



Urban Disaster Impact and Role of Urban Planning for Risk Mitigation

By


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- Urban landscapes are characterized by its built form, land use, circulation patterns, social and economic systems, all connected in a complex network of people and organizations.
 - Disaster risks form an integral part of this complex network.
 - A part of the risks accrue due to the location of the city in a hazard-prone area, a considerable part accrues out of the inherent vulnerabilities due to uncontrolled urbanization and planning, unsafe construction practices, vulnerabilities linked with livelihood and social stereotyping.

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- India and most of South Asia, the process of urbanization has been uncontrolled and ad hoc.
 - Urban centers therefore are formed from a collection of different types of structures built within a network of circulation elements.
 - The structures range from high-rise to mansions to shanties and tenements while the circulation ranges from lanes and by-lanes to avenues and highways.
 - It naturally follows that the city offers shelter to the rich and the poor alike, each with different needs and vulnerabilities.
 - The urban landscape therefore is a complex mix of varied structures and people.




Urban areas are prone to these disasters:

- Urban Floods
- Urban Fires
- Earthquakes
- Heat island effect
- Epidemic and pandemic breakout
- Emission of hazardous gases

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- **Risk Assessment and Analysis:**
 - Risk is an expected occurrence of failure of any functioning or management operations that are harmful to life, social and economic activities. Risk increases with the increase in vulnerabilities that often intensifies the impact of hazards and disasters.
 - The Risk assessment process involves analysis and evaluation of existing conditions and interactions that interpret the nature and extent of damages from risks. **It is based on a data set of features such as location, frequency, intensity, physical features, social demographics, economic structure, etc., collected from interviews, existing data sets.** This assessment identifies the risk factors that help in improving the measures and management to reduce the risks and decision-making.
 - Certainly, there are challenges in developing assessments like limited research and understanding of methodology, institutional members, budget allocation, etc.


Urban risk factors-

- Location of hotspots in town based on seismic data, flood data, rainfall patterns, geotechnical data.
- Data of engineered and non-engineered structures for safety and capacity evaluation.
- Social and economic inequalities, vulnerable groups for accessibility, and extent of measures.
- The Capacity of Urban infrastructure such as sewage system, drainage system, water supply, roads, hospitals, fire safety, etc.
- Urban governance, policies, enforcement, and public participation in sustainable development.
- Insurance and funding assistance factors will reduce considerable stress on the economic activities to start all over for reconstruction and resettlement.

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- **Disaster Risk Reduction can be achieved by preparedness and preventive measures on risk factors, monitored by risk management systems. Key areas to focus on while planning and implementation are-**
 - **Construction:** Large-scale utility projects with huge investments are constructed such that it ensures flood protection, earthquake resistance, fire protection, and safe access to emergency services, etc., by structural design and quality control in construction practices. These construction practices and building codes as per the standards set by government authorities need to be promoted to get awareness.

- The research on provisions is to be extended for review according to the changes in demographics. Declaration of incentives to promote safe and sustainable constructions on areas that were specified on hazards and vulnerabilities. Following are few coral provisions for construction –
- IS 1893(Part 1):2002 `Criteria for Earthquake Resistant Design of Structures: Part I General provisions and Buildings' (Bureau of Indian Standards)
- IS 13827:1993 Improving Earthquake Resistance of Earthen Buildings – Guidelines (Bureau of Indian Standards)
- IS 13828:1993 Improving Earthquake Resistance of Low Strength Masonry Buildings – Guidelines (Bureau of Indian Standards)
- IS 13935:2009 Seismic Evaluation, Repair and Strengthening of Masonry Buildings – Guidelines (Bureau of Indian Standards)
- IS 13920:1993 Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces – Code of Practice (Bureau of Indian Standards)
- SP 7: 2016 National Building Code of India 2016 (NBC 2016) (Bureau of Indian Standards)

- Guidelines on disaster management by National Disaster Management Authority (National Disaster Management Authority, Government of India)
- **Epidemics:** An epidemic is usually confined to a region having a focal point. When the risk of transitivity is intensified, that is, it can cover a large number of regions, it becomes a pandemic which is more turbulent than epidemics. They also occur after the hazards due to mismanagement in relief and rehabilitation.
- **To assess the risks in epidemics for future-**
- Time taken to realize the health condition.
- What and Which type of measures were adopted out of possible measures based on the urban scenario.
- When to start vaccination? Either supervise on disease changes or vaccination before the breakout.
- The Capacity of patient occupancy and medical service availability per person in that area.
- Classification of population based on age, gender, medical conditions, living conditions, medical accessibility etc.
- Supply of water and sanitation arrangements, solid waste disposal system.

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- Epidemic examples:
 - Nipah virus outbreak in Kerala, India in 2018. (WHO)
 - Ebola virus outbreak in the Democratic Republic of the Congo in Africa in 2018. (WHO)
 - Pandemic examples:
 - Coronavirus Covid 19 pandemic worldwide in 2019. (WHO)
 - **Fire Accidents** at Public places, LPG stations, and petrol pumps, slum areas, residential buildings, commercial buildings, chemical plants, etc., cause serious injuries and loss of wealth. Further resettlement and redevelopment with lost employment and personal wealth challenge the livelihood economic growth and health disorders.

Few indicators to assess the risks in fire mitigation and management at urban areas-


- Population occupancy per household per area.
- Availability of firefighters and services for the population and buildings in that area.
- Data of buildings with poor fire safety and safe building standards.
- Constraints inaccessibility of emergency like road, water drawing power, site accessibility conditions, etc.
- Evacuation and escape routes availability.

Fire accidents occur when –

- Unauthorized unsafe electrical connections and in-house wiring – risks of short-circuiting leading to fire accidents.
- Unsafe storage of hazardous and flammable substances.
- Industries with less fire protection and fighting services without safety preparedness.
- Illegal operations and unsafe working conditions at flammable materials storage and handling.
- Lack of standard operating procedures and inspection on vulnerabilities.

Risk mitigation –

- Risks can be minimized by adopting disaster risk management methods like the fire detection and safety alert system with automatic water sprinklers to put off the flame.
- Establishment of fire pumps in the potential sites to draw at emergency services.
- Encouragement of fire-resisting building materials and fire extinguishers with water pumps within the building, awareness on evacuation and exit routes to the people. (Provide full knowledge of Emergency medical kits, Safety audits, and mock drills)

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- **Climate change** is caused by manmade activities that stress the ecosystem creating unfavorable environmental conditions that slowly result in the occurrence of natural hazards.
 - It affects the urban system indirectly by altering the demand and supply of food due to the impact on the production stage by shifting rainfall patterns, temperature effects, and wind patterns.
 - It also changes the average temperature in the atmosphere, floods, droughts, and stress on water systems, and ecological imbalances.

Some indicators to assess the risks in climate change are–

- Future forecasts of temperature changes by reviewing the annual, decadal temperatures and their effect on sea levels.
- Temperature effect on melting of ice on mountains causing floods and cyclones.
- Pollution levels and Greenhouse gas concentrations in the atmosphere causing global warming.
- Probability of the occurrence of disasters.
- Urban infrastructure, living conditions, and preparedness for various natural hazards caused by climate changes. Particularly at the coastal areas and cities near rivers.
- The development activities and migration data at risk-prone areas in the city
- Groundwater levels to assess the aquifer's capacity and recharge.
- **Industries and factories usually dispose of hazardous waste** into water sources and exhaust harmful gases into the people living near such emissions face health complications based on the toxic levels and the exposure. They are subjected to air pollution, sound pollution, and water pollution if unchecked. These settlements can be assessed for environmental audits and safety audits for planning and mitigation.


- **Few examples of risks and hazards from Industries and factories are,**
- On 2nd December 1984, Bhopal Gas Tragedy occurred due to leakage of Methyl isocyanate (MIC) gas from Union Carbide India Limited (UCIL) a pesticide plant in Bhopal causing the death of about 4000 people and adversely affected the health of lakhs of people. Some of the post-disaster effects are still continuing (Byju's).
- Gas leak from LG Polymers Pvt Ltd in Andhra Pradesh's Visakhapatnam caused 12 deaths and 585 hospitalized 585 on May 7, 2020 (Bisht, 2020)

Urban Resilience

- Urban resilience is the capacity of a system to resist the risks and impacts of hazards while still maintaining its function.
- It depends on the availability of essential assets and services during emergencies and post-hazard.
- They are flexible to function under different conditions so that they can convert assets or structures for emergency relief camps and services that can be accessed easily.
- Such systems have infrastructure which is redundant and modulate services under extreme stress with minimal failures.
- They observe and try to reduce the stress of slow-onset challenges to avoid failures

To make the cities resilient to climate change:

- The city needs to be assessed for capacity, vulnerabilities, and available resources.
- Develop human skills or societal infrastructures within a community or organization to reduce the level of risk.
- In addition to this, capacity building also includes the development of institutional, financial, political, and other resources, such as technology at different levels and sectors of the society.
- To set up organizations like local authorities, public, NGO, private entities to address and work on risk reduction and awareness through information centers, media publications, meetings, etc,
- Build infrastructure and financial institutions for resisting and assisting during hazards and disasters.
- Measures to minimize the temperature and climate changes to reduce the emission of greenhouse gases and pollutants.


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- Energy conservation codes need to be adopted and followed.
 - Afforestation should be followed along with zoning out the areas to avoid settlements.
 - Best drainage and sewerage plans need to be adopted to minimize the risk of urban floods.
 - Zoning and protecting the natural drainages and catchment areas from dwellers and settlements.
 - Hotspot analysis and prioritizing the services as well as development activities.
 - To develop a casualty management system for safe disposal and to provide prioritized services during hazards according to the severity of injuries and chances of survival for best utilization of available resources without any social discriminations.


Flooding





Urban Flood: Man-Made Disaster


- Overburdened drainage, unregulated construction, no regard to the natural topography and hydro-geomorphology all make urban floods a man-made disaster.
- **Inadequate Drainage Infrastructure:** Cities like Hyderabad, Mumbai rely on a century-old drainage system, covering only a small part of the core city.
 - In the last 20 years, the Indian cities have grown manifold with its original built-up area.
 - As the city grew beyond its original limits, not much was done to address the absence of adequate drainage systems.
- **Terrain Alteration:** Lasting irreversible damage has been done to the city by property builders, property owners, and public agencies by flattening terrain and altering natural drainage routes.


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- **Reducing Seepage:** Indian cities are becoming increasingly impervious to water, not just because of increasing built up but also because of the nature of materials used (hard, non-porous construction material that makes the soil impervious).
 - **Lax Implementation:** Even with provisions of rainwater harvesting, sustainable urban drainage systems, etc, in regulatory mechanisms like the **Environmental Impact Assessment (EIA)**, adoption at user end as well as enforcement agencies remains weak.
 - **Encroaching Natural Spaces:** The number of wetlands has reduced to 123 in 2018 from 644 in 1956.
 - Green cover is only 9 per cent, which ideally should have been at least 33 per cent.

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- **Need For Holistic Engagement:** Urban floods of this scale cannot be contained by the municipal authorities alone. Floods cannot be managed without concerted and focused investments of energy and resources.
 - The Metropolitan Development Authorities, **National Disaster Management Authority**, State revenue and irrigation departments along with municipal corporations should be involved in such work together.
 - Such investments can only be done in a mission mode organisation with active participation of civil society organisations at the metropolitan scale.
 - **Developing Sponge Cities:** The idea of a sponge city is to make cities more permeable so as to hold and use the water which falls upon it.
 - Sponge cities absorb the rain water, which is then naturally filtered by the soil and allowed to reach urban aquifers.
 - This allows for the extraction of water from the ground through urban or peri-urban wells.
 - This water can be treated easily and used for city water supply.

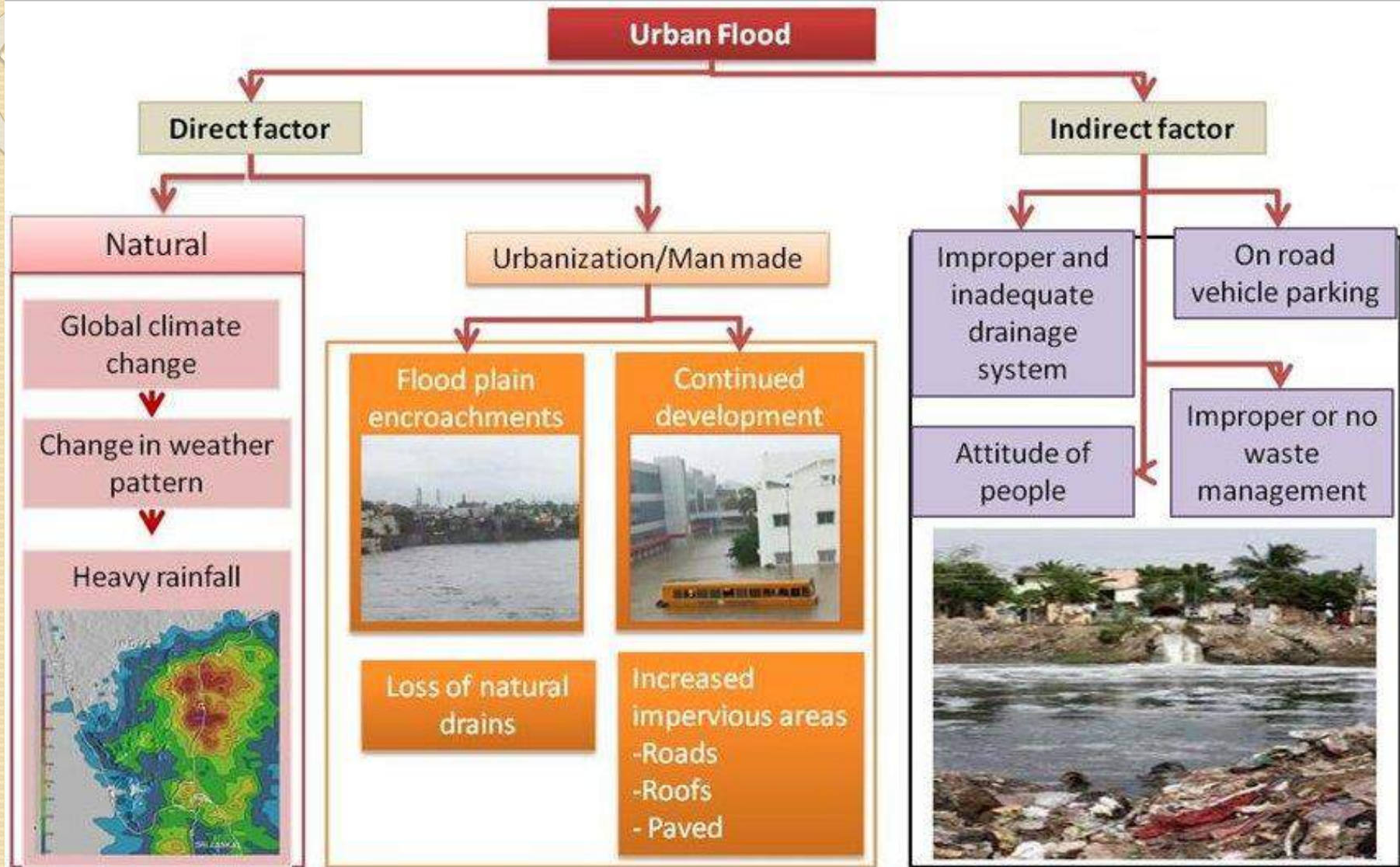
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- **Wetland Policy:** There is a need to start paying attention to the management of wetlands by involving local communities.
 - Without doubt, terrain alteration needs to be strictly regulated and a ban on any further alteration of terrain needs to be introduced.
 - To improve the city's capacity to absorb water, new porous materials and technologies must be encouraged or mandated across scales.
 - Examples of these technologies are bioswales and retention systems, permeable material for roads and pavement, drainage systems which allow storm water to trickle into the ground, green roofs and harvesting systems in buildings.

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- **Drainage Planning:** Watershed management and emergency drainage plan should be clearly enunciated in policy and law.
 - Urban watersheds are micro ecological drainage systems, shaped by contours of terrain.
 - Detailed documentation of these must be held by agencies which are not bound by municipal jurisdictions; instead, there is a need to consider natural boundaries such as watersheds instead of governance boundaries like electoral wards for shaping a drainage plan.
 - **Water Sensitive Urban Design:** These methods take into consideration the topography, types of surfaces (permeable or impervious), natural drainage and leave very less impact on the environment.

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- Vulnerability analyses and risk assessments should form part and parcel of city master plans.
 - In a changing climate, the drainage infrastructure (especially storm water drainage) has to be built considering the new 'normals'.
 - Tools such as predictive precipitation modelling can help do that and are also able to link it with the adaptive capacity of urban land use.
- **Convergent Approach:** These can all be delivered effectively through an urban mission along the lines of the **Atal Mission for Rejuvenation and Urban Transformation (AMRUT)**, **National Heritage City Development and Augmentation Yojana (HRIDAY)** and **Smart Cities Mission**.

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- Urban Flood management will not just help control recurring floods but also respond to other fault lines, provide for water security, more green spaces, and will make the city resilient and sustainable.

Causes of Urban Floods



FACTORS CAUSING URBAN FLOODS IN INDIA


- Urban flooding occurs when storm water flows into an urban area at a higher rate than it can be absorbed into the ground or moved to water body (lake, river, etc.) or stored in a reservoir.
- The increased flow of water can be due to river floods, flash flooding, coastal flooding, or rapid snowmelt .
- Inundations tend to become more serious flood hazards by accentuated flood peaks.
- Although the factors that cause urban floods are very diverse, they generally can be seen as the cumulative result of natural and human factors


Meteorological Factors	Hydrological Factors	Human Factors
Unprecedented Rainfall	Change in course of rivers	Surface sealing due to urbanization and deforestation
Cyclones and Hurricanes	Type of soil and water retention capacity	Building design without regard to flood risk
Heavy Thunderstorms	Infiltration rate and Ground water level prior to floods	Encroachment of floodplains and lowlying areas
Global warming (Snowfall, snowmelt and sea level rise)	Synchronization of runoffs from various parts of the watershed	Lack of maintenance of infrastructure and drainage channels
Influence of Urban microclimate		

Meteorological Factors	Hydrological Factors	Human Factors
Influence of Urban microclimate	Very efficient drainage of upstream areas in comparison to downstream areas	Siltation and improper solid waste disposal in Drainage channels
	Presence / Absence of over bank flow and High tide impeding drainage	Unplanned release of water from dams / lakes located upstream of cities and towns
	Channeled storm water network. cross-sectional shape and roughness	Absence of administrative framework
	Landslides and soil erosion	Lack of preparedness

Meteorological Factors


- India being a tropical country, has very heavy rainfall throughout the monsoon season. Besides, there are other climatic factors that bring in a lot of rain.
- Global warming results in extreme weather conditions and is apparent to increase the flood risk significantly; the number of events is consistent with a warming climate.
- Even though climate change is an important factor increasing the chance of those events happening, all the extreme weather events can't be linked to climate change


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- Changing climate and increased precipitation had a huge role to play in the devastating floods that happened across central Indian states, including the 2006 and 2017 Mumbai floods. IMD's data reveal that - In the past century (1901-2015), there has been a rise in widespread extreme rainfall events across the Indian subcontinent by three-fold, especially in the states of – Chhattisgarh, Gujarat, Jharkhand, Maharashtra, Madhya Pradesh, Odisha, Telangana, Assam; and parts of Western Ghats – South Kerala, Goa, north Karnataka and Tamil Nadu.
 - The extreme rise in the number of rainfall events are directly linked with increased warming of the Arabian Sea and Bay of Bengal causing fluctuations of the monsoon winds.
 - This results in the occasional high-intensity cyclones from the Arabian Sea to the western coast and Bay of Bengal to the eastern coast, resulting in heavy rains lasting for at least 2–3 days, which when spread over a large region causes flash floods

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- Each of these components - rapid urbanization, increase in the amount of rainfall due to climate change, and outdated or insufficient stormwater infrastructure – form challenges to be addressed individually.
 - Urban flooding is a complex problem that is a result of a combination of these factors happening simultaneously.
 - Urban floods are on an increasing trend at an alarming rate and have slowly become a regular phenomenon in most of the fast-developing cities of India and especially after 2000.
 - The most damaging Urban floods amongst them in chronological order are 2000 in Hyderabad, 2001 in Ahmedabad, 2002 and 2003 in Delhi, 2004 in Chennai, 2005 in Mumbai, 2006 in Surat, 2007 in Kolkata, 2008 Jamshedpur, 2009 in Delhi and 2010 in Guwahati, Delhi, large scale floods in Uttarakhand and Kashmir 2013, Chennai deluge 2015 and Assam and Madhya Pradesh in 2016, Mumbai floods 2017

Hydrological Factors


- Flood risk arises when the surface runoff is more than the infiltration rate during precipitation. The infiltration rates depend upon the type of soil and their respective water retention capacity.
- Vegetation and trees reduce the speed of the water, the presence of a pervious surface helps in percolation and increases the infiltration rates, hence avoiding heavy damages to life and property. Rapid urbanization has a direct impact on hydrology and surface runoff. Some of which are
 - Restricting the natural change in the course of rivers
 - Deforestation and soil erosion
 - More impervious surface and decreased infiltration resulting in more runoff
 - wastewater entering rivers and lakes – causing siltation further reducing the capacity of natural drains;


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- Topography plays a major role in carrying the runoff water outside the urban areas.
 - Based on topography the urban settlements can be broadly classified into three major categories – Hill towns, Coastal towns and landlocked towns.
 - The hydrology and topography differ in each of the types of towns and thus the causative factors and duration of inundations in urban areas.
 - Riverside urban settlements and coastal towns in the delta region are more susceptible to flood hazards during monsoon.
 - Such towns may even be affected by floods happening inland on the river basin.
 - In such cases because of expanded hard surface area, the increased surface runoff increases peak flows and reduces the time to peak in the drainage channels.
 - Usually, a combination of two or more of the following factors: extreme climate-related events, unplanned development in the catchment area and under capacity natural drainage, blocked stormwater drainage system, are the major cause of the urban flooding


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- Non- perennial rivers change course when huge amounts of water flow during extreme floods beyond the carrying capacity of the river, affecting the immediate surrounding.
 - Such changes in a developed urban area can cause devastating damages to life and property.


Human factors


- Human intervention in the natural environment has increased the urban flood risk.
- These anthropogenic factors can be a direct result of Urbanization coupled with encroachments, Pollution which causes interference in the smooth flow of water in the drainage channels.
- Mining activities and tourism in water bodies can deteriorate the ecosystem. Negligence and lack of a proper governance framework have caused floods on a destructive scale.


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- (i) **Urbanisation:** Urbanization in India is directly linked with the increase in impervious surface. This reduces the speed and scale of percolation and increases surface runoff from buildings, roads, and other hard surfaces. By the very definition of urban floods – It can be stated that urbanization is directly linked with the risk of urban flooding.
 - (ii) **Encroachment:** As more people migrate towards cities in search of employment, the demand of land for housing rises which increases the economic value of the available land. People start settling on the ownerless available vacant land i.e. Low-lying areas near water bodies. Sometimes these encroachments cover up the whole catchment area and in worst-case scenarios – there will be no trace of the existence of the water body. Example: Ousteri Lake in Puducherry, Deeporbeel in Guwahati, Charkop Lake in Maharashtra, Pallavaram marshlands in Chennai. Encroachments in the upper catchment areas of a river basin (i.e. hill towns) can create excessive runoff in the river causing flash floods in the towns situated in the valleys [14].


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- (iii) Pollution: Population densities in urban centres are increasing at an alarming rate than designed for.
 - The supporting infrastructure facilities such as solid waste disposal, sewer lines, stormwater drains etc are not being developed to adapt to the increased demand.
 - This results in improper solid waste disposal into waterbodies, unattended street waste clogging drainage channels.
 - The design capacity of the STP planned at the city level easily gets overwhelmed, resulting in the release of untreated sewage into rivers and canals.
 - These result in chocking and siltation further reducing the flow capacity during a flood event


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- (iv) Illegal mining activities: Illegal mining of river sand and quartzite for use in building construction deplete the natural bed of the rivers and lakes and have an irreversible damaging impact.
 - This causes soil erosion and reduces the water retention capacity of the waterbody, increasing the speed and scale of stormwater flow and changes the natural course of water. Example: Jaisamand Lake - Jodhpur, Cauvery river – Tamil Nadu


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- (v) Interference in the drainage system: These interferences can also be in the form of the poorly planned construction of roads, bridges, railway tracks, and check dams, which hampers the flow of water resulting in a flood.
 - In Indian cities and towns, due to increased land prices and less availability of land near the city centre.
 - New developments are coming up in low-lying areas, usually as encroachments over lakes wetlands and riverbeds.
 - The width and depth of the water bodies are greatly reduced, sometimes even creating blockages to the natural flow of water.

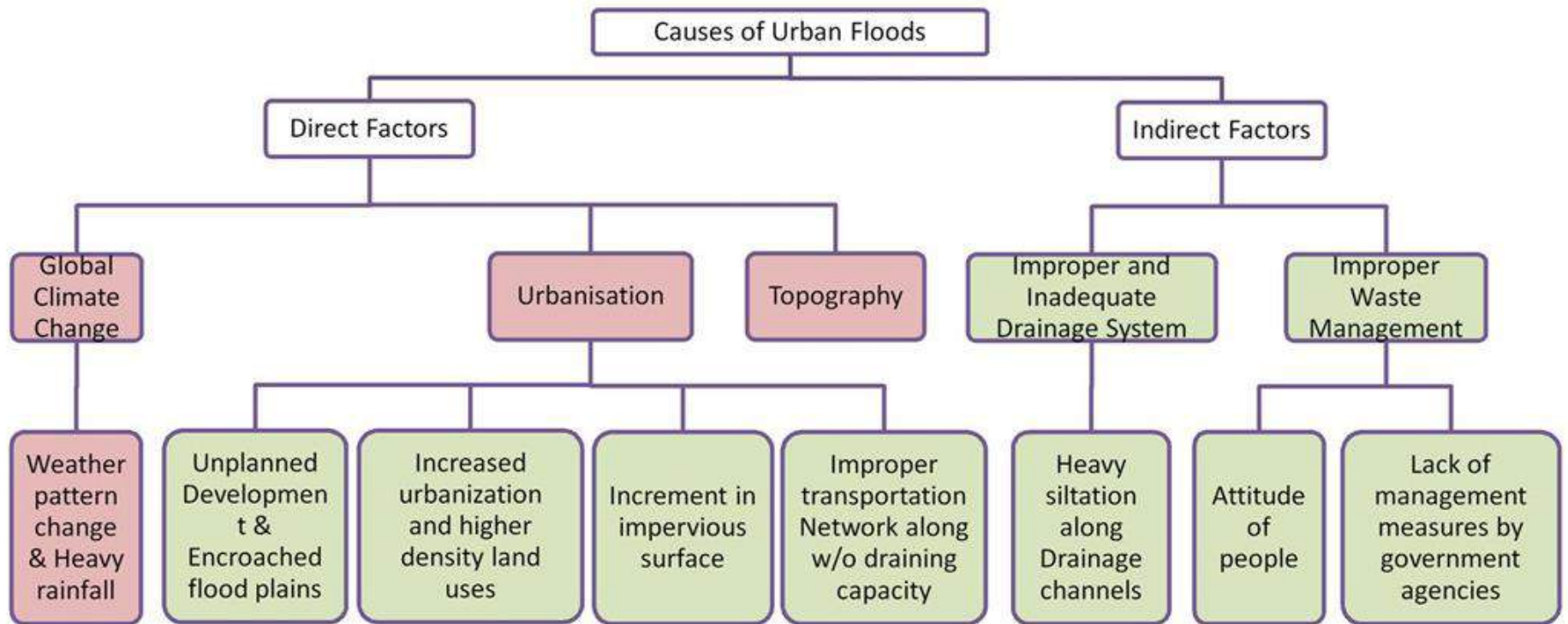
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- (vi) Unplanned tourism activities: Water bodies have been used as an attraction for tourism development for decades. Water plants and other eutrophication are being removed from rivers and lakes which are otherwise necessary for reducing the runoff speed.
 - These activities have to be monitored in such a way that there are no ill effects on the environment and the water body. Cultural or religious festivals also misuse water bodies by throwing non-bio degradable matter into the rivers and lakes, reducing the water quality.
 - In the event of floods, the suspended particles and pollutants overflow into the neighbourhood posing health risks. Example: Ashtamudi Lake in Kollam, Kerala - polluted from oil spillage from boats. Ganga Ghats in Kanpur – solid waste and oil by tourists and pilgrims

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- (vii) Unplanned release of water from dams: Unplanned and sudden release of water from dams and lakes lead to floods in an urban area, without giving the public enough time to respond. Example: Floods in Northern Bihar - Unplanned release of water from Nepal has caused; Chennai Floods 2015 – Release of water from Chembarampakam lake

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- (viii) Absence of administrative framework: Protection of water bodies was not a primary concern of urban planning; this has come into light only after the recent incidents of inundations in major cities causing huge economic losses. Instead of imposing strict laws to restrict or remove encroachments from drainage channels and wetlands, there have been cases where the local government has been given powers to regularize the development by giving them legal rights to own the land.
 - There has been very little initiative from the government to place the waterbodies as a protected environment free from pollution and encroachment.
 - The factors responsible for Urban flooding are identified and segregated into two categories: Solvable – Unsolvable through change in planning guidelines in Fig. 1 (Adapted from various sources and improved upon). Planning interventions should be aimed at mitigating the adverse effects of Urban flooding by addressing the factors which can otherwise be solved at root cause level.

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IMPACT OF FLOODS ON THE URBAN ENVIRONMENT OF INDIAN CITIES


- Urban floods have extensive effects especially as far as economic losses both direct and indirect. Flood risk is a component of exposure of the population and the economic activities alongside the vulnerability of social and economic components.
- The effect of such floods on the lives and livelihoods of individuals, a component of their vulnerability, should be comprehended. An estimate by the Central Water Commission (CWC) states that 12% of India's available land surface is prone to floods.
- Flood losses accounted up to 0.86% of the total national GDP of the country in the 70s and 80s. The present decadal share of these losses has gone down to 0.1% of the National GDP. Considering that the Indian economy has grown a lot, the losses are huge in absolute numbers.
- Hence the government agencies should take long-term concrete measures to prevent recurrent floods. The damages caused by the urban flood can be direct or indirect and can be broadly categorised as tangible and intangible losses.

A. Tangible losses The losses that can be measured physically and can be assigned an economic value. These losses can be direct or indirect

- Direct - Structural damage to buildings, property damage, damage to infrastructure
- Indirect - Economic losses, Traffic disruption, and emergency costs Flood damages the structural integrity of the buildings in an affected area, if the inundations last for a longer period.
- Buildings along the riverbed or the sloped are subjected to damage because of soil erosion weakening the basement. Small huts and temporary structures may get washed away. Croplands, shops, and industries get damaged heavily due to floods, especially warehouses. These losses are not just momentary; the increased demand for the goods after the floods coupled with low production increases the prices of such goods and commodities. Physical infrastructure facilities get damaged during a flood. Electricity and water supply

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- lines get affected which in turn hinders the communication network and media transmission gets hampered. Fire breakouts due to short circuits are common during inundations. Urban Floods results in inundation of storm water on railway tracks, roads, underground metro lines, and even runways at airports when the level of precipitation is low compared to the city's drainage capacity.
 - This causes hindrances in the traffic movement of goods, services, and people. Educational services, industries, and the service industry get heavily disrupted when transportation gets affected. Sometimes people may even get stranded for days without even access to basic amenities such as food and water.
 - If the rainfall is substantial, even air rescue operations might be impossible. The cost incurred by the government agencies and the public to rebuild after a disaster is generally very high. Some businesses may even go bankrupt. All the losses in cumulation reduce the Gross Domestic Product of the state and in turn the country. Urban floods have been attributed to be one of the costliest types of disasters to recover from.


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- Intangible losses Intangible losses include loss of life, secondary health effects, and infections or damages to the environment which are difficult to assess in monetary terms since they are not traded. • Direct - casualties, Health effects, ecological losses • Indirect – post-flood recovery process, mental damage to the people Urban floods are often associated with loss of life and physical injury either directly due to the effect of floods or indirectly due to infections by water-borne diseases spreading during the inundated period.
 - Loss of shelter and relative creates emotional turmoil in the mental health of the stranded. These damages can be long lasting psychological trauma. The ecological losses include trees and plants being washed away during an extreme flood event. Sewage and solid waste being washed into houses and neighbourhood create a huge array of issues like disease outbreak, economic losses to the households. The recovery process in case of such incidents is a tiresome process and time consuming.


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- Removal of the population in low lying regions and crumbled structures, for the most part, meets firm opposition. An interruption in the supply of necessary wares incorporating power requirements results in agitation.
 - Because of traffic interruption, disposal of wastes gets hampered and water bodies get polluted. Gathering of waste at dustbins, the stagnation of stormwater in the localities, and contamination of consumable water – leads to various health problems resulting in plagues/epidemics.
 - Mishaps because of pits kept open, covered up sewer vents under amassed inundations adds to issue.
 - The upset in traffic hinders the timely provision of medicinal help




human interventions, or a combination of these. But in the case of recurrent floods, it is a man-made disaster caused by rapid urbanization.

- The level of damage and vulnerability of an urban area is directly proportional to the density of development in that settlement. Overburdened drainage infrastructure, unregulated, and unplanned construction without regards to the hydrology, topography, and geomorphology in an urban area increases the flood risk.
- Metro cities of India have reached a saturation point in terms of both population and physical growth. The total share of population living in urban areas was 27% in 2001 and grew to 31% in 2011, and is projected to be 50% by the end of 2050.
- With no vacant land available to expand, new developments have started to shift to the low-lying areas and wetlands. Squatter settlements and slums start developing in the buffer zones of nullahs and railway lines.
- These areas are the first to get affected in case of an unforeseen amount of precipitation. Example: Yamuna pushta area, Delhi – Slum areas getting flooded every year. Chennai International Airport – Built over the flood plains of Adayar river, Mithi river basin, Mumbai – 70% occupancy by slums and pavement dwellers.


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- Urban flooding is differed significantly from flooding in rural areas. As the city gets urbanized, the risk of urban floods increases by up to 3 times.
 - Due to faster flow times, peak flows result in inundations in a matter of minutes. In the densely population residential clusters, the number of people affected is huge and heavy losses to industry and commerce in terms of infrastructure and economic value.
 - The losses can be reduced by measures like providing alternative storm water drainage path, maintaining existing channels, reducing impervious surface to allow better rainwater infiltration, keeping the drainage systems free of pollutants and solid waste, etc.

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- The Center for Science and Environment's report on the state of urban water bodies of Indian cities, outline the fact that urban water bodies have been exploited for the past two decades. This is a result of urbanization without monitoring in India.
 - Major threats to the surface area of water bodies by the rapid urbanization are “urban sprawl, encroachment upon water bodies, unplanned tourism activities, solid waste and sewage disposal, the decline of groundwater and soil moisture leading to the low water level on the lakes and the lack of proper maintenance and monitoring.
 - Analyzing the Table I, it can be observed in general that the number of Urban flood events is more in the coastal and delta settlements compared to that of the landlocked towns, even when the percent loss of spread area of water bodies is more.
 - This can be attributed to the topography of the settlements and their height from mean sea level. In the case of delta towns, during monsoon storm water from the whole mainland gets drained into the rivers which when flooded, both tangible and intangible losses are multiplied.

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- **V. LACUNAS IN EXISTING PLANNING LEGISLATION RELATED TO URBAN FLOODING** As a part of its responsibilities, an effort has been made by National Disaster Management Authority (NDMA) in preparing the National Guidelines on Management of Urban Flooding. Proper attention was not given to prepare and plan guidelines to deal with urban flooding, even though it is recurrent over the past few decades in India.
 - The past strategies on flood risk management were mainly focused on riverine floods which affect rural areas to a great extent. The eye-opening event for NDMA was the floods in the month of July 2005 in Mumbai.
 - The causes inundations were unique and so are the interventions required to deal with them, The problem and the scale of urban flooding were finally addressed by NDMA, considering it a separate disaster


WAY FORWARD FOR MITIGATING URBAN FLOOD IN INDIAN CITIES

- After intense rainfall when the city floods, the major hit areas include difficulty in the transportation of goods and services, breakdown in the public service sector, schools closing, etc.,
- These factors bring life in the city to a standstill. Understanding who gets hit worse and how will provide a better way towards a flood resilient future.
- Floods in Urban India are a result of both natural and manmade factors. Hence comprehensive urban planning which reconciles both environment and economic needs is required.
- Mitigation and rehabilitation measures should be the main focal area in solving the problem of recurrent floods.




Maintaining a record of all the water bodies and wetlands at city and village levels.


- Catchment areas of Rivers, lakes and other water channels have to be brought under protected areas and included in city development rules.
- Planning guidelines with sufficient weightage to topography, drainage, rainfall, lithology with improved storm water disposal system.
- In the case of newer developments, urban water problems should be studied in union with all the planned and unplanned change in land-use, and application of planning strategies.
- Flood vulnerability mapping should be the primary step involved in risk reduction. Identification of the vulnerable areas can be done by analysing topography and historical data of inundations – extent and duration.





The flood pattern at least for the past five years has to be studied using hydraulic and hydrological models. The results can be used to guide strategic planning.


- **Watershed management:** De-silting, timely cleaning and deepening of drainage channels have to be taken up along the whole river basin instead of just the urban areas. Catchment areas of water bodies need to be maintained well and should be free from encroachment and pollution, thus keeping the course of water free from obstructions.
- **Construction of Flood walls, raised platforms** along flood prone river basin and coastal areas. For mitigating floods town protection works must be implemented with proper monitoring.
- **Public facilities** like hospitals and schools should be relocated from such areas. Critical emergency and livelihood services such as food, water, health and sanitation should be made disaster resilient. They should be located such that they are able to function without hindrance during inundations.


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- The damage in a vulnerable area is directly proportional to the density of development and population. Encroachments should be relocated to sites where the flood risk is low.
 - No development zones should be marked out in the flood prone lowlying areas. Such areas should be the primary concern for response during a monsoon.
 - Strict control on the land use will reduce the tangible and intangible losses, especially in hill towns, coastal towns and flood plain areas.
 - Protecting the existing green cover, Reforestation, and removal of debris from catchment areas could help prevent soil erosion, which might further damage the resources of an urban settlement.
 - The amount of runoff can be reduced by reducing the area of hard surfaces and providing more green cover, conservation of water bodies and rainwater harvesting from built spaces. Measures such as rain gardens, green roofs, bio-retention swales, artificial ponds and underground storage sumps can also enhance percolation and reduce runoff. Current guidelines have to be revised to drain runoff from up to 1:30 year per day rainfall, as opposed to the existing 1:10.


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- Floods can be diverted through measures like construction of embankments, levees and dams etc. • River-front water development plans help the primary and secondary stakeholders manage flood control plans more efficiently and create awareness about the benefits of maintaining a water resource. • Awareness to be created about flood preparedness and mitigation measures along with response drills. People participation from all economic classes in the decision-making processes for flood reduction policies should happen with experts on a regular basis.


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- Spatial planning and construction in urban areas need to be sensitive to disaster risks and ensure safer constructions.
 - This presupposes strict disaster sensitive urban planning initiatives that incorporate risk reduction and disaster safety.
 - A good way to begin would be to critically assess the risks to a locality and then plan for quick response facilities and further risk reduction.
 - For individual buildings too, strict adherence to building bye-laws and structural safety features on the basis of risk assessment is required.
 - The Hyogo Framework for Action recognizes unplanned urbanization as a key factor in increasing global vulnerability and disaster losses.
 - The Global Platform on Disaster Risk Reduction held in June 2009 in Geneva has also committed that “By 2015, all major cities in disaster prone areas to include and enforce DRR measures in their building and land use codes.”


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- The Indian scenario of cities and buildings reflect lack of disaster risk reduction concerns in the planning and construction process.
 - The biggest challenge is to make all structures, residential, social or economic safe from disaster risks.
 - The Bhuj Earthquake of 2001 was an eye opener for the failure of buildings due to faulty construction practices. Inadequate spatial planning should take into account a disaster scenario, in terms of rescue, evacuation and reconstruction.


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- Layout of roads, parking areas and other amenities need to be planned according to the risk conditions of the area.
 - No development should be allowed that aggravates the risk of the area.
 - The planning process should have a bottom-up approach wherein neighbourhood and ward level plans collate to form a comprehensive city plan.
 - Community involvement is an important aspect of the city planning process, to be completed alongside systematic capacity building processes of the stakeholders.
 - A framework of local level city planning, as developed by UNDP

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- The largely unplanned expansion of cities to accommodate rapid population growth, combined with inappropriate land-use planning and the failure of urban authorities to regulate building standards, contribute to the vulnerability of urban populations.
 - In addition, inadequate living conditions of poor populations – including poor health, inadequate nutrition, poverty, illiteracy, and deficient or non-existent sanitation – constitute a permanent threat to their physical and psychological security and create “everyday risks” which cause small-scale disasters on an ongoing basis.
 - Disaster risks from extreme natural hazards are compounded by these everyday risks, resulting in a process of “risk accumulation” specific to urban areas, where risk is amplified by human activities.
 - Urbanization, therefore, often increases the exposure of people and economic assets to hazards and creates new patterns of risk, making the management of disasters in urban areas particularly complex.

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- Nevertheless, urban areas can also provide opportunities for reducing risks.
 - Cities are usually the economic drivers within their countries and the centers of intellectual, political, business and financial activities.
 - If managed well, cities have huge potential for influencing improvements in risk management.
 - These advances are achievable through economies of scale and the proximity of risk-reducing infrastructure and services, such as provision for sanitation, drainage, waste collection, health care and emergency services, and through the use of the high-level technical expertise and knowledge that cities often contain.
 - Urban centers typically have people with comparatively higher levels of education in better informed communities and powerful economic and political interest groups controlling economic resources - all of which are potential amplifiers of DRR efforts.

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- Urban areas have been expanded exponentially in recent areas.
 - Along with this, few towns are being developed as suburban regions, but not as fast as urban areas. It is expected that about 68% of the world population will be living in cities by 2050 (United Nations Department of Economic and Social Affairs, 2018).
 - These urban areas will face the immense risk of disasters due to the population and available resources.
 - The Impact of a disaster is the loss of our resources, livelihood, and existing infrastructure which will have to be controlled with the help of disaster risk management techniques.

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- In recent times, the disasters were considered to be unforeseen stress, and measures like relief camps, and financial assistance for living and resettlement were taken to mitigate them.
 - **Several governmental authorities have started developing an action plan for disaster risk reduction to reduce the risk of injuries, casualties, and loss of wealth when a hazard or disaster occurs.**
 - During such hazards, urban areas become vulnerable to devastation since large concentrations of people are managed with limited emergency services and low capacities.

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- As we cannot prevent the occurrence of natural hazards, they are escalated further by human interventions and unplanned development- creating more risks while managing the hazards and disasters.
 - We can check and act on certain anthropogenic activities that increase the frequency of hazards to reduce their impact on population and wealth.
 - **Several international organizations recommended Disaster Risk Management (DRM) and Disaster Risk Reduction (DRR) to focus on urban planning and on sustainable development to resist and reduce the risks with the help of strong infrastructure and funding systems and by understanding the vulnerabilities, potential causes, and effects, economic and social impacts, mitigation plans, preparedness and response.**



Thank You