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# Strategies for Flood Mitigation

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***Abstract***

*The world has always experienced change. Water-too much or too little is the most common cause of migration and a city's downfall. The notable and significant distinction right now is that we are seeing it in real-time for the first time in human history. We contributed to the dangers that were produced, and we contributed to the remedies that will influence the pace and scope of change and disruption. One could argue that we haven't really learned much from recent history. We haven't left the floodplains; instead, we've expanded inside of them, destroying any natural features that may have shielded us from natural disasters. We are located near earthquake faults, storm, and tsunami pathways. The ecological advantages of the coastal zone ecologies, which support all life, have not been respected. Opportunities to direct growth and development have been turned down. Instead, we create default land-use patterns that are frequently immoral and ineffective. All of these actions have a negative impact on the environment, the economy, and our families. We have dumped our rubbish into the very water reservoirs that supply our kids' drinking water. But this time, we are more knowledgeable and capable. We have improved at grasping the larger picture. We have advanced technological skills in mapping and data resource analysis, and in some circumstances, real-time satellite weather monitoring, enabling preparation for some (but not all) extreme weather occurrences. We are intrigued by the special ability of the creative spirit. The threat of flooding is no longer specific to any one area, nation, or region but has spread worldwide. Floods now happen more frequently than ever before, which affects any location's socioeconomic structure. The frequency and severity of floods have increased to the point where they can occasionally become catastrophic and out of control. In the absence of such technology, a variety of tools, techniques, and data that can play a crucial role in forecasting, controlling, and mitigating various natural threats, such as floods, earthquakes, and so on, were either impossible to gather or were extremely difficult and time-consuming to do so. It is time to recognize, comprehend, and respect natural drainage systems, and entire ecosystems, with the least amount of human intervention, and to learn how to adapt to floods and other inevitable natural events. Resilience is the primary design strategy that can support all the planning processes that can establish a symbiotic relationship with various natural processes and phenomena because we also realize that all the different types of events, such as climate change, earthquakes, tidal waves, or even flooding, are natural events and their occurrences are part of the evolution of the current earth's landscape.*

**Keywords:** Food plains, ecosystem, deforestation, coastal floating, water resource.

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## INTRODUCTION

This study aims to comprehend "why to" and have a complete understanding of "how to" create with this important resource. It starts off with a crystal-clear illustration of water as a network of interconnected systems that includes the atmosphere, the oceans, and the land. Today, we require a design strategy that is flood-resistant to turn the threat into an opportunity.

 

It is now commonly acknowledged that in densely urbanized floodplains, a paradigm shift is required from flood control to flood adaptation [1]. Urban and landscape designers have created design solutions that are able to boost urban ecological resilience by assigning space to fluctuating water levels in order to solve riverine and flash flooding in urban settings. This study investigates how engineered flood resilience might be operationalized. These systems could be made up of robust green infrastructure systems, including those for transportation networks, that cleanse and absorb flood water, allowing communities to effectively live with more water. Parks and open spaces that let water flow through safely or store excess water for later use. Preserved and strengthened ecosystems that serve as natural channels and buffers.

Maintaining ecosystems for flood control also entails maintaining their biodiversity and the other ecosystem services they offer, such as clean air and water. Parks that transport or hold water during floods provide recreational areas that improve public health. Green infrastructure cleans and cools the air, improves the quality of the water, and replenishes water tables in addition to absorbing water.

The most frequent natural disaster in the world is flooding. More than 32.4 million people have been displaced by flooding and other natural disasters, and since 1995, flooding has killed 1,57,000 people worldwide. Human settlement flooding has always been a problem [2], but risk factors like climate change, the placement, and growth of cities, as well as their reliance on impermeable surfaces, mean floods are affecting more people and causing more damage to life and property.

Deforestation, excessive development, the encroachment of flood plains, disruption of natural drainage patterns, and many other factors have changed the general characteristics of a place over the past ten years as a result of altered environmental and climatic conditions brought on by extensive human activity due to urbanization. These factors have sparked an increase in flooding events as well as many other catastrophes like earthquakes, tsunamis, climate change, and more. Ozone layer depletion and so on. Change in land-use, which is in fact the outcome of overpopulation is another major reason for impounding flooding situation.

Floods are one of nature’s most catastrophic disasters, wreaking havoc on human settlements, the built environment, and the natural world. Worldwide economic losses as a result of destructive floods have dramatically increased. Flood disasters of large scale and short frequency are common around the world, and while the number of flood-related fatalities has reduced, the number of impacted populations and financial losses have greatly increased. When a patch of land, typically one that is low-lying, gets submerged in water, a flood occurs.

These developments highlight the necessity of paying closer attention to how flood dangers affect human development (Asian Disaster Preparedness Center's Activity Report for 2005-2010).

## TYPES OF FLOOD

### River Floating

Riverbank flooding is a normal occurrence. Seasonal rains and snowmelt that fill river basins too quickly with too much water might cause this when they fall in the winter or spring. River flooding can also be caused by torrential rainfall from tropical systems or storms that are losing strength.

### Coastal Floating

Ocean water can be driven onshore and result in substantial flooding when winds from tropical storms, hurricanes, or powerful offshore low-pressure systems are present. High water might cut off and restrict escape routes [3]. Tsunamis (tsoon-m z), also known as tidal waves, are ocean waves that can cause coastal inundation. Oceanic volcanic activity or earthquakes are the sources of these waves.

 

### A City Floods

Urban areas are found to have impermeable paving on 70% of their surface area. Even a grass is regarded as an impenetrable finishing treatment since constant movement compacts the dirt beneath it. As a result, it is unable to absorb rain. Runoff is increased by 2 to 6 times in urban areas compared with natural terrain. Even a light downpour can cause flooding, turning the streets into fast-moving rivers and overflowing the drainage systems, while flooded basements can become lethal traps.

### Quick Flood

A flash flood is a flood that rises and recedes [4] quickly with little to no notice. Flash floods typically happen when there has been a lot of rain in a short amount of time and space.

## EFFECTS OF FLOOD

### Local Effects

- *Casualties:* Drowning claims the lives of people and animals. Diseases and outbreaks may potentially result from it.
- *Physical damage:* Flood water damages several types of structures, including buildings, sewage lines, transit systems, and communication networks.
- The city's drainage systems fall short of expectations.
- Overflowing drains transporting contaminated wastewater, which is a major contributor to numerous illnesses connected to water.
- *Crops and food supply:* Loss of the entire harvest can result in a shortage of food crops.

### National Effects

- One of the main consequences of severe [5–7] flooding is soil erosion.
- Sedimentation issues, such as the 6 meter sediment deposit caused by the flood in the Cuttack region in 2001.
- The affected areas are cut off from the rest of the nation. Every river is rising quickly. Another result is that there is not enough food or medicine to handle the issue.
- Several hutments, granaries, fisheries, and standing crops are also harmed by the floodwaters.
- Floodwaters may potentially engulf several roadways and humanitarian camps.
- During floods, landslides are frequently followed by nonstop rain.

Floods are capable of rolling boulders, uprooting trees, destroying structures including homes and bridges, and scouring out new channels. Flood floods frequently contain a dangerous freight of debris and can rise to heights of 10 to 20 feet.

### What Factors Cause Floods?

What Elements Lead to Floods?

- Flooding happens in recognized floodplains when a river or stream overflows due to lengthy or strong precipitation over a short period of time, ice or debris jams, or protracted or intense rainfall over several days.
- Tropical cyclones can bring intense rainfall to the coastal and inland states in the summer and fall. Floods happen after a dam or levee failure, or following a sudden release of water held by a reservoir, and can catch people off guard. Melting snow can combine with rain in early spring. Severe thunderstorms can bring heavy rain in the spring and summer. We never receive any advance notice of these catastrophic, unexpected floods.
- Land loses its capacity to absorb rain as it is changed from fields or trees to roads and parking lots. Runoff is increased by two to six times in urban areas compared to natural terrain. Streets can turn into fast-moving rivers during times of urban floods, and as basements and viaducts fill with water, they can become deadly death traps.

 

- *Estuarine floods:* Estuaries are the only parts of the coastline where a concentrated river's seaward flow of fresh water meets the regular tidal currents. During high tides, the interaction of freshwater flowing seaward in a river and saltwater flowing landward from the sea may cause opposing land water flow and result in the formation of a "wall" of water.

**Water Conservation in Ancient Era**

In order to reduce India's water shortage, water conservation is a crucial method. The Indian government has begun looking at ways to receive the traditional systems of water harvesting in the nation because these systems are straightforward, environmentally friendly, extremely successful, and excellent for the environment. However, rainfall patterns in India are changing practically every year. According to history, ancient India experienced both floods and droughts on a regular basis. As a result, each area of the nation has a unique traditional water harvesting technique that is a reflection of its terrain and culture. The practice of water conservation has a long history in Indian science, according to archaeological evidence. Indus Valley excavations reveal a superb water harvesting and drainage system.

The settlement of Dholavira laid out on a slope between two stormwater channels is a great example of water engineering. Drawing upon centuries, Indians build structures to catch, hold and store monsoon rainwater for dry seasons.

Today, there is a need to study some traditional water harvesting techniques. Here is a brief account of some of the unique water conservation systems prevalent in India.

- *Kerala:* Surangam
- *Tamil Nadu:* Eri, Ooranis
- *Karnataka:* Madakas, Neeruganti
- *Andhra Pradesh:* Cheruvu
- *Maharashtra:* BhandaraPhad irrigation, Ramtek
- *Madhya Pradesh and Orissa:* Katas, Mundas, Bandhas
- *Gujrat:* Virdas
- *Rajasthan:* Naada/Bandha, Johads,Talabs, Tankas/Tanks, Stepwells, or Baoli
- *Uttarakhand:* Naula, Gul, Dhara, Simar, Khel
- *Himachal Pradesh:* Kul, Khatri
- *Jammu and Kashmir, Ladakah:* Zing
- *Uttar Pradesh:* Kunds
- *Bihar:* Ahar, Pynes
- *Bengal's:* Inundation channel
- *Meghalaya:* Bamboo Drip irrigation
- *Arunachal Pradesh:* Apatan
- *Assam:* Dongs, Garh and Dam
- *Nagaland:* Zabo

A great example of water engineering is the town of Dholavira, which was built on a slope between two stormwater channels. Indians have built structures for ages to collect, hold, and store monsoon rainwater during dry seasons. There is a need today to research various old-fashioned water collection methods. Here is a short description of a few of the unusual water conservation methods used in India.

Securing the water supplies is [7, 8] now vitally crucial for us. To meet the demand for water, we must revive the conventional water management system. To solve the difficulties of current agricultural and drinking water supplies, we must study old knowledge and apply it to our contemporary civilization in order to end the condition of water stress. These dependable and affordable conventional water collecting devices are safe for the environment alternatives to replenishing India's dwindling water supplies. The solution to India's ongoing water needs will be to combine historical structures with contemporary rainwater conservation methods, such as percolation tanks, injection of wells, and surface barriers.

Several other factors contribute to flooding. Two key elements are as follows:

1. Rainfall intensity (the rate of rainfall) and
2. Duration (how long the rain lasts)

Topography, soil conditions, and ground cover also play important roles. Most flooding is caused by slow-moving thunderstorms, thunderstorms repeatedly moving over the same area, or heavy rains from hurricanes and tropical storms. Floods, on the other hand, can be slow- or fast rising, but generally develop over a period of hours or days.

## ROLE OF VARIOUS ELEMENTS WHEN MODIFIED

Native vegetation is frequently replaced by non-native species during land development since they are less effective at absorbing rainwater and may need additional irrigation.

- One of the most harmful forms of vegetation replacement in terms of water resources and flooding is lawn replacement.
- Turf grass only offers a limited amount of interception because of its short, uniform, vertical nature. The regular mowing required by turf grass compacts surface soils, compressing and eradicating the macropores and micropores that allow water to move into the soil. The root system of turf grass is shallow, typically not more than 2.5 inches (6 cm) deep. The roots have little chance to introduce water into the soil. Rainfall quickly turns into a runoff.
- The biological community of the soil is altered by the monoculture of lawns, which results in much fewer soil fauna and decreased soil porosity. The use of pesticides and an imbalance in soil nutrients frequently make the loss of the biological community worse.
- Under forested or meadow conditions, the surface temperature of the lawn is significantly higher than those conditions. The soil surface quickly dries up and hardens as a result, losing some of its ability to absorb moisture following precipitation. Increased surface temperatures affect the biological community and raise the temperature of runoff.

Urban trees frequently have less capacity to absorb water and lessen flooding than forested systems do. Urban trees only live for about 32 years on average. planted trees. Trees planted in parking lots average only 12 years. Urban trees rarely reach full maturity or succeed in developing an extensive canopy for rainfall interception.

### Surfaces Interception

Roads, driveways, sidewalks, building roofs, plazas, and patios are examples of impervious surfaces since they do not absorb water. The result is runoff. The water balance and flooding are significantly affected by the impervious surfaces that development creates.

### Several Factors

- Almost every rainfall event produces runoff, which raises the total amount of water that is released as runoff. Small storms that wouldn't result in any runoff in a natural setting will be translated almost immediately into all the way into the runoff. The amount of runoff produced and released downstream will rise during heavy precipitation occurrences.
- Almost immediately after the rain starts falling, runoff starts. There is hardly any time in between the start of rainfall and the start of runoff.

 

Impermeable regions are directly associated with locations where runoff is piped into a storm sewer. Compaction and soil modification, Healthy soil acts as the planet's filter, replenishing and protecting the quality of its water supplies. Natural soils have the capacity to absorb water right where it hits them. Due to interference by others.

Compaction and vegetation removal make soils lose their ability. Flooding increases in tandem with both the volume and pace of rainwater runoff. Soils are disturbed and compacted as a result of construction and maintenance techniques. Any area undergoing construction, including areas where lawns will be restored, has topsoil removed.

Even in situations when soils are removed [9–11], disturbed, compacted, rebuilt, or replanted as lawns, typical stormwater calculations do not take changes in the soil reaction to precipitation into consideration. A lawn is frequently thought of as a natural setting or a green area. Lawns and other forms of vegetation are rarely distinguished significantly in engineering calculations of runoff, which frequently use the same engineering coefficient values for lawn as would be applied for meadow or pasture. Playgrounds and lawns that receive a lot of maintenance are almost as dense and impenetrable as concrete.

**Loss of Groundwater Recharge**

The loss of shallow interflow significantly impacts the vegetation. Impacts on the landscape may take years to become noticeable, therefore, they are rarely related to modifications in land use. Groundwater levels normally decrease as more water is extracted, first through efficient extraction, and then as recharge flows are reduced or stopped.

A decrease in stream base flow causes an increase in flood flows in the opposite direction. The microbial population of a stream can be changed by even slight variations in the average stream temperature. The entire system’s food chain is built on the foundation of the microbial community.

## ALTERED STREAM SYSTEMS AND INCREASED FLOOD DAMAGE

In a natural setting, vegetation provides stormwater with a “tortuous” course to follow that slows and stores water along the way. This is true both at the big and local scales (stream meanders and floodplains). Extreme event’s downstream flood effects are mitigated in a complex system that starts with headwater streams.

## VARIOUS RESILIENCE DESIGN CONSIDERATIONS: RAINFALL CONSIDERATIONS FOR RESILIENT DESIGN FOR FLOODING

Utilizing current rainfall patterns and amounts [12–15], the resilient design must assess and accommodate rainfall volume (Table 1). A design objective is to capture all or most of the little storms, as well as the initial flow from heavy rainfall. This mimics how a natural system might react to rainfall by drastically reducing the amount of water discharged downstream. The most efficient method for reducing flooding, whether it is used at the site or at the planning level, is to preserve, restore, or mimic how a natural system would react to small, frequent rainfall events.

No of the location, the majority of rainfall events produce less than 0.5 inches of precipitation. These insignificant occurrences barely cause any runoff in a natural setting.

- In general, more than 90% of precipitation events produce less than 1.5 inches of precipitation, which again results in minimal runoff in a natural environment.
- In a natural setting, the “capture” of the lighter rains also helps to lessen the overall volume of water that is lost as runoff during heavier and more frequent downpours. For extreme events to inflict less damage, rainfall volume must be captured.

 

**Table 1.** Recommended flood-resistant tree species in flood-prone areas are as below:

| Trees (botanical name) | Common name |
|---|---|
| Acacia nilotica | Babool |
| Terminalia arjuna | Arjun |
| Ficus recimosus | Goolar |
| Garcinia gummi-gutta Alastonia scholaris Syzygium cumini | *Cambodge Tree, Malabar-tamarind, Bilatti-amli Scholar's tree, Devils tre, Blackboard tree Jamun* |
| Mangifera indica | Aam |
| Murraya paniculata | Kamini |
| Glochidion sp. | *Umbrella Cheese Tree* |
| Caryota urens | *Fishtail Palm* |
| Phoenix dactylifera | Khajoor |
| Ficus carica | Anjeer |
| Albizia procera | *Siris* |
| Zizyphus jujube Casuarina cunninghamiana Casuarina equisetifolia Salix babylonica Taxodium distichum Morus alba | *Ber* River oak Whistling Pine, Junglisaru Water willow Swamp cypress Mulberry |
| Artocarpus heterophyllus Artocarpus lacucha Averrhoa carambola Ceiba pentandra Tectona grandis Bambusa sp. | Jackfruit Monkey jack Crambola Kapok tree Sagwan Tree or Teak Tree Bamboo |
| Ziziphus mauritiana | Ber Tree |

- The amount of rain that falls could also cause harm. However, the local effects of a sudden surge of water will be less harmful if rain is captured during periods of intense rainfall.

## VEGETATION ROLES FOR RESILIENT DESIGN FOR FLOODING

The vegetation serves to:

- Intercept rainfall that would otherwise directly hit leaves and stems, returning up to 50% of the annual rainfall volume back to the atmosphere.
- Limit the amount of rain that reaches the soil; this will lessen soil erosion.
- Construct an underlayment of materials that enhances water absorption and safeguards soils.
- Transport water to the soils along stems and trunks.
- During periods of surface saturation, transport water into deeper soils.
- By adding organic material, you can make soils that are more absorbent.
- Increase soil porosity by forming tiny water-conducting tunnels (macropores) in the soil.
- Encourage a thriving microbial ecosystem, which boosts organic matter and porosity.
- During photosynthesis, draw water from the soil to release it into the atmosphere (through transpiration).

## STREAM SYSTEMS, WETLANDS, RIPARIAN ZONES, AND FLOODPLAINS FOR RESILIENT DESIGN

The streams [16–18], wetlands, riparian zones, and floodplains that make up the watershed system work together to:

- Provide storage that helps moderate downstream flooding.
- Moderately reduce downstream floods by reducing flow velocity.
- Enhance water quality by nutrient and sediment capture.
- The biological activity that takes place in the sediment of bed bottoms and in the riparian zone will improve the water quality.
- Encourage infiltration to cut down on runoff quantities. Water that moves more slowly has a higher chance of penetrating the banks and bed.
- Improved ecological health and increased biodiversity.

 

## CONCLUSION

1. We must be responsible and cautious when it comes to climate change. It is imperative that we act responsibly and collectively to address the causes of climate change, such as deforestation and petrol emissions.
2. The haphazard construction of low-lying or floodplain areas should be completely prohibited and controlled. Additionally, construction work close to natural drainage channels should be prohibited because it can impede or block those channels, which can result in flooding.
3. Ponds and lakes should be restored in addition to being constructed, as they serve as natural reservoirs and lessen the effects of flooding. They also assist in recharging the groundwater table, restoring the environment, and ultimately assisting in the reduction of drought-like conditions.
4. Softscape material should be preferred over hardscape wherever possible since it not only allows rainwater to seep into the earth but also lessens the stress on the stormwater system by slowing the quantum and lowering the flow velocity. Additionally, soft landscaping aids in reducing the heat island effect, which is one of the primary causes of climate change.
5. In a manner similar to point No. 4, we should promote and implement the use of pre-existing materials as opposed to impenetrable materials.
6. Given that deforestation is the main cause of climate change, afforestation is one of the major tasks that need to be handled as soon as possible. Deforestation also worsens the ecology as a whole because it causes soil erosion, which may be brought on by wind, rain, or other factors.
7. Another thing to remember is to plant more native plants than alien ones. Native species are non-invasive and easily establish in their particular zones, helping to resuscitate and recreate the environment that was common in that zone.
8. There should be good connectivity between and among all-natural water catchment regions, including lakes and ponds. Interconnecting. The benefits of this include lessening the immediate strain on municipal drainage systems, preventing the buildup of silt in drainage channels, recharging aquifers, and more.
9. Lakes and ponds also serve as temporary water reservoirs during dry spells, as has long been seen and demonstrated. There were other methods used, including the Rajasthani tanka system, Step wells in Gujarat and Rajasthan, and countless more regional vernacular systems all over India and the rest of the world.

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