
RIVER INDUS
JINNAH
ARRAGE

CHAPTER 9

There is a need to launch a Blue Revolution ....water would thus be required to play even a more important role than it did in the so called Green revolution , which was driven primarily by agricultural expansion[1]

DEVELOPING AN INTEGRATED FLOOD MANAGEMENT PLAN - THE WAY AHEAD

- *Developing integrated & holistic Flood Management Plan*
- *Factoring Climate Change into Flood Management architecture*
- *Improving Pre Flood Preparedness, Flood Forecasting, Flood Fighting, etc*

1. INTRODUCTION

1.1. This inquiry has revealed that despite multiple flood sector related institutions, Province of Punjab (or the country as a whole) does not have an Integrated National Flood Management Plan. In other words, our country does not have a strategy to combat floods.

1.2. We have noticed that floods are being poorly managed. Except the ritualistic high powered pre-flood meetings and perfunctory departmental pre-flood inspections there is no PLAN or STRATEGY to combat floods. Reliance by the flood managers is on Barrage Regulations and the Flood Fighting Plan which fall short of an integrated and holistic inter departmental flood management plan. This inquiry shows that the flood managers are not fully conversant with the Barrage Regulations and have failed to follow them in the recent floods. Flood Fighting Plan, on the other hand, is a document generated by thoughtless cut and paste of the previous year's plan. There has been no up gradation or innovation in these plans over the years. Such poor regulation and planning can only lead to results we witnessed in the recent floods.

1.3. To us unprecedented flood peak is of little significance. The real worrying issue is the absence of STRATEGY AND AN INTEGRATED FLOOD MANAGEMENT PLAN. Mere reliance on Barrage Regulations and Flood Fighting Plans will not do. An Integrated Flood Management Plan is an immediate necessity, and must be put in place before the next flood season starts.

[1] (Draft) National Water Policy (Pakistan)

1.4. With dismay and displeasure we note that the Federal Flood Commission (an authority constituted for this purpose), Provincial Irrigation Department(s), Planning Commission and Planning & Development Department have failed to come up with a Water Resource Management Plan for the country and as a consequence have also miserably failed to develop an Integrated Flood Management Plan.

1.5. Floods are a blessing[2] and they ought to be welcomed with the confidence and ability of the flood managers to mitigate loss and to take advantage of the benefits floods bring.

1.6. Flood management is much more than minimizing economic losses and damages. It requires intelligent management of both the flood plains and water resources generated by floods. Doing this well can support development instead of preventing it. Separating the floods from the development and natural resources context in which they occur increases the risk that poverty alleviation and adaptation strategies fail[3].

1.7. Floods are part of a natural cycle that can never be fully controlled. "Flood control" is therefore a futile terminology and a counter productive mandate. It is time to move towards an integrated approach to flood management to save lives, increase resilience and take advantage of the bounty floods bring. Flooding supports ecosystems which provide services that are essential to human livelihoods.

1.8. When formulating a Flood Policy we need to take a more holistic view of the floods, one that goes beyond looking at the immediate misery that floods can cause. We need to move away from flawed strategies of "flood control" to more practical and achievable strategies of "Flood Mitigation" or "Flood Risk Management" or "Flood Resilience."

1.9. The flood managers need to understand the challenges before drawing up a Flood Policy. Population growth is perhaps the most important challenge. Rising population requires more food and in turn more agriculture. Most rain fed agriculture is in the arable land of the flood plains. Flood plain resources require planned management, more so in a country like Pakistan which has an agro-economy. With growing population, human settlements by the river increase flood risks and threaten human safety through deforestation and altering of the hydrological properties of the catchment area. This can lead to accentuation of flood peaks, hill torrents and increased sedimentation.

1.10. While flood managers in the past have focused on structural and non structural measures to protect and mitigate flood, a broader set of objectives need to put on the agenda. While structural safety of the barrages and training works is critical, human safety, protection of human shelters, safeguards for agriculture and fisheries, roads, ecosystems, health, and biodiversity need equal attention. This further requires a more holistic planning

[2] Enhancing agricultural productivity and water availability, if floods are properly managed.
[3] Mark 137 - article by Joachim Saalmueller, Associated Programme on flood Management Climate and Water Department, World Meteorological Organization (WMO).

pattern involving a number of connected departments and agencies.

1.11. A flood is perceived as an event best suited for the disaster and relief management agencies. This approach requires a fresh look. We need to develop our resilience, we need to accept floods as a bounty and learn to absorb them and live with them and enjoy its fruits. Our flood policy must then primarily revolve around land use zoning, flood plain management, watershed management, environment conservation and management, enhancing forest cover along the riverine belt, redesigning the architecture of human settlements in the flood plains, developing retention pools, learning to understand the morphology of the river and tampering little with nature and natural river flows unless necessary. Therefore, flood policy cannot only be a long list of structural embankments and levees. Thwarting nature will never provide a solution, it never has.

1.12. It is once again underlined that National Flood Management Plan cannot exist without a National Water Resource Management or National Water Policy/ Plan. Flood management is, therefore, weaved into a national water management plan, and any planning for the flood sector will flow from the water sector. We notice with deep concern that the National Water Policy is still a DRAFT and is awaiting approval since 2005. Additionally, the National Flood Protection Plan–IV (2008-2018) has not been approved. This governmental and perhaps bureaucratic inertness is most disturbing and can be listed as a cause behind the recent devastation.

1.13. Water and our future are deeply interlinked. Our future progress has a serious risk of being threatened if governments of the day do not put water, floods and droughts on their top agenda.

1.14. In the face of governmental inertia in devising a plan, we felt it obligatory to formulate policy recommendations for the development of an integrated flood management plan in the Province, as well as, the county.

2. EXISTING THOUGHT ON FLOOD MANAGEMENT

2.1. We draw strength from the local and international material on the subject. Relevant portions are reproduced hereunder as a guide for the flood managers and policy makers, who should waste no time in developing an Integrated Flood Management Plan VERY SOON.

2.2. INDUS BASIN IRRIGATION SYSTEM (IBIS)- AN OVERVIEW: Pakistan's economy is largely based on its agricultural produce. Water is therefore a critical resource for its sustained economic development. In order to fully utilize the river water resources, the IBIS has emerged as the largest contiguous irrigation system in the world. The IBIS comprises of three large dams, 85 small dams, 19 barrages, 12 inter river link canals, 45 canal commands. This network is the biggest infrastructure enterprise of Pakistan accounting for approximately US$ 300 billion of investment. The average annual flow of Western Rivers of Indus basin is approximately 142 million acre feet (MAF) with about 104 MAF diverted for

irrigation purposes and 35 MAF outflows to the Arabian Sea.

2.3. In addition to providing food security, the agricultural produce of IBIS constitutes 23% of GDP, 70% of total export earnings and 54% of employment of labour force. The IBIS is therefore essential in sustaining the agriculture sector and consequently economic well being of Pakistan. The Indus basin now serves as a breadbasket of Pakistan[4].

2.4. *VISION-2030 OF THE GOVERNMENT OF PAKISTAN[5]:* According to the Vision 2030 (August 2007), prepared by the Planning Commission, Government of Pakistan, natural resource will be severely depleted and stressed, especially water, land and forests, assuming that current water consumption patterns continue unabated. The projection shows that at least 3.5 billion people or 48% of the world's projected population will live in water stressed river basins in 2030 including Pakistan.

2.5. Integrated water resource management which aims at ensuring the most optimal use of water is a major strategy for overcoming the looming water scarcity. Pakistan has not managed its water resource with care and is now becoming increasingly water-stressed (less than 1000 cubic metres per capita). The country's current storage capacity at 9% of average annual flows is very low as compared with the world average 40%. However, on average, 35 MAF of water flows in the sea annually during the flood season. In addition, extensive damages result due to flooding. Without additional storage, the shortfall will increase by 12% over the next decade. The increasing storage capacity is thus an important part of the strategy.

2.6. *NATIONAL WATER POLICY 1987[6] (INDIA) :* There should be a Master Plan for flood control and management for each flood prone basin. In flood control and management, the strategy should be to reduce the intensity of floods by sound watershed management and provision of adequate flood cushion in water storage projects wherever feasible to facilitate better flood management of each flood prone basin. According to the Policy (for Flood Control and Management):

i. There should be a master plan for flood control and management for each flood prone basin.

ii. Adequate flood-cushion should be provided by water storage projects to facilitate better flood management.

iii. In highly flood prone areas, flood control should be given overriding consideration in reservoir regulation policy even at the cost of sacrificing some irrigation or power benefits.

[4] Mark 137
[5] Ex I.W. 137/5
[6] Reference in Mark 136 - NATIONAL WATER POLICY (India)(As adopted by National Water Resources Council in its 5th meeting held on April 1, 2002)

iv. While physical flood protection works like embankments and dykes will continue to be necessary, increased emphasis should be laid on non-structural measures such as flood forecasting and warning, flood plain zoning and flood proofing for the minimization of losses and to reduce the recurring expenditure on flood relief.

v. There should be strict regulation of settlements and economic activity in the flood plain zones along with flood proofing, to minimize the loss of life and property on account of floods.

vi. The flood forecasting activities should be modernized, value added and extended to other uncovered areas.

vii. Inflow forecasting to reservoirs should be instituted for their effective regulation.

2.7. *INDIAN EXPERIENCE*[7]*:* It has also been argued by some environmentalists that in order to control floods, the level of water in the reservoir of the dam should be kept at minimum level. However in order to generate hydro-electricity and bring more agricultural area under irrigation, the level of the water in the reservoir is kept high which leads to flooding in the upstream areas. Thus the measure that is often touted as a solution to the flood woes itself becomes a cause of it. Hence it is high time for the government to look for ecological measures that can help in the management of floods on a durable, long-term basis. Afforestation of the flood plains must be encouraged as trees not only absorb rainfall water but also obstruct its flow to the rivers. Construction activities on the flood plains should be stopped altogether. The flood plains, being very fertile, can be used for economic activities like agriculture. Those living in flood plains for these activities should have an efficient early warning mechanism that ensures their evacuation before the calamity strikes. With the advancement in space technology that India has achieved, remote-sensing should be effectively used for prediction of rainfall and floods. It is only with these comprehensive and holistic measures that an efficient management of floods can be ensured with least damage to life and property.

2.8. *BANGLADESH EXPERIENCE:* Options for flood management can include flood forecasting and warning, preservation of retention ponds, land use planning, flood zoning, emergency services, shelters, flood proofing, flood fighting and post-flood rehabilitation measures. Moreover, experiences from 1998 flood indicate that coordination between agencies responsible for flood protection and drainage of the city can significantly reduce the flood damage.

2.9. *PAKISTAN'S FLOOD POLICY*[8]*:* A number of Provincial and Federal Acts drive the flood policy in the country. The major Provincial Acts are Punjab Irrigation Act 1873, Sindh

[7] Indian National Water Policy
[8] Mark-134, (Indus Basin River System-Flooding and Flood Mitigation by H. Rehman and A.Kamal)

Irrigation Act 1879, NWFP Act 1873, Balochistan Ordinance 1980, Punjab Soil Reclamation Act 1952, Water Users Association Ordinance 1981, Provincial Irrigation and Drainage Authority (PIDA) Acts 1997, etc. At the federal level the relevant acts are WAPDA Act 1958, Indus River System Authority (IRSA) Act 1992 and Environment Protection Act 1997. Additionally, a Provincial Water Accord was signed in 1991 for apportionment of Indus River Waters between the four provinces.

2.10. None of the above laws provide a national or provincial flood management policy.

2.11. A recent report on disaster management policies in Pakistan (WCDR, 2005)[9], inter alia, highlights that Disaster Management in Pakistan basically revolves around flood disasters with a primary focus on rescue and relief. After each disaster episode the government incurs considerable expenditure directed at rescue, relief and rehabilitation.

2.12. *NATIONAL WATER POLICY*[10] *(Draft):* Draft National Water Policy prepared in 2005 addresses all the water related issues in the country, including the flooding issue. The Policy provides a framework whereby flood management in the country can be improved through necessary institutional and legal reforms. The National Water Policy is a landmark document and can go a long way in improving flood management in Pakistan.

2.13. The Policy acknowledges gaps in the existing policy framework and recommends rationalizing various pieces of legislature to minimize overlap and redundancy. It proposes to create a Federal Water Commission incorporating FFC, part of Planning Wing of WAPDA and Office of the Chief Engineering Advisor. It also recommends replacement of various water related provincial acts with a simple unified law that enables clearer understanding and subsequent application of the law.

2.14. The Policy has been prepared on modern lines and emphasizes all the necessary structural and non-structural measures for flood management. It emphasizes the need of stakeholder participation in the flood management process and enhancing flood awareness in the community.

2.15. A step forward would be to acknowledge the floods as a 'resource' and harness the numerous benefits that are associated with the regular flooding. In this regard flood mitigation measures need to be developed that acknowledge the floodwaters as a resource and ensure that the best possible outcome is achieved in terms of socio-economic and environmental benefits for any proposed structural measures.

2.16. The Policy also recommends strengthening of information management and research in the area of flood management. In this regard the Policy calls for promotion and support of public and private research in the fields of weather forecasting, rainfall predictions and flood forecasting.

[9] Mark 133
[10] Mark 142- Still a draft since 2005

2.17. *FLOOD MANAGEMENT.*[11] Draft National Water Policy provides the following flood management strategy

Issues	Policy	Strategy
■ Increase in flood peaks due to sedimentation of reservoirs. ■ Problem of inundation and land erosion. ■ Lack of proper maintenance of flood protection works. ■ Inadequate management of floods and flood forecasting and warning system. Flood Plain encroachments.	■ Greater emphasis on proper maintenance of the existing infrastructure. ■ To attenuate flood peaks, additional multi-purpose storages (including flood control) be constructed ■ Promote flood retardation structures ■ Promote Watershed Management and provision for sediment sluicing in new dams ■ Review the design and maintenance standards of existing flood protection structures, and make improvement where necessary to bring them to the level of functional capability and reliability ■ Encourage flood adaptability in riverine belts. ■ Improve flood forecasting and warning system ■ Towards better flood management, review and update Flood Manual and National Flood Protection Plan, Flood routing study be undertaken ■ Improvement of design and standards of flood protection interventions ■ Establish and promote flood zoning and enforce appropriate land use by avoiding growth of vulnerable developments in flood-hazard areas. ■ Develop River Laws to protect waterways and flood plains from encroachment, misuse etc. ■ Optimize reservoir operational rules to ensure efficient and prudent decisions to control floods, particular when reservoirs are near to maximum conservation level.	■ **Continue with the construction of additional flood protection facilities** ■ **Creation of public awareness education on flood related intervention** ■ **Support a special study to explore various methodologies such as dredging, flushing and/or removal of accumulated sediment from river beds, particularly in the lower reaches of Indus, to check the river levels from rising further** ■ **Promote and support research for better understanding of the monsoon systems** ■ **Strengthen Pakistan Metrological Department through modern weather forecasting equipment.**

[11] Mark 142

2.1.8. *FLOOD PROBLEMS*[12]*:* The main issues relating to flood works in the Punjab Province include the following:

i. Lack of strategic / master planning for flood management and implementation of flood protection works.

ii. Concerns related to planning, design and implementation of river training works, particularly with regard to the absence of objective / coherent selection criteria and repeated damages to the constructed facilities.

iii. Partial implementation of the identified interventions due to inadequate planning, delay in approval and funding, and delays in construction.

iv. Sustainability concerns with particular reference to lack of criteria / mechanisms for financing the O&M and restoration costs.

2.19. Mr. Asrar-ul-Haq[13], Chief Strategic Planning / Reform Unit, Irrigation and Power Department, Lahore deposed before the Tribunal that:

"…lessons learnt from the recent floods are as follows:

(i) To further develop the flood fighting plans which are currently merely reactive. The plan should include a plan "B" as well.

(ii) Various second defense bunds need to be repaired and brought up to the mark;

(iii) The system of embankments need to be improved and wetting channels may be provided for safety of embankments;

(iv) The system of flood embankments and structures need to be revisited on the basis of new benchmarks / high flood levels as experienced this year;

(v) Improvement of drainage infrastructure;

(vi) Location of relief cuts need to be identified by the department like the breaching sections, so that in an emergency there is no problem of their activation and the local community is also aware of the impacts of the steps being taken by the department;

(vii) Adequate funding for improvement / construction of flood protection

[12] Mark 107
[13] I.W. 141

infrastructure, as well as, for operation and maintenance of the flood infrastructure.

2.20. According to Naseer Ahmad Gillani[14], Chief (Water) Planning Commission, Government of Pakistan, Islamabad: "Planning Commission's view on the Flood Sector is covered in the Medium Term Development Framework ("MTDF") 2005 – 2010. In this regard, it is pointed out that the Working Group of MTDF on Flood Sector was also constituted with the primary purpose of developing an integrated Flood Management Plan, they have tendered their report. . . . The Planning Commission has worked on the Water Resources Management, however, as far as, Flood Management is concerned, it is the understanding of the Commission that this is the task to be undertaken by the FFC which is later on integrated into MTDF."

2.21. According to Mr. Asif H. Kazi in his paper Flood Control and Management[15], the following are the key issues that need to be appropriately addressed in order to ensure a proper flood management plan for the Province:-

i. Development in irrigation, drainage and other water management activities per se must interact with flood management. Planning for flood management must be regarded as an integrated and a continuous process which is not being done.

ii. Most structural planning is required in developing flood protection facilities rather than a local emergency approach which is more frequent.

iii. Design standards of existing flood protection works grossly fall short of the required levels. For instance, existing side slopes of protective embankments are rather too steep. The shanks of spurs are too long and spacing too large.

iv. The maintenance standards of the existing flood protection infrastructure are particularly deficient. Replenishment of eroded embankments, spurs and stone aprons, etc. is carried out inordinately late while adventurous risks are taken with the result that breaches/damages are not uncommon. This needs an asset management plan and assessment of liabilities.

v. Appropriate actions are lacking in the land use, and, therefore, growth of vulnerable developments in floodplain areas continue unabated.

vi. Old reservoir operational rules are not being upgraded to properly attenuate flood peaks despite better forecasting methodologies now available.

vii. Monsoon systems causing Pakistan's high-magnitude floods, including travel mechanisms of weather systems from Bay of Bengal and their interaction with

[14] I.W. 143
[15] Mark-134

westerly currents from Arabian Sea and Mediterranean, etc. vis-à-vis seasonal low pressure over Balochistan, Tibet Plateau pressures, wind velocities and other relevant factors are not fully integrated and understood. There are also many gaps in the coverage provided by the existing weather radars.

viii. Flood response plan lacks (1) level of awareness (2) flood warning time and (3) reliability of warnings.

ix. Implications of the vague terms currently used for Flood Warning such as "High Flood", "Very High Flood" or "Exceptionally High Flood" are not understood by even literate person, let alone the potential village affectees.

x. Progressive deposition of sediment on the river beds, particularly in the lower reaches of the River Indus, is proceeding unchecked. Current management of the problem by correspondingly raising of the dykes to contain the river every few years, is certainly not sustainable on a long-term basis.

2.22. According to Mr. Asif H. Kazi[16], urgent measures are required to ensure:-

(a) Sufficient and efficient transport system for mobility of staff.

(b) More effective patrolling of bunds and river training works.

(c) Strengthening of communication system by providing additional wireless equipment or use of internet in the flood affected areas.

(d) Shingle roadways be provided on the bunds for quick access and flood fighting.

(e) Old system of providing lanterns to patrolling staff be replaced with portable generators with poles and electric cables, if proper monitoring and timely remedial action is to be ensured to avoid breaches during floods.

NON-STRUCTURAL OPTIONS: various non-structural options are composed of the following:-

(f) *Watershed Management Practices* - As also stated earlier, watershed management, though a long-term activity, yields major flood mitigation benefits. The function of such measures is to reduce the velocity of flow and sediment generation, by providing/restoring afforestation cover in the catchment areas. In the face of scanty rainfall, the success of planting in the catchments of hill torrents, is generally possible only under strict prohibition against grazing. In other areas such as the

[16] Mark-134

upper parts of the Indus catchment, plantation is not possible because monsoon systems are unable to penetrate and thus there is hardly any rainfall to support vegetation. Mangla Dam watershed management has been under way for the last 45 years, and its positive effects became apparent some years ago when the annual silt load entering the reservoir was found to have reduced by almost half, thus doubling the life span of the reservoir. Prolonging the effective life of a reservoir indirectly helps in attenuating flood flows that are routed downstream. At the time of design and construction of Mangla Dam, the silt particles per million (PPM) were such that the annual sediment deposits in the reservoir were estimated as 60,000 acre feet which subsequently reduced to approximately 35,000 acre feet.

(g) Land-Use Restrictions, Cropping Patterns, etc. Flood damages are reduced by adopting modified land-use practices suitable to the local conditions. Furthermore, in flood-prone areas, development of infra-structure, residential colonies and industrial states have to be discouraged through proper legislation and only flood-resistant crops be sown, especially those spanning the flood season. In practice, there is very little work achieved under this option, and the land use/cropping patterns remain virtually unregulated, and the people continue to take risks freely. Any high-asset infrastructure has of course, to be provided with adequate flood protection.

(h) Soil and Water Conservation Techniques: Soil and water conservation practices are extremely useful if properly adopted in accordance with the catchment characteristics of river/hill torrent basins. This greatly helps in reducing erosion of otherwise productive soils, especially through storing flood waters for agriculture. In some hill torrent areas and in river catchments, conservation techniques including terracing, contouring, strip cropping, are being practiced very successfully. Such techniques significantly contribute in flood abatement, besides providing livelihood to the hilly area residents.

(i) Reservoir Operation Regulations: Pakistan has three large reservoirs, namely Tarbela and Chashma on Indus River, and Mangla on Jhelum River. These reservoirs are primarily meant for irrigation supplies, hydropower generation being the secondary purpose. However, the reservoirs also provide an opportunity in flood management by depressing flood peaks.

(j) In India, there exist five storage dams on rivers that eventually flow into Pakistan. On the Ravi River Thein Dam; on the Sutlej River Bhakara and Nangal Dams; and on the Beas River Pando and Pong Dams. These dams were constructed after the 1960 Indus Water Treaty. With these dams the Ravi and Sutlej Rivers in Pakistan, have become literally dry, except for occasional flood flow that enters Pakistan when the huge reservoirs in India, are already full or it is not otherwise feasible to store water.

(k) The power generation and irrigation requirements aim to fill the reservoir to

full capacity by the end of the monsoon in August each year, both in Pakistan and in India. In terms of releases, optimum power generation requires maintaining the high water level during the entire period of operation, while irrigation supplies require maximum level in August and minimum water level in June next year, thereby enabling full utilization of the stored water for agricultural purposes. If some degree of priority was to be given to flood, space would need to be reserved at a certain level below the full capacity. Another option would be to permit flexibility in operational regulations relying upon instant information that is now possible from the newly-installed telemetry and more efficient communication system; by storing flood peaks in the event when the reservoirs are full at the end of August and a flood is experienced (say) in early September. Under the current regulations no flood mitigation is possible in such circumstance just as it happened at Mangla in the year 1992. This aspect needs to be given serious consideration.

2.23. According to World Meteorological Organization (WMO)[17] the summary of an integrated plan is as follows:

Strategy	Options
Reducing flooding	Dams and reservoirs Dikes, levees and flood embankments High flow diversions Catchment management Channel improvements
Reducing susceptibility to damage	Floodplain regulation Development and redevelopment policies Design and location of facilities Housing and building codes Flood proofing Flood forecasting and warning
Mitigating the impact of flooding	Information and education Disaster preparedness Post-flood recovery Flood insurance
Preserving the natural resources of Flood Plains	Floodplain zoning and regulation

[17] Mark 146- Integrated Flood Management – concept paper – WMO no. 1047

2.24. According to *PAKISTAN WATER SECTOR STRATEGY*[18] the objectives for flood protection as based on the Draft National Water Policy are to:-

(i) Place priority for flood protection on areas of major human habitation and economic importance;
(ii) Prepare flood and drought management strategies, especially for major cities, key secondary cities and towns & major infrastructures;
(iii) Promote the delineation of Flood Risk Planning and Regulatory Zones to be adopted by all agencies as part of the planning process and for them to:

- identify consistent standards of service for differing land uses
- priorities areas for flood protection
- prepare plans in terms of areas for full, appropriate and non-structural measures
- regulate land use and development of floodplains
- Develop flood forecasting, warning and preparedness strategies for flood prone areas
- Implement effective recovery of operating and maintenance costs from beneficiaries of urban flood alleviation and stormwater drainage schemes.

2.25. FLOODING AND FLOOD MITIGATION[19]

2.26. Flood management in the Indus Basin is a multi-dimensional process that demands intensive resources and requires efficient coordination between various government agencies. However, even advanced flood management systems are no guarantee against flood disasters as has often been proved in the more developed countries. Pakistan being an agricultural economy cannot afford to risk its agricultural infrastructure consisting of dams, barrages and irrigation canals, which can be under severe stress in major flood events.

2.27. Currently, the flood management policy of the country is more reactive than proactive in dealing with the flood issues. However, with the preparation of National Water Policy, the situation is likely to change with far reaching effects on the flood management process in the country. The National Water Policy provides the necessary legal and institutional framework to improve the flood management process in Pakistan.

2.28. Although the National Water policy provides the necessary guidelines for flood management, there is a need for a separate national policy for flood management to deal specifically with the flood issues in the country. Such a policy may be called National Flood Policy that may outline the details of policy framework for flood management. It is worth noting here that a new paradigm in flood management that considers flood as a resource rather than a menace can be highly beneficial in achieving the environmental objectives of

[18]Pakistan Water Sector Strategy, Ministry of Water and Power, Chairman Federal Flood Commission (Mark 138)
[19]Mark 135- Indus basin River System- Flooding and Flood Mitigation - H. Rehman and A. Kamal.

the government, which are set under various international conventions to which Pakistan is a signatory.

2.29. It is envisaged that the flood forecasting capabilities would be improved considerably under the second Flood Protection Sector Project being undertaken by the Federal Flood Commission. The task of quantification of flood risk thorough detailed studies and subsequent measures required in minimizing the risk should be taken on priority basis.

2.30. BEST PRACTICE METHODS FOR VALUING FLOOD CONTROL BENEFITS[20]

- Flood events are a part of nature. They have existed and will continue to exist. As far as feasible, human interference into the process of nature should be reversed, compensated and, in the future, prevented.
- Flood strategy should cover the entire river basin area and promote the coordinated development and management of actions regarding water, land and related resources.
- Considering the evolution and trends, the approach to natural hazards requires a change of paradigm. One must shift from defensive action against hazards to management of the risk and living with floods, bearing in mind that flood prevention should not be limited to flood events which occur often. It should also include rare events.
- Transnational efforts should be intensified to restore rivers' natural flood zones in order to reactivate the ability of natural wetlands and floodplains to retain water and alleviate flood impacts.
- Flood forecasting and warning is a prerequisite for successful mitigation of flood damage. Its effectiveness depends on the level of preparedness and correct response.
- Human uses of flood plains should be adapted to the existing hazards. Appropriate instruments and measures should be developed for all flooding related problems: flooding, rising groundwater tables, sewage network disruption, erosion, mass deposition, landslides, ice flows, pollution, etc.
- Mitigation and non-structural measures tend to be potentially more efficient and long term more sustainable solutions to water-related problems and should be enhanced, in particular to reduce the vulnerability of human beings and goods exposed to flood risk.
- Structural measures (defence structures) will remain important elements and should primarily focus on the protection of human health and safety, and valuable goods and property. We will have to keep in mind that flood protection is never absolute, and may generate a false sense of security. The concept of residual risk, including potential failure or breach, should therefore be taken into consideration.
- A compensation system should support the victims of flood disasters to restore their economic basis and their living conditions in due time. Insurance solutions at the private or public level or subsidence

[20] Colin Green, Flood Hazard Research Centre, Middlesex University, U.K. - Best Practice Methods for Valuing Flood Control Benefits (Mark 136)

Therefore the responsible authorities should provide timely and reliable flood warning, flood forecasting and information.

- A specific preparedness to alert, rescue and safety measures should be planned and implemented at all levels, including the public, by maintaining regular basic information and continuous ongoing training actions. With appropriate and timely information, preparedness, everyone who may suffer from the consequences of flood events should be able to take –if possible- his/her own precautions and thus seriously limit flood damages.

- Solidarity is essential, one should not pass on water management problems in one region to another. The appropriate strategy consists of three steps: retaining, storing and draining (first make every effort to retain rainfall at the spot, store excess water locally, only then let the water be discharged to the watercourse). Flood prevention has also to be based on the precautionary principle.

by state, which reinforce solidarity, should be furthered.

- In flood-prone areas, preventive measures should be taken to reduce possible adverse effects of floods on aquatic and terrestrial ecosystems, such as water and soil pollution. It is necessary to distinguish between different kinds of flooding and the environmental conditions that contribute to the problem. For instance, there are significant differences between on the one hand sudden flooding in upstream or headwater areas where mitigating risk involves a wide range of innovative small-scale solutions and on the other hand lowland flooding where warning periods and the duration of flood events are longer and large-scale measures have to be taken. Therefore, the effectiveness of the best practices described in part II depends on among other hydrological and environmental circumstances.

2.31. FEDERAL FLOOD COMMISSION (MANUAL[21] OF DESIGN CRITERIA AND METHODOLOGY). NON-STRUCTURAL PROTECTION (SECTION 7) *General:* The non-structural protections should preferably be considered in conjunction with the planning and use of structural protection. However, at locations where structural protection are too expensive non-structural protection will be introduced. The selection of protection type will depend upon the site requirements. The most available and practiced types of non-structural protections are discussed in the subsequent sub-sections.

2.32. *FLOOD-PROOFING:* In general, people in all flood environments want the impact of flooding to be reduced, although there is a widespread acceptance of normal monsoon or other heavy rain conditions. The real concern of people is to reduce the effects of severe floods. Therefore, the flood-proofing needs and interests of local communities depend on the characteristics of the prevailing floods and local consultation and participation. Basically, five types of flood–proofing can be distinguished:

[21] Ex I.W. 103/2

i. Protection of infrastructure like roads, railways, water and gas pipelines, telecommunication, utility building and equipment.

ii. Protection of public buildings, industrial plants and private houses.

iii. Measures directed at emergency situations like creation of refuge areas including water supply, sanitation and flood storage facilities and access to refuge areas in a flood situation. The refuge areas have to be available close to the normal place of residence.

iv. Flood-proofing in agriculture such as the use of crops which are harvested before the flooding season starts, use of flood-resistant crops and food storage facilities for well stocking prior to flood season.

v. Drainage of flood water can be an important flood-proofing measure. It may prevent total flooding or for all cases lower the maximum floods levels and decrease the duration and extent of flooding.

2.33. *FLOOD-FIGHTING*[22]*:* Flood-fighting is an emergency measure which has the objective of mitigating flood impacts, particularly when flood protection and control structures and flood proofing measures have proved ineffective or failed. The measures and means of flood fighting are many and diverse, always requiring adaptation to local conditions. A brief description and requirements of flood-fighting is provided below.

i. Flood-fighting is an important element of non-structural measure for reducing flood hazards. Its important features are the preparedness of all potentially involved persons, availability of technical means and resources, support of respective authorities and cooperation of the public.

ii. Generally, flood-fighting is required for the failures of flood protection structures, such as:

1. Failure of dykes, flood walls and embankments The immediate causes could be scour, overtopping, piping, undermining, bank erosion, breaching and impact of floating debris.
2. Reduced capacity of river channels, flood ways and flood bypass channels; by obstructions of the flow particularly at channel constrictions, bridges and weirs.
3. Failure of weirs and barrages with consequent devastating flood waves.
4. Failure of land drainage systems causing flooding of agriculture land.
5. Failure of urban drainage systems causing flooding within protected urban area.

[22] ibid.

iii. Flood-fighting plans should be part of a well-designed flood management strategy, in which priority zones are clearly indicated and possible sacrifices of areas of lesser importance envisaged. Hence, flood-fighting plans are closely linked to the other emergency measures, such as evacuation of people to safe zones, emergency flood – proofing of structures etc. Flood-fighting plans cannot remain unchanged during longer periods and these should be kept abreast of area developments.

2.34. The flood-fighting measures should be based on clear plans, containing the following main elements:

a. Assessment of flood risk.

b. Zoning of protected or unprotected area according to flood risk.

c. Inventory of flood control or protection systems in the area.

d. Analysis of possible modes of failure of protection structures and technical means to counteract failure during floods.

e. Study of situations which may develop when parts of flood protection systems fail.

f. Planning of second, third and subsequent defence lines for the case of progressive failure of embankments, groynes, spurs etc.

g. Planning of measures for protection against flooding urban areas by closing gaps in flood banks and flood walls, closing sewer outlets etc.

h. Planning of successive measures of retreat; sacrificing less important areas and defending more important areas. In critical situations, the most difficult decision is to sacrifice a certain area in order to relieve the pressure from other areas or to abandon flood-fighting. While the detail of such situations cannot always be foreseen in the flood fighting plans, this contingency must be anticipated.

2.35. Flood-fighting actions are varied, depending upon the development of the flood, the area endangered, the protection structures and available means. For flood-fighting the typical measures are:-

a) Closing of gaps in flood walls or groynes etc. by sand bags or other available methods.

b) Protection of river banks by sand bags, stone, or other available methods.

c) Counteracting piping which is the main cause of collapse of embankment and dykes etc.

d) Protection of bridge piers, weirs, barrages and dams against erosion by rockfill, sand bags and other available methods.

e) Construction of temporary non-structural protection measures to prevent the propagation of flood on non-protected land.

f) Construction of second and future "defence structures", according to the flood-fighting plan.

g) Cutting of embankment, dykes etc. in order to allow flooding of less important areas, and thus to save other more important areas, according to the flood-fighting plan.

h) Removing obstacles from active or potential flood ways, relief and flood bypass channels.

i) Protection of structures exposed to strong wind wash action.

j) After the flood is over, the flood-fighting will enter the follow-up stage. The flood-fighting system should not be demobilized until the valuable experience gained during the flood has been recorded for later analysis and application for improving flood-fighting methods for the next flood event.

2.36. *PROVINCIAL PLANNING COMMISSION- CHAIRMAN[23], P&D BOARD:* The Chairman deposed that the department does not have a holistic master plan for flood management in the Province. The flood sector projects are not totally integrated, however, they have their own strength and benefit the local areas. The Planning Commission, Federal Government, does the over all vision regarding planning and development. P&D uses a master plan of the Planning Commission and does further planning on a provincial level. P&D works within the parameters of the master plan prepared by the Planning Commission (referred to as the White Paper[24]). He admitted that there is no over all vision pertaining to water management or flood management within the White Paper.

2.37. P&D Department does not have a follow up mechanism regarding the approved flood sector projects. In the last two years, the said department has initiated third party validation (TPV). For success or failure of the project the parent department is responsible and it is the parent department alone to monitor the said projects. " I realize that there is a need for going to the drawing board and developing an integrated flood management plan for the province[25]."

[23] I.W.137
[24] Ex.I.W.137/6 and 7
[25] I.W.137

2.38. There are two main streams of funding for the flood sector. One is by the Federal Government and the other is by the Provincial Government. The Public Sector Development Programme (PSDP) is funded by the Federal Government. "the practice is that the MNAs obtain tacit approval from the Federal Government and then press the Provincial Government to initiate flood sector projects/schemes pertaining to their areas against the said fund."

2.39. At the provincial level the funding is through the Annual Development Plan (ADP). The resource allocation for ADP is around 90% from the Federal Government (under the NFC Award) while the provincial contribution to the fund is around 10%. At times, foreign loans and borrowing from the Commercial Banks are also taken which contributes around 10% of ADP.

2.40. Projects (flood sector) are initiated by the respective departments which are scrutinized by the P&D Department (mainly regarding the budgetary limits of the projects) are included in the Annual Development Plan.

2.41. According to the Medium Term Development Framework (MTDF-2009-2012)[26] as well as the Development Programme 2009-2010, the sector has been described in the following manner:

"Irrigated agriculture is the major determinant of economic growth potential of the province as it accounts for 26 percent of the GDP and caters for over 40 percent of the province's work force. Over 90 percent of agricultural output in Punjab comes from farmlands irrigated by one of the largest contiguous irrigation systems in the world. The colossal irrigation conveyance network is serving 21 million acres (8.4 million hectare) cultivable command area with cropping intensities generally exceeding 120 percent. The vast irrigation system in the province, however, faces major irrigation and drainage challenges with serious economic, environmental and social implications. Hydraulic infrastructure has deteriorated and large deficits in O&M maintenance have led to sub-optimal service delivery levels characterized by low water conveyance efficiencies and inequitable water deliveries. Replacement costs for Punjab's irrigation infrastructure including barrages and conveyance network is estimated as Rs.1600 billion whereas the estimated cost for rehabilitation and deferred maintenance needs is Rs.170 billion. Consequently, development in the sector needs to enshrine rehabilitation, improvement and modernization of infrastructure coupled with holistic reforms aiming at integrity and sustainability of the system through improved management and service delivery levels."

2.42. *INTERNATIONAL EXPERTS:*

[26] Ex.I.W.137/2/2

2.43. *JOHN BRISCOE*[27], Gordon McKay Professor of the Practice of Environmental Engineering, Harvard University Schools of Engineering and Applied Sciences, Public Health and Kennedy School of Government, USA submitted to the Tribunal that:

> "The flood problem cannot be tackled in isolation without attending to the overall area of water resource management. Any flood management plan without the isolation of water resource management is erroneous.
>
> The authority dealing with water management in Pakistan is supposed to deal with flood management. The whole challenge is to weave "flood management" in the over all water management context, e.g., if we take Tarbela and reduce its storage prior to the floods, it raises a corresponding issue of hydropower and irrigation security, therefore, flood management and water management are inseparable. For example, the Three Gorges Dam on the Yangtze River in China, which produces 20,000 MW of hydropower, reduces its productivity during the flood season in order to make space for flood water. Such an operating rule can work only because China has redundancy in its power generation system. Pakistan does not have this redundancy and therefore Tarbela cannot be operated in this way. This again illustrates the fact that flood management is part of a bigger picture – not just of water management but energy and food security, too.
>
> As a conclusion there can be no Flood Plan without a Water Plan. The landmark 1968 study on Water and Power Resources of West Pakistan by Lieftinck said that Pakistan should build a dam the size of Tarbela on the Indus every 10 years. However, nothing has been built in the last 40 years. The result is that there is a massive underinvestment in storage on the Indus. Consider the comparison with major rivers in arid areas of the US and Australia. On both the Colorado and the Murray Darling dams have been built which can store about 1000 days of average flow of those rivers. Tarbela can store only 30 days of average flow of the Indus. All measures of infrastructure development point in the same direction. Whereas rich countries have developed over 70% of their economically viable hydropower potential, Pakistan has developed just 10%. Whereas the US and Australia have over 5000 cubic meters of storage capacity per person, and China has 2,500, Pakistan has only 120. The bottom line is that there can be no security – food security, energy security or water security – without major and continuous investments in infrastructure on the Indus. There is 40 years of underinvestment in infrastructure on the Indus.
>
> Of course infrastructure alone does not solve the problem. Water management walks on two legs – infrastructure plus institutions. There are also major institutional issues – legal, regulatory, organization, human resources and knowledge

[27] John Briscoe spoke with the Chairman of the Tribunal over phone from USA and got recorded the above statement. On his visit to Lahore he also met the other members of the Tribunal on 6-12-2010. The above statement is transcribed from the recording made over the phone. The statement was sent to Mr. Briscoe over email which was confirmed with slight modifications on 24-12-2010. Therefore, there is no signature on the statement.

—that have to be addressed, too. Investments in modern institutions must go hand-in-hand with investments in infrastructure. When we did our book on water in Pakistan we commissioned a very good paper on floods. I annex an extract of what we wrote on "living with floods" which is highly germane to [this] inquiry:

> "Flood management is characterized by 'short bursts of feverish activity stimulated by a flood event followed by long periods of complacency… as the memory of flood fades into the past, the motivation for action also passes away'. *(Briscoe and Qamar, page 60).*
>
> While this flood was and is a horrendous event, the reality is that the endemic problem of drought looms very large. As the endemic reality of drought again takes hold, floods will fade away from people's memory. The context is therefore floods, drought, and productivity, agriculture, energy all integrated. As in many countries, attention to floods is episodic and goes into hibernation during periods of drought, with devastating consequences (as witnessed in the recent drought-ending floods in Balochistan)[28].
>
> Pakistan has a long-standing and sophisticated understanding of flood management, and has long emphasized both 'hard' solutions (such as dams, embankments, and drainage works) and 'soft' solutions (such as watershed management, land use planning and flood warning systems).
>
> There are a number of factors—including declining storage capacity in the major reservoirs, and the increased flows likely as a result of glacial retreat—which indicate that Pakistan is likely to be entering an era of increased flooding.
>
> Flood management always involves difficult trade-offs. Embankments and drains and other protective structures cannot realistically be built to such a level that there is no threat of floods. And so when floods do occur, they should not be seen as 'a failure' of the system, but rather as an inevitable part of the uneasy balance which is struck when man lives in very large numbers in a hazardous environment. In addition, populations move into the Indus flood plain, which sustains a productive shallow-tubewell-based agriculture. Priority must be given to structural protection of high-value infrastructure assets, the failure of which would be catastrophic. This obviously includes the barrages, where there is both need for urgent structural attention (witness Sukkur Barrage) and attention to bypass floodways that need to be properly demarcated and channelized, and from which encroachments need to be removed. There are some major structures, such as the Alexandra Railway Bridge over the Chenab, that need to be extended to avoid choking and flood

[28] Briscoe and Qamar, Pakistan's Water Economy – Running Dry- Oxford (World Bank) - 2006: "living with floods" - page 59

ponding upstream that causes frequent inundation of towns and villages. A major problem is that maintenance of the existing flood protection infrastructure is deficient, with the result that breaches/damages are not uncommon. As for all other infrastructure (discussed in more detail in the next section), there is a need for an asset management plan, and assessment of liabilities and mechanisms for regular funding of these. While the concept of flood hazard land-use planning is well understood, the fact is that there is little enforcement, and growth of vulnerable developments in flood-vulnerable areas continues unabated. Post-dam records are long enough to give a fairly good indication of the effect of the reservoirs, but the quality of regulation is not being improved by extending the period of record by simulating reservoir operation for the pre-dam periods. There is a need to review the magnitude of Probable Maximum Flood (PMF) for major facilities.

Flood response plans exist but implementation is weak, with specific priority items being the need to raise the level of awareness, and to the timing and reliability of warnings and how they are understood by the general population.

Progressive deposition of sediment on the river beds, particularly in the lower reaches of the Indus, is proceeding unchecked. Current management of the problem by correspondingly raising the dykes to contain the river every few years is certainly not sustainable on a long-term basis.

Flood management is characterized by ‘shortbursts of feverish activity stimulated by a flood event followed by long periods of complacency… as the memory of flood fades into the past, the motivation for action also passes away’.

The lack of maintenance is a very serious institutional and financial issue. 'Since 1958, with the transfer of major development works to WAPDA, provincial irrigation departments' functions were reduced mainly to the operation and maintenance of the systems. PID managers have not been finding these functions sufficiently challenging, and over the years have lost much of their initiative, innovativeness, and morale. The PIDs' attention remains almost exclusively focused on the irrigation distribution network. Let alone the flood protection works, even the river barrages have been in a state of neglect. Whenever a major problem of a catastrophic nature takes place on a barrage or a flood protection embankment, lack of adequacy of maintenance funds is given as a standard cause which in several cases would be valid while in others not quite so. Deferred maintenance has become a routine practice with PIDs, which eventually results either in a disaster or in a major repair and restoration undertaking in the shape of an independent project.'

> In summary, there is a long tradition of excellent professional flood management capability in Pakistan. But the great challenges are those of making explicit but difficult trade-offs, financing, implementation, maintenance, and institutional performance—in short, the fundamental problems of development.

Finally, while it will be tempting to look for scapegoats in an enquiry on the floods, in my view this should not be the focus. The roots of the tragedy are in the failures of all – not least the Government of Pakistan and the donors who have supported Pakistan – for 50 years. The tragedy is the result of these accumulated failures to make good decisions: both political (especially in building transparency and trust among the provinces) and on both infrastructure and institutions. But there are some good signs –some important reforms in some provinces, for example. Pakistan is at a fork in the water road. It can continue down the path of stagnation, or it can build a new consensus on water, it can end the self-destructive bickering and start building a solid basis of infrastructure and institutions for water, energy and food security.

2.44. *ADIL NAJAM,*[29] Director and the Frederick S. Pardee Professor of Global Public Policy, Boston University,[30] USA deposed before the Tribunal that "although the current focus is on floods because of the tragedy of 2010, focusing on the Indus Water System as a whole is important because future water related disasters by climate change could include not only floods but also sever droughts. Therefore it is important to focus on water system as a whole and the water management systems that can be more feasible both in case of water and extreme drought conditions."

2.45. NESPAK's RECOMMENDATIONS[31]: The flood management and protection systems need to be accorded high significance. The systems are required to be upgraded and strengthened to a high level so that upgraded system are able to sustain high magnitude events as experienced in the 2010 floods. In this context the following areas have been identified where major improvements and major upgrades are required.

i. Improving and extending the Flood Forecasting System to include the upper Indus above Tarbela, Kabul river system above Nowshera and Indus river below Thatta-Sajawal bridge up to coastline of the Arabian Sea.

ii. Development of the flood passage guidelines for Tarbela reservoir so as to enhance its flood mitigation role.

iii. Implement evacuation of the people living in the reservoir areas up to the level of designed highest flood level so that the reservoir operators can implement

[29] I.W. 150
[30] The Frederick S. Pardee Center for the Study of the Longer-Range Future 67-Bay State Road Boston, Massachusetts -02215
[31] Ex I.W. 101/A/1

the SOPs of flood passage through the reservoirs without any constraint.

iv. Capacity building/training for enhancing the technical capability of PMD technical staff and operators of the dams and barrages is required so that they can perform their roles in an efficient and effective manner.

v. Identification of the future reservoirs that would have high flood mitigation role in addition to their agriculture and hydropower benefits and developing flood passage guidelines through them to achieve the desired flood mitigation role.

vi. Identification of flood release channels/escape channels to desert areas / off channel storages that would provide major reduction in flood peak discharge in the main rivers.

vii. Flood Plain Mapping/Zoning along all the Indus river and its tributaries for identifying high and medium flood risk areas for permanent settlements

viii. Identification of low flood risk areas for future cities, towns and villages, industrial areas and other vital installations etc.

ix. Formulation of requirements for legislation for restricting the development of permanent settlements in high and medium flood risk areas

x. Resettlement/relocation of the villages in the flood plains to safe areas outside the flood bunds

xi. Review and revise the flood design criteria of barrages, bridges, bunds and communication infrastructure on the Indus River System, and implement up-gradation where required.

2.46. *SUBMISSIONS OF WWF (WORLD WIDE FUND FOR NATURE):* Mr. Ali Hassan Habib, Director General, WWF, Pakistan in his Position Paper[32] submitted that the recent floods are consistent with the types of events that have been projected from human-induced climate change and such extreme events are occurring with more frequency and with greater intensity or severity according to the latest IPCC report. Therefore, it can be expected that a greater number of intense floods and droughts will be occurring as a result of climate exchange.

2.47. Deforestation has led to increase peak flow of floods. According to the State of the World's Forests 2009[33], the total land area of Pakistan has only 2.5% forest cover and even that is decreasing at an alarming rate. According to this FAO report, Pakistan is losing forests

[32] Ex.IW-81/1

[33] Bradshaw CJA, Sodi NS, Peh KSH, Brook BW (2007a) Global evidence that deforestation amplifies flood risk and severity in the developing world. Global Change Biology, 13, 2379-2395

at an annual rate of 2.1% and no other country in Asia/Pacific region has a higher rate for deforestation.

2.48. According to "Deforestation in Himalayan Forest watersheds and floods": For centuries it has been traditionally believed that forests provide natural protection against flooding. The role of forests in sustaining water supplies, in protecting the soils of important catchments and in minimizing the effects of catastrophic floods and landslides has long been discussed and debated by scientists.

2.49. A recent study published in the journal Global Change Biology by Corey Bradshaw and colleagues details the first global-scale and empirical evidence linking loss of natural forest cover to increased flood risk and severity in developing countries. Researchers from Charles Darwin University (Australia) and the National University of Singapore analysed 10 years of flood data from the Dartmouth Flood Observatory to monitor flood frequency at a country scale. "Our empirical results indicate that halting deforestation or reducing the rate of natural forest loss should be beneficial in alleviating the incidence and severity of floods that ultimately cause undesirable disruption and damage to human life and property", says Corey Bradshaw, the first author of the publication.

2.50. The extent of forest cover in Pakistan in 2005 was 1,902,000 hectares (ha) which is 2.5% of its land area. The annual rate of change of forest cover during 1990 –2000 was –1.8% while during 2000—2005 it was –2.1%. No other country in the Asia/Pacific region has a higher rate of deforestation, according to the country tables provided in this FAO report (FAO, 2009 State of the World's Forests).

2.51. The recent floods in Pakistan started from the catchment areas of the River Kabul, in Afghanistan and River Swat, in Pakistan. These catchments have lost vast areas of forest over the past few decades.

2.52. A recent study on forest cover assessment over the last eight years (2001-2009) of Swat and Shangla Districts highlights that in Swat ~ 7,300 ha of forest has been damaged which is 13% of the forest cover in 2001 and in Shangla ~ 2860 ha of forest has been damaged which is 11% of the forest cover in 2001.

2.53. This degradation has been attributed to institutional failure and lack of law enforcement leading to exploitation of forests by local communities and timber smugglers.

2.54. Mr. Ali Hassan Habib further submitted that most areas in the flood plains or sailaba areas were inundated by floodwater. Historically, Indus River used to flow in the *katcha* area which is about 5 to 25 kilometers wide. Now, one can see encroachments, human settlements, villages and extensive areas under agriculture in this floodplain. We feel this is not wise long-term management of floodplains. More sensible and long-term flood management allows inundation of pond areas, depressions along the floodplains during high flood.

2.55. The Director General of WWF further contended that management of our water resources is widely viewed as unsustainable, inefficient and inequitable. Weather extremes and climate change underscore the need for us to reform our water management practices. He suggested reliance only on building of more reservoirs, such as upper-catchments, small dams, on-farm storage, micro-hydels, localized self help dams, etc. This may also include reconnecting certain natural depressions and pond areas within the broader floodplains of our rivers. A more efficient land use management regime is needed for floodplain management including collaboration of local communities and warning systems supported by smart infrastructure.

2.56. Zoning of areas with respect to vulnerability to floods will need to be done. In cities, flood channels and storm water drainage systems should be separated from sewage systems to eliminate solid waste clogging these channels. Overlapping responsibilities of PMD, FFC, IRSA, PIDA, NDMA and District Governments needs to be eliminated. It is high time that Integrated River Basin Management (IRBM) be applied in letter and spirit. Projected areas like forests, national parks, mangroves, natural depressions, marine ecosystem can play very important role as buffer zones and biological corridors which can act as disaster risk reduction measures. Hence, the role of projected area system be included in the comprehensive flood management plan. National Water Policy needs approval which also supports flood management initiatives in the country.

2.57. *[SIND] BUND MANUAL*[34] also provides for flood management, which is instructive. Key extracts are as under:

2.58. *PROPOSALS FOR WETTING BUNDS (PARA 28) :* Adequate arrangements for soaking are an essential pre-requisite of a safe bund, for the consolidation or compaction of a bund depends on the soaking, which helps settlement and discloses faults which can be repaired or leaks which can be filled before the main rise of the river. Therefore, every proposal for a new bund or a loop bund is incomplete without the attendant proposals for sufficient arrangements for early wetting and consolidation of a bund, unless the bund is likely to get automatically soaked with the early levels obtained in the river on account of low-lying and near the bund on the river side.

2.59. In case of existing bunds, wherever arrangements do not already exist, proposals should immediately be made for their efficient wetting wherever necessary. The two principal ways of wetting bunds in Sind are:

[34] Mark-38 Government of Sind, Public Works Department, Central Designs Division, Mechanical & Research Circle, Karachi Printed at the Sind Government Press 1954. Introduction: Following the breach in the Sukkur Begari Bund and the consequent floods of 1942, there was constituted by the Sind Government a Court of Inquiry into matters connected with the floods, under the Public Inquiries Act, 1940. There was, also, a Technical Inquiry into the causes of breaches in River Bunds in Sind and steps required to minimize the danger of a recurrence. The Court of Inquiry remarked that though now regarded as a complete guide in all matters pertaining to the construction and maintenance of bunds, the Bund Manual manifestly required revision. It considered that there were doubtless matters in which the Manual can be improved and that it required re-editing and keeping upto date. The recommendation to revise the Bund Manual, made both by the Court of Inquiry and the Technical Inquiry, was accepted by the Indus River Commission at their meeting on 26th October, 1943. They suggested that an officer on Special Duty may be appointed to revise the Bund Manual. The present edition of the Bund Manual is the result of that decision.

(a) Wetting channels, and
(b) Flooding of a compartment through a bund sluice in the front bund.

2.60. While method (a), wetting channels, can be used for soaking both front and loop bunds, method (b) is available only for wetting the loop or retired bund. In other words, while the loop bunds can be wetted by either method, the only arrangement possible for wetting front bunds is by means of wetting the channel.

2.61. Wetting channels are of two kinds:-

2.61.1. Gravity channels excavated from the river lip (which is generally higher than the other ground) to the bund along the lowest contours, to lead flow water early against the bund, in advance of the sudden over-topping of the higher ground near the river edge causing a rush of flow against the bund.

2.61.2. High level artificial wetting channels, made by adding a trench bund to a main bund (see Chapter IX para.99). In rare cases, it may be possible to get flow water in these channels with the river levels obtaining at the beginning of the season; but generally, water is lifted into the wetting channels by means of pumps. A centrifugal pump worked by a suitable engine is placed on some canal, or special channel from the river and water pumped thence into the wetting channel.

2.62. The Indus River Commission have, therefore, enjoined that:-
" In all cases of front bunds the river water should be brought to the bunds sufficiently early through leading channels. Where, in case of important bunds this is not possible wetting trench bunds should be provided."[34-A]

2.63. *PRESENCE OF MAINTENANCE ESTABLISHMENT REQUIRED ON BUNDS (PARA 103):* The principal maintenance of bunds comes during high water when the safety of the bund is threatened. Frequent inspections, particularly in case of new bunds or dangerous sections of old bunds, and constant attendance on the bunds, within their charge, by everybody from the humblest beldar to the Executive Engineer are essential.

2.64. Patrolling by beldars commences as soon as water comes against a bund. From that time onwards, until water has finally left the bund, all the establishment engaged on the maintenance of bunds, from the beldar upto the Sub-Divisional Officer, must be present on the bunds within their jurisdiction.[34-B]

2.65. UNREMITTING PATROLLING DURING HIGH ABKALANI ESSENTIAL (PARA 105) : The first line of defense, when the river is in floods, requires close and constant patrol and

[34-A] Bund Manual, Government of Sind, Public Works Department, Central Designs Division, Mechanical & Research Circle, Karachi Printed at the Sind Government Press, 1954
[34-B] Bund Manual, Government of Sind, Public Works Department, Central Designs Division, Mechanical & Research Circle, Karachi Printed at the Sind Government Press, 1954

unremitting supervision, both by day and night, by adequate, trained staff. A stitch in time saves nine : timely warning and timely action, which efficient, unremitting patrolling alone can provide, will save a dangerous situation while complacency born of a false sense of security following a series of low rivers, may lead to disaster. Continuous vigilance in patrolling everywhere is, therefore, enjoined on all the staff, particularly during the night and in the early hours of morning when breaches most frequently occur with the slackening of supervision.

2.66. The temporary headquarters of the Overseer, Sub-Divisional Officer and Executive Engineer should, as far as possible, be in the centre of the active bund line in their charge. Katcha landhis should be constructed for the overseer in the center of his section, if no pucca landhi exists. The Executive Engineer and the Sub-Divisional Officer should, whenever necessary and as far as possible, patrol frequently at night[34-C].

2.67. *WETTING OF FRONT BUNDS AND LOOP BUNDS WITH WETTING CHANNELS (PARA 110):* The wetting of the bund is an essential process in the maintenance and in the safety of a bund, particularly in the excessively dry climate of Sind. However carefully the bund may have been constructed, with thorough clod-breaking, ramming, and rolling, perfect compaction, so that there will be not cavities or no settlement, however small, cannot be expected, unless the soil is also ideal for bund construction, since the clayey soils ordinarily met with in Sind are liable to expand and slide when wet and to shrink and crack when dry. The kalarish soils are even more treacherous, leading to hollows in the bund as the salts in the soil dissolve. The conditions to which bunds in Sind are exposed, alternating between excessive and sudden soaking by the river in the flood months and complete dryness during the rest of the year, make the gradual wetting of the bund in advance of the river floods impinging upon a dry and unprepared bund a vital necessity.

2.68. The purpose of wetting a bund is to consolidate the bund and render it watertight by enabling leaks to be closed, as the contact of water with the bund during the progress of wetting reveals them, so that they may not develop into breaches.

2.69. The relative merits of different methods of wetting of bunds have been set out, while dealing with proposals for wetting of bunds (para.29 Chapter IV). During maintenance, whatever artifice is available at hand has to be made use of to the fullest advantage.

2.70. A bund has to be wetted throughout its entire length if the wetting is to serve its designed purpose, *since a bund is only as strong as its weakest portion.* The plan for wetting should be carefully thought out so that the wetting of the whole length of bund is completed before the rise of the river.

2.71. First of all, water is to be led to the front bund. If the katcha and pucca foreshore on

[34-C] Bund Manual, Government of Sind, Public Works Department, Central Designs Division, Mechanical & Research Circle, Karachi Printed at the Sind Government Press, 1954

the river side of the bund slopes towards the bund, all that may be necessary is to give cuts to the lip at the river edge, which is generally somewhat higher. If there is low-lying land near the bund on the river side but there is high land between the river and the bund, low level gravity channels have to be constructed along the lowest contours from the high river edge to the bund. If wetting by flow water is not possible, sufficiently in advance of the rise of the river, artificial wetting is possible by lifting water into previously constructed wetting channels (see Chapter IV para.28) by means of pumps; a certrifugal pump worked by a suitable oil engine is placed on some canal or special channel from the river and water pumped into the wetting channel. About 1 cusec per mile of wetting channel is required and more while the bund is new.

2.72. Wetting engines should begin to operate about the beginning of May or in sufficient time to enable the water to get to the end of the reach concerned before the water touches the bund and not later than the end of May. As, however, the canals are not generally opened till the beginning of May, in the case of water being taken from a canal, a pipe of sufficient capacity in the bunds, at the heads of the canals, will be required and/or a trench about 3 or 4 feet wide in the center of the canal, with bed level corresponding to suitable river level.

2.73. At any rate, pumping should be commenced as soon as water can be obtained from canals or through connecting channels from the river so that the bund may be soaked gradually and the establishment may have sufficient time to consolidate the surface of the slopes of the main and trenching bunds by sprinkling or splashing water over them and also to close any leaks which may develop. As there may be a considerable depth of water in the trench and as it is constructed in made-earth, leaks from the slopes or from the bed are likely to occur. Unless there is some arrangement to arrest it, the whole of the water contained in the trench may then be washed down through the leak and cause much damage. The wetting channel should therefore be provided with temporary bundas at short intervals, say every two furlongs or less, so that if a big leak occurs and the establishment is unable to detect or close it at once while the pumping engine is working, the water in the channel can be held up at the bunda next above the site of the leak. After water is held up at the bunda, the leak can be properly opened and repaired.

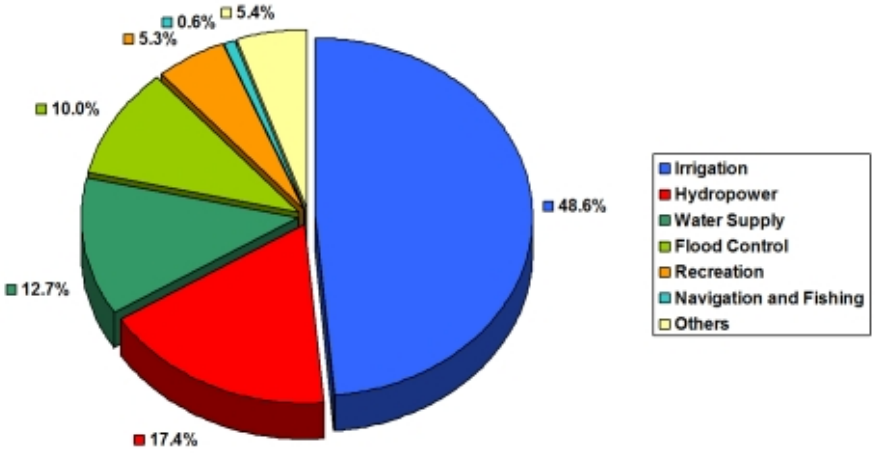
2.74. The pumps should work throughout the period of rising river. The ideal condition would be that the water level in the trench should always be about 1 foot higher than river water level against the bund while the river is rising and the bund must be wetted artificially at least 6 inches higher than the D.H.F.L. to meet any possible rise in the D.H.F.L. Gauges are provided in the wetting channel opposite every gauge in the front line, their zeroes at 4½ feet below D.H.F.L. (vide para. 48)[34-D]

[34-D] Bund Manual, Government of Sind, Public Works Department, Central Designs Division, Mechanical & Research Circle, Karachi Printed at the Sind Government Press, 1954

2.75. *ROLE OF DAMS- Flood Protection Benefits of Dams*[35] As water is not evenly distributed in spatial and temporal scale all round the world, reservoirs created by dams are necessary to even it out. The reservoirs so created are helpful in providing the water when it is in short supply and in avoiding the water it is available in excess. A majority of the dams built in the world are multipurpose in nature (as below), but irrigation is the largest user of the waters withdrawn.

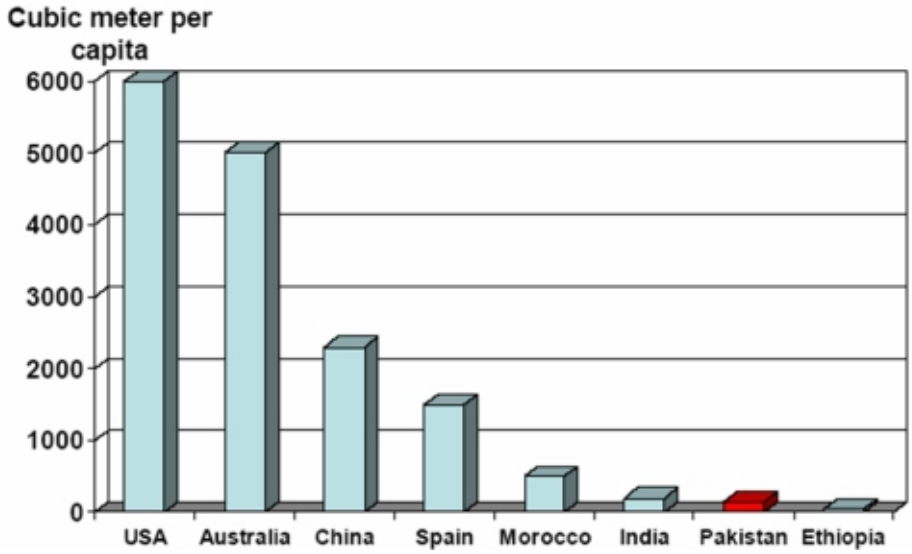
a. Irrigation for agriculture (food supply)
b. Flood control
c. Hydropower
d. Inland navigation
e. Recreation

2.76. Primary benefit of dams/reservoirs in the world is supply of water. Other major benefits are: Out of more than 45,000 large dams around the world, 10% are constructed with the major objective of flood control, as shown in figure below.



2.77. Dam reduces the total quantum of flow and size and frequency of peak floods in the flood season, reducing flood hazard due to inundation of land, crop and property which might result into economic upheavals. Dams, reservoirs, flood levees, embankments, and river training works constitute structural measures for better flood management. Intensive economic developments have been realized, for instance in the areas of Damodar, Mississippi, Missouri, Nile, and Tennessee rivers, only because of flood protection by the dams.

[35] WCD (2000), WCD Case Study: Tarbela Dam and related aspects of the Indus River Basin Pakistan, Islamabad, Pakistan. website: http://www.dams.org E-mail: info@dams.org, ICOLD (1998), Register of Large Dam by International Commission on Large Dams, WAPDA (2007), Presentation by the Chairman WAPDA, April 2007. ICID (2000), Role of Dams for Irrigation, Drainage and Flood Control, ICID Position Paper. S K Sinha and Rishi Srivastava (2010), Role of Large Dams in Flood Moderation Case Studies. Patrick Hawker and Halcrow, UK, A Review of the Role of ams and Flood Managemen



2.78. Developed countries has constructed major dams to harness their water availability, as shown in figure below, while Pakistan has fallen short of constructing dams as shown in figure below. There are about 150 (technically) large dams in Pakistan, while the USA has more than 6,000 large dams. In India, Damodar Valley Reservoirs achieve flood moderation of about 75% in case of high floods, Bhakra Dam, even though not specifically designed for flood moderation, achieves a moderation of about 70% in case of very high floods and Pong Dam achieves about 90% flood moderation.

2.79. Countries which each have more than 10 registered dams with an exclusive or partial flood control function are listed in Table 1 and account for some 95% of the approximate 4400 total registered in these categories. In terms of global distribution: Some 2100 (nearly half) of the registered dams with a flood control function are in the USA; China, Japan and Korea between them have nearly 1100 such dams; Europe is also well represented, with 535 such dams spread among 12 countries; Australia is poorly represented and there are no countries in the Indian sub-continent or in sub-Saharan Africa with more than 10 registered flood control dams of the USA flood control function registered dams, nearly half are exclusively for that purpose; elsewhere, some 25% of registered flood control dams are exclusively for that purpose;

2.80. Summary of Countries with more than 10 Dams Whose Purpose Includes Flood Control (Source: ICOLD World Register of Dams, 1998)

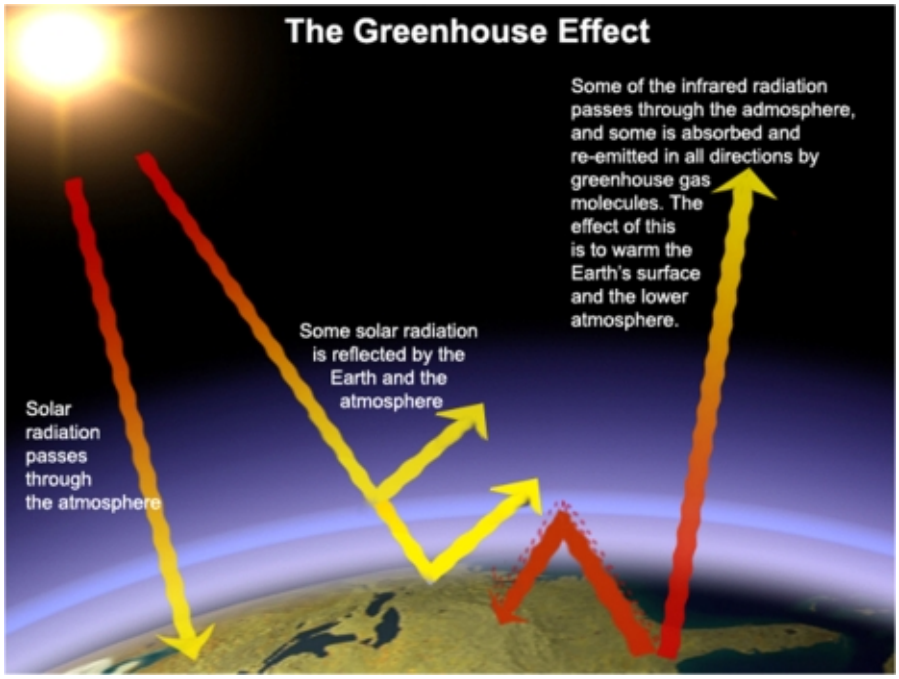
Region	Country	Single Purpose Flood Control Dams (No)	Multi-Purpose Dams incl Flood Control.
America N	Canada	21	53
	USA	988	1099
America Central	Mexico	20	61
America S	Argentina	5	35
	Brazil	168	44
	Venezuela	0	25
Africa North	Libya	2	8
	Morocco	5	9
Africa Sub-Sahara			
Asia-Middle East	Saudi Arabia	13	0
	Turkey	2	65
Asia-Central			
Asia-Indian SC			
Asia-Far East	China	25	488
Australasia	Australia	9	13
Europe	Austria	1	22
	Bulgaria	3	8
	Croatia	4	15
	Czech Republic	7	48
	France	11	32
	Germany	57	117
	Italy	3	10
	Poland	0	36
	Romania	24	75
	Slovakia	0	25
	Spain	17	9

2.81. Although flood protection was not the major purpose of the Tarbela Dam constructed in 1976. In addition to recovering its costs of construction through provision of cheap electricity and water for irrigation, it has also helped in attenuation of high flood peaks during the filling period of June through August.

2.82. *Chinese Experience*[36]*:* The most significant function of the dam is to control flooding, which is a major problem for the seasonal river of the Yangtze. Millions of people live downstream of the dam, with many large, important cities like Wuhan, Nanjing, and Shanghai situated adjacent to the river. Plenty of farm land and China's most important industrial area are built beside the river. The reservoir's flood storage capacity is 22 cubic kilometres (18,000,000 acre ft). This capacity will reduce the frequency of major downstream flooding from once every ten years to once every 100 years. The dam is expected to minimize the effect of even a "super" flood.

3. FACTORING CLIMATE CHANGE IN FLOOD MANAGEMENT ARCHITECTURE

3.1. Climate Change is "the greatest challenge facing the world at the beginning of the century" World Economic Forum Davos, Switzerland 2000[37].



3.2. *Temperature Trends over Pakistan*[38]

3.3. The decadal changes in the mean annual temperature over Pakistan during the

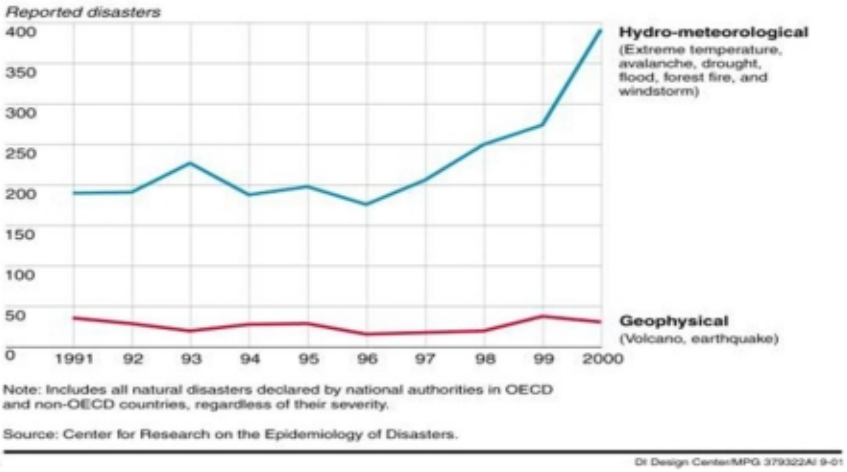
[36] Wikipedia
[37] Ex I.W.134/1
[38] Ex I.W. 135/1

periods are shown as under:

1901-2000	0.06 °C per decade (GCISC)
1960-2007	0.24 °C per decade (PMD)
1981-2000	0.27 °C per decade (GCISC)
1991-2000	0.76 °C per decade (GCISC)

3.4. Temperature changes during the previous century (1901-2000) over Pakistan using the CRU data has shown an increase of 0.6 degree centigrade and +25% in precipitation

3.5. The past global trends of hydro-meteorological disasters clearly point to the likelihood of increased frequency and intensity of floods with increase in average temperature.



3.6. Some Recent Precipitation related Extremes in Pakistan

2010	Heavy rains during July, 2010 leading towards a major flood in most parts of Pakistan bringing in its wake huge devastation to life and property
2010	A Cyclone named Phet of Cat-4, the second strongest storm ever to develop in the Arabian Sea after Gonu, had a landfall along Makran Coast west of Karachi during June, 2010 and brought serious damages in its wake
2009	Karachi received 205 mm of rain on July 18 & 19. Heaviest prior rainfall event recorded at Karachi was 207 mm on July 1, 1977. The normal rainfall at Karachi for the periods 1961-1990 is 85.5 mm
2007	Record heat wave gripped Pakistan during June, 2007. 48°C temperature was recorded on June 9 at Lahore, a record repeated after 78 years. Earlier it was recorded on June 8, 1929

2007	Two super cyclones namely Gonu (02A) of Cat-5 and Yemyin (03B) of Cat-1 developed in the Arabian Sea during June 2007 and hit Makran Coast and adjoining countries. The history of the Arabian Sea at least during the previous century shows no such events occurring twice in a month
2001	620 mm rainfall in Islamabad during 10 hours in the month of July (on 23rd of July); it caused flooding in Lai nullah
1998-2001	History's worst drought gripped southern parts of Pakistan and parts of surrounding countries
1996	438 mm rain in Lahore in 72 hours in August 1996 the wettest month on record
1992	Previous century's worst flood in Jhelum river

Source: Global Change Impact Studies Centre, Islamabad

3.7. Flows at Tarbela during July 2010 show that despite the mega flood due to the heavy rains during 27-30 July, 2010, the average flows during the month remained close to 216,000 Cusecs which is less than the normal value of around 247 000 cusecs during July. Base flows or the contribution due to glacier melting is seen decreasing, consequently the glacier melting did not contribute to the floods as reported in some press media[39].

3.8. *El Nino and La Nina, effects on the rainfall pattern:* Studies done at GCISC reveal that rains are mostly deficient during the El Nino years. Monsoonal systems developing over the Bay of Bengal either dissipate around Bangladesh or over India and do not reach Pakistan in most of the cases.

3.9. La Nina events are mostly seen as the reverse to El Nino episodes causing heavy rains in the country. NASA studies attribute the occurrence of the July 2010 mega flood to tropical monsoon moisture coupled with a strengthened La Nina that dominate this region's weather patterns.

3.10. Additionally, "a massive heat wave in Russia during July, 2010 and the devastating flood in the same month in Pakistan can be linked by the unusual behaviour of the Jet stream, some scientists now believe. The jet stream is the high altitude wind that circles the globe from west to east. It is held by the Rossby waves that normally produce its distinctive wave-like pattern. A blocking event (still an enigma to be solved) during July brought the jet stream to a halt and made weather patterns stationary and trapped the weather systems that were caught between the meanders of the jet stream. The dry air brought from east Africa right up to Russia also observed the halt and caused heat wave to continue. Monsoonal rains in July prevailed in the country[40]."

3.11. Major CLIMATE CHANGE related concerns[41] for Pakistan are:

[39] GCISC Ex I.W. 135/1
[40] GCISC Ex IW-135/1
[41] GCISC

- Increased variability of Monsoon;
- More rapid recession of HKH Glaciers threatening IRS Flows;
- Increased risks of floods and droughts;
- Severe water- and heat- stressed conditions in arid and semi-arid regions leading to reduced agricultural productivity;
- Health Risks, Increase in Deforestation; Risk to Coastal Areas; Loss of Biodiversity

3.12. According to Dr Arshad Muhammed Khan, Executive Director, GCISC[42] "there is no joint research activity or interaction between R & D Division of PMD and the Centre regarding monsoon or monsoon prediction. One of the tasks of the Centre is dissemination of information and knowledge regarding climate change, however, so far our focus has been on policy makers and we have not integrated with the various provincial departments especially the I & P department which could have benefited from our knowledge on climate change."

3.13. Adil Najam[43], Director and the Frederick S. Pardee Professor of Global Public Policy, Boston University[44], USA deposed before the Tribunal:

> "While it is very difficult to make a direct co-relation between climate change and a particular flood our knowledge about climate change science including in the South Asian Region, particularly based on recent IPCC studies is making it increasingly clear that climate variability in this region is going to be (a) high (b) is likely to increase the incidence of extreme climate events particularly those dealing with water in the South Asian Region. While our ability to predict particular events at particular places or particular times remained highly uncertain, our general understanding of global climate model is making it clear that more such events are likely to happen with greater frequency as we move to the future.
>
> It is not particularly useful to figure out how much of a particular event is because of human induced human change and how much of it is because of historic weather patterns. What is important is that climate change is likely to increase the likelihood of climatic disaster; therefore, the need to prepare for the likelihood of greater number of events as well as events of greater severity is becoming increasingly clear from climate science.
>
> Within South Asia and particular within Pakistan the existing literature suggests that extreme events are more likely to be water related including the possibility of greater

[42] I.W. 134
[43] I.W. 150
[44] The Frederick S. Pardee Center for the Study of the Longer-Range Future 67-Bay State Road Boston, Massachusetts -02215

floods not only because of changing weather patterns but also because of the changing hydrology of the water system specially as it is driven by the glacial melting in the Himalayan region.

While the floods of 2010 were not related to glacial melting, the possibility of future change in the water system of the Indus because of glacier changes should also be kept in mind for designing future water management and flood management strategy.

Although the current focus is on floods because of the tragedy of 2010, focusing on the Indus Water System as a whole is important because future water related disasters by climate change could include not only floods but also sever droughts. Therefore it is important to focus on water system as a whole and the water management systems that can be more feasible both in case of water and extreme drought conditions.

It is important to understand that the key issue based by climate change lies in the increasing variability of climate patterns. These patterns are already very difficult to project or predict even in the best cases and the scientific consensus that it is going to become increasingly difficult to project and predict because of the new levels of variability added by climate change.

For this reason to strengthen our currently weak Meteorological capabilities and adding new capabilities to include climate change science becomes a major priority in the future and will require close collaboration between different centers of a relevant knowledge going beyond the currently narrow focus on immediate weather patterns that is already insufficient and will become increasingly more challenging.

While it is important for the future to improve the quantity of data generated, it is probably more important to strengthen the institutional abilities to analyze the data in time and over time. The current structures of data calculation and dissemination related to extreme climatic events such as floods are disbursed in multiple institutions which have not had a history of effective coordination or communication amongst them. Improving the analytical capacity and the ability for cross institutional connections is a key challenge in this regard. Within this challenge the role of the Irrigation Department is particularly important not only as a recipient of Meteorological Department from the PMD but also as a partner in the analysis of real time use of that data.

Bench marking with best international practice within our region and internationally would be an important first step particularly in two areas: (a) Meteorological data calculation and analysis; and (b) Water System Management with a special focus on flood management."

4. POLICY RECOMMENDATIONS

4.1. *INTEGRATED FLOOD MANAGEMENT PLAN*[45]

4.2. *Suggestions and recommendations made above* may be considered as an integral part of these Policy Recommendations.

4.3. *The new paradigm:* Floods are part of a natural cycle that can never be fully controlled. "Flood control" is therefore a futile terminology and a counter productive mandate. The future is to think of "Flood Mitigation" or "Flood Risk Management" or "Flood Resilience." Our flood managers should consider this new paradigm as a starting point in developing an integrated flood management plan.

4.4. *Broader set of objectives:* While flood manager in the past have focused on structural and non-structural measures to protect and mitigate flood, a broader set of objectives need to put on the table. While structural safety of the barrages and training works is critical, human safety, protection of human shelters, safeguards for agriculture and fisheries, roads, ecosystems, health, and biodiversity need equal attention.

4.5. *Non-structural measures* Ecologically friendly non-structural measures for flood mitigation measures like afforestation of the watershed and the riverine belt, developing and effectively using lakes, depression and retention pools along the river.

4.6. *Flood Forecasting:* Better flood forecasting is required. Hydro-meteorological forecast needs to assess floods on the basis of precipitation- in the air. Radars and other equipment which was missing this year needs to be immediately procured so that the upper catchment area of River Indus is fully covered.

4.7. *Early warnings* by PMD need to be relayed on TV , radio and website. Early warnings must also be in vernacular so that it is understandable and effective.

4.8. *Land use and Flood Plain Management:* Flood plains are the hardest hit during the floods. Still there is no land use or flood plain management regulation. As population increases, human settlements and agriculture in flood plain will increase and so will loss to human life and property. The regulations for proper land use and other related issues in flood plains should be made on priority basis with the consent of stakeholders. Emphasis should be laid on proper implementation of these regulations in letter and spirit.

4.9. *Managing Flood Protection Structures:* Structural measures such as embankments suffer from neglect and poor maintenance. More vigilant structural management is required involving participation of the local community. Proper Embankment Maintenance Manual to

[45] This chapter gives valuable foundational inputs for the policy and flood managers to successfully draw up a Flood Management Plan for the country.

be developed that carries out a regular check of the embankments round the year. Encroachments from embankments to be removed. All major embankments to be GIS mapped and monitored through remote sensing. Design criteria of the embankments to be ensured according to the latest design manual prepared by FFC.

4.10. *Developing detailed flood regulations or FLOOD MANUAL*

4.11. *Pre-flood preparedness* is the bedrock of any successful flood management plan. The wisdom in Sind Bund Manual, FFC Manual and series of loose leaf guidelines which are mostly unavailable are unknown to many officers and must be developed into a proper MANUAL and religiously followed by the zone during the flood season EVERY YEAR WITHOUT FAIL.

4.12. *Asset management,* environmental protection and health care must be built into the pre flood preparedness manual.

4.13. *The Flood Fighting Plan* must be enforced strictly, with strict penal consequences for non-observance.

4.14. Flood Fighting Plan must be an *integrated plan* worked out with key related departments e.g., Health, C & W, Food, Agriculture, Environment, Wildlife, Civil Administration, Army, Civil Defence, Home Department, 1122, etc.

4.15. *Localized Ownership:* Nazims, DCOs and respectable residents of the Districts to be made a part of the Integrated Flood Management Plan to broaden its ownership and effective implementation.

4.16. Other than the *Breaching Section* on the right side, shadow breaching sections and emergency relief cuts must be chalked out in the plan and clearly visible in the Flood Emergency Map which should be a part of the Flood Fighting Plan. Locals of the area must be included in the preparatory discussions so that their ownership is present at all times.

7.17. This year it was noticed that the morphology of the river changed and the flow of the water was on the left side rather than on the right side. This necessitates to rethink the breaching sections located on the right side only. Should there be breaching sections on both the sides ? (e.g., Taunsa Barrage this year used the left side)

4.18. *FACTORING IN CLIMATE CHANGE*

4.19. The most recent IPCC report states that climate change will be inevitable as present mitigation efforts will not be enough. Therefore, adaptation to climate change is required. As climate change will likely increase the variability of weather, Flood Management Plan should be adaptive to future floods rather than strictly preventive.

Immediate future action

4.20. It is expected that the Provincial Government will immediately set out to develop an Integrated Flood Management Plan, so that the first phase of the Plan can be operationalized in the coming Flood Season-2011[46].

[46] Integrated Flood Management Plan requires constant upgrading and updating and should be considered to be a live document that is improved every year by incorporating the post flood lessons learnt.