

Annexures

Annexure 1: Status of the drainage system in India

With the expansion of cities and the migration of people from rural areas to urban areas, there has been immense pressure on urban infrastructure and living conditions, and the problem of urban drainage systems in India is worsening (Central Public Health and Environmental Engineering Organisation [CPHEEO] 2019a). Several factors are responsible for the present status of poor urban drainage systems in India. These are:

- Due to high urbanisation, the natural drainage system in most cities and towns is severely compromised. The flooding situation has worsened due to the non-availability of properly engineered stormwater drainage infrastructures (CPHEEO 2019a). Moreover, encroachment and rampant dumping of garbage and solid waste exacerbate the situation in the absence of preventive maintenance of the drainage system.
- Megacities have a long history of municipal drainage since the British era. Most of the underground drainage systems within core clusters are century-old, antiquated brick masonry conduits (CPHEEO 2019a). The existing stormwater system was mainly designed to serve as a combined sewerage and stormwater runoff system. However, many cities have initiated the process of separating the two systems such as Thane, Ahmedabad, Delhi and many others.
- In 2011, the coverage of the stormwater drainage network was just 20 per cent of the road network and its allied catchment areas, which is too inadequate to cater to the present stormwater disposal (CPHEEO 2019a).
- Most cities are facing worsening flooding because natural drainage systems are deteriorating and engineered stormwater infrastructure is lacking. This is further aggravated by encroachments, indiscriminate dumping of waste into drains, and the absence of preventive maintenance (CPHEEO 2019a).
- Stormwater drain services in India have traditionally been managed by state-level public health engineering departments for capital works and by local bodies for operations and maintenance. To improve effectiveness, especially in a large country like India, the CPHEEO 2019b recommends decentralising administration to the city, zone, and ward levels. It emphasises that placing senior officers in charge at the zonal or divisional level with delegated powers can ensure more focused management. Additionally, the 74th Constitutional Amendment mandates the formation of Ward Committees in cities with populations over 3 lakh, which can play a valuable role in managing stormwater drainage at the ward level (CPHEEO 2019b).
- Stormwater drains often get blocked during the monsoon due to poor maintenance and the dumping of solid and construction waste, leading to localised flooding. This is worsened by the lack of routine operations and maintenance, which is typically neglected and underfunded. The situation can be improved by integrating stormwater drainage with rainwater harvesting or the city's water supply system. Involving citizens in these efforts is essential for improving service delivery and reducing costs for urban local bodies (CPHEEO 2019b).
- Intensity-duration-frequency curves, which are essential for designing stormwater drains, are prepared using an average of 25–30 years of historical rainfall data (CPHEEO 2019a). Further, these are not updated frequently enough to account for the changing rainfall patterns.

Annexure 2: Methodology to estimate IDF curve and peak flood flow

The methodology to estimate the IDF curve and peak flood flow is adapted from Kumar et al. (2022). The intensity of flood-causing rains and the peak flood volume were estimated using historical data on rainfall. For this, the intensity-duration-frequency (IDF) curve of rainfall was developed using the maximum daily rainfall data from 1970 to 2021 for Navsari City. This data was accessed from the daily rainfall available from IMD (see Table A1).

Using Gumbel distribution, the statistical analysis of daily and hourly rainfall data was performed. The maximum daily precipitation in a particular year was identified for all the 55 years considered, and ranking was done based on the rainfall values. Using the daily precipitation figures, hourly rainfall depth corresponding to 1, 2, 6, and 12 hours was estimated using the IMD empirical reduction formula presented in equation A1

$$P_t = P_{24} \sqrt[3]{\frac{t}{24}} \dots\dots\dots \text{(Equation A1)}$$

Where, P_t is the required rainfall depth in mm at t -h duration, P_{24} is daily rainfall in mm, and t is the duration of rainfall in h. This method is widely used for short-duration rainfall events.

Gumbel’s probability distribution was used to determine the return period (frequency) of storms of different intensities and durations (Chow et al. 1988). As a first step, the frequency factors (KT) for the desired return periods (T) were computed using equation A2. For this purpose, the return period of 2,10, 50, and 100 years were considered.

$$KT = -\sqrt{6} \Pi \{0.5772 + \ln [\ln (T T- 1193)]\} \dots\dots\dots \text{(Equation A2)}$$

In the second step, the rainfall intensity corresponding to the different durations and their return period was estimated using equation A3, which is based on Chow et al. (1988).

$$X_T = X + KT S \dots\dots\dots \text{(Equation A3)}$$

Where, X_T is rainfall intensity at a given return period, X is the mean of a particular time, and S is the standard deviation. From the estimated rainfall intensity of different durations and frequencies, the peak flood flow for the city was estimated using equation A4 based on Rodriguez-Iturbe et al. (1979).

$$Q_T = 0.278 \times I_T \times A \dots\dots\dots \text{(Equation A4)}$$

Where, Q_T is the design peak discharge in m^3/s , with a return period of T years; I_T is the average rainfall intensity of design rainfall in mm/h , with a return period of T years and with rainfall duration being equal to the time of concentration, and A is the catchment area in $sq\ km$.

Table A1: 24-hour maximum precipitation in mm for the period (1970–2021), NMC

Year	Rainfall (mm)	Year	Rainfall (mm)
1970	313.7	1998	417.0
1971	100.3	1999	114.8
1972	70.2	2000	81.7
1973	176.6	2001	224.2
1974	62.4	2002	165.4
1975	223.1	2003	255.1
1976	144.4	2004	208.3
1977	134.3	2005	247.9
1978	108.0	2006	195.6
1979	141.6	2007	112.8
1980	88.2	2008	122.2
1981	179.8	2009	118.5
1982	118.7	2010	109.1
1983	130.7	2011	125.4
1984	134.4	2012	176.1
1985	152.3	2013	107.5
1986	174.0	2014	84.4
1987	93.4	2015	118.9
1988	230.0	2016	81.2
1989	138.0	2017	217.4
1990	224.0	2018	158.3
1991	84.9	2019	115.4

1992	214.1	2020	146.0
1993	190.2	2021	165.7
1994	136.0	2022	156.4
1995	191.9	2023	278.3
1996	136.0	2024	184.0
1997	154.5		

Source: Authors' analysis using IMD data

Annexure 3: Components of the risk assessment framework

In its AR5, the IPCC highlights three major components of risk: hazard, exposure, and vulnerability. The framework of urban flood risk assessment of the system deals with the flood hazard, exposure of the system to the flood hazard, and vulnerability of the community to disruptions caused by flood hazards. It also highlights that vulnerability is an endogenous characteristic of a system and is determined by its sensitivity and adaptive capacity (in this analysis, a system is equivalent to wards). The risk components are defined in Figure A1.

Figure A1: Definition of components of risk—hazard, exposure and vulnerability



Source: Authors' compilation using data from IPCC 2014.

The vulnerability component of the risk assessment framework includes the following two sub-indices:

- **Sensitivity**, which refers to the degree to which a system or species is negatively or positively affected by climate variability or change.
- **Adaptive capacity**, which refers to the ability of systems, institutions, humans, and other organisms to adjust to potential damage, seize opportunities, or respond to consequences arising from climatic or anthropogenic causes.

Annexure 4: Selection of indicators for hazard, exposure, and vulnerability assessment

The degree of risk induced through floods depends on various social, physical, institutional, economic, and environmental factors that vary from one locality to another (in this analysis, wards). Hence, the degree of risk induced by flooding is expected to vary significantly across each ward in TNMC.

To determine indicators reflecting the three dimensions of risk—hazard, exposure, and vulnerability, a comprehensive review of literature, both national and global, along with other flood action plans and a handbook of urban flood risk assessment, were undertaken (Ferguson et al. 2023, Osman and Das 2023, Hagos et al. 2022, Rincón, Khan, and Armenakis 2018, Zhao et al. 2023, Muis et al. 2017, Shanableh et al. 2018, Ttayab et al. 2021, Sridhar, Johnson, and Mosuro 2020, Tiwari et al. 2018, (“Report of Sub-Committee for Development of “National Sustainable Habitat Parameters on “Urban Stormwater Management”” n.d., Zhou et al. 2019, Zimmermann et al. 2023, “United Nations Office for Disaster Risk Reduction: 2018 Annual Report | UNDRR” 2019, “Urban Stormwater Management –Potential and Challenges,”). Following that, a series of consultations and discussions were held with various departments and relevant stakeholders within NMC. While the hazard indicators were based on the extent of variability in rainfall and storm events, the final indicator list of exposure and vulnerability (sensitivity and adaptive capacity) reflected the socio-economic, physiological, climatological, and behavioural variables impacting the risk either directly or inversely. A detailed list of indicators, along with their description and data sources, is provided in Tables A2–A4.

Table A2: List of hazard (and associated events) indicators

Categories	Indicators	Sub-indicators	Description	Correlation	Source
Natural	Frequency of occurrence of extreme rainfall, i.e., magnitude exceeding 100 mm over 24 hours (1970–2021)	No sub indicator	Higher magnitudes of rainfall will lead to higher chances of flood occurrences	Direct	Indian Meteorological Department gridded rainfall data set
	The proportion of flood inundated area (highest annual flood event in last five years) (2018–2023)	No sub indicator	The greater the extent of flood inundated area, the greater the hazard it will create	Direct	Digitised using the already present map of inundation area at NMC level for indicator calculation , made by the Town Planning Department, Navsari Municipal Corporation

			The average time taken to evacuate waterlogged areas reflects the efficiency and responsiveness of the urban drainage and disaster management systems.	Direct	
	Instances of water logging events or frequency of flooding (in the last five years) (2018–2023)	Water logging hotspots identified from the year 2024	The municipal corporation keeps a record of the number of complaints reported by civilians in their neighbourhood	Direct	Drainage department
		Average duration of waterlogging (in hrs)		Direct	Drainage department

Source: Authors' compilation

Table A3: List of exposure indicators

Categories	Indicators	Sub-indicators	Rationale	Correlation	Source*
Social	Population density	No sub-indicator	The higher the population density, the higher the proportion of the population exposed to flood impacts.	Direct	Census 2011
Physical	Stormwater network coverage	Existence of a stormwater network	The presence of a stormwater network will lead to reduced exposure to floods.	Direct	Drainage department
		Area under stormwater network coverage	A comprehensive stormwater drainage network will ensure systematic disposal of stormwater and minimise the incidents of water logging and the impact of floods.	Direct	Drainage department
	Sewerage network coverage	Area under sewerage network coverage	A higher proportion of the area covered with the sewer network will minimise the recurring events of water logging, especially during the rainy season, and reduce flooding in the ward.	Direct	Drainage department
	Elevation	Slope	The slope influences the direction and amount of surface runoff or subsurface drainage reaching a	Inverse	CEEW analysis based on SRTM 30m resolution

Categories	Indicators	Sub-indicators	Rationale	Correlation	Source*
			site. The slope has a dominant effect on the contribution of rainfall to stream flow.		
		Drainage density	High drainage density implies a greater number of streamlines per unit area, increasing the likelihood that human settlements, infrastructure, and agricultural land are located in close proximity to flowing water. This increases their spatial exposure to riverine and surface water flooding, especially during extreme rainfall events.	Inverse	CEEW analysis based on SRTM 30m resolution
	Characteristics of land cover	Percentage of built-up area to the total area of the ward	Built-up areas reduce the surface roughness and enhance the surface runoff coefficient, thereby increasing the risk of flooding and making the area more exposed. Whereas areas having a higher proportion of blue-green spaces would ensure higher run-off detention and promote infiltration in surrounding soil	Direct	CEEW analysis based on Land Use Land Cover Analysis from Sentinel 2A at 10 m

Source: Authors' compilation

Table A4: List of vulnerability indicators

Categories	Indicators	Sub-indicators	Rationale	Correlation	Source*
Physical	Distance from the river	No sub-indicator	The relative location of a place from the stream is very important in determining whether this area will be affected by flood or not and to what extent it will be affected. If the distance from the river of an area is greater, it is less likely to be flood-affected. According to studies, the areas most affected by floods are those near these rivers as a consequence of overflow.	Direct	CEEW analysis, based on euclidean distance from streams
	Households (HHs) with access to water	No sub-indicator	During flood events, access to common water discharge points will be restricted. Therefore,	Inverse	Public Health department

	supply within the premises		the presence of a water supply within the premises will enhance their adaptive capacity and lower their vulnerability.		
	Households (HHs) with access to safely managed sanitation services	No sub-indicator	During floods, access to common toilets located outside the dwelling premises will be restricted. Therefore, access to individual toilets within the premises will lower the vulnerability of the HHs and enhance their adaptive capacity.	Inverse	Public Health department
Socio-economic	Proportion of the population living below the poverty line	No sub-indicator	During flood events, poor people are generally more vulnerable as they lack access to resources, have low educational attainment, and often lack awareness of flood response measures; hence, their adaptive capacity would be poor to cope with such extreme events.	Direct	Census 2011
	Population with special needs/disability	No sub-indicator	During flood events, populations with special needs/disability often lack access to basic services due to the absence of disabled-friendly infrastructure, which hampers their mobility and increases their dependency. Hence, they are highly vulnerable to such extreme shock events and have poor adaptive capacity.	Direct	Urban livelihood department
	Number of slum settlements per ward	No sub-indicator	The number of slum areas reflects how many locations within a ward are physically and socially vulnerable to climate hazards.	Direct	Urban livelihood department

	Literacy rate	No sub-indicator	The higher the literacy rate, the better the population will be prepared to respond to disasters	Direct	Census 2011
Medical	Access to emergency medical services	Availability of hospital beds per 1,000 Population	This indicates the level of access to inpatient medical care. Lower values reflect higher sensitivity, as limited hospital bed availability reduces the community's capacity to cope with health impacts from climate-related hazards.	Inverse	Public Health department
		Availability of healthcare personnel per 10,000 population	This reflects access to essential medical support. Lower staffing levels indicate higher sensitivity, as insufficient health personnel reduce the ability to respond to illness, injury, or disease outbreaks during climate-related events	Inverse	Public Health department
Institutional	Early warning and emergency preparedness	Number of functional automated weather stations (AWS)/automated rain gauge (ARG) in each ward	This indicates the level of access to inpatient medical care. Lower values reflect higher sensitivity, as limited hospital bed availability reduces the community's capacity to cope with health impacts from climate-related hazards.	Inverse	NA
		Presence of a dedicated Emergency Operation Center (EOC) connected to the automated rain gauge station (ARG)/AWS in each ward	The presence of EOC will ensure prompt response to the events of urban flooding and thus strengthen the adaptive capacity of that ward.	Inverse	NA
	Response Measures	Proportion of shelter capacity available with respect to ward population for temporary evacuation	Identifying ward-wise suitable sites for evacuation as the preparatory measure will make the response measure during the event more organised	Inverse	Town Planning department

			and smooth and thus improve the adaptive capacity.		
		Training and orientation programmes conducted to strengthen the ability to manage and cope with disasters involving multi-stakeholder participation, such as government officials, RWAs, SHGs, and NGOs	Capacity-building programmes involving multi-stakeholders enhance the overall adaptive capacity of the wards to cope with extreme events as they ensure better coordination and responsibility sharing.	Inverse	NA
	Research and documentation	Existence of updated city disaster management plan	Research and documentation are related to flood vulnerability because they help identify and reduce risks. Research aids in locating susceptible communities, infrastructure, and locations, and documentation documents historical occurrences and their effects	Inverse	Fire department but not legible
		Presence of Ward-Level HRVA and Capacity Assessment		Inverse	NA
		Ward-Level Repository of Flood Damage Data Prepared		Inverse	NA
	Mobility and access through public transport for emergency response	Percentage road network coverage per ward		Direct	Road and Transport department
		Accessibility to transport infrastructure which can be used for mobilisation as well as emergency shelters (bus stops, metro stations, railway station and bus terminals) (in per sq.km)		Direct	Road and Transport department

Source: Authors' compilation

Note: *indicators for which the source is not mentioned were not considered for computation.

Normalisation and reclassification of indicators

All the indicators were normalised by bringing them to a common scale. For this, the min–max normalisation technique was used to make them unit–free. The normalisation is based on the functional relationship of indicators. For positively related indicators, i.e., where risk increases with an increase in the value of the indicator, the following formula was used:

$$X_{ij}^P = \frac{X_{ij} - \text{Min}_i\{X_{ij}\}}{\text{Max}_i\{X_{ij}\} - \text{Min}_i\{X_{ij}\}}$$

For negatively related indicators, i.e., where risk decreases with an increase in the value of the indicators, the following formula was used:

$$X_{ij}^N = \frac{\text{Max}_i\{X_{ij}\} - X_{ij}}{\text{Max}_i\{X_{ij}\} - \text{Min}_i\{X_{ij}\}}$$

The indicators after normalisation ranged between 0 and 1, where 1 corresponds to a ward with maximum risk, and 0 corresponds to a ward with minimum risk.

Annexure 4.1 : Assumption and estimation due to existing data gaps in NMC

The flood risk index for Navsari City was computed based on the IPCC framework comprising three components – hazard, exposure, and vulnerability. However, due to the unavailability of certain data sets, some indicators were excluded from the risk index computation. The list of complete indicators, including those excluded from the risk assessment, is provided in Annexure 3. The data gaps may impact the reliability of the risk assessment (Table 3). The missing data sets are attributed to various reasons, including limited monitoring infrastructure, insufficient data collection processes, or challenges in accessing certain geographical areas.

Table A5 : Data assumption and estimation due to existing data gaps in NMC

Components of risk	Indicator	Data received NMC	Dataset format	Assumption
Hazard	The proportion of flood inundated ward area (highest annual flood event in last five years, 2020–2024)	Flood inundation map of Navsari city with ward wise demarcation was considered to proxy for the highest annual flood event	PDF format	Digitised the pdf file to make it a shapefile and estimated ward wise area using QGIS.

Exposure	Stormwater network length (in km)	Ward wise stormwater network length	Excel format (Partial) (in km)	Apportioned using ward wise dataset to make it equivalent to total stormwater network length of 180 km, received was only for 8.95 km of the city.
		Total length of stormwater network length	Number (in km)	
	Sewerage network coverage (in per cent)	Total number of HHs connected to sewerage network ward wise	Number	Apportioned using total sewerage network length using ward area (in sq km) and total number of HHs connected to sewerage network.
		Total length of sewerage network	Number (in km)	
	Built up area to the total geographical area (%) and Land use and land cover (LULC)	None	NA	Estimated through Sentinel 10m Land use land cover
	Sensitivity	Percentage of population living below poverty line	None	NA
Adaptive capacity	Literacy rate	None	NA	Ward wise data was assumed similar to city level data which was obtained from Census 2011.

	Number of emergency response equipment (dewatering pumps, boats, life jackets, ropes)	Total city level inventory of response and relief equipment	Numbers	Divided equally among each ward
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Source: Authors' compilation from the datasets received through NMC

Annexure 5: Analytical hierarchy process (AHP)

Weightages were assigned to all the indicators using the analytical hierarchy process (AHP). The AHP is a multi-criteria decision modelling tool widely applied within vulnerability and flood risk assessment studies (Hasanuzzaman et al. 2022, Mohanty and Wadhawan 2021, Hoque et al. 2019, Danumah et al. 2016). It is a semi-quantitative approach that allows for stakeholder engagement in determining the relative weights of the indicators being compared. The AHP undertaken for the APFRM involved the following steps:

- **Hierarchy:** The AHP uses a hierarchical structure consisting of a main goal or objective, criteria (or components), and sub-criteria (or indicators). The indicators chosen under each risk component (except hazard) underwent pairwise comparison to arrive at different weightages based on stakeholder judgement. Some indicators for exposure and vulnerability components were clubbed to minimise response fatigue while executing the AHP. As a result, 14 indicators were considered in the AHP analysis. Hazard indicators were considered to have equal weightage and, hence, were not included in the AHP.
- **Pairwise comparison through stakeholder consultation:** To compute weights for the indicators in the AHP, an $n \times n$ matrix was developed, where n is the number of indicators within a particular risk component (Pacetti et al. 2022). Within the matrix, indicators were quantitatively compared based on a predetermined scale in sets of two. This scale, developed by Saaty, uses a scale of preference with values ranging from 1–9 (Figure A2 and Table A5) to rate the relative importance of two indicators (Saaty 1987). Data is collected through experts' judgements, called pair-wise comparisons, where stakeholders are asked to assign a value to their subjective judgements. Based on priorities assigned by comparison, indicators are ranked according to their importance, and a weight is assigned to each indicator.

For the APFRM, pairwise comparison was undertaken at a stakeholder consultative meeting with representatives from eleven concerned line departments of NMC, including the Fire and emergency services Department, Drainage Department, Solid waste Department, Health Department, Road and Building Department, Stormwater Department, Town Planning Department, Water Supply Department, Electrical Department, IT Department and Disaster Shakha Navsari. Additionally, inputs from an Urban Planning Consultant with NMC and an external expert were also obtained. The stakeholders were asked to complete a structured questionnaire to collect individual pairwise comparisons of indicators related to exposure sensitivity and adaptive capacity. The hazard index indicators were not included in the pairwise comparison process as we assumed equal importance for all indicators within the hazard component; all indicators received equal weightage. Similarly, all three risk components (hazard, exposure, and vulnerability) were assigned equal weightage due to their equal importance in contributing to urban flood risk.

Figure A2: Satty scale used for pairwise comparison of indicators

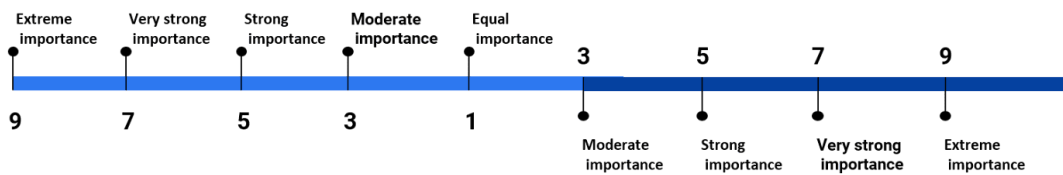


Table A6: Relative importance based on Saaty scale

Intensity of importance	Definition	Explanation
1	Equal importance	Two indicators are equally important with respect to the objective
3	Moderate importance	As per experience and judgement, one indicator is slightly more important
5	Strong importance	As per experience and judgement, one indicator has strong importance with respect to the objective over another
7	Very strong importance	One indicator has a much stronger importance than the other
9	Extreme importance	The evidence signalling the importance of one indicator over another is of the highest possible order of affirmation

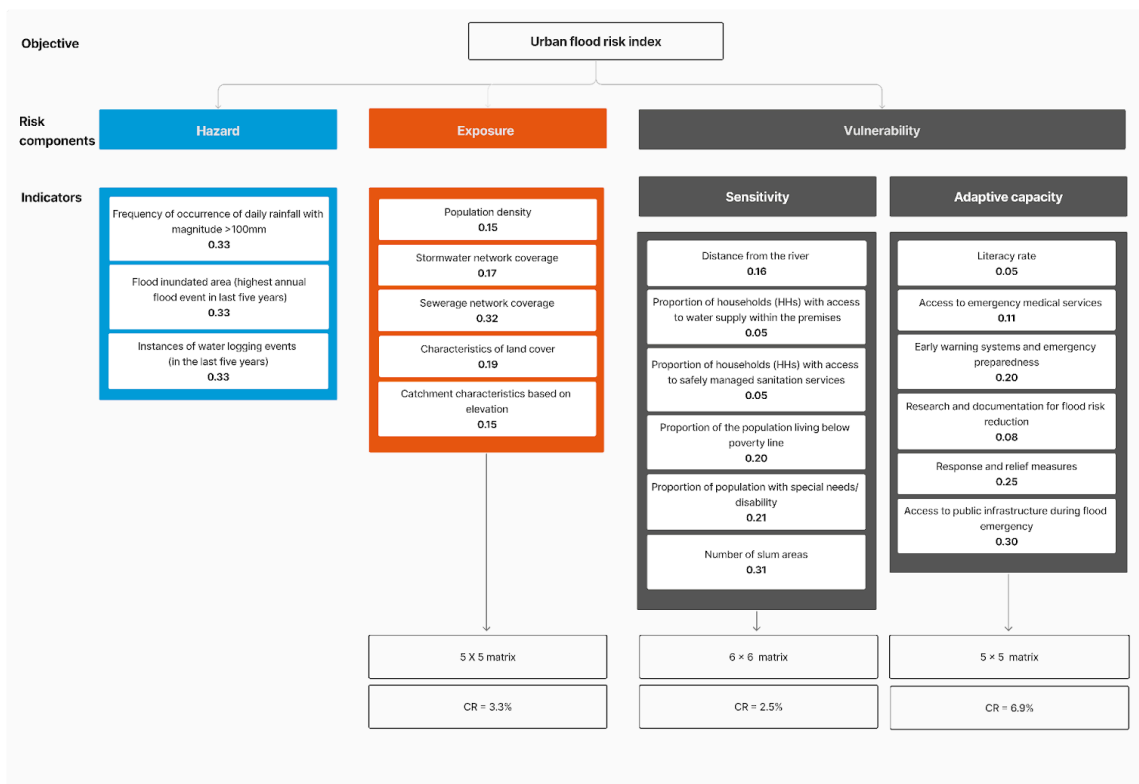
Source: Authors’ compilation based on Saaty 1987

- Computation of weights:** Matrices developed from individual stakeholder responses were aggregated to calculate the percentages weights assigned to each indicator relating to the three components. The ten responses were aggregated through the geometric mean method to derive a consolidated preference matrix. The final weights of indicators lay within the range of 0–1 (Figure A3). Finally, the consistency ratio (CR) was calculated to check for consistency in stakeholder judgements using equation A5. For a matrix to be consistent, the CR value should lie below 10 per cent or less than 0.1. The CR of all the consolidated matrices was under 10 per cent.

$$CR = \frac{(\lambda - n)}{(n - 1)} \dots\dots\dots(\text{Equation A5})$$

Where λ = maximum eigenvalue of the matrix n = number of indicators. An AHP template (Goepel 2013) was employed to aggregate and analyse the pairwise comparison matrix collected from stakeholders.

Figure A3: AHP approach and results



Source: Authors' compilation

Questionnaires developed for AHP are provided in Tables A6 to A8.

Table A7: Exposure questionnaire

Indicator A	Indicator B	Equal	Relative Importance Scale				Rationale
		Equal Importance (1)	Moderate Importance (3)	Strong Importance (5)	Very Strong Importance (7)	Extreme Importance (9)	

Population Density (Higher the population density, the higher the proportion of the population exposed to impacts of floods)	Stormwater Network Coverage (Larger the coverage of stormwater network , lower the exposure risk)						a
Population Density (Higher the population density, the higher the proportion of the population exposed to impacts of floods)	Sewerage Network Coverage (Larger the coverage of sewerage network , lower the exposure risk)						
Population Density (Higher the population density, the higher the proportion of the population exposed to impacts of floods)	Elevation (Lower the elevation , higher the exposure risk)						
Population Density (Higher the population density, the higher the proportion of the population exposed to impacts of floods)	Proportion of built up area (in %) (Higher the proportion of built up area, higher the exposure risk)						
Stormwater Network Coverage (Larger the coverage of stormwater network , lower the exposure risk)	Sewerage Network Coverage (Larger the coverage of sewerage network , lower the exposure risk)						
Stormwater Network Coverage (Larger the coverage of stormwater network , lower the exposure risk)	Elevation (Lower the elevation , higher the exposure risk)						
Stormwater Network Coverage (Larger the coverage of stormwater network , lower the exposure risk)	Proportion of built up area (in %) (Higher the proportion of built up area, higher the exposure risk)						
Sewerage Network Coverage (Larger the coverage of sewerage network , lower the exposure risk)	Elevation (Lower the elevation , higher the exposure risk)						
Sewerage Network Coverage (Larger the coverage of sewerage network , lower the exposure risk)	Proportion of built up area (in %) (Higher the proportion of built up area, higher the exposure risk)						

<p>Elevation (Lower the elevation, higher the exposure risk)</p>	<p>Proportion of built up area (in %) (Higher the proportion of built up area, higher the exposure risk)</p>						
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Table A8: Sensitivity questionnaire

Indicator A	Indicator B	Equal	Relative Importance Scale					Rationale
		Equal Importance (1)	Moderate Importance (3)	Strong Importance (5)	Very Strong Importance (7)	Extreme Importance (9)		
<p>Distance from the river (Lesser the distance from river, more sensitive the area is to flooding)</p>	<p>Households (HHs) with access to water supply within the premises (Larger proportion of HHs with access to water supply within the premises, lower will be their sensitivity towards flood risk)</p>							
<p>Distance from the river (Lesser the distance from river, more sensitive the area is to flooding)</p>	<p>Households (HHs) with access to toilet within the premises (Larger proportion of HHs with access to toilet within the premises, lower will be their vulnerability)</p>							
<p>Distance from the river (Lesser the distance from river, more sensitive the area is to flooding)</p>	<p>Proportion of population living below poverty line (Higher the proportion of population living below poverty line, higher will be their sensitivity towards flooding impacts)</p>							
<p>Distance from the river (Lesser the distance from river, more sensitive the area is to flooding)</p>	<p>Population with special needs/disability (Higher the proportion of population with special needs and disability, higher will be their sensitivity)</p>							
<p>Distance from the river (Lesser the distance from river, more sensitive the area is to flooding)</p>	<p>Number of slum areas (Higher the number of slum areas, higher will be their sensitivity towards flooding impacts)</p>							

<p>Households (HHs) with access to water supply within the premises (Larger proportion of HHs with access to water supply within the premises, lower will be their sensitivity towards flood risk)</p>	<p>Households (HHs) with access to toilet within the premises (Larger proportion of HHs with access to water supply within the premises, lower will be their sensitivity towards flood risk)</p>						
<p>Households (HHs) with access to water supply within the premises (Larger proportion of HHs with access to water supply within the premises, lower will be their sensitivity towards flood risk)</p>	<p>Proportion of population living below poverty line (Higher the proportion of population living below poverty line, higher will be their sensitivity towards flooding impacts)</p>						
<p>Households (HHs) with access to water supply within the premises (Larger proportion of HHs with access to water supply within the premises, lower will be their sensitivity towards flood risk)</p>	<p>Population with special needs/disability (Higher the proportion of population with special needs and disability, higher will be their sensitivity)</p>						
<p>Households (HHs) with access to water supply within the premises (Larger proportion of HHs with access to water supply within the premises, lower will be their sensitivity towards flood risk)</p>	<p>Number of slum areas (Higher the number of slum areas, higher will be their sensitivity towards flooding impacts)</p>						
<p>Households (HHs) with access to toilet within the premises (Larger proportion of HHs with access to water supply within the premises, lower will be their sensitivity towards flood risk)</p>	<p>Proportion of population living below poverty line (Higher the proportion of population living below poverty line, higher will be their sensitivity towards flooding impacts)</p>						

Households (HHs) with access to toilet within the premises (Larger proportion of HHs with access to water supply within the premises, lower will be their sensitivity towards flood risk)	Population with special needs/disability (Higher the proportion of population with special needs and disability, higher will be their sensitivity)						
Households (HHs) with access to toilet within the premises (Larger proportion of HHs with access to water supply within the premises, lower will be their sensitivity towards flood risk)	Number of slum areas (Higher the number of slum areas, higher will be their sensitivity towards flooding impacts)						
Proportion of population living below poverty line (Higher the proportion of population living below poverty line, higher will be their sensitivity towards flooding impacts)	Population with special needs/disability (Higher the proportion of population with special needs and disability, higher will be their sensitivity)						
Proportion of population living below poverty line (Higher the proportion of population living below poverty line, higher will be their sensitivity towards flooding impacts)	Number of slum areas (Higher the number of slum areas, higher will be their sensitivity towards flooding impacts)						
Population with special needs/disability (Higher the proportion of population with special needs and disability, higher will be their sensitivity)	Number of slum areas (Higher the number of slum areas, higher will be their sensitivity towards flooding impacts)						

Table A9: Adaptive capacity questionnaire

Indicator A	Indicator B	Equal	Relative Importance Scale				Rationale
		Equal Importance (1)	Moderate Importance (3)	Strong Importance (5)	Very Strong Importance (7)	Extreme Importance (9)	

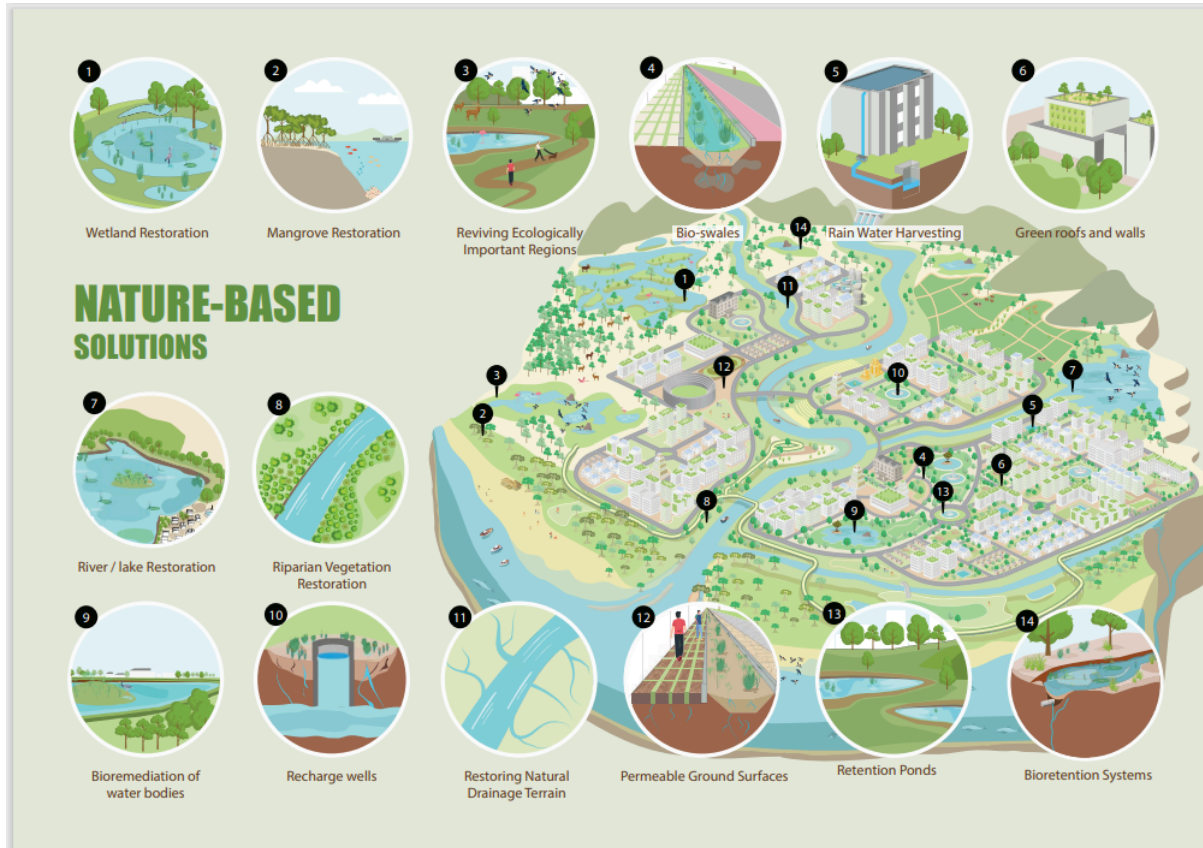
<p>Literacy Rate (The higher the literacy rate, the better the population will be prepared to respond to disasters)</p>	<p>Access to Emergency Medical Services (The higher the access to medical services, higher the adaptive capacity)</p>						
<p>Literacy Rate (The higher the literacy rate, the better the population will be prepared to respond to disasters)</p>	<p>Early Warning System and Emergency Preparedness (The more advanced the early warning system and better emergency preparedness, better would be the Adaptive Capacity)</p>						
<p>Literacy Rate (The higher the literacy rate, the better the population will be prepared to respond to disasters)</p>	<p>Response & Relief Measures (Better the preparedness and planning for R&R measures, more the promptness in the response action and hence better will be the AC.)</p>						
<p>Literacy Rate (The higher the literacy rate, the better the population will be prepared to respond to disasters)</p>	<p>Research and Documentation for Flood Reduction (Better the identification and reduction of risk because of Research and Documentation, better will be the AC.)</p>						
<p>Literacy Rate (The higher the literacy rate, the better the population will be prepared to respond to disasters)</p>	<p>Access to public infrastructure during flood emergency (Better the access to public transport during floods, better will be the AC)</p>						

<p>Access to Emergency Medical Services (The higher the access to medical services, higher the adaptive capacity)</p>	<p>Early Warning System and Emergency Preparedness (The more advanced the early warning system and better emergency preparedness, better would be the Adaptive Capacity)</p>						
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<p>Access to Emergency Medical Services (The higher the access to medical services, higher the adaptive capacity)</p>	<p>Access to public infrastructure during flood emergency (Better the access to public transport during floods, better will be the AC)</p>						
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Annexure 6: Nature-based solutions under runoff management



Source: NIUA, World Bank, and GFDRR, 2022

