MUKESH PATEL SCHOOL OF TECHNOLOGY MANAGEMENT AND ENGINEERING

(Affiliated to NMIMS Deemed to be University, Mumbai)

ENVIRONMENTAL SCIENCE

Project Report

on

BIODIVERSITY DAMAGE DUE TO FLOODS

Submitted by:

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1. INTRODUCTION

Biodiversity, short for biological diversity, refers to the variety of life forms, including different species of plants, animals, microorganisms, and the genetic differences within these species. Biodiversity is crucial for the health and stability of ecosystems and has significant ecological importance for several reasons:

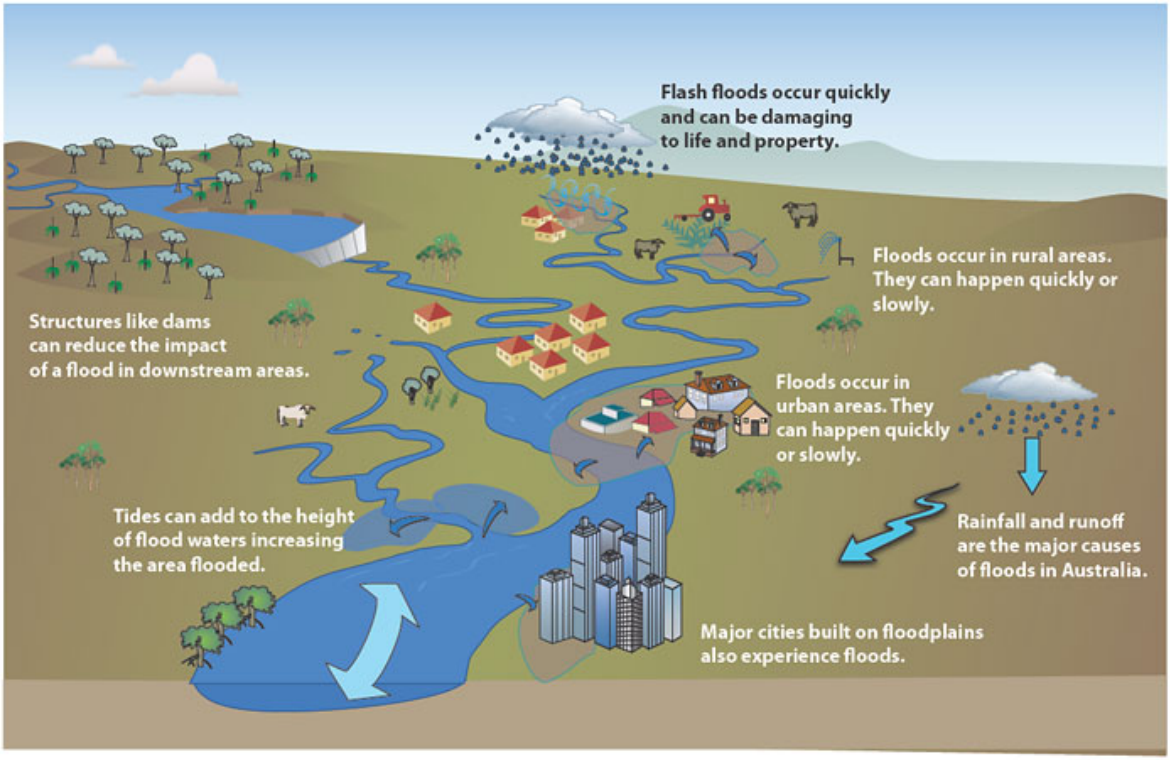
1. Ecosystem Stability: Biodiversity contributes to the stability and resilience of ecosystems. Diverse ecosystems are better equipped to withstand and recover from environmental disturbances like climate change, diseases, or natural disasters. When one species is negatively affected, others can often compensate.
2. Nutrient Cycling: Various species play specific roles in nutrient cycling within ecosystems. For example, decomposers break down organic matter, returning essential nutrients to the soil. Without this biodiversity, nutrient cycles may be disrupted.
3. Pollination: Many plant species rely on animals like bees, butterflies, and birds for pollination. This ecosystem service is vital for the production of fruits, vegetables, and nuts. Reduced biodiversity can disrupt pollination, affecting food production.
4. Biological Control: Predators, parasites, and herbivores help control populations of pests. Maintaining a variety of these natural enemies can reduce the need for chemical pesticides in agriculture.
5. Resistance to Invasive Species: A diverse ecosystem can often resist invasion by non-native species. When biodiversity is reduced, invasive species may have a greater opportunity to establish themselves and can outcompete native species.

The purpose of this report is to explore the detrimental effects of floods on biodiversity so as to provide a comprehensive understanding of how floods can impact various forms of life within ecosystems.

2. FLOODS & THEIR CAUSES

The increasing frequency and severity of floods globally can be attributed to a combination of natural and human-induced factors. Here are some key reasons behind this trend:

1. Climate Change: Climate change is a major driver of increased flooding. Rising global temperatures lead to the melting of glaciers and polar ice caps, causing sea levels to rise. Warmer air also holds more moisture, leading to more intense and prolonged rainfall events. These factors contribute to higher risks of both coastal and inland flooding.
2. Extreme Weather Events: Climate change is associated with an increase in the frequency and intensity of extreme weather events, such as hurricanes, typhoons, and intense rainfall. These events can result in severe flooding when they make landfall or affect a region.
3. Deforestation: The removal of forests and vegetation for agriculture, urban development, and other purposes reduces the land's ability to absorb and slow down rainfall. This can lead to faster runoff and increased flooding
4. Urbanization: Rapid urbanization often leads to the construction of impermeable surfaces like roads and buildings, which can increase surface runoff during heavy rainfall. Inadequate urban planning and drainage systems can exacerbate flood risks in cities.
5. River Management: Alterations to rivers and waterways, such as dams and levees, can change the natural flow of water. Poorly managed or maintained infrastructure can sometimes fail, resulting in destructive floods.
6. Land Use Changes: Changes in land use, such as agricultural practices and the draining of wetlands, can alter natural drainage patterns and increase the risk of flooding.



3. DIRECT & INDIRECT EFFECTS

Floods can have both immediate and long-term impacts on biodiversity, including habitat destruction, population decline, and changes in species distribution. Here's an overview of these effects:

a. Habitat Destruction:

Immediate Impact: Floodwaters can directly destroy or disrupt habitats, especially in low-lying areas. Terrestrial habitats, such as forests and grasslands, and aquatic habitats, like wetlands and riverbanks, can be submerged or eroded during a flood. This immediate impact can lead to the displacement or death of many species.

Long-Term Impact: The long-term effects of habitat destruction are profound. Species that rely on these habitats may face challenges in finding suitable places to live and reproduce. Habitat loss can lead to reduced breeding success, increased competition, and sometimes even extirpation (local extinction).

Figure: Philippines – 30,000 Displaced After Low-Pressure Area Causes FloodsS

b. Population Decline:

Immediate Impact: Floods can lead to a sudden reduction in the population of many species. This may happen through direct mortality during the flood event, particularly for species with limited mobility or those unable to escape fast-rising waters.

Long-Term Impact: Even if populations don't face immediate extinction, they may experience long-term declines due to the loss of individuals, especially when key reproductive or foraging areas are affected. Reduced population sizes can make species more vulnerable to other threats and challenges.

c. Changes in Species Distribution:

Immediate Impact: During a flood, species may be forced to move to higher ground or migrate to escape rising water levels. This can result in short-term shifts in species distribution and can sometimes lead to unusual encounters, such as terrestrial species being found in unexpected places.

Long-Term Impact: Changes in species distribution can persist well beyond the flood event. Species may adapt to new habitats, leading to shifts in their ranges. In some cases, invasive species may take advantage of the disturbance, further altering the composition of ecosystems.

d. Altered Ecosystem Dynamics:

Immediate Impact: Floods can disrupt the intricate ecological interactions within an ecosystem. Predators and prey, as well as plant-pollinator relationships, can be affected. These disruptions can lead to immediate ecological imbalances.

Long-Term Impact: Altered ecosystem dynamics may persist as populations of species change and adapt. Long-term shifts in species composition can lead to novel interactions and sometimes to the loss of key ecosystem functions, such as pollination or nutrient cycling.

Secondary effects of floods on biodiversity are often interconnected and can significantly impact ecosystems and the species within them. These effects include soil erosion, water contamination, and disruption of ecological processes:

a. Soil Erosion:

Immediate Impact: Floodwaters can erode soil from riverbanks, floodplains, and upland areas, leading to immediate loss of fertile topsoil. This erosion can cause habitat degradation and affect the plants and animals that rely on stable soil conditions.

Long-Term Impact: Soil erosion can have long-lasting consequences. It reduces the capacity of land to support vegetation, affecting the habitat for various species. Eroded sediments can also be carried downstream and deposited in aquatic ecosystems, altering water quality and habitat conditions.

Figure: After effects of floods leads to barren and fertile land

b. Water Contamination:

Immediate Impact: Floodwaters often carry contaminants, including agricultural chemicals, industrial pollutants, and sewage, into water bodies. This immediate influx of pollutants can harm aquatic life and disrupt the integrity of ecosystems.

Long-Term Impact: The long-term impact of water contamination can persist well after the floodwaters recede. Pollutants can accumulate in sediments and continue to affect water quality, potentially leading to chronic exposure and harm to aquatic organisms. Water contamination can lead to declines in fish populations, changes in aquatic plant communities, and compromised water resources for both wildlife and human use.

4. STRATEGIES FOR RESILIENCE & ADAPTATION

a. ***Apply Green Infrastructure strategies***: Bioretention, using a blue roof, using permeable pavement to allow runoff, using underground storage systems, using a stormwater tree trench to store and filter, use a retention pond to manage stormwater, use extended detention wetlands to reduce flood risk etc.

b. ***Construct new infrastructure:*** Build flood barriers to protect infrastructure, Build infrastructure needed for aquifer storage and recovery, Plan and establish alternative or on-site power supply, Relocate facilities to higher elevations etc.

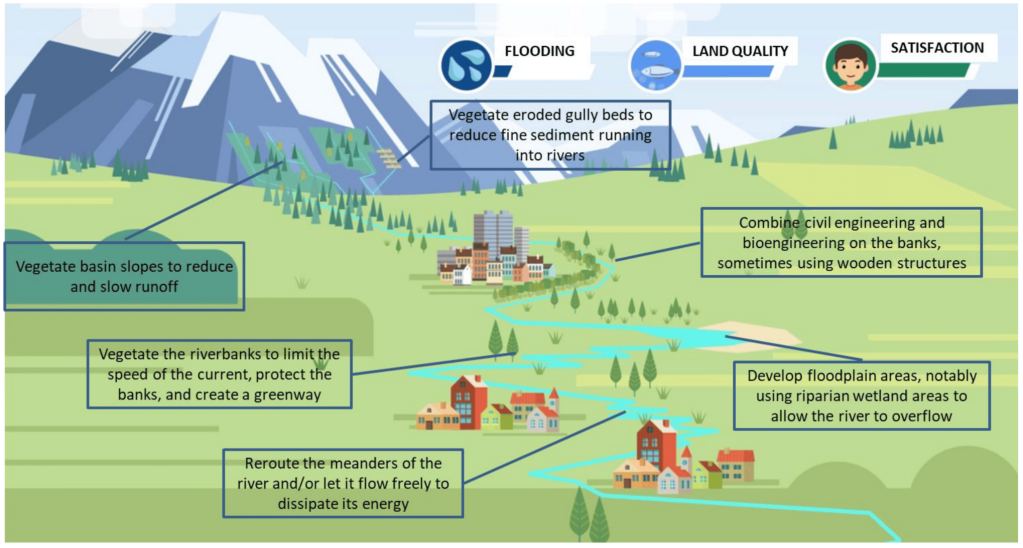
c. ***Maintain water quality and availability:*** Design new coastal drainage system, Develop adaptive stormwater management practices, e.g., remove impervious surfaces, replace undersized culverts, restore wetlands and plug drainage canals.

d. ***Modify land use:*** Integrate flood management and modeling into land use planning. It is critical that future water utility infrastructure is planned and built in consideration of future flood risks. Study response of nearby wetlands to storm surge events.

e. ***Provide public awareness:*** Adopt more stringent policies, build awareness and knowledge via climate change and stormwater management curriculum, collaborate with community groups through activities such as tree planting or installing rain gardens, showcase green infrastructure climate adaptation projects etc.

f. ***Use natural infrastructure:*** Build swales and rain gardens, control soil erosion in the watershed, create deep pools or artificial logjams, promote stormwater infiltration, removing unneeded dams and impoundments etc.

g. ***Use Soft shoreline maintenance:*** Redefine river flood hazard zones to match the projected expansion of flooding frequency and extent



5. CASE STUDY

A. Flooding in the Mississippi River Basin, USA

The Mississippi River Basin in the United States is one of the world's largest and most complex river systems, encompassing 31 states and draining an area of about 3.2 million square kilometers. It is prone to periodic and severe flooding due to its extensive drainage area, which is subject to rainfall and snowmelt from a vast region.

Figure : Flood waters surround area businesses near the main breach in the Mississippi River in Davenport, Iowa on Friday, May 3, 2019. Credit: KC McGinnis Getty Images

Impact on Biodiversity:

Immediate Impact: Severe floods in the Mississippi River Basin have caused extensive damage to natural habitats, particularly in the region's bottomland hardwood forests, wetlands, and floodplain ecosystems. These habitats are critical for numerous species of fish, birds, amphibians, and mammals.

Long-Term Impact: The long-term impact includes habitat destruction, changes in species distribution, and declines in populations. Many species in the region rely on these unique ecosystems for breeding, foraging, and shelter. Floods disrupt these essential ecological processes, leading to population declines, particularly for species like the Louisiana black bear and several bird species.

Conservation and Mitigation Efforts:

a. Various organizations, including state and federal agencies, have invested in habitat restoration projects to replant native vegetation and restore the ecological integrity of impacted areas. These efforts aim to stabilize soil, improve habitat quality, and provide refuge for wildlife.
b. There has been a focus on improving floodplain management and land use planning to reduce the impact of floods on both biodiversity and human communities. This

includes better floodplain zoning, levee systems, and regulations to minimize further habitat destruction.

c. Scientists and conservation organizations have been conducting research and monitoring programs to understand the long-term impacts of floods on species and ecosystems. This information is critical for informed conservation and management decisions.
d. Conservation easements and partnerships with landowners have been established to protect and preserve critical habitats. These voluntary agreements allow private landowners to maintain and restore natural habitats while receiving certain benefits or financial incentives.

The case of flooding in the Mississippi River Basin illustrates the complex interplay between floods and biodiversity. It also highlights the importance of a multi-pronged approach to mitigate the impact of floods on ecosystems, including habitat restoration, improved floodplain management, ongoing research, and collaborative efforts with various stakeholders. These initiatives are essential for conserving biodiversity in the face of recurrent flood events.

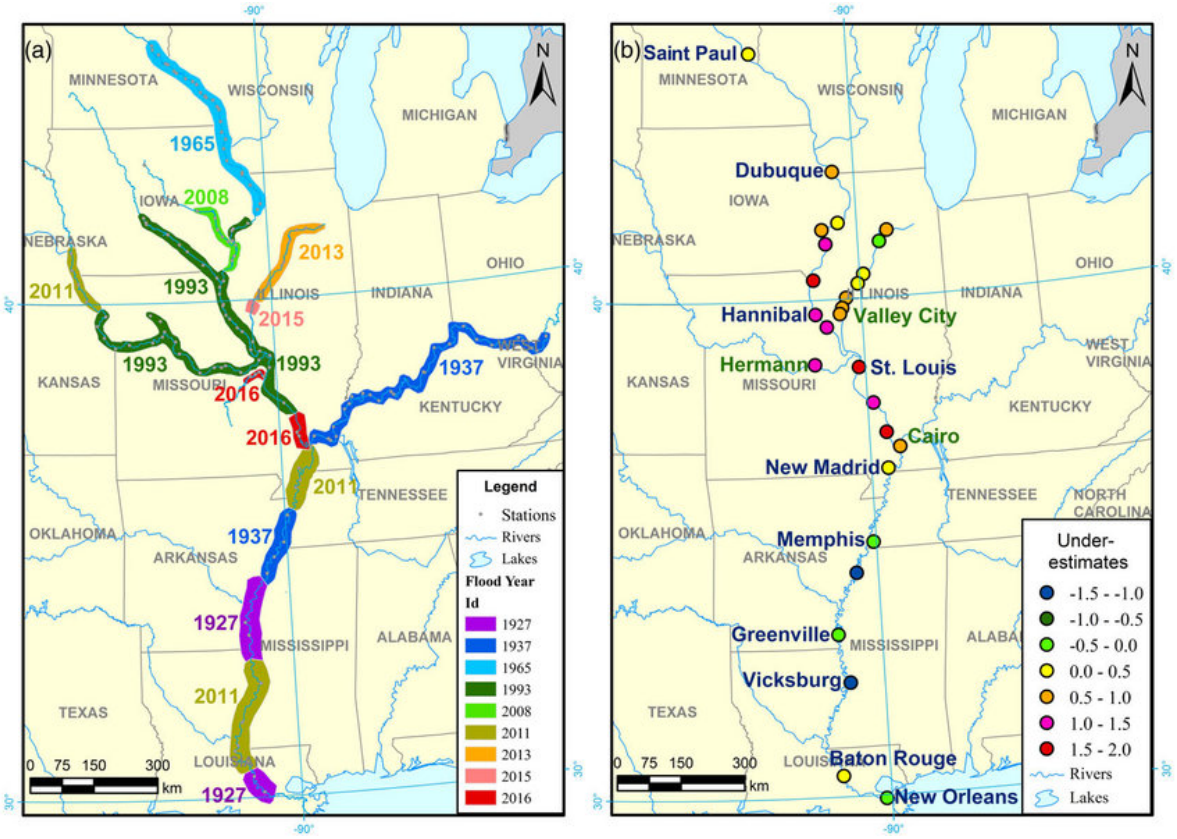


Figure: Occurrence of flood along the years

6. FUTURE OUTLOOK

The future outlook for addressing the impacts of floods on biodiversity is challenging due to the increasing frequency and severity of flood events, often exacerbated by climate change and other human-induced factors.

To safeguard biodiversity in the face of these challenges, a combination of proactive strategies and adaptive measures is necessary. Here are some recommendations for the future:

a. Climate Change Mitigation: Mitigating climate change by reducing greenhouse gas emissions is crucial. This includes transitioning to renewable energy sources, increasing energy efficiency, and implementing policies to limit global temperature rise. A reduction in the frequency and intensity of extreme weather events, including floods, can help protect biodiversity.

b. Floodplain Management: Improved floodplain management and land use planning are essential. Communities should implement sustainable land use practices that consider the natural dynamics of floodplains, maintain riparian buffers, and avoid building in high-risk areas.

c. Biodiversity Monitoring: Continued and comprehensive biodiversity monitoring is essential. This includes tracking changes in species distribution, population trends, and ecosystem health to better understand the impacts of floods and human activities. Such data can inform conservation actions.

d. Adaptive Management: Implement adaptive management strategies that allow for the adjustment of conservation practices based on evolving flood patterns and their impacts on biodiversity. Flexibility in conservation plans is essential.

e. International Collaboration: Foster international collaboration to address transboundary issues related to flooding and biodiversity. Many rivers and ecosystems span multiple countries, and coordinated efforts are essential.

f. Disaster Preparedness: Enhance disaster preparedness and response mechanisms to minimize the loss of life and property during flood events. Evacuation plans, early warning systems, and emergency response coordination are critical.

g. Sustainable Agriculture and Forestry: Encourage sustainable agricultural and forestry practices that minimize soil erosion and contamination. Incentives for conservation-minded farming and forestry can help protect biodiversity.

The proactive protection of ecosystems and the development of resilient strategies for both biodiversity and human communities are key to ensuring a sustainable and biodiverse future in the face of increasing flood risks.

7. CONCLUSION

In conclusion, the detrimental effects of floods on biodiversity are a critical concern in a world facing increasing frequency and severity of flood events. Floods, driven by factors like climate change and human activities, have immediate and long-term impacts. The purpose of our report was to; Raise Awareness, Scientific Understanding, Highlight Ecosystem Services, Discuss case Studies and Climate Change.

By taking concerted and sustained action, we can mitigate the detrimental effects of floods on biodiversity, promoting a harmonious coexistence of human society and the natural world. The road ahead is challenging, but with a shared commitment to conservation, we can strive to ensure the continued existence and vitality of Earth's rich tapestry of life.

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