	Stormwater plans, bioswales, retention ponds.	GIS-based flood mapping and hydrological modelling.	Better stormwater management and reduced public disruption.
Hydraulic Infrastructure						
1	Dams & Spillways	Conduct post-monsoon audits and repair embankments/spillways.	Ensure safety and operational readiness.	RCC, geotechnical equipment, SCADA.	Priority repairs based on damage index.	Operational and structural safety of major hydraulic structures.
2	Canals	Desilt, rebuild damaged sections, upgrade monitoring systems.	Restore irrigation and prevent overflows.	Desilting machines, telemetry, flow regulators.	Integrate real-time monitoring with canal operations.	Recovered irrigation efficiency and reduced overflow risk.
3	Weirs & Headworks	Strengthen crests, install deflectors, expand spillways.	Increase capacity to manage future flood volumes.	Concrete, sensors, booms, low-cost weir retrofits.	Targeted retrofitting with local materials.	Sustained structural performance during heavy flow.

Industrial Facilities						
1	Critical Industries	Elevate machinery, secure chemicals, ensure data and utility resilience.	Prevent hazardous exposure and business interruption.	Elevation platforms, waterproofing kits, cloud servers.	Conduct industrial DRR audits, implement EHS protocols.	Reduced environmental and operational risk.
2	Small & Medium Enterprises	Provide post-flood financial/technical support for facility restoration.	Support business continuity and local employment.	Recovery grants, insurance payouts, SME toolkits.	Partner with chambers and DRR networks.	Economic recovery and resilience in local markets.
Community Infrastructure and Services						
1	Flood Shelters	Construct or upgrade with elevated platforms and sanitation.	Provide emergency refuge for displaced populations.	RCC, WASH kits, solar lighting, emergency stocks.	Construct based on flood risk maps, integrate with NDMA protocols.	Life-saving support and reduced casualties in future floods.
2	Early Warning Systems	Enhance community alert mechanisms with real-time communication.	Improve preparedness and response.	Sirens, mobile alerts, PA systems, local volunteers.	Train community focal points; simulate evacuation drills.	Faster response and reduced panic in vulnerable areas.