Improving Flood Resilience in Pakistan: A White Paper

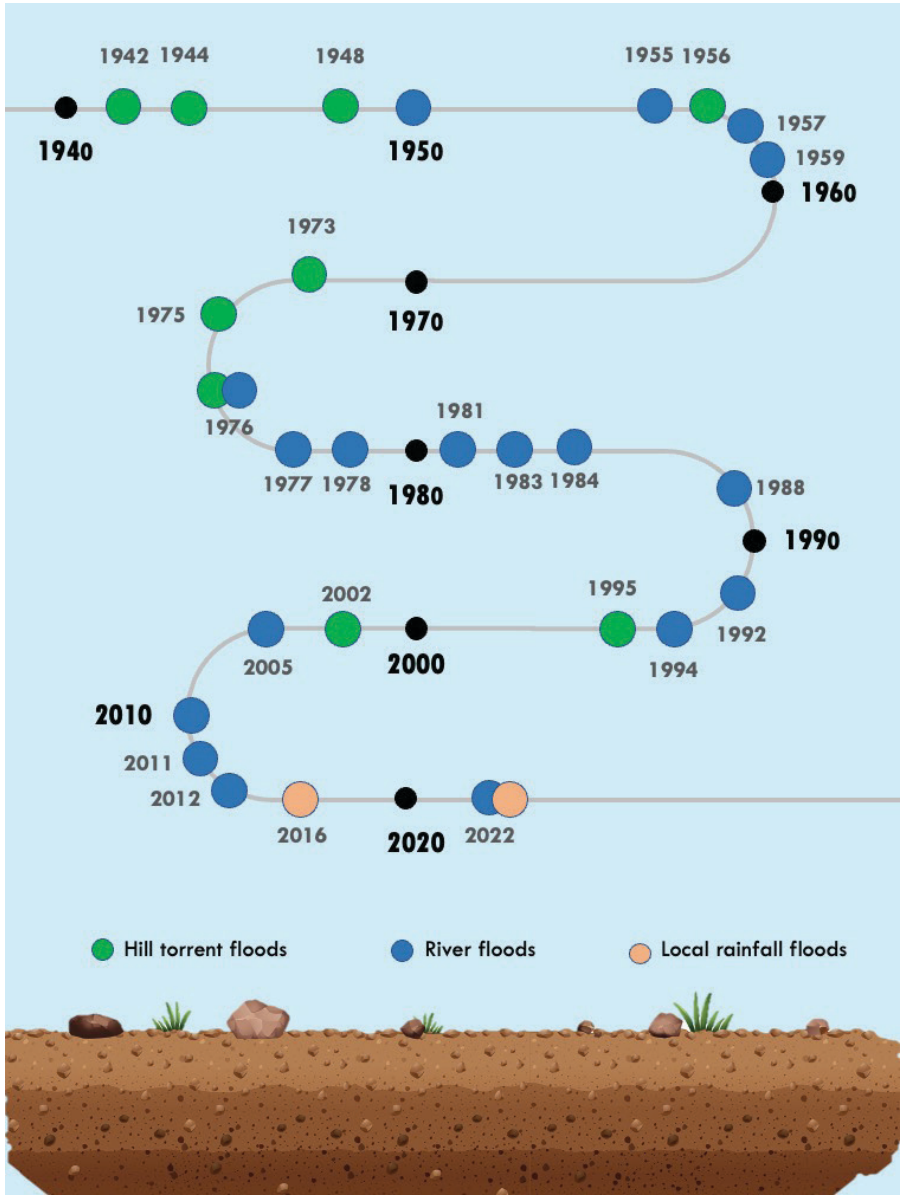
1. Introduction

This white paper describes the improvement of flood resilience in Pakistan, Pakistan has been through a large number of flood events in the last decades, including the two mega-floods of 2010 and 2022. Floods are common: in the last 80 years the frequency of disastrous flood events has been more than one in four years.
The white paper builds on the Post Disaster Needs Assessment (PDNA) of the 2022 flood in which a multi-layer flood safety strategy approach and practice was put forward. Flood resilience consists of three elements:

- Flood prevention, by protection through conventional hard defences: dikes, embankments, barrages
- Flood/resilient-proof sustainable spatial planning (land and water management) with measures in flood mitigation and adaptation
- Disaster management, early warning and flood forecasting

The second element of spatial planning has not been given much consideration, rather the opposite. The absent and disjointed spatial planning has given rise to distorted flood water and storm water removal, creating flooding in unexpected places and prolonged inundation. The focus in this white paper is on flood water drainage, spatial planning and flood resilience in general.

Climate change – in particular changes to the Indian monsoon pattern – is expected to increase Pakistan's exposure to destructive floods. The floods of 2022 were triggered by rainfall records: Baluchistan registered 327 mm against a thirty-year average of 61 mm; Sindh 694 mm against 123 mm and Punjab 427 mm against 225 mm . These extraordinary rainfall events were unexpected and far above what was predicted by the Meteorological Department.



Floods in Pakistan differ in nature, either being riverine floods (caused by floods in the Indus or tributaries), hill torrent floods (generated by heavy run-off in the western mountain ranges) or rain floods (caused by excessive local rainfall). In some cases – like the 2022 floods – different types of floods combine.

This white paper discusses the need to prioritize the improvement of flood resilience and the ability to manage flood events by minimizing damage and enhancing beneficial effects. It focusses in particular on floodwater management, the ability to evacuate flood water in a controlled manner and the related spatial management measures and underlying governance. The fact that in December 2022 five districts in Sindh and one in Baluchistan were to a large extent still inundated illustrates the challenge of flood water disposal in flood events. The pattern of the 2022 flood was to a large extent determined by how floodwater drainage functioned.

After the previous floods the need to revisit the overall floodwater system facilities were highlighted. Studies were undertaken and plans made , but limited action was taken. This underlines that underneath flood resilience there is a governance challenge. The responsibilities for flood water management are not clear; low priorities are assigned in spite of the recurrent devastation; and there are undiscussed and unresolved issues between Provinces and between districts in storm and flood water removal. This white paper aims to describe approaches to improved flood resilience through integrated flood water management, the need to simultaneously address governance and the steps needed. The paper is contextually framed by the water security paradigm.

2. Better flood resilience through an integrated basin approach

Current situation

At the peak, the 2022 floods inundated more than 30% of the territory of Pakistan, mainly in Sindh and Baluchistan. The floods withdrew slowly as the capacity to remove water was affected by many factors. This caused widespread damage . Large parts of the country – especially in Sindh and in the Nasirabad division of Baluchistan- assets and infrastructure were lost. The kharif crop was lost and the rabi crop was not planted. The PDNA of the 2022 put the total damage in 2022 at USD 14.9 billionn, weighing disproportionally on vulnerable people, with extensive damage to housing, crops and livestock. Of the 25 poorest districts in Pakistan 19 were calamity-stricken. The need for rehabilitation and reconstruction in a resilient, 'building back better' manner of existing assets is estimated at USD 16.3 Billion .

There were some silver linings. Not everywhere the flooding was detrimental. In large parts of the extensive Kacchi Plains (8000 km2) crops were grown on the residual moisture, generally by farmers mobilizing seeds through their own efforts. In Badin and Tando Muhammad Khan in lower Sindh the flood water was evacuated in time, allowing a better than average crop in these tail end districts.

The flood was caused by the exceptionally high rainfall but was exacerbated by the inability to retain (store) water in the catchment and the impeded capacity to evacuate the flood water. At basin scale there were four main factors, briefly discussed next:

- Reduced capacity of the primary canals of the Indus River to discharge floods
- Distortion of the natural drainage paths throughout the affected areas
- Extensive water logging in the farm areas ahead of the flood season
- Inadequate drainage infrastructure

2.1 Reduced capacity of main Indus River to discharge floods

The capacity of the Indus River and the tributaries to transport floods has been reduced over the last decades. At the same time some operational practices aggravated the situation during the flood. The time for flood peaks to travel between the barrages is said to have doubled. Such figures need to be confirmed, yet the changes in the Indus and its flood plains, as well as other rivers in Pakistan, is undeniable. The flood plain is restricted and in front of Guddu and Sukkur Barrage for instance sand shoals have developed. Combined with the accumulation of flood run-off in the main river, this poses a threat to these main barrages and creates the risk of by-passes, especially since the Indus in Sindh flows on a ridge.

The main factors affecting the capacity of the lower part of the Indus are:

- Bridges that have affected the active flood plain
- Encroachment on the flood plains by conversion into permanent farmland including the development of embankments and road infrastructure, construction of embankments in the riverbed
- Non-operable gates on the main barrages

Bridges affecting the floodplain and the primary river channels

Three bridges in particular, constructed since 1972, in Sindh across the Indus have restricted the width of the river flood plains and hence the capacity to evacuate flood peaks. This has led to land accretion, further confining the river. In Sindh the Dadu-Moro Bridge and the Larkana- Khairpur Bridge have constricted the flood plains at their locations from 15 kilometer to 1 kilometer. A third bridge from Amri to Sakrand has also narrowed the width of the flood plain reportedly from 7 to 4 kilometers. A main issue is that these bridges have not just confined the vast flood plain but have encroached upon the active flood channel. This problem may occur elsewhere in Pakistan too.

Encroachment on the flood plains by conversion into agricultural land and interfering road infrastructure

Much of the flood plain has been converted from riverine forest to farmland and fisheries over the last 30 years. The past system whereby land was leased in the flood plain on an annual basis has given way to permanent cultivation including land being embanked with the zamindari bunds, causing the land to rise. A related factor is that after the devolution of 2001 road infrastructure and other permanent assets were developed by district governments in the flood plains, often without sufficient causeways or culverts to allow the passage of flood water.

Changes to riverbed morphology

There have been many changes to the Indus riverbed. The development of land shoals upstream of the barrages is of great concerns as it puts the barrages at risk. The morphology of the Indus River and its distributaries has also been affected by the construction of embankments inside the floodplain. A prime example during the last floods is the bund constructed in the past near Ghotki by the Oil and Gas Development Company Limited (OGDCL) to protect their gas wells. This OGDCL bund caused the river current to be diverted and directed to Qadirpur Shank Bund and Qadirpur Loop Bund, causing breaches in these protection structures in the 2022 flood, as well as during earlier flood events.

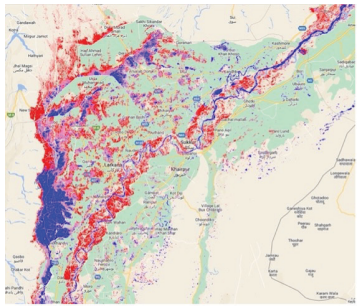
Non-operable gates on the main barrages

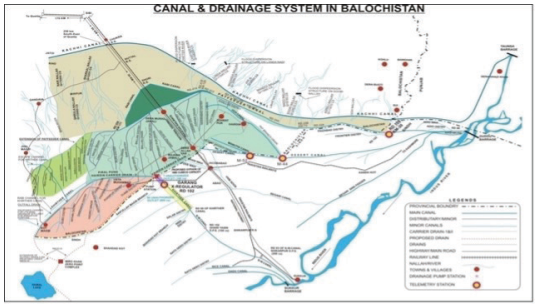
During the floods not all gates were opened on the barrages, some of it related to long-standing operational problems. On Sukkur Barrage 10 out of 64 gates are more or less permanently closed on account of the silt island that was formed in front of the piers. In the 2022 floods the same thing happened on Kotri Barrage where 15 gates out of 42 gates were silted on the right side of the Indus. This blockage added to the flood congestion in the Indus and for instance the reduced capacity to drain the area around Manchar Lake.

2.2 Blockage of the natural drainage paths by uncoordinated infrastructure development

Over the years throughout the basin the entire natural drainage pattern has become distorted. Over the years, canal and drainage embankments, roads and railways have built been across floodwater routes, typically with no or insufficient cross drainage. In addition, housing estates and private property has been developed in the natural drains. All this has altered run-off patterns importantly. The precise effect of all of this is unknown and the extent is unmapped. In some cases, the blockages may have helped to retain the floods and mitigate their destructive effect. In many other cases they will have obstructed the passage of flood water, causing ponding of flood water or uncontrolled diversions of the flood run-off.

A major case in point here are the canal embankments higher in the basin, i.e., in the Kacchi Plains in Balochistan. The respective embankments of Kacchi Canal, Pat Feeder Canal, Hairdin Drain and Khyrther Canal were constructed with almost no cross-drainage facilities (see figure). As a result, almost all of the hill torrent run-off from Balochistan (estimated by some sources at 8 MaF – to be further investigated) entered into Sindh at Dhorei Chuki causing massive flooding around Hamal Lake.

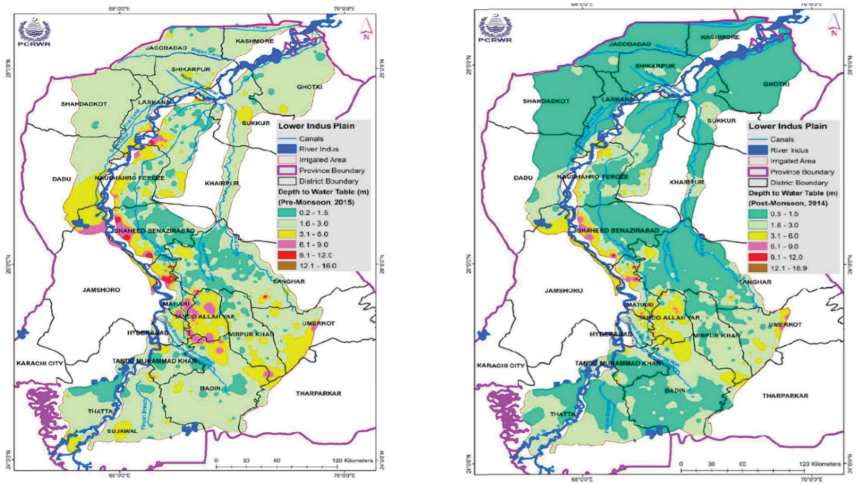




Similarly, the blockage of natural drains on the left bank of the Indus was identified as a major factor in the floods in the Left Bank in Sindh. Ironically some of these blockages were caused by the LBOD drainage facilities, constructed to improve land drainage .

2.3 Water logging in the farm areas ahead of the flood season

The extensive canal irrigated areas in Sindh and Baluchistan are not equipped to deal with floods as a significant portion of the farmland is waterlogged, hence having little capacity the absorb excess water during flood situations. In the post-monsoon period this may increase to 70% of the land. In the pre-monsoon period, it is still 10-20%, and these areas are most vulnerable to flooding in case of unusual weather events. This water logging has been persistent over the years.



This water logging is to a degree avoidable by more balanced water management for and within the concerned canal commands. There was a time in 1998-2002 when droughts prevailed: water logging at that time largely disappeared and as a result crop production increased. This holds an important message. It is important to reconsider water management for the waterlogged areas before investing in more drainage. This would improve production and reduce water logging related damage to private and public investments. It would increase the capacity to absorb the flood and rainwater in the soil profile. This is particularly important in case of rain floods, where local absorption of excess water is the main response mechanism.

2.4 Inadequate drainage infrastructure

One special intervention that has had much impact on the flood pattern is the construction of drainage canals in Sindh over the last decades, the unfinished RBOD/ MNVD and LBOD. Both these outfalls drain systems were developed primarily to remove excess water from the agricultural land, not floodwater. But of course, during heavy rainfall events they serve to take flood water as well. This has had disastrous effects before in earlier floods in Badin which received large volumes of flood water through the LBOD Spinal Drain. The modification of these drainage systems by developing flood water escapes at appropriate places could have reduced such a disaster and would have turned the flood water into an asset by allowing groundwater recharge in some of the adjacent desert tracks. On RBOD there is only one escape (and two more planned), on LBOD there is none. The cleaning of these drainage canals has been insufficient too.

3. Towards flood resilience: practical agenda

3.1 Introduction

With the Indus flowing in convex regime (i.e., flowing on a ridge) below Guddu Barrage and with the Sindh Province having extreme low gradients, flood water removal is particularly precarious in the best of times and the risk of the river breaching high. Add to this the effect of climate change and the encroachment on the flood plains and the degradation of the catchments with reduced capacity to hold flood water, defines the challenge of integrated flood management in Pakistan.
Due to human interference and the absence of coordinated spatial planning

at present there is no functional floodwater evacuation system. This is manifest in uncoordinated development of infrastructure and lack of joint flood management measures. Blockages in cross drainage contribute to water logging, even in relatively normal years. In flood years prolonged inundation is common. All in all, this calls for integrated flood resilience approach based on spatial planning, as was highlighted in the PDNA. Integrated flood management needs to be part of flood resilience, in addition to secure flood protection , flood early warning and improving access to safe flood shelters.

Improved flood management would consist of:

- Reuse – optimize beneficial use (spreading for soil moisture, well planned escape, recharge, storage)
- Retain and reduce – to attenuate flood peaks
- Remove – to safely evacuate flood water

3.2 Reuse: optimizing beneficial use

There are opportunities to use flood events beneficially, converting it into productive soil moisture or use it for groundwater recharge. These should be optimized. In this way flood and drought management may combine at basin level and flood peaks will reduce. Such options are now not considered systematically, but should be explored:

Option	Purpose	Possible interventions
Flood water retention in up-per catchments	Reduces flood peaks, groundwater recharge, In-crease soil moisture for pro-ductive use (crops and range-lands)	Catchment improvement/ water retention Roads for Water
Flood water spreading in Kacchi Plains	Reduces flood peak, Increase soil moisture for productive use (crops and rangelands)	Remodeling canal em-bankments, cross drainage on roads and canal em-bankments
Controlled overflows on main Indus, on RBOD and on LBOD (spinal drain),	Release flood pressure, flood water reuse in adjacent de-sert, nature development, prevent damage to infra-structure	Strategically placed es-capes
Increase storage capacity of Manchar lake: raising em-bankments and spill ways	Improves ecosystem, fishery, additional water storage	Lake remodeling, emer-gency pumping facility

3.2 Retain and reduce: Improve cross drainage

The natural drainage system of old is disrupted and the current capacity to deal with flood run off is not well understood, though it is clearly problematic. It is necessary to map all blockages and obstructed cross drainage on account of road and railway development, canal and drainage embankments and housing development and assess the capacity of the main natural waterways and dhoras to remove flood water. This should be the basis for prioritizing improvements and reparations to the (natural) drainage systems, including the development of new cross drainage and special flood channels. This should be combined with a critical review of the water management practices that lead to widespread water logging in normal

rainfall years. The objective should be first to safely retain and reduce flood peaks and secondly to facilitate effective evacuation.

3.3 Remove: space for the river

The capacity of the Indus system to handle flood events is critical, both to avoid prolonged inundation but also to safeguard the barrages, particularly in Sindh where the river flows on a ridge. The options to give space for the river needs to be investigated: in bridge remodeling or placing spurs, in removing semi-permanent zamindari bunds and in revisiting road infrastructure developed in the flood plains. In addition, it is important to critically review and reconsider the position of spurs and deflectors at critical points (especially ahead of the barrages) needs to be investigated as well as the closure of gates on these barrages.

4. Towards flood resilience: governance agenda

The vision of water security that underlies many policies focused on investments in water infrastructure financed by multilateral investment banks is also relevant for Pakistan. In a nutshell, countries that are moving to a tipping point whereby they establish a "minimum platform" of water infrastructure and the institutions with the capacity to manage it can focus their investments on improving the control of water for economic development. In countries where this has been reached water enhances growth overall. In countries where this platform has not been reached water is an obstacle to growth. This seems to be the case in Pakistan. There is a direct link between GDP and flood events, which indicates that Pakistan is still at a stage where it is a victim to water.
The establishment of a minimum platform is done through investments in infrastructure, institutions, and information systems for an integrated development accepted by all stakeholders. The amount and proportion of

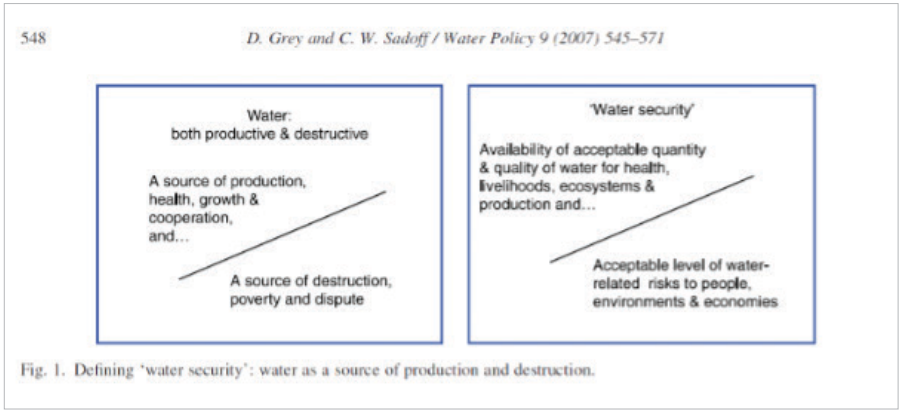


Fig. 1. Defining 'water security': water as a source of production and destruction.

investment in each country is directly contingent upon the contribution of the investment to an improved water security in the country or region. In other words, when weighing the option whether to invest in a specific project the main question that has to be asked by the GoP and donors is whether and how this investment will bring the country closer to the tipping point to attain water security, or in some cases will further consolidate the water security status of the country. The second question to ask is what the best alternative use would be of the funding and water involved. In other words, whether other investments or allocation of the water which is part of the intervention to another use would provide a higher return on attaining the platform of water security.
It is important to note that the focus on infrastructure does not refute the importance of ecosystems and an integrated approach such as the approach dictated by the Integrated Water Managemment (WRM) approach. Infrastructure to improve water security can also refer to e.g., dams or groundwater storage facilities that will ensure an appropriate quantities of environmental
flows. It is furthermore important to note that the water security approach also focusses on institutions. These are common institutions such as water resource management organisations at federal and provincial level, data management institutions and infrastructure and in some cases conservation agencies.

For this White Paper we would like to propose that investments for water infrastructure be aligned on the basis of a water security paradigm as described above, and to highlight the potential of managing flood waters to optimize the benefits that can accrue from the flood waters. This requires investments in flood and drainage infrastructure, but foremost inter-provincial cooperation and capacity building to ensure that the investments and efforts align to benefit all parties.
The issues related to drainage are detailed above. It is important to note that inter-provincial cooperation is crucial in this context, and that investments will have to be made both in infrastructure as well as capacities of the water management institutions at federal and provincial levels.

4.1 Building trust between the provinces. One of the key issues to achieve the above is an improved coordination in spatial planning and cooperation in flood management between provinces, that by law have a considerable autonomy in water managemennt.. In the case of the floods of 2022 this would be between Balochistan and Sindh, but as this also refers to other flooding events, this has a broader application.
To achieve this, we propose to work with the Stabilization Mechanism, and develop a Multilateral Dialogue Platform (MDP). For an MDP to be effective, the following elements are important:

1. Joint ownership by core parties is required as equal partners.
2. Official endorsement of core parties with complete government authority,).
3. Diplomatic as well as technical representation
4. Compensation for capacity disparities
5. MDP possibly being a conduit for different initiatives, such as information management, modelling and scenario building and capacity building.)

In the case of Pakistan, it is proposed that the MDP would consist of representatives of the four provinces, and would also have representatives from the federal government, as well as international donors and supporting states. The organisation would be a venue for open dialogue, research, communication and negotiations. The nature of the MDP would be such that any statement made by one of the core parties would not have repercussions on a political level. In other words, conflicts and disagreements can be voiced fully without fears of repercussions. The venues for the dialogues would not be in Pakistan, and the minutes of the meetings would be confidential.
The main aim would be to improve relations and confidence levels between the provinces to be able to effectively implement measures to manage floods, and to re-calibrate the capacities of water management organisations in Pakistan.
Initial topics proposed to be research and discussed with the MDP are:

1. Spatial planning so as to optimize flood water drainage in the basin to safely retain and remove flood water
2. Managing the discharge capacity of the main Indus and its distributaries
3. Using the potential of beneficial use of floods and allocating excess flood water.

4.2 Mandate to manage floodwaters at a Federal Level

On the basis of the issues raised above and the suggestion to work through an MDP the question has arisen as to who has the legal mandate to decide on the use and disposal of floodwaters. As water is a provincial subject, this mandate would seem to lie at the provincial level. However, as the floodwater crosses provincial borders and as the spatial development (encroachment of flood plain, development of structures that effect storm water removal) it becomes a federal issue.
At Federal level the Federal Flood Commission is the most appropriate entity to coordinate floodwater management . In addition, the Indus River System Authority (IRSA) is an agency with the Federal government that has gained a certain level of acceptance in dealing with the four Provinces and apportioning water.

As part of one of the three topics mentioned above for research and dialogue within the MDP, we propose to carry out a thorough review of the institutional landscape of flood water management at the Federal Level in Pakistan specifically with the aim to cement the legal mandate for the management of flood waters at a Federal level. This review should be highly participatory and inclusive, addressing the concerns of all Provincial and Federal level institutions, as well as key civil society organisations.

4.3 Connecting with provincial governance agendas

Flood resilience and spatial planning has to be rooted in better practice and governance in flood water management at provincial and local level. Through the MDP approach the provincial governance agenda is implicitly addressed by their representatives on the enforcement and implementation challenges and unclarities related to mandates in flood water management at different levels. The MDP could encourage and keep track of these developments within the provinces. Main agenda items within the provinces would be:

Addressing mandates:

- Responsibilities for spatial planning
- Responsibilities for floodwater removal and inspection of flood and storm water management network
- Responsibilities for main river canals
- Coordination between at least Irrigation Department; Local Government, Roads/Highways, PDMA and Planning Department
- Addressing enforcement problems and blind spots
- Unauthorized breaching at different level (bunds and drains)
- Routine of bathymetric survey near barrages
- Encroachment of flood water drains
- Land leases in flood plains
- Redesign of bridges
- Use of overflow land.

As part of the institutional review proposed above in the last paragraph of section 4.1 the issues above should also be included, both to provide clarity and as input to the dialogue within the MDP.

5. Next steps

This white paper is for discussion and elaboration. It proposes and develops a number of approaches and recommendations that go beyond the assessment of damages and the costs needed to rebuild, but to create flood resilience rooted in spatial planning and basin management. We have proposed ways to build back better, and to build trust between stakeholders. These kinds of flood events cannot be ruled out given the advent of the impacts of climate change. Government, civil society and international partners have to move with these changes. The recommendations present a way forward that not only may prevent some of the worst impacts of climate change and flooding in the future, but they will also improve the use of flood waters, and the coordination between federal, provincial and local authorities to manage the flood event itself.

It is proposed to follow this up with :

- Improved confidence building and strengthened coordination
- Working on governance agenda
- Scenario development and inundation models
- Exploring technical options

As a follow up to the white paper and based on the comments and suggestions,, a road map and plan of next steps will be prepared

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