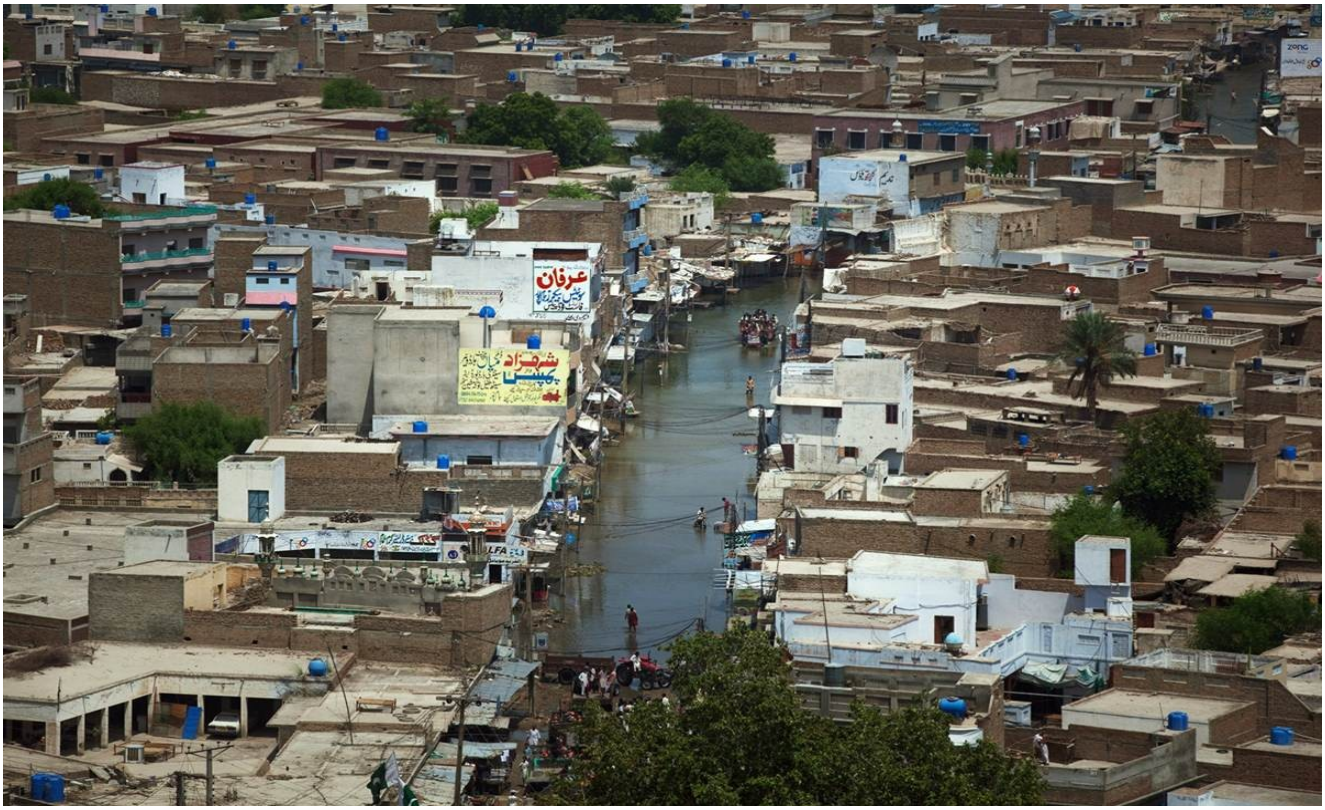
PROCEEDINGS OF

NATIONAL SEMINAR ON

" URBAN FLOOD MITIGATION"



Organized by

National Disaster Management Authority (NDMA)

&

Coalition for Disaster Resilient Infrastructure (CDRI)

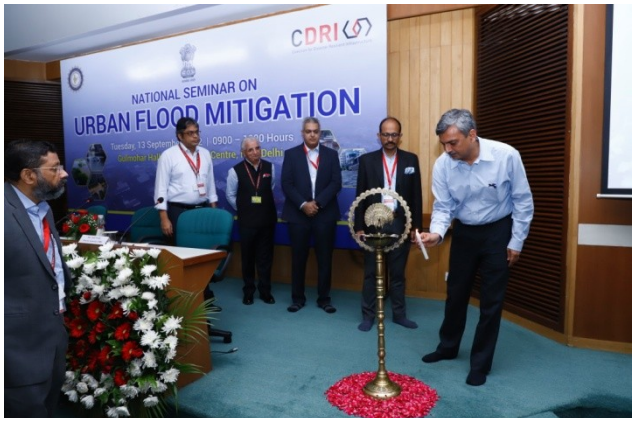
(13th Septemer, 2022)

Contents

1. Introduction-

- **Background**

Urban floods impact cities by damaging civic infrastructure and houses, and urban economy in a big way. Suspension of critical services has a cascading impact on many other interdependent services. Restoration and rebuilding of houses and civic infrastructure requires a commitment of resources which strains municipal corporations. It also raises the issue of urban governance and resilience. In a situation when the cities are seriously affected by extreme events, the residents look up to the government for protection of lives, livelihoods, and services. In view of the scale of the issue across the cities, urban floods require a national approach.



The 15th Finance Commission acknowledged the magnitude of urban flood hazard and made the certain recommendations in its report which has now been accepted by the Central Government: Based on that, to undertand the situation in detailed manner with all important stakeholders, the National Disaster Management Authority (NDMA) and the Coalition for Disaster Resilient Infrastructure (CDRI) held a "National Seminar on Urban Flood Mitigation" on September 13, 2022, at the India Habitat Centre in New Delhi, to address the implementation of the 15th Finance Commission's recommendations on urban flood management.

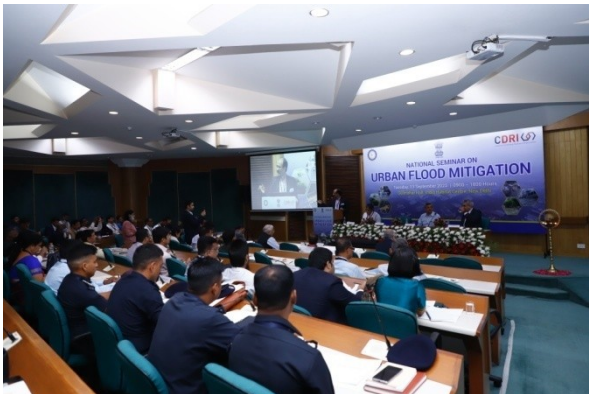
The seminar focused on urban flood risk challenges and solutions in India's inland and coastal cities. Representatives from Mumbai, Kolkata, Delhi, Chennai, Ahmedabad, Bengaluru, and Hyderabad discussed the difficulties encountered, the steps taken, and the assistance required to reduce the risk of flooding. Experts with hands-on experience working on urban flood mitigation in cities discussed these challenges and issues.

- **National Seminar (Rationale)**

The major metro cities of India have been facing severe flooding in the past few years. Chennai received unprecedented flooding in 2021. The city was flooded twice with North-east monsoon heaping heavy rainfall in the months of November and December. The city also experienced heavy flooding in 2015, which caused major damage to its

infrastructure. Mumbai experiences flood almost every year and in 2020, South Mumbai, which is a better-planned part of the city, experienced heavy flooding due to excessive rainfall. In October 2020, Hyderabad witnessed flash floods due to a deep depression and cyclonic winds in the Bay of Bengal. This is the pattern of hazard which repeats itself in almost all major cities of the country.

Previously NDMA has issued guidelines on the **management of urban floods in 2010**. The guidelines suggest several measures which include early warning, design and management of urban drainage system, urban flood disaster risk management, techno-legal regime, response, capacity development, and awareness. There are several recommendations for sustainable solutions to the problem of urban risk management. NDMA has been pursuing the implementation of these guidelines at several levels.



"While State Governments have sought to address these issues, it requires an approach which brings together urban planning, ecological conservation, and disaster management together. State Governments need to support a set of interventions that are implemented by multiple urban agencies working together. In view of the regular incidence of flooding and heavy losses, we recommend that a targeted allocation be made to address urban flooding in seven cities (excluding Delhi), which have a metropolitan area with a population exceeding five million. These cities are Mumbai, Chennai, Kolkata, Bengaluru, Hyderabad, Ahmedabad and Pune.

These recommendations need to be implemented in partnership with the State Disaster Management Authorities and the concerned municipal corporations. The allocations provide catalyst support for urban flood management. It is expected that these resources would be augmented by State Governments and Municipal Corporations for a larger, long-term mitigation solution for urban floods

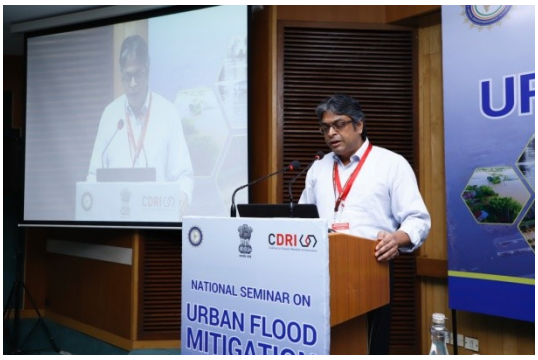
As a first step towards implementation of the recommendations of the 15th Finance Commission, NDMA in partnership with Coalition for Disaster Resilient Infrastructure (CDRI) has organized the National Seminar on Urban Flood Mitigation with the concerned State Governments, Municipal Corporations, and selected experts. The stakeholder consultation dwell upon plausible and appropriate solutions to address urban flood risk in India. The final outcome of this seminar will be the development of the Roadmap for the National Framework for Urban Flood Risk in India.

- **Programme Schedule**

Date: 13th September 2022 |Time: 0900 – 1730 Hours | Venue: Gulmohar Hall, India Habitat Centre, Detailed program is attached at Annexure-I.

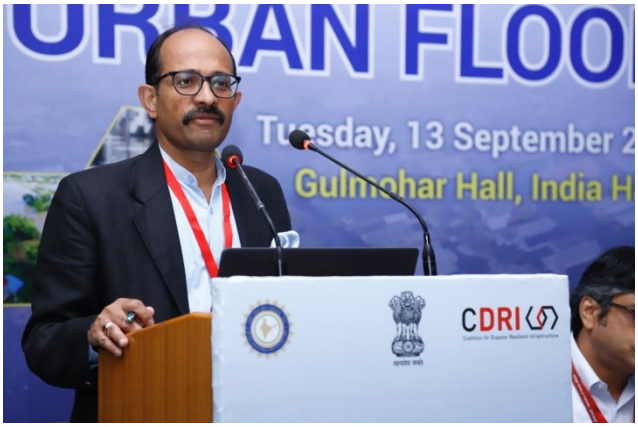
2. Stage Setting & Remarks

- **Welcome and opening remarks -:**

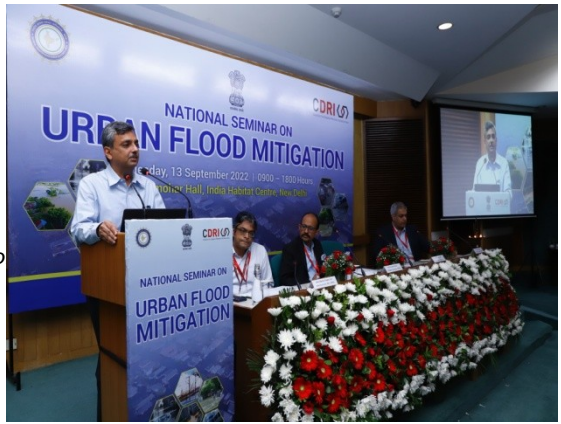


Shri Harsh Gupta, Joint Secretary, Mitigation, NDMA, began by welcoming the dignitaries and participants. Explaining the rationale of the workshop, he said that recent urban floods annually result in the loss of an unacceptably high number of human lives and property. He said urban flood risk management requires the collaboration of the concerned Ministries / Departments, State Governments, Civil Society Organizations and other stakeholders. He also referred NDMA guidelines Management of Urban Flooding (2010)' and Urban Flood Framework (2016) of NDMA which elaborate several action points for various agencies and State governments for Urban flood risk management.

Afterwards he briefed 15th finance commission recommendations, an allocation of Rs. 100 crore per year be made for each of the metros – Mumbai, Chennai and Kolkata – to prepare integrated solutions for flood management (Rs. 1,500 crores over five years). For the next tier of cities – Bengaluru, Hyderabad, Ahmedabad and Pune – an allocation of Rs. 50 crore per year should be made to prevent urban flooding (Rs. 1,000 crores over five years). The total assistance for urban flood management based on the proposed assistance is estimated to be Rs. 2,500 crores during our award period.



Shri Kamal Kishore, Member Secretary (I/C), NDMA, stated in remarks that In the past decade, there has never been a year without flooding in Indian cities. From major cities like Bangalore to secondary cities like Silchar, all types of city are being impacted. Flooding affects cities all around the world, not only in India, and it is a significant issue that needs to be taken into account. In India, the urbanization rate is between 30 and 35 percent, and it is increasing, which will make the flooding issue worse.

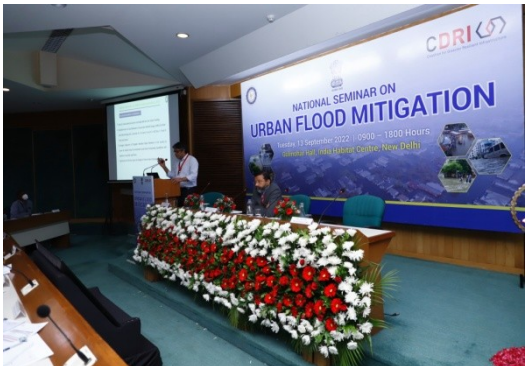


Standard operating procedures, manuals,guidelines and other documents have been published since 2010.

Shri Manoj Joshir, Secretary, MoHUA, also highlighted the

important aspects of urban flooding, i.e. reservoir management and appreciated the efforts of Chennai and Mumbai. He said that there is a chance to alter the way we see flooding-related issues, such as by considering early warning systems, land use planning, etc.Additionally, collaboration across multiple ministries and stakeholders is necessary. Urban flooding is nested in urban development practice. Urban flood mitigation should be incorporated in other city initiatives like smart cities and investments made by the cities should be integrated with urban flooding investments to make them effective. He identified some specific areas which need to be addressed to mitigate urban floods.

- ***Early warning systems:*** It is necessary to build warning systems to communicate information on rainfall and the water level in reservoirs.
- ***Reservoir Management:***Better reservoir management has made it easier to control flooding in many citiese.g. Idukki dam management in Kerala
- ***Stormwater drains:*** Under the AMRUT scheme, 3000 crores have been disseminated to cities for building drains, but the effectiveness of the drains on the ground controlling the flood has to be checked. Prioritization of mitigation measures and proper Detailed Project Report (DPR) preparation has to be done
- ***Sponge city concept:*** Rejuvenation of water bodies to hold more water and flow management to reservoirs are cost-effective methods. Chennai has done similar work. Flow patterns should be incorporated in master plans and no construction zones should be marked. Building bye-laws should be followed and a legal system to demolish constructions along the water flow channels should be explored.
- ***Capacity building:*** Capacity development at the local level is required. Engineers of the local bodies should be trained. Urban planning and hydrology institutes should develop some competencies in this area.
- ***Urban flood mitigation fundin****g* should be prioritized.



Shri Harsh Gupta, Joint Secretary, Mitigation, NDMA, briefed an introductory session in which he described that Urban flooding can be of 3 types, i.e. coastal flooding(due to storm surge), fluvial (riverine), and pluvial (rainfall). NDMA has taken various initiatives and published guidelines on flooding. The 15th finance commission has recommended a targeted allocation be made to address urban flooding in seven cities (excluding Delhi), which have a metropolitan area with a population exceeding five million. Delhi being UT will get a separate allocation from MoF. This seminar will discuss the appraisal mechanism to be adopted and support to be provided by NDMA and the retrofinancing of ongoing mitigation projects.

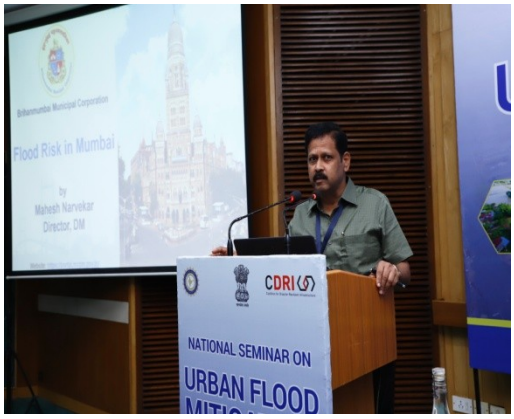
Afterwards Shri Krishna Vatsa, Member NDMA has initiated the session with brief remarks on Urban floods and triggering factors..

3. Flood Preparedness & Mitigation Pathways -:

a) Mega and Coastal Cities

- **Mumbai**

✓ **City Overview**: Mumbai has a population of 12.9 million, a population density of 2847, and receives an annual mean rainfall of 2000-2500mm.



✓ **Vulnerabilities:** The city has an exceptionally high population and structural density and is bordered by the sea on three sides. Slums, which are vulnerable to all forms of disasters, are home to 55% of the population. The city has a gravity-based underground drainage system, however many of the drainage system's connections are still missing, and the drainage is affected by tides. There is a significant tract of reclaimed land, and the outfall locations include a considerable number of unauthorized buildings. In just a few rain events, 35–40% of the annual rainfall is produced.

✓ **Measures taken:**

a) Structural Measures: As part of the BRIMSTOWAD project, a master plan for improving stormwater drainage in the city was created in 1993. The drainage network was updated as recommended by the plan to handle the rainfall intensity of 50mm/hr with runoff coefficient 1. The project proposed 58 priority works, including stormwater pumping stations, training programs for nullahs, drain rehabilitation, and new drain construction. In 2007, Mumbai City created a GIS database with contours at 0.2m intervals using LiDAR and a digital mapping camera. Eight stormwater pumping stations were built, and six of them discharged 70000MLDs of floodwater during the 2019 monsoon. To prevent flooding during periods of heavy rainfall and high tides, flood gates with pumping stations were built.

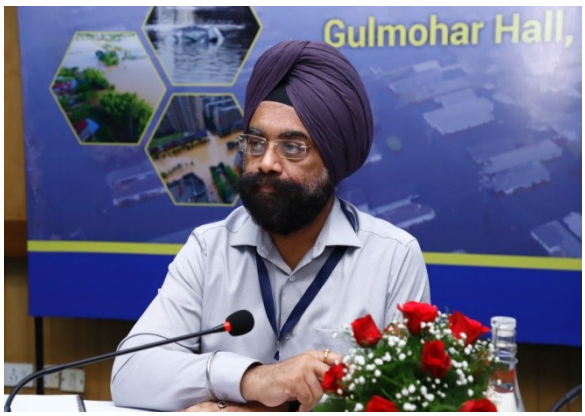
b) Non-Engineering Measures: Emergency operations centers are open 24*7 at the Municipal Head Office and in each of the 24 administrative wards. To monitor all hazards, 10000 CCTV cameras have been installed. Each ward has five municipal schools designated as emergency assembling points. The centers have hotline connections to the local ACP Office, EOC MCGM, CIDM, and fire station. The city has 60 automatic weather stations, and rainfall data is transmitted every 15 minutes. At 100 flood locations, automatic rain gauges with flow, level sensors have been installed to help monitor flood levels and start an early evacuation.

The data is also available on the ArcGIS platform. The areas to be evacuated are viewable on the GIS platform based on water level data. Additionally, flood modeling has been undertaken, and flood inundation maps are accessible. Through the BMC smartphone app and social media sites, all information is shared. The development plan of the city is available in GIS and the locations of hospitals, transport stations, and temporary shelters are also mapped so it helps in disaster management activities. Disaster Recovery Sites are established which acts as a backup for emergency operations centers. The city has an academic institute for disaster management and various courses are available.

- ✓ **Challenges:** Increasing precipitation, varying frequency of extreme events, sea level rise, and increased concretization and run-off are some of the challenges. Engineering solutions need to be funded, hence new finance methods must be employed. Housing and protection for communities in need have to be provided. The scope of disaster management protocols needs to be expanded to include instruments for better preparedness and flood resilience.

- **Chennai**

- ✓ **City Overview**: Four rivers flow through Chennai, three of which are located inside the boundaries of the municipal corporation. There are numerous discrete watersheds between the rivers, and all surface runoff from Greater Chennai and its peri-urban areas drains into the Bay of Bengal.



- ✓ **Vulnerabilities**: The city is subjected to short-duration, high-intensity rainfall, cloud bursts, and thunderstorms. Due to rapid urban growth without considering drainage elements, urban drainages have limited carrying capacity and low storage capacity of irrigation tanks or wetlands. There are no flood protection walls or river training projects in the vulnerable river segments, and the river mouth has sedimentation from littoral movements. Increased tidal levels during extreme weather conditions make the city more vulnerable.

- ✓ **Measures taken**: Chennai has developed a Real-Time Flood Forecasting & a Spatial Decision Support System (RTFF & SDSS) and Real-time Data Acquisition System (RTDAS).The city has carried out detailed hydrological studies. A 1D model for rainfall forecast & river flow forecasting and 1D coupled for model river flow & reservoir/water body operation guidance system has been developed. The forecast system was piloted during the NE monsoon 2021. With the support of RTFF, lakes were managed, and downstream flood disasters

were avoided. A drone survey has been conducted for the Chennai River Basin. As part of the RTDAS,an automatic rain gauge, automatic weather station, automatic water level recorders, and gate sensors were installed and many control rooms were established. In collaboration with the Japan International Cooperation Agency (JICA), Chennai Corporation is developing a Comprehensive Flood Control Master Plan for Chennai Metropolitan Area. Integrated stormwater drains, canal improvement, restoration and rejuvenation of temple ponds, river and water bodies, and desilting projects were carried out in the city for flood mitigation. New reservoirs outside the city were constructed for flood control in the city. The city corporation is trying to develop Chennai as a sponge city by making urban areas more permeable.

- ✓ **Challenges:** The responsibility to mitigate the disasters rests with the state governments.The funding required to implement the medium and long-term measures to reduce the risk of flooding in Chennai and other urban parts of the state is huge compared to the allocation state funds.

- **Kolkata**

  - ✓ **City Overview**: Kolkata has a combined sewerage and drainage system that includes extensive networks of the trunk and lateral sewers as well as 78 pumping stations. The underground system has a length of over 2000 kilometers, of which 200 km is a century-old brick sewer.

  - ✓ **Vulnerabilities**: In Kolkata, the terrain progressively slopes into the marshy plains to the east and is more elevated to the west and this unique landform characteristic makes drainage a challenge. Because of the saucer-like (bowl-shaped) form of the city's center, every rainwater drop has to be pumped out. The city's vulnerability is growing as a result of rapid urbanization, a rise in impervious surface, the loss of water bodies, improper land use planning, climatic events, and decreased drainage system capacity.

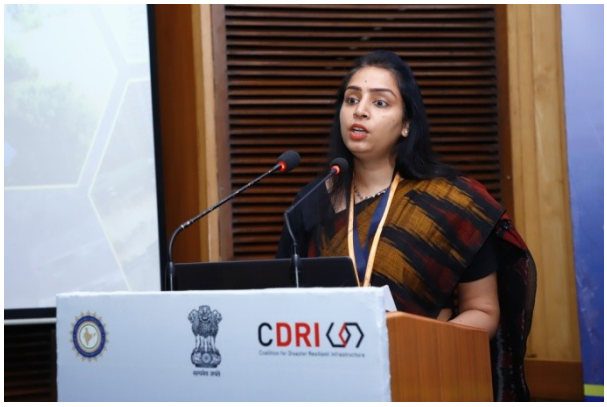
  - ✓ **Measures taken**: The Kolkata Municipal Corporation (KMC) is carrying out the dusting work throughout the year mechanically.Portable submersible pumps in low-lying areas are installed to remove stormwater. Water channels are improved to increase capacity. Ultrasonic flowmeters and multifunctional energy meters are used to measure the flow. The aging brick sewers are upgraded and maintained for more efficiency. Deeper sumps are constructed at water logging areas. GIS mapping of underground sewage and drain network is recommended as per the master plan of KMC.

- ✓ **Challenges**: Feasible solutions for water logging areas have to be identified.Properties are constructed above drainage lines due to poor land and town planning. Stormwater management in the city can only be accomplished through forced discharge, which is a very difficult task.

- **Delhi**

  - ✓ **City Overview**: 75% of the annual rainfall in Delhi occur during the monsoon season. The Yamuna is the principal river that traverses the city.

  - ✓ **Vulnerabilities**: The city is vulnerable to two types of flooding. Riverine flooding caused by the Yamuna and pluvial flooding The major flood from riverine flooding occurred in 1978. The city has been heavily urbanized, clogging natural drainage and encroaching on drainage areas. The natural flow of water has been disrupted as a result of this.



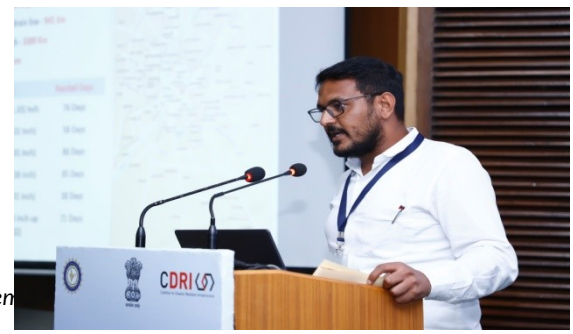
  - ✓ **Measures taken**: The Delhi Municipal Corporation has taken two approaches;preventative and mitigating measures. Desilting works are primarily undertaken as preventive measures. The Delhi Municipal Corporation area is divided into 12 zones, and desilting initiatives are implemented on a zone-by-zone basis. Mitigation measures include the installation of groundwater recharging systems in buildings. Building, structural safety is ensured through audits prior to the monsoon season to reduce disasters.

b) Inland Cities

- **Ahmedabad**

  - ✓ **City Overview**: Ahmedabad City is 505.73 square kilometers in size and contains 13841 people per square kilometer. A stormwater network is present in one-third of the urban areas. There are 156 lakes, 2 main canals, and 2 rivers in the city.

  - ✓ **Measures taken**: (i) Monitoring and controlling during heavy rain: The city has 25 automatic rain gauges, 19 control rooms, and 2559 CCTVs monitor floods (ii) Percolation wells: These are built to replenish groundwater and reduce losses. According to the provisions of the Comprehensive General Development



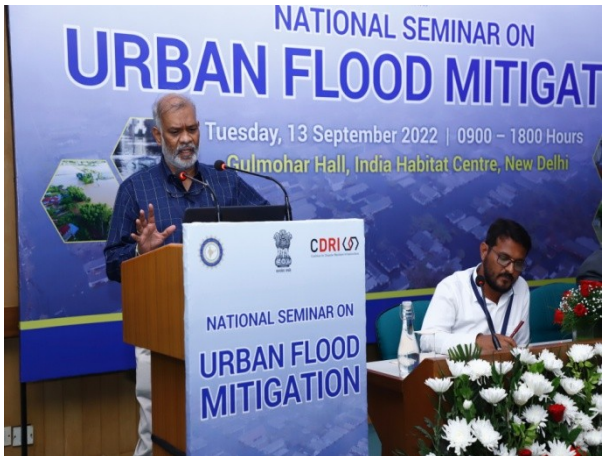
Control Regulations(CGDCR), it is mandatory to provide percolation wells.(iii) STP & TTP: sewage is treated, and the cleaned water is then used for irrigation. To replenish the lakes with clean water, tertiary treatment plants (TTP) are proposed.

As part of the flood mitigation strategy, clearing catch pits and lines, installing dewatering pumps, laying new stormwater lines, building a new stormwater pumping station, desilting existing stormwater lines, and developing the lake and its surrounding network in catchment areas are also carried out.

- **Hyderabad**

✓ **City Overview**: Greater Hyderabad Municipal Corporation (GHMC) covers an area of 650 km^2 and now has a population of approximately 90 lakhs (2011- 68 Lakhs). Heavy floods have occurred multiple times in Hyderabad. The flood of October 2020, which received 300 mm of rain in just 6 hours, was the worst since the flood of 1908 in Musi.

✓ **Measures taken**: Strategic Nala Development Program is a GHMC initiative for urban flood management. Short-term and long-term measures are planned under the program.



- Short-term measures planned (Annual, 1 year): Pre-monsoon and post-monsoon cleaning of sewers/drain manholes and culverts, desilting of drains, maintenance of sluice valves and spillway gates, removal of obstructions in the drains, implementation of lake management practices, installation of pumps with actuators linked to the water level of rain gauges.

- Medium Term(Quinquennial)5 Years: Removal of encroachments from the natural and built-up drains, clearing bottlenecks in the drains and culverts, creation of holding ponds as per land availability, capacity augmentation of the drainage system by constructing new drains, remodeling of existing drains by widening/deepening and construction of parallel drains.

- Long Term(Quindecennial)15 years: Creation of Sponge City, construction of permeable pavements footpaths and gardens, creation of flood plains, rooftop gardens and wall gardens, flood inundation modeling using 1D -1D and 1D-2D modeler or any other suitable

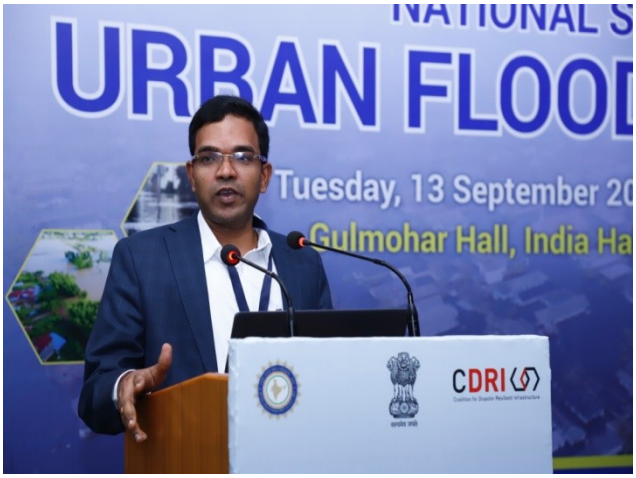
software, use of technologies like GIS, RS, flood forecasting and early warning systems & deployment of urban flood nowcasting system

- **Bangalore**

✓ **City Overview**: Bengaluruis well known internationally for Information Technology.It is the fifth largest city inIndia with a population of about 7 million located around 100 km from the Kaveri river. The mean annual rainfall is about 880 mm with about 60 rainy days a year.

✓ **Vulnerabilities**: Due to construction activities and coverage of open lands the runoff has increased. Rainwater flow from the outside area of BBMP (Bruhat Bengaluru MahanagaraPalike) enters the city which contributes to increasing the volume in SWD and lakes. Encroachments of lakes, narrowing of drainage, the collapse of size stone masonry walls at the critical location, and many other factors contribute to flooding in the city.

✓ **Measures taken**: Encroachments were removed to reduce flooding.BBMP has set up a control room at each zone and sub-division level. Detailed surveys and locations of SWDs and lakes are made available in the "Dishaank" app by the Government of Karnataka so that homeowners, insurers, and buyers can understand the actual impact of flooding on their property.Water level sensors were installed. During monsoons desilting and cleaning of drains and lakes are carried out. Retaining walls and U shape drains were constructed in the outer zones where the kaccha drains were present there by avoiding flooding in low-lying areas and also preventing encroachments.In Bengaluru urban district, 500 volunteers were trained underAapadMitra Yojana.



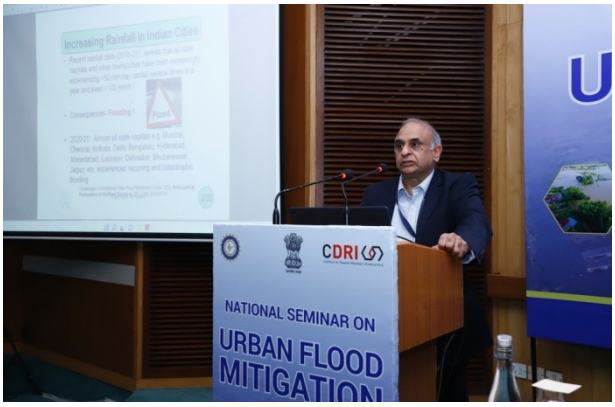
✓ **Challenges**: Rapid urbanization and unplanned growth is the main challenge. Peripheral areas of the city are being irregularly developed. Flood plains are occupied without proper buildings. Lack of civil support and political, legal, administrative, financial, and technical capacity are also challenges.

c) Presentation by experts (National & International)

➢ National level experts

- **Urban Flood Disaster Reduction Under a Changing Climate– Mumbai city – Dr. Kapil Gupta**

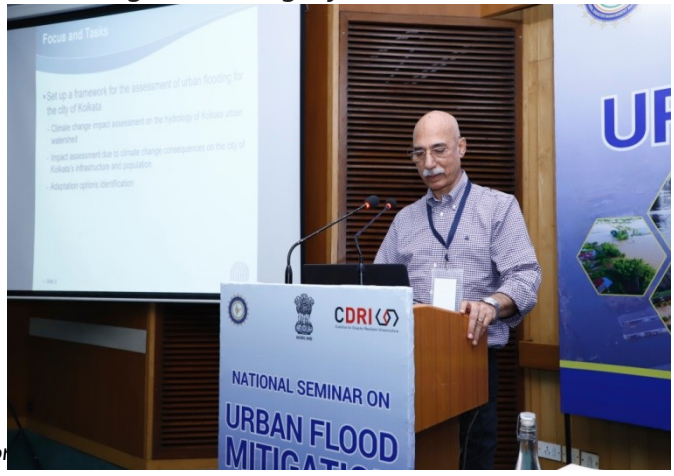
- ✓ **Non structural flood mitigation measures:** The Mumbai Metropolitan Region has a rain gauge network and now contains 117 operable rain gauges that are configured to capture and display data every 15 minutes and are calibrated to sound an alarm at certain rainfall intensity values (40 mm/h). Rainfall estimations in space-time are provided by Doppler Weather Radars (DWRs).



- ✓ **Structural flood mitigation measures:** Sustainable Urban **Drainage** Systems (SUDS) with engineering devices to control or delay stormwater runoff, green roofs and porous pavements to increase infiltration, roof rainwater collecting systems, detention ponds(Eg;-Japan), Orifice/Weir with inline detention (Eg- Mithi River, Mumbai), Weir/Off-line Detention (Eg;- JVLR-MithiBridge, MUMBAI), Underground Storage Scheme (Eg- Tai Hang Tungstormwater storage tank, Hong Kong)
- ✓ **Flood control measures for critical infrastructure:** (i) Mumbai International Airport: Two additional culverts of 12m each were designed under the main runway to discharge the design flood corresponding to a 1 in100 year return period including 20% extra for climate change. (ii) Mumbai Rail Network: Detention facilities to reduce the flood water level below the track level in the Mumbai railway network

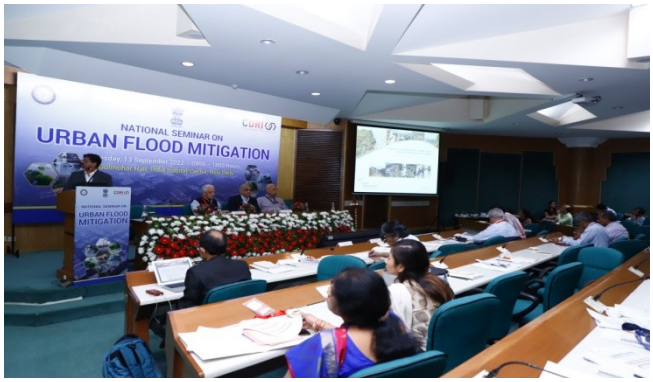
- **Urban Flooding and Damage & Loss Assessment: A Case Study of Kolkata – Dr. A K Gosain**

- ✓ The methodology used for the assessment of urban flooding for Kolkata includes the following steps (i) Local Rainfall Analysis - Return period of extreme rainfall (1976-2001, 15 min) (ii) Hydrological Modelling (SWAT)Riverine flooding - Estimate the Flood (Hooghly Basin) (iii) Hydraulic Modelling of Hooghly (HEC-RAS)For Routing of Flood discharge (KMA Inundation) (iv) Urban Storm Water Modelling (SWMM)Local flooding - extreme rain storm events (KMC Inundation) (v) Impact/ Vulnerability Assessment (Exposure Map) (vi) Economic Impact Assessment (Estimate direct loss)



- ✓ Possible Adaptation Strategies include: Conservation of wetlands and other natural water bodies, maintenance of old pumps, sewerage and drainage network, restricting encroachments and settlements on canal banks, increasing the hydraulic capacity of the system by desilting, use of state of art technologies for integrated data management, information gathering, sharing, dissemination, use of modern technology including satellite remote sensing and GIS and modeling tools to assist in developing and assessing alternative options, development of early warning system

- **Hydro-Meteorological Resilient Action Plans (HmRAP) in selected Urban Areas in India – Dr.Hari Prasad Vajja**

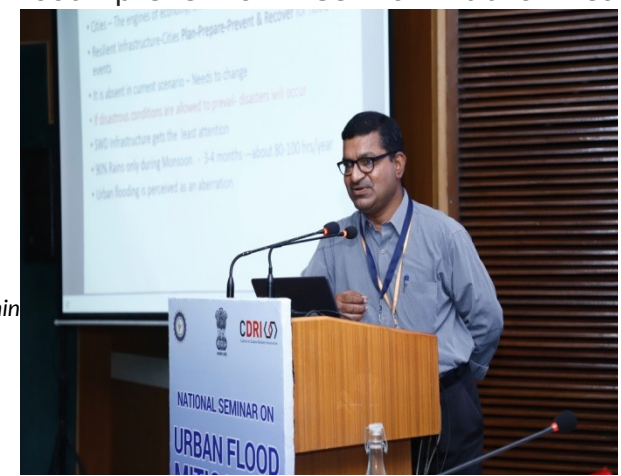


  - ✓ **Proposed structural measures for Mangaluru under HmRAP:** Installation of automatic weather stations (AWS), cleaning of canals, tree plantation, maintenance of drains, installation of early warning systems, installation of lightning conductors.

  - ✓ **Proposed nonstructural measures:** Capacity building, public awareness programs, separate building byelaws for low-lying areas, master planning of the city incorporating HmRAP's current and future scenarios outcomes, alternative livelihood options for the vulnerable communities, application of space technology, use of state-of-the-art technology in the extraction of relevant data, modernization in the collection of Hydrometeorological data, flood forecast formulation, and forecast dissemination.

- **Storm Water Drainage Infrastructure– Mr. J B Ravinder, Joint Adviser,CPHEEO, MoHUA**

  - ✓ Stormwater drainage systems aid in proper drainage of runoff and helps in flood prevention. Central Public Health And Environmental Engineering Organization (CPHEEO) under MoHUAhas published a Manual on Storm Water Drainage Systems



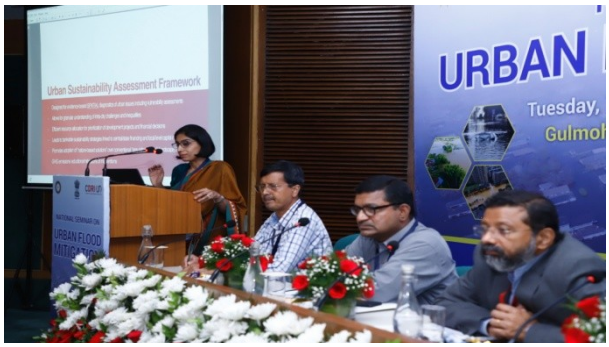
which covers the engineering design, operations and maintenance, and management of SWDS.

- ✓ Innovative stormwater management practices include (i) Water Sensitive Urban Design(WSUD) (Australian Model), Sustainable Urban Drainage System (SuDS) (France Model), and Low Impact Development Design (LID) (USA Model).

- ✓ **Case study:** The city of Victoria, B.C., has some of the oldest stormwater infrastructures in Canada,dating back to the early 1900s. The city administration decided to rollout the stormwater drainage utility in 2014 and subsequently adapted the user-fee billing-based model from 2016. The stormwater utility for every property is calculated based on the following four factors: impervious surfaces factor, street cleaning factor, intensity code factor, and codes of practice factor.

- **Spatial Strategies for Urban Flooding, Jaipur- Ms. Mansi Sachdev, UNHABITAT**

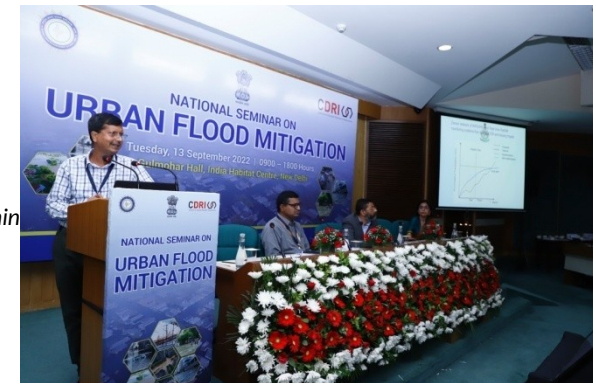
- ✓ Urban Sustainability Assessment Framework (USAF) by UNHABITAT is designed for evidence-based spatial diagnosis of urban issues involving vulnerability assessments. USAF has been applied to Jaipur city to identify and respond to the urban flooding challenges. Diagnostic issues in Jaipur include urban sprawl, weak urban mobility, multi-hazard vulnerability, and green-blue disconnects.



- ✓ Various interventions proposed in Jaipur include (i) Conveyance of stormwater- Re-designing incoming drainage channels, future development of the city should follow the city's natural drainage profile (ii) Treatment of stormwater (iii) citywide green and blue space network – connecting blue-green through eco trails (iv) capturing stormwater through green roofs, increasing groundwater percolation and community recharge pits(v) conserve and protect existing natural assets through the protection of water bodies and building new green assets.

- **The early Warning system of IMD for Urban Flooding - Dr. J.Rajendra Kumar J, IMD**

- ✓ 1168 city forecast stations are currently available in India. Observational and forecast products are available on the IMD website, including Current Weather Observations, Current Air quality Observations, Radar, Lightning



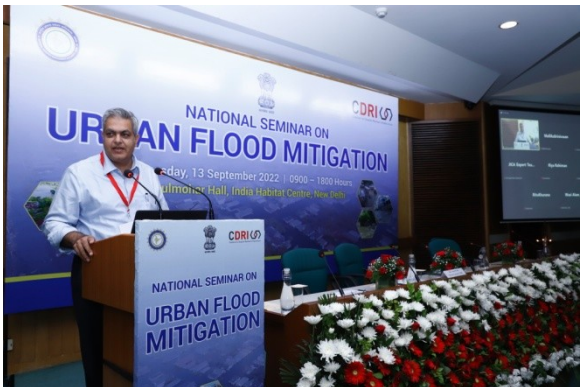
and Satellite, Weather warnings of District/City-wise, and Nowcasting (District/ City-wise). 34 Doppler Weather Radars are operating in the country.

- ✓ Generation of forecasts for urban areas includes nowcasting to very short range (12 hours), Short range (3days forecast), medium range (10 day forecast), extended range (32 days), and seasonal (4 to 7 months). There are 4 stages of the forecast and warning system.
- ✓ Stage -1: Heavy rainfall Advisory (Watch) -(3-5 days lead time 12-h updates), Stage 2: Heavy rainfall Alert (1-3 days lead time 12-h updates), Stage3: Heavy rainfall Warning (24 hours before the occurrence of the event at 06/12- hourly updates) with IBFW and Stage-4: Heavy rainfall Warning (6-12 hours before the occurrence of the event at 01/03- hourly updates) with IBFW. Impact-based flash flood forecasting is implemented in Mumbai and Chennai.

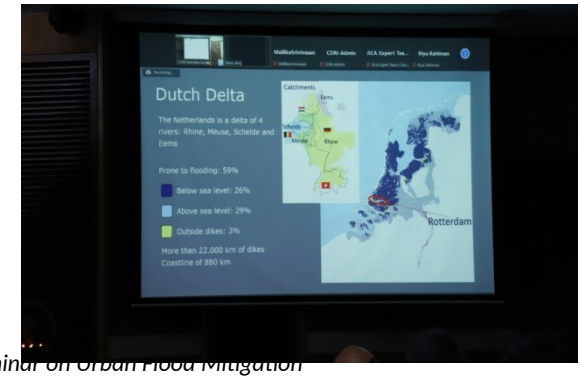
➢ Inter-national level experts

- **Case Study – Floodmanagement in Rotterdam– Mr. Niels Bleij**

- ✓ In the Netherlands, a delta of four rivers, 59% of the land is at risk of floods. The size of the city of Rotterdam is 325 km2 and is home to the Port of Rotterdam, the biggest port in Europe. Every year, Rotterdam receives 800-900mm of precipitation. Man-made land and builders make up the city. Amid structures and other infrastructure, primary dikes shield the land from rising sea levels. Additionally, the city features secondary flood defenses such as dikes, dams, and barriers.



- ✓ Rotterdam has a Climate Adaptation Strategy and the core of the strategy consists4 elements (i) appreciate – maintaining and strengthen the robust water infrastructure (ii) adapt- extend options,make use of the public and private space in the city (iii) Engage – cooperate and link in and (iv) Add value for the environment, society, economy, and ecology
- ✓ Rotterdam has a three safety layer approach (i) Crisis management - Prepare for managing uncontrolled flooding events (ii) Spatial measures- Measures via spatial planning and design and construction for 'controlled handling of water (iii) Prevention - Measures aimed at preventing that flooding occurs.
- ✓

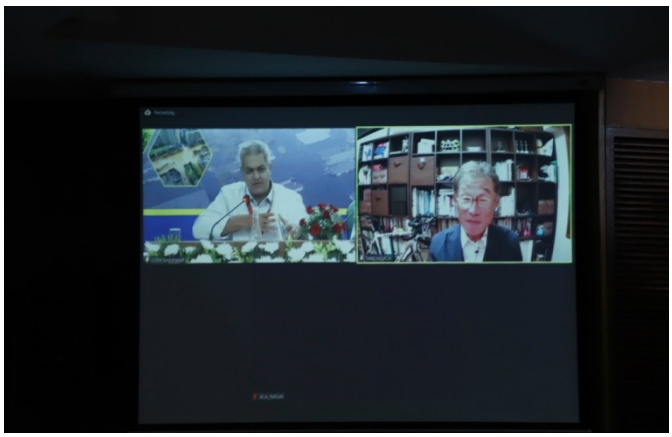


Rotterdam has a 'Living with water' approach and a 'Room for River' program. In the room for river program, the riverbanks are used for inundation. And in living with the river, the sponge city concept is implemented for more

infiltration of water, and public spaces like parks, parking lots, rowing courses,etc are used for water storage. In a football stadium, rainwater is harvested, filtered, and stored for a long season. During the dry season, the water is pumped and reused. Urban greening is also promoted. Rotterdam has a rooftop landscape program to promote green roofs and facades. Rotterdam also has floating buildings to adapt to sea level rise and flooding.

- **Case Study – Urban Flood Management- Tokyo, Japan – Prof. TAKEYA Kimio**

✓ Tokyo has reduced its damages due to floods by continuous investments in Disaster Risk Reduction. Japan has spent 5-8% of its budget on DRR. Tokyo is topographically divided into two types, i.e. hill areas and floodplain areas. In the hill area, an underground tunnel reservoir system is used for flood control and this system has reduced the inundation and damage drastically. In the low flood plain area, the government has invested in building reservoirs, levees, and retention areas with land use regulation and controlled inundation.

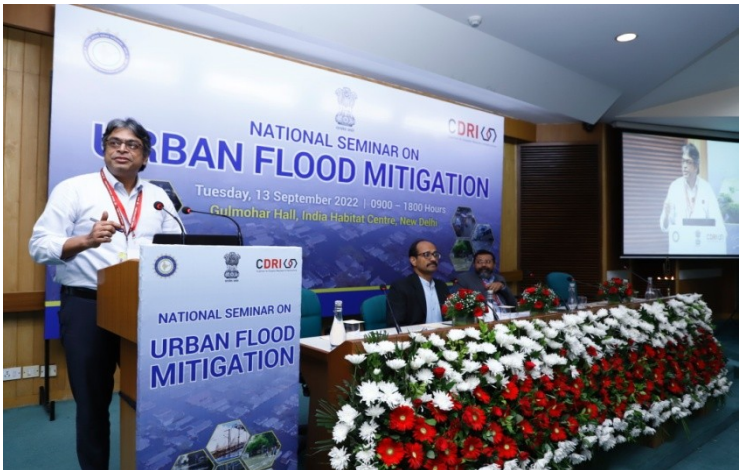


✓ Tokyo City is located downstream of the river, and the area is highly urbanized. To prevent flooding, continuous efforts have been made through river improvement and drainage empowerment. Super levees are provided to protect the low-lying flood-prone areas and the levees are strong which prevents overtopping and catastrophic damages inside the levee area. Elevated land areas are proposed for city infrastructure and to use as temporary evacuation places. In the Yokohama area, land use is regulated to prevent the creation of new risks by retaining the flood plains for agricultural purposes and prohibiting the construction of new dwellings there.

✓ To prepare for excess floods and residual risks the priority should be to understand the disaster risk which can be done through hazard mapping.

4. Outcomes and Reflections

The NDMA has already published comprehensive guidelines on urban floods. There is a need to give attention to both the structural and non-structural interventions are also necessary, however, the NDMF funds should primarily not be utilised for capital intensive structural interventions. Based on the deliberations in the seminar, it is planned to develop a broad framework or indicative list of Do's and Don't's for utilization of the earmarked allocation under NDMF. The demand of the cities for greater flexibility to them for utilisation of NDMF funds and for also allowing retro active financing for the activities carried out by them already also need to be kept in mind. The capital intensive works also need to be discouraged for being taken under NDMF.



In this context, it is also important and necessary to build technical capacities of the nation to city level and develop a strong community of practitioners. There is a need for developing clear indicators for mapping the funds against actual impact on the ground, and a framework and criteria for evaluation. The cities should have the flexibility to tailor programs based on their specific requirements and craft programs that have maximum impact.

Annexure-I

NATIONAL SEMINAR ON URBAN FLOOD MITIGATION

TENTATIVE AGENDA

Date: 13th September 2022 |Time: 0900 – 1730 Hours | Venue: Gulmohar Hall, India Habitat Centre

TIME (IST)	THEME
0900 - 0930	**REGISTRATION**
0930 - 1000	**INAUGURAL** • *Welcome Remarks:* Mr. Harsh Gupta, IAS, Joint Secretary, Mitigation Division, NDMA • Opening Address : Mr. Kamal Kishore, Member Secretary, National Disaster Management Authority • *Inaugural Address*: Mr. Manoj Joshi, IAS, Secretary, Ministry of Housing &Urban Affairs
1000 - 1015	**Tea/Coffee**
1015 - 1030	**STAGE SETTING:**By Mr. Krishna S. Vatsa, Member, National Disaster Management Authority and Mr. Harsh Gupta, IAS, Joint Secretary, Mitigation Division, NDMA
	Flood Preparedness and Mitigation Pathways: Mega and Coastal Cities
1030-1200	Session Chair- Mr. Kamal Kishore, Member Secretary, National Disaster Management Authority **Presentation of Municipal Commissioner/SDMA official** (15-20 minutes each) • Mumbai • Chennai • Kolkata • Delhi
1200-1330	Session Chair- Dr. Krishna Swaroop Vatsa, Member, National Disaster Management Authority **Flood Preparedness and Mitigation Pathways: Inland Cities** **Presentation by Municipal Commissioner/SDMA official(10 minutes each)** • Ahmedabad • Bengaluru • Hyderabad • Pune

1330-1430	**Lunch**
	Presentations by National and International Experts
1430 -1600	Session Chair- Mr. Rajendra Singh, Member, National Disaster Management Authority Presentation By Dr. Kapil Gupta, Professor, IIT, Mumbai ,Dr. A K Gosain, Professor, IIT, Delhi, IIsC, NRSC, HM_RAP, IMD and Others
1600 - 1615	Tea/Coffee
1615 -1700	Session Chair- Mr. Amit Prothi, Director General, CDRI **Presentation – Urban Flood Management Case Study of Rotterdam** Mr. Niels Bleij, Advisor, Water Strategy and Development, City of Rotterdam **Presentation – Urban Flood Management Case Study of Japan** Prof. Takeya, Distinguished Technical Advisor on DRR, JICA
	URBAN FLOOD MANAGEMENT– Developing a National Framework for Urban Flood Risk Management in India
1700-1715	• Presentation of Workshop Outcomes and Reflections: By Mr. Krishna S. Vatsa, Member, National Disaster Management Authority and Mr. Harsh Gupta, IAS, Joint Secretary, Mitigation Division, NDMA
1715-1720	**CLOSING REMARKS**