Retrospective and Prospective of 2014 Floods For Building Flood Resilient Kashmir

Centre for
Dialogue and
Reconciliation

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Preamble

A two day national Seminar on "Retrospective and Prospective of 2014 Kashmir Floods for Building Flood Resilient Kashmir" was held at Srinagar from 15-16 November 2014. The Seminar was organised jointly by the Department of Earth Sciences, Kashmir University and Centre for Dialogue and Reconciliation (CDR). The 2014 flood was triggered by the complex interplay of atmospheric disturbances that brought widespread and extreme rains all across the state. The Jhelum waters, that used to be the provider of life and sustenance, suddenly became a monstrously destructive force against the human life and the infrastructure that cohabit its backyards since millennia.

Any future flood strategies for Jhelum Basin shall benefit from our learning from this horrendous experience and the threadbare deliberations held at the two days National Seminar. The September 2014 floods were unprecedented in the flood history of Kashmir and got everyone concerned about the consequences of another such disaster if it recurred. The immediate steps to be taken are to develop a strategy for mitigating floods in the state and that requires realisation across the region at the local and the national level. The aim of this symposium was to conduct deliberations with the select group of relevant people who have the expertise to recommend and formulate a long term action plan for flood disaster management and mitigation in the state of Jammu and Kashmir.

The experts from various central agencies (Central Water Commission, National Institute of Hydrology, National Geophysical Research Institute, Central Groundwater Board, National Disaster Management Authority, NRSC/ISRO and National Green Tribunal), India Meteorological Department (IMD) and State Government agencies - Irrigation and Flood Control (IFC), Public Health Engineering (PHE), Rural Development, LAWDA, Srinagar Development Authority, IMPA, Agriculture Department, academia from Kashmir University, Indian Institute of Technology-Roorkee, National Institute of Technology-Srinagar, Jammu University, and various segments of the civil society, including experienced professionals, attended the Seminar.

Short-term and Urgent Recommendations

The following recommendations made at the Seminar need to be taken up on priority immediately and could be accomplished in the shortest possible time to reduce the risk to the public and to property in Jhelum Basin from flooding.

- Knowledge driven all-inclusive multidisciplinary flood planning needs to be initiated on priority by engaging technocrats with relevant expertise to develop insights into flooding mechanisms in the Jhelum Basin building on comprehensive existing studies.

- Strengthening the flood infrastructure in the Jhelum Basin to cope up with the probability of next extreme flooding event of the magnitude observed in 2014. This includes the preparation of an integrated DPR for the construction of the alternate flood channel from Dogripora to Wullar, increasing the carrying capacity of the main Jhelum, dredging of the existing flood channel, dredging of the wetlands like Hokersar, Narkara, Nowgam Jheel, and Wullar lake, and strengthening of breached and weak embankments the broad plan of which is before the CWC.

- The management of the water bodies/lakes and wetlands in the Jhelum Basin needs to be brought under one regulatory authority for their integrated management, being a single catchment area served by the same watershed.

- The government, with the help of academia/research institutes, must consider undertaking a scoping study to assess the probability of flooding in immediate future based on the understanding to be developed from the interactions of Ground Water, surface water and the glacier-melt in the Jhelum Basin.

- Urgently operationalising the Flood Early Warning System (FEWS) for Jhelum and Chenab.

- The State Government must initiate on priority (with the help of leading academic institutions), to undertake transparent flood zonation and flood vulnerability assessments of people and places at village level so that the flood risk reduction is integrated with developmental planning at village level in all District Development Plans.

- Government consider assigning proposals for bringing the technical ingenuity of the Irrigation & Flood Control in operationalising of FEWS, basin wide IFM and flood scenario mapping. The identified scientific studies on various aspects of flooding identified above are required to be undertaken on priority by involving Universities, consultants and institutes both national and international.

Urgent Long-term Recommendations

The following recommendations made at the Seminar need to be initiated immediately and might take a few years to complete for flood risk reduction in the Jhelum Basin.

- There is an urgent need to institutionalize the disaster management in the state by setting up of a vibrant and structured State Disaster Management Authority with a clear mandate to build the capacity of the state to prepare for, protect against, respond to, recover from, and mitigate all types of hazards, the state is vulnerable to.

- Strengthening of flood control infrastructure in 4 high gradient streams in the south Kashmir viz., Rambiara, Veshu, Romshi and Lidder, that enormously contribute to the discharge at Sangam using the available techniques, so that the flood peak and concentration time is appreciably delayed by staggering them in the watershed itself before their discharge into the Jhelum at Sangam.

- Initiating a massive capacity building program for building public awareness and soliciting public involvement in flood risk reduction.

- In order to arrest the siltation of the watercourses from the catchment, the participants recommended the massive reforestation of the Jhelum catchment under CAMPA, IWMP and other existing governmental schemes.

- Structural and non-structural erosion control measures in the high gradient tributaries in the south Kashmir viz., Rambiara, Veshu, Romshi, Lidder, Bringi and Aripath.

- Consolidation of the fragmented data and knowledge into a database so that it is available to everybody for use on understanding the hydrological and meteorological processes and phenomena in the state.

- Strictly regulating mining of the riverbed keeping in view the river/channel morphology and other required hydrologic and geologic criteria

- The flood disaster preparedness at government and community levels need to be strengthened so that there is a well-rehearsed mechanism in place for quick response, despite all the adversities and limitations, to minimize the impacts of flooding on the people and property.

- Revision of the existing land use policy and building codes is required and enforce strict implementation in order to minimize human and economic loss in the event of natural disaster.

- Comprehensive community based Disaster risk reduction plans need to be prepared on priority

Long-term Recommended Measures

These long term recommended measures are essential for building the necessary flood control infrastructure in the basin so that in the eventuality of the next extreme flood event, the loss of life and property is reduced appreciably in the basin

- Construction of the alternate flood channel from Dogripora to Wullar
- Improving the drainage system in the urban areas of the Jhelum Basin including the restoration of natural drainages wherever possible
- The government needs to initiate programs aimed at conservation and restoration of the degraded wetlands in the Jhelum Basin to enhance their flood mitigation, in selected cases even sewage treatment functionality.
- Bring city and town planning in the state into consonance with the flood and earthquake vulnerability.
- Structural and non-structural measures be initiated under the supervision of I&FC for erosion control in the central and north Kashmir part of the Jhelum basis.

September 2014 floods : Important Contributory Factors

Geography of Jhelum Basin

It is widely known that historically, the Kashmir valley is highly prone to floods due to its geographical structure and location.

The hydrographic features and the drainage characteristics of the Jhelum River system establish, that the frequency of floods has been very high ever since the valley assumed its present form after draining out of the ancient Karewa lake, the Satisar.

The valley is surrounded by mountains through which a silent river of about 225 kms flows. The mountains on the right side are closer to river than the left side. There is a level difference of about 24 metres from Khannabal to Khadanyar, with a varying bed slope of 1/8000 to 1/12000. The Kashmir valley could be segmented into three topographic units, north, south, and central topographic units. Various tributaries that join the Jhelum River are: in south - Lidder, Vishaw, Bringi, Rambiara, in the centre join Ferozpur, Sukhnag, Sindh and in the north, Pohru, Ningli, Khursu, Erin, Madhumati. Hence, the valley is prone to floods.

Historically flood measures for Jhelum were taken first during the reign of Zainul Aabideen Budshah in 1430 when *Naala mar* was created that connected *Baba Demb* to River Jhelum. Further, near *noorbagh* again, interior channels that we see today such as *koot kul, sonar kul,* etc. were constructed in 19th century to divert the extra discharge from Jhelum. In 1903, Maharaja Pratap Singh with an idea to divert the excess flood discharge from the River Jhelum constructed flood spill channel with its discharge going to low lying wetlands of *Batamaloo* and then *Hokarsar wetland*.

Considering the fact that absolute protection from extreme flooding is not possible, a scale of intervention priorities is needed to reduce the risk of the people to floods, based on the comprehensive understanding of the causes and consequences of the extreme flooding.

Extreme Weather Event

The seminar aimed at covering a holistic view of the flood problem in Kashmir in order to come up with a feasible solution to the problem. There was general agreement that the government needed to take all the necessary steps to avoid such disastrous eventuality in the future. For that, the initial step was to understand the major causes that had magnified the impact of the floods.

The seminar primarily highlighted the scientific causes of the 2014 extreme floods in Kashmir. It was observed that intense rains in the state from 1 to 7th September 2014 that caused the floods. The causes of excessive rainfall were the **combined effect of the western disturbances (WD) and its interaction with monsoon rains over J&K.** With the urbanized and mismanaged floodplains of Jhelum lending impetus, the situation attained disastrous dimensions. That was also due to the prolonged extreme precipitation events observed over the entire Kashmir valley during the first week of the September, exacerbated by the higher snowmelt runoff from the extensive snow–packs observed in the mountainous regions in 2014.

During the course of presentations, the data proved that two major reasons were responsible for the flood vulnerability in the Kashmir valley – firstly due to **inadequate carrying capacity of the River Jhelum** from Sangam (Anantnag) to Khandanyar (Baramulla) and secondly due to **natural flat topography of the Jhelum Basin**. There was evidence shown to prove that the existing flood spill channel which starts at Padshahibagh (Srinagar), with the original capacity of 17, 000 cusecs has now reduced to less than 5, 000 cusecs due to the siltation and encroachments. The Jhelum channel and flood spill channel proved insufficient to accommodate the enormous discharge of floodwater in September measuring more than - 1, 20, 000 cusecs. It was therefore on expected lines that the floodwater of such volume and magnitude lead to flooding of Srinagar.

Overflow of Jhelum - One of the important reasons highlighted was the over flow of the Jhelum waters. The embankments for a major part of its stretch from south Kashmir to the Srinagar city created almost 150 breaches on both sides of the Jhelum. The gauge reading at Sangam crossed 36 feet on 5th September, 2014 with the floodwaters measuring about 1, 20, 000 cusecs. The Jhelum was flowing almost 1m above its embankments through the stretch from Sangam (Anantnag) to Kakapora (Pulwama) for a distance of about 25 km on 6th and 7th September, 2014. The river attained a width of more than 2 kms at certain places in South Kashmir. With the help of viewgraphs, it was shown that out of the 1760 sq. km. of floodplains, 594 sq. kms were flooded in the Jhelum Basin during the 2014 flooding. A hydrograph was used during a presentation to project how the water gauge at Srinagar (Ram Munshibagh) crossed 30 feet on 7th September, 2014 much above the danger mark of 22 feet discharging more than 70,000 cusecs of floodwaters against the drainage capacity of only about 35,000 cusecs. The floodwaters entered the Srinagar city through 16 breaches along the weaker sections of its embankments as well as due to the overflowing of the Jhelum 3-5 feet above its banks. This was because the recorded water levels in the river were exceptionally high and much above the drainage capacity of the river in Srinagar. It was agreed that the flood inundation levels recorded in the floodplains of the Jhelum were the highest in the archived hydrological history of Kashmir leading to inundation of vast areas in Kashmir valley. Many of these inundated areas remained under floodwaters for more than a week. Some low lying areas in the Srinagar city like Rajbagh, Kursoo and Jawahar Nagar remained under floodwaters for more than 4 weeks. In south Kashmir, the recorded flood extent and levels were also unprecedented. Several villages, some cultivated land and orchards in South Kashmir were

washed away by the floodwaters of the turbulent mountainous tributaries of the Jhelum like Rambiara, Vaishav and Romshi.

Heavy Rainfall – A conclusion was arrived at the seminar that the most important reason for the high magnitude inundation and loss during the September 2014 floods in Kashmir was the cumulative effect of the heavy rainfall in the valley, the massive uncontrolled encroachments of the floodplains along both sides of the Jhelum since 1972, loss of wetlands, and the reduced drainage capacity of Jhelum due to siltation from the catchment areas.

There were other reasons put forward among the causes of the flood:

- **Cloudburst** - There were some unconfirmed reports of several cloudbursts in the upper reaches of the Jhelum Basin. During the period, the drastic increase of the water levels in the basin was ascribed to those cloudbursts. It was however pointed out that there was no scientific evidence of any cloudburst anywhere in the state preceding these floods. The rainfall intensity did not cross 30 mm per hour as per the observed precipitation records. The archived meteorological data for the last 125 years for the Srinagar city shows that September is the least rainy month for the valley with the mean rainfall of 26.6 mm, but Srinagar recorded about 173 mm of rainfall in the first week of September, crossing its 25 year high record of 151.9 mm preceding the 1992 floods. Seven-day long incessant rainfall recorded at certain places in the south Kashmir like Qazigund crossed 617 mm of rain. From the analysis of the precipitation records from the Automatic Weather Stations, it is observed that South Kashmir, on an average, received rainfall almost twice to that of the central and north Kashmir that generated enormous surface runoff and base flow leading to the flood in the basin. Qazigund station recorded 620 mm of rainfall during the week preceding the floods. However, analysis of the data from 28 Automatic weather stations in the Valley and half a dozen of the Earth Observation Geostationary satellites does not give credence to any of the cloudbursts.

- **Ethical question of Kandizal** –There was an opinion that if Kandizal would have been breached deliberately 24 hours prior to its natural breach, the devastation caused in the Srinagar might have been comparatively less. There were however responses that stated that the Government of Jammu and Kashmir had done everything possible to reduce the impact of the flood on life and property of the people of Kashmir. The idea of breaching the Kandizal to save Srinagar city was nullified. According to some experts, the Kandizal breach would not have reduced the magnitude of floods in the Srinagar. Moreover, some felt it was an ethical issue for the government. Was it right to save Srinagar by submerging a populated area around the Kandizal. This needs further discussion.

- **Illegal Mining** - The participants also threw light on the devastations that had resulted due to the illegal sand and gravel mining/extraction in rivers like Sindh, Baramulla, Ferozpur nalla. There were suggestions made towards banning the illegal extraction which was changing the water regime of the rivers causing maximum slope failure in Sumbal Sonawari area. There were various methods discussed which could reduce the velocity of water too.

Visible damage in the Kashmir valley

Srinagar received rains during floods that were 3471% higher than the normal rainfall, which caused water congestion, and the water from the overflowing Jhelum and the surrounding hills added to the high inundation observed in the city. In the sub-basin, the flat portion got inundated completely. In the low-lying areas, the flood depth increased up to 3-4m. Right from Sangam up to Srinagar, the water was spilling over the Jhelum banks. The estimated time of travel was very fast and within 8 hours, the rain raised the water level at Sangam, which led to pooling up of the city.

The Dal Development project which focussed on Dal Lake conservation and management is an example of the losses suffered during the flood. Under the Dal Development Project, 16 lakh trees had been planted in the Dal Lake catchment under the project. About 80% of the siltation load in the Lake has been stopped, due to the impact of the structural and non-structural measures carried at the catchment scale. On 7th September, 2014 morning at 10:30 am, the embankment at Rammunshi bagh broke as a result of which a huge amount of water entered the Dal Lake. The impact of floods on Dal in terms of the silt load and the biological load that the floodwaters deposited into the lake was massive. The Lake and Waterways Development Authority (LAWDA) has been monitoring the lake water chemistry, microbiology, aquatic life, etc. Regularly and as per the recent observations, the silt load and coliform count in the waters of the Dal Lake has significantly increased during and after the floods.

During the presentations, the mechanism and implications of the weather phenomenon that caused the September, 2014 floods in Kashmir were discussed in detail. The attention was also given to the steps that need to be taken in case another event of the same magnitude hits the region in future. Various institutions like the Central Water Commission have made special efforts to geographically build a model of the Kashmir Valley using Google maps, ASTER DEM in ArcGIS. The model depicted the problem caused by the concentration of water of the three tributaries at the Sangam, which had lead to the deluge. The extreme rainfall was deemed as the main cause behind the September 2014 floods. It was pointed out that the analysis of the meteorological data from the month of September showed that the rainfall received in Pulwama was 311mm, Pahalgam and other areas also had the same situation. Thus, the amount of rainfall received was about 300

to 700% above the average rainfall recorded in these areas. For the entire Kashmir valley, the expected daily average rainfall is 7.5mm, but the 5-day rainfall recorded during the September floods was 303mm, which was extremely high. With such a heavy rainfall, the runoff expected was huge.

The point of emphasis was that increasing the capacity of Jhelum River and the flood spill channel must be the priority in order to ameliorate the flood situation in the valley. It was stated that on 3rd September morning after recording the rainfall measurements; the people were alarmed and all the lifesaving gadgets were made available to them. After reaching Sangam, it takes almost seven hours for the flood water to reach Srinagar. However, the precipitation and discharge levels during the September 2014 floods were beyond imaginations and the water behaviour was quite abnormal.

Preventive Measures Suggested by the Experts

There were suggestions made to avoid the floods of such enormity in the future. Some of them were – strengthening of the flood control infrastructure system by the State Government, development of early warning systems, massive conservation and storage of wetlands, construction of alternate flood channels, creation of public awareness, undertaking of flood vulnerability assessment at the village level, and massive dredging of Jhelum and other wetlands/water bodies in the Jhelum Basin.

The other measures suggested were:

- A demand for a flood forecasting system to be developed and installed that could provide 12-48 hrs flood prediction in order to reduce the risk to people in future. It was pointed out that the Jhelum River lacks the carrying capacity to handle extreme flooding events. For that reason, some channels are to be bypassed and some flood management modifications have to be put in place. To facilitate that process, extensive research needs to be carried out for proper implementation of hydraulic instrumentation, for developing early warning system and other control measures.

- A suggestion was also made to construct the *Dogripora-Wullar* alternate channel to increase the capacity of the flood spill channel to 25000 cusecs from the current 8000 cusecs. An important aspect was dredging of the Jhelum tributaries to increase their water holding capacity. The government has already released Rs 98 crores for flood management. The immediate steps to be taken were the establishment of a state of the art early warning system that includes installation of the Digital Water Level Recorders (DWLR) and Automatic Water Station (AWS).

- Interestingly, the impact of railways and other development projects on flood scenario of Kashmir was also seen as a subject that needed a detailed scientific study. It was accepted by all that the city planning will be a challenging task for the Srinagar Development Authority. It was pointed out that since Srinagar was in the Seismic zone V, any vertical expansion needed to be carefully weighed before it is carried out.

- It was asserted that the IMD has already sanctioned Doppler weather system for the state that would facilitate early warning weather system in the state. In addition to the importance of the early warning systems, the importance of ground water hydrology was highlighted. There is a need for understanding and modelling the surface water and groundwater interactions and that understanding shall help in flood mitigation. Monitoring the groundwater levels and the relevance of developing a database on surface and groundwater resources was stressed upon.

- The other areas that required attention were wetland mapping, seismic micro-zonation and flood hazard zonation. An important aspect was the need for massive afforestation in the Jhelum catchment in order to arrest the sediment load to the Jhelum. It was observed that the lakes and wetlands in the valley of Kashmir are directly or indirectly linked to River Jhelum. So the changes within the catchment affect the hydrological processes and have profound effect on the bio diversity and socio economics of the valley. Therefore, the management of River Jhelum and wetlands situated in the floodplains cannot be addressed in isolation.

- In order to control flood problem in Jhelum, it is important to stagger the flood peaks of Vishu, Rambiara and other high gradient tributaries before they discharge their flood waters into Jhelum. For doing that, topographical surveys are necessary. Supplementary flood channel need to be approached irrespective of the cost or investments.

There is a need for increasing the carrying capacity of Jhelum to reduce the impact of floods. The drastic changes in the hydrological regimes have been observed over the last few decades and are attributed to the loss of marshy lands, deterioration of wetlands, catchment degradation and climate change There is no doubt that the destruction of the wetlands has led to enhanced flooding. A high temporal variability has been recorded in the inflow and outflow of Wular and it is also the case with other water bodies like Manasbal. This trend is likely to exacerbate the hydrological extremities viz., droughts during dry winds and floods in the high flow season. Further over the past decades, the Wular Lake has lost about 37% of its water holding capacity. Therefore a study based on hydraulic modelling is a must to ensure correct decision making for restoring Wular Lake through dredging of its outfalls. It was stressed that a systematic flood studies that includes pre- and post- flood assessment starting from micro catchment to the macro level is the need of the hour. Then, issues like deforestation especially in the hilly areas like Uri, Kishtiwar, and Doda should be studied in detail. All these hills are denudated and they are more susceptible to landslides and siltation.

Initiatives taken post September floods for overcoming the shortcomings

There have been several steps taken by the government and other organisations to avoid massive damage in an event of recurrence. It was important to discuss them to get an idea of the current situation.

It was indicated that the blame on IMD regarding not issuing any timely forecast during the floods were not entirely justified. Forewarning the people is the domain of the Government of Jammu and Kashmir. IMD had informed the government and the people about the emerging weather situation. It was said that the state did not have the technology to pin point specific areas which might receive heavy rainfalls at a particular point in time. September is not rainy season in the valley. March and April months are usually very wet in which floods and flash floods occur in the state. It was noted that the highest monthly rainfall of about 185mm recorded in 114 years was in September 2004 followed by 181mm in 1992 and 142mm in 1928. There was a proposal to exchange data with other agencies hosting Automatic Weather stations in the state.

On 08th September, 2014, the Government of Jammu and Kashmir had sent a letter to Central Government requesting that September floods be declared as a national disaster and to depute a team of experts who could scientifically assess the causes of these floods. The Central Government constituted a committee to draft a holistic flood mitigation and management report. The committee consisted of experts from Central Water Commission (CWC), National Institute of Hydrology (NIH), Roorkee, Indus Water Commission (IWC), besides two chief engineers from the state of Jammu and Kashmir. The expert committee had prepared its report along with recommendations to the Central Government.

The State Government had requested the Central Government to incorporate two important projects in its recommendations; one was the Rs. 2200 crore bypass channel project and second was the Chenab project.

National Institute of Hydrology (NIH), Roorkee has carried out integrated watershed management plans for many of the flood prone states of India. An integrated approach based on satellite imagery, ground truthing

and model simulations for drafting flood hazard strategies for the state of Jammu and Kashmir could be one of the ways forward. This would include an institutional framework for early warning during the possibility of a flood.

Indian Space Research Organisation (ISRO) provides the disaster management support through the use of satellite imagery to the State Government on need basis. VSAT based connectivity is must for any state that is vulnerable to hazards and needs to be utilized in the event of any disaster. During floods of the September, 2014, ISRO joined with the army and Air Force to provide support and help to the affected populace.

The Central Government had initially released 97 crore rupees in instalments that were utilized for resurrecting and dredging of the Jhelum outfall. The Flood Spill Channel (FSC) embankment will be constructed right from Hokersar to Wular Lake.

The construction of the bypass channel is must for effective flood mitigation strategy for the Kashmir region. The Central Government must understand its necessity. However due to the delay in its sanctioning, over the years, there has been an increase in the cost of the land that has to be acquired. Now from the total project cost of Rs. 2200 crores, about Rs. 1800 crores is required for only compensation. Therefore, immediately the land that is needed for the channel must be notified.

Road Ahead

After discussing the facts, the next step was to look at the issues that need immediate attention. The general opinion was, that for a comprehensive flood risk assessment through computational models; the measurement of rainfall, hydraulics of the channels, and other important parameters needed to be worked out accurately. There was one suggestion towards building a rational rainfall-runoff model that would help us to predict with accuracy the type of flood that could be encountered in future.

The experts *suggested the following initiatives*:

- An analysis by the government regarding management of the September 2014 floods.
- Proposal of a bypass channel to be taken up urgently. Mathematical and physical modelling needs to be carried out to understand the feasibility of the bypass channel. Hydraulic infrastructure needs to be installed at Sangam in case of bypass channel. This whole process requires lot of knowledge of the system.
- Encroachments along the watercourses, lakes and wetlands need to be stopped forthwith and dealt with according to the rule of the land.
- Need for restoration of the Wular Lake and all other Lakes of the Valley through an integrated scientific plan.
- Since 2009, several surveys have been done, however Central Government is still not convinced with the idea of Alternate Flood Channel. To convince the funding agencies about the feasibility and need of the alternate flood channel, a Detailed Project Report (DPR) must be prepared and should reflect the realistic cost/benefit ratio.
- City planning is the major challenge for the State Government. Marsh lands that have been occupied in the city need to be recovered and reclaimed including Nallamar channel.
- The existing inland waterways that pass through the Srinagar city need to be strengthened. Raising and strengthening of the bunds is very important and will be the priority of the government. Wetlands of the

Kashmir need to be restored to their original glory to increase their water holding capacity so that they could store more water during flooding. There needs to be a complete ban on their conversion to other uses and removal of encroachments around and within wetlands.

- Resurrecting and dredging are two important recommendations that need to be continued for flood mitigation and control. A suggestion was made to make the efforts time bound and finish the process by March-April, 2015.

- The government should have a clear-cut policy about the operation of flood infrastructure during the floods, including the need, if any, for deliberate breaches. It is both a question of ethics and politics.

- The government should look at town planning and go for vertical city expansion and discourage horizontal expansion to cater to the housing needs of the burgeoning population. Shortage of land is prompting encroachments of wetlands and river banks

- The State Government must hire an international consultant for planning the Srinagar city. The City plan should be drafted holistically, by taking on board experts from diverse scientific fields. India is now shifting its cities to Smart City Concept and J&K should also follow.

- A time bound schedule of dredging from Khannabal to Khadimyar and of FSC should be the priority of the government to reduce the impact of floods in Kashmir valley.

- Watershed management needs to be integrated with the flood hazard management and mitigation for the state of Jammu and Kashmir. The State Government must employ scientists to provide modelling simulations and scenarios for managing such hazards. A multidisciplinary team from different State Government departments such as revenue, flood, irrigation, power etc. together with the scientific community should be involved for drafting the plan.

- Structural measures for flood control are not always the best possible steps; therefore State Government must think of utilizing non-structural measures as well. Community based flood management is the key non-structural measure for pre- and post-floods management.

- Appropriate sediment estimations models, hydrological and hydraulic models need to be run for the Jhelum in order to simulate sediment inputs, flood inundation depth and patterns and quantification of the hydrological processes.

- To stagger the peaks, the government should construct engineering structures such as Piano Key Weirs in the watersheds that have small lag time. This can help control velocity of water flows of the tributaries arriving at the same time at Sangam. These structures are recognised the world over for their efficacy in reducing the velocity of the water at the outlet of the watershed. Moreover, there is a need for rigorous sediment yield assessment of the watersheds of the Jhelum Basin so that the appropriate structural measures are employed to control sediment input to Jhelum River.

The seminar proved to be an excellent opportunity for exchange of ideas between experts from different field. The real challenge lies in dealing with the problems on the ground and overcoming the existing obstacles.

Key Issues

- Absence of a Disaster Management Authority in the state which could have institutionalized the disaster management planning and operation in the state
- Inadequate flood control infrastructure.
- Siltation of water channels in the Jhelum Basin due to deforestation, road cutting etc.
- Lack of information on flood vulnerability assessment at desired spatial scales.
- Lack of Integrated Flood Management Planning.
- Scanty network of hydro-meteorological observation stations in the mountainous J&K State.
- Inadequate technical capacity of the State Government in undertaking flood forecasting, vulnerability assessments, flood DSS and scenario mapping. .
- Lack of high resolution quality spatial data .
- Fragmented knowledge on hydro-meteorological processes.
- Absence of any Flood Early Warning System (FEWS).
- Government unpreparedness in tackling the enormity of the 2014 flood disaster.
- Absence of community based disaster preparedness plan.
- Inadequate drainage system in the city and towns.
- Reckless horizontal urbanization in the Jhelum floodplains.
- Loss of wetlands in the floodplains of Jhelum.
- Inadequate urban planning in the basin particularly cities and towns. .
- Communication failure at the critical time when it is needed the most. .
- Lack of awareness about flood vulnerability at the community level.
- Lack of consideration of the development projects including railways, highways and other development projects on the flood vulnerability.
- The probability of the flooding within next few years due to high Ground Water levels in the basin..
- Unscientific mining of the bed material from the Jhelum weakens the Flood Control structures.
- Climate change concerns about increasing frequency of extremes in the state.
- Likely impacts of the 2014 flooding on aquatic flora and fauna.
- Sluggish implementation of the Land use policy .
- Lack of disaster resilient measures in the construction practices in the basin.
- Fragmented administrative management of the water bodies in Jhelum Basin

Thus, the main issues related to flooding phenomena were highlighted at different technical sessions of the Seminar and the participants of the Seminar unanimously made the recommendations outlined below:

Short-term and Urgent recommendations

The following recommendations made at the Seminar need to be taken up on priority immediately and could be accomplished in the shortest possible time to reduce the risk to the public and to property in Jhelum from flooding.

- Knowledge driven all-inclusive multidisciplinary flood planning needs to be initiated on priority by engaging technocrats with relevant expertise to develop insights into flooding mechanisms in the Jhelum Basin building on comprehensive existing studies.

- Strengthening the flood infrastructure in the Jhelum Basin to cope up with the probability of next extreme flooding event of the magnitude observed in 2014. This includes the preparation of an integrated DPR for the construction of the alternate flood channel from Dogripora to Wullar, increasing the carrying capacity of the main Jhelum, dredging of the existing flood channel, dredging of the wetlands like Hokersar, Narkara, Nowgam Jheel, and Wullar lake, and strengthening of breached and weak embankments the broad plan of which is before the CWC.

- The management of the water bodies/lakes and wetlands in the Jhelum Basin needs to be brought under one regulatory authority for their integrated management, being a single catchment area served by the same watershed.

- The government, with the help of academia/research institutes, must consider undertaking a scoping study to assess the probability of flooding in immediate future based on the understanding to be developed from the interactions of Ground Water, surface water and the glacier-melt in the Jhelum Basin.

- Urgently operationalizating the Flood Early Warning System (FEWS) for Jhelum and Chenab.

- The State Government must initiate on priority (with the help of leading academic institutions), to undertake transparent flood zonation and flood vulnerability assessments of people and places at village level so that the flood risk reduction is integrated with developmental planning at village level in all District Development Plans

- Government consider assigning proposals for bringing the technical ingenuity of the Irrigation & Flood Control in operationalization of FEWS, basin wide IFM and flood scenario mapping. The identified scientific studies on various aspects of flooding identified above are required to be undertaken on priority by involving Universities, consultants and institutes both national and international.

Urgent Long-term Recommendations

The following recommendations made at the Seminar need to be initiated immediately and might take a few years to complete for flood risk reduction in the Jhelum Basin.

- There is an urgent need to institutionalize the disaster management in the state by setting up of a vibrant and structured State Disaster Management Authority with a clear mandate to build the capacity of the state to prepare for, protect against, respond to, recover from, and mitigate all types of hazards, the state is vulnerable to.

- Strengthening of flood control infrastructure in 4 high gradient streams in the south Kashmir viz., Rambiara, Veshu, Romshi and Lidder, that enormously contribute to the discharge at Sangam using the available techniques, so that the flood peak and concentration time is appreciably delayed by staggering them in the watershed itself before their discharge into the Jhelum at Sangam.

- Initiating a massive capacity building program for building public awareness and soliciting public involvement in flood risk reduction.

- In order to arrest the siltation of the watercourses from the catchment, the participants recommended the massive reforestation of the Jhelum catchment under CAMPA, IWMP and other existing governmental schemes.

- Structural and non-structural erosion control measures in the high gradient tributaries in the south Kashmir viz., Rambiara, Veshu, Romshi, Lidder, Bringi and Aripath.

- Consolidation of the fragmented data and knowledge into a database so that it is available to everybody for use on understanding the hydrological and meteorological processes and phenomena in the state.

- Strictly regulating mining of the riverbed keeping in view the river/channel morphology and other required hydrologic and geologic criteria

- The flood disaster preparedness at government and community levels need to be strengthened so that there is a well-rehearsed mechanism in place for quick response, despite all the adversities and limitations, to minimize the impacts of flooding on the people and property.

- Revision of the existing land use policy and building codes is required and enforce strict implementation in order to minimize human and economic loss in the event of natural disaster.

- Comprehensive community based Disaster risk reduction plans need to be prepared on priority

Long-term Recommended Measures

These long term recommended measures are essential for building the necessary flood control infrastructure in the basin so that in the eventuality of the next extreme flood event, the loss of life and property is reduced appreciably in the basin

- Construction of the alternate flood channel from Dogripora to Wullar
- Improving the drainage system in the urban areas of the Jhelum Basin including the restoration of natural drainages wherever possible
- The government needs to initiate programs aimed at conservation and restoration of the degraded wetlands in the Jhelum Basin to enhance their flood mitigation, in selected cases even sewage treatment functionality.
- Bring city and town planning in the state into consonance with the flood and earthquake vulnerability.
- Structural and non-structural measures must be initiated under the supervision of I&FC for erosion control in the central and north Kashmir part of the Jhelum basis.

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