International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 04 | April - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

Factors Influencing Urban Water Bodies in Ecological Contexts

[1]*Harsh Vyas,* [2]*Ar. Sarang Bhide*
[1]*Undergraduate student,*
[12]*School of Architecture,*
[12]*IPS Academy, 452012, Indore, Madhya Pradesh*

Abstract: Water quality in rivers is supposed to be affected in both the urban and rural regions, both naturally and by human causes. River watershed determines the water quality of the river based on changes and factors that occur in it. Thus, the most important factors which can influence the water quality of rivers need to be determined. This study is an appraisal on aqua ecology factors in managing water quality as well as time and space fluctuations that affect water quality in rural and urban rivers which flow in the area of interest for aqua ecology. Reasons like weathering of rocks, sedimentation through surface flow or evapotranspiration, atmospheric deposition, climate change, and natural catastrophes cause the deterioration of river water. The human element can be seen in industrial effluent, in domestic chores, and from agriculture activities such as slurry, dairy farming, irrigation practices, deforestation and fish farming. It is talked about river water quality fluctuations in space and time and is posed as either a positive or negative influence on water quality parameters as land use or cover change is being taken into consideration. Last but not the least is that along with the traditional pollutants which are the degraders of biodegradable organic matter, heavy metals and pathogens which act as emerging and historical contaminants, there are OCPs, PAHs, PCBs and perfluoroalkyl substances (PFCs) among others.

Keywords- *River water quality, Aqua ecology, Urban and rural rivers, Human impacts, Agricultural activities*

I. INTRODUCTION

Urbanization has the capacity to change the physical characteristics of urban water bodies, especially in the outer suburbs where environmental regulations are weak. This transformation mostly brings about a decreasing in the drinking water quality for the surrounding rural areas surrounding expanding urban centres, where environmental regulations may not be as strict as in the core cities. The disagreement with urban expansion and water preservation endangers the already decreasing water quality, especially in the smaller water exist further from the cities. Scientific evidence suggests that regions undergoing massive increase in urbanization generally possess different approaches to water quality with each varying in terms of its effectiveness and impact). Spatially heterogeneous

features are the factors that help to determine the amount of pollution coming from different sources, which adds to the complexity of pollution issues in the cities.

Studies revealed that it is possible to prove there is a direct relationship not only between the TN (total nitrogen) and TP (total phosphorus) concentrations in the small urban water bodies, but also their distance from the city centre – the farther away from the city centre, the higher the levels of pollution. Also, the water bodies that are under poor management conditions and the degraded ones have significantly a high credible figure of TN and TP due to pollution and this highlights the role of environmental management in mitigation of pollutions in urban water systems. To start with, urbanization will not only generate new types and extent of environmental urban problems but will affect many activities of life in surprising ways. Perhaps there is no other subject that is as prevalent and controversial as water pollution.

There is no groundwater for the people to take untreated water and that is why water quality management is gaining more attention because all water sources used serve the community. The quantity of water in a river depends on internal factors, such as weather, and trading, production and classify can affect it. One of the natural environment themes that could affect the quality of hydrochemistry monitoring is land management which would either lead to its quality improvement or deterioration. Furthermore, the flushing effect can occur due to the erosion of soil, organic matter, and nutrients from runoff of streams. Livestock waste and farming activities are mostly barriers to it Owing to higher population and booming urbanization, construction of residential and commercial buildings, roads, factories, and other developmental projects, demands natural resources in more quantities, resulting in devastating environmental effects.

Thus, such industrial occupations are promoted so much in order to cope with high growing population that in turn can let to the water contamination. Illustration of a wastewater or emissions which might cause a quality of a river water to decrease might make a problem. River waters may be of different quality at their regional or seasonal level. Space-time changes cause changes in terms of temperature, rainfall and drought that may result in fewer flows or lower dilution in streams.

This would render substances to reach the rivers. The physical environmental factor which determines how and in what quantities pollutants are transported can be seen as an aspect relevant in this study. The different elements like the topography of the surrounding area of the waterways and the amount of precipitation getting closer into the water bodies, are the two main factors that contribute to the volume of runoffs into the water bodies. The presence of the waterbody condition which where the stream has its flow and water circulates among the waterbody also contributes to the water quality. It is through these activities can be considered as the potential ones that make pollution sources, mobilization of chemicals from the source to the surface waters and delivery of chemicals to the surface scenarios that are responsible for water impairment. Moreover, unforeseen contaminants might be attributed to the catchment or to surrounding zones.

1. Land use change and its impact on urban water bodies.

Environmental hazard on the water quality with intensive land use changes can be formed and disordered the aquatic ecosystems in an urban area. This paragraph deals mostly with the different types of impacts to the urban hydro-eco-systems assessment consequence because of the alteration of the land use.

1.1: Loss of natural habitat

Along with the growth of urban area, the natural area is destroyed to provide a space for human living, such as wetlands, forests, and grasslands. The conversion of these resources to parking lots, buildings and roads would consequently result in habitat loss for the aquatic populations and affect ecological factors like nutrient cycling and sedimentation.

1.2: Increased runoff and urban heat island effect

Overall, the area of land subject to the presence of impervious surfaces during torrential rains in the cases associated with the rainfalls is seriously affected. The runoff of excess water is the process that leads to the pollution of the aquatic environment with the heavy metals, oil, and nutrients' overflows. These overflows consequently result in the quality depletion and changes of the aquatic environment. Moreover, due to the presence of surfaces that are able to soak up heat mainly characteristic of urban areas such as buildings and constructions, the number of plants have decreased leading to now urban waters that are even warmer than before that are not at all friendly to the amphibians which lived over there previously.

1.3 Altered hydrological regimes.

The emergence of urban watersheds as land use patterns modifies the natural hydrological cycle along the urban streamlines and so the streamflow patterns, groundwater recharge and base flows of the rivers are affected. This additional surface runoff and very little of infiltration lead to flash floods and erosion, and these all diminish the dry season flows. These modifications may result in habitat destruction, depletion of riparian vegetation and solid pollution of water bodies in urban areas.

1.4 Fragmentation of green spaces

Usually, urban development turns into a habit disruption that leads to patched only green space habitats with disruption of ecological connectivity. Input of fragmentation is certain decrease of dispersal of species which results in reduction of genetic diversity and, accordingly, an increase of susceptibility to environment-related stressors. For the aquatic life, broken green spaces mean the loss of the habitat to be occupied while species, in turn, unable to migrate and disperse the way they should.

1.5 Impacts on ecosystem services

Land use change transforms the supply of ecosystem services linked with urban waters. The destruction of natural habitats leads to the reduction in its ability to purify water, regulate floods, and sequester carbon. More so, there is an impact on recreation, cultural values, and aesthetic elements related to urban water bodies which in turn affect human well-being and quality of life.

Dealing with the problems associated with land use change needs integrated smart planning and implementation of green infrastructure, as well as ecosystem-based approaches to urban water management. Awareness of and emphasis on the interrelations between land use and aquatic ecosystems may lead to implementation of sustainable development practices by policymakers as well as the planners which in turn helps reduce the negative impacts of urban activities on the water bodies and enables ecosystems in urban areas to become more resilient.

2. Pollution sources in urban water bodies

Urban water bodies are subject to a large dump of pollution inputs from both point as well as non-point sources. The understanding of where these resources come from is a fundament necessity for the effective management and preservation of urban aquatic ecosystems. This section explains the different pollutants and how they have detrimental effects on the water quality and biodiversity.

2.1 Point sources of pollution

2.1.1 wastewater treatment plants (wwtps)

Wasting waters from municipal WWTPs usually comprise of different pollutants like the nitrogen and phosphorus nutrients, organic matter, pathogens, or the emerging contaminants (e.g., pharmaceuticals, personal care products etc.) as well. Improper or combination sewer flow can lead to the switch of untreated to partially treated water which reduce the quality of downstream water.

2.1.2 Industrial discharges

Industries are bound to dump their effluent rich in heavy metals, toxic substances and industrial wastes into urban water bodies. Runoff from manufacturing operations, chemical plants and oil refineries may encompass pollutants which could harm aquatic population or human beings.

2.1.3 Urban runoff hotspots

There are the urban area-bound point sources, for example, stormwater overflows from sewage systems, that serve as concentrated sources of pollution. The problem of water contamination contributed by stormwater runoff, such as sediments, oils, heavy metals, solvents, and herbicides, can aggravate the water quality of those receiving water bodies closer to outfalls.

2.2 Non-point sources of pollution

2.2.1 Urban runoff

Urban runoff which is dispersed from non-point pollution sources is a major factor in water quality deterioration in urban waters. Runoff occurs due to rainfall that washes contaminants, on places like roads, parking lots, rooftops and yards, over the storm drains and into the water bodies directly. The run-off from urban areas normally brings with it pollutants like sediments, nutrients (e.g.; nitrogen and phosphorous), bacteria, heavy metals, oil and chemicals from urban activities.

2.2.2 Construction sites

Urban area constructions can accumulate sediment runoff, erosion, and discharging construction-related pollutants to the water bodies in the neighbourhood to water bodies nearby. In the stream, siltation from construction site can bury aquatic habitats and also downgrade water quality, which results in a negative impact on aquatic ecosystems.

2.2.3 Transportation

The areas of emission from vehicles, roads salts, and also, the wear and tear of tires are sources of pollutants in urban water bodies. Road and highway runoffs may be laden with heavy metals, hydrocarbons, and road salts that eventually reach surface waters, which eventually affects water quality and aquatic biota.

2.2.4 Urban agriculture and landscaping

The use of fertilizers, pesticides and herbicides in the urban agriculture and landscape practices catalyses nutrient runoff, pesticide pollution and soil erosion. High volumes of nutrients from fertilizers can result in eutrophication, presence of algae and lack of oxygen in urban water systems.

3 Impacts on water quality and ecological health

From a point and non-point sources, water bodies can get polluted thus humidifying the habitats which in turn may lead to diseases in aquatic organisms.

Inadequate nutrient supplies often lead to eutrophication and algal bloom which, in turn, trigger hypoxia in the aquatic communities, killing fish and other aquatic creatures.

Lurking threat of heavy metals and toxic chemicals in silt and Sharples has been taken on by aquatic organisms and also human through biomagnification and bioaccumulation.

Microbes from sewage and urban use watersheds spread the pathogens, as a result, the water recreation and public drinking water are endangered by waterborne diseases as well as impaired.

Construction operation can release sedimentation in to a body of water, as well as disrupt the flow and cause the loss of various types of species in a body of water that live in the sediment, and finally can smother a bottom community, thus impacting aquatic biodiversity.

4 Management strategies

Ensuring the use of engineering BMPs to control sediment moving, direct stormwater runoff flow, and the total amount of loads of pollutants coming from urban sources.

Converting aging wastewater infrastructure to high risers has a progressive impact that includes enhancement of treatment efficiency and emissions of wastewater nutrients and contaminates.

Green infrastructure solutions such as rain gardens, permeable driveways, and constructed wetlands should be encouraged to attenuate urban runoff and increase water quality.

Conduct regular monitoring and assessment of local water resources to determine pollution origins, tract water quality conditions, and so, feed management strategies.

Development of public information programs, and volunteer initiatives that seek to inculcate such sustainable behaviours and practices that put at the least amount of pollutants and controls into the urban water bodies.

Sources of pollution could be checked by means of combining regulation with infrastructure improvements and community-based initiatives. As two effects, water quality in urban areas would improve, aquatic ecosystems would be protected, and infrastructure would become more resilient to the ongoing urbanization processes.

5 Implications of pollution on water quality and biodiversity in urban water bodies

Pollution in the urban waters has considerable effect on the water quality and diversity, and damages ecosystem services provided to members of the society. This part looks into the complex ways in which water quality and biodiversity gets affected by pollution and unveil the extent of cause-and-effect relationship.

5.1 Water quality impacts

5.1.1 Nutrient enrichment and eutrophication

Sources such as urban runoffs, urban stormwater, and wastewater discharges offer nutrients surplus (Nitrogen, and phosphate).
The process of nutrient enrichment is called eutrophication, the symptoms of which are highlighted by the occurrence of algal blooms, oxygen depletion and the worsening water quality.

The excessive nutrients in water can be metabolized by the algae organisms, making them grow rapidly and even produce toxins that are harmful to other aquatic forms of life and humans.

5.1.2 Chemical contamination

Industrial flow outs, urban runoff, and even the release of many chemical pollutants into urban water bodies makes them polluted with heavy metals, pesticides, pharmaceuticals, and industrial sludges.

In the aquatic ecosystems, the concentrations of pollutants increase in the sediments, water, and biota by toxicity, bioaccumulation, and biomagnifications.

The lasting effect of persistent organic pollutants (POPs) and endocrine-disrupting chemicals (EDCs) can be very harmful to aquatic organisms as they can act as a major disruption to the normal process of the reproduction; alter the chemical balance and disturb the immune response of the living species.

5.1.3 Sedimentation and turbidity

This debris comes from construction sites, urban development and stream is mobilized with many particles of soil, causing urban water bodies to sedimentation.

The cases of excessive sedimentation raise water turbidity, decrease the penetration of light and make the benthic habitats go under water leading to aquatic vegetation, invertebrates, and fish losses.

Bank-sediment associated pollutants, like heavy metals and nutrients, can be brought into the water column under certain conditions, thus worsening existing water pollution discord.

5.2.1 Biodiversity impacts

5.2.2 Loss of habitat and biodiversity

Air and water pollution and habitat depletion that occur due to urbanization make the quality of open spaces decrease resulting in reduction of the amount of suitable places for aquatic animal breeding.

If variations in riparian habitats and wetlands as well as decline in aquatic foliage is observed, habitat complexity and diversity is decreased.

Populations of water organisms in urban waterways tend to be composed mainly of the species that are tolerant to pollutants and this is what leads to reduced diversity and altered community structure.

5.2.3 Altered trophic dynamics.

Disordering of water quality and nondedicated habitat could be a root to trophic relationship disruption and compounded rearrangement of aquatic ecosystem food web.

Eutrophication gives rise to algal blooms resulting in changes in the cycling of key nutrients, primary productivity, and energy flow in the food web, which, in turn, affect the abundance or distribution of species at one trophic level or another.

Species shifts and community changes can lead to network disturbances that leave crucial vital carbon cycling, nutrient cycling and water purification processes staggered.

5.2.4 Impaired reproduction and recruitment

From all types of stressful situations, like chemical pollutants, habitat destruction and water flow alteration, the aquatic species' reproduction success and population recruitment can be affected.

The mechanisms of population decrease in urban water bodies are not just simple byproducts of habitat loss and habitat pollution in urban water bodies, they include the disruption of the reproductive output and larval survival, which both contribute to recruitment rates.

Species of endangered and sensitive kinds may often be under the risk of being affected by pollution and in some cases lose habitat since the local extinctions may occur and biodiversity hotspots may be lost.

6 Broader implications

6.1 Ecological resilience

Accumulation of pollution destroys the advantage of urban aquatic ecosystems adapting to changes in the environment after the disturbance, that leads to higher risks and severity, in case of a disaster.

The Loss of biodiversity, habitat destruction, and a diminished capacity to perform ecosystem functions limit the capability of urban water bodies to carry on their essential ecosystem services like water purification, flood control and provision of habitat.

6.2 Human health risks

Pollution of public water systems and seas due to pollution is often associated with a broad spectrum of health risks, including direct contact with contaminated waters, consuming poisonous seafood as well as exposure to phycotoxins and pathogens.

Towns relying on urban water bodies for drinking, recreation, and culture may have their health threatened and lowered quality of life Combating pollution in urban water bodies with respect both to water quality and environmental diversity implies the integration of approaches that control both point and non-point sources of pollution, strengthen the regulatory system and encourage the development of eco-friendly practices in land use. For the betterment of the water quality, provision of habitat conservation and sustenance of biodiversity will achieve the ecological resilience of urban areas and also will promote the livelihoods of both humans and water-based creature.

7 Biological invasions

The most prominent effect of the termination of the urban water bodies is the addition of non-native plants and animals.

Outlines for the Management and Prevention of Invasive Species

7.1 Implications for Water Quality and Biodiversity

Both intensify or compound one another to affect water quality levels.

Local diversity of the native plants and animals depletes, and ecosystem resilience goes down in the urban watershed area

The link between environmental degradation and human health is more complex than environmentalists have recognized earlier.

7.2 Ecosystem Services and Human Well-being

Urban water bodies are essential sources of nutrition, air purification, and recreational opportunities for human population.

Environmental contradictions resulting from the degraded ecosystem to human health and quality of life.

The prospects of nature-realized solutions in the area of urban water management.

7.3 Management Strategies

Sustainable use of limited urban water resources requires an integrated planning framework

Green infrastructure including local development solutions will help alleviate urban water problems.

Involvement of the community and community engagement in conservation programs are seen as the important elements that contribute to the successful conservation initiatives**.**

II. CONCLUSION

Urbanization creates an immense load on the urban ecosystems and this in turn brings alterations to hydrology, water quality deterioration, loss of biodiversity, and survival of native species susceptibility to invasions. Though, it is evident that understanding of these phenomena is developing, but the need of the hour is to fill the knowledge gaps remained to be addressed.

KEY FINDINGS

Urbanization profoundly impacts hydrological regimes, leading to increased runoff, altered streamflow patterns, and heightened flood and drought risks.

Pollution from various sources, including point and non-point, degrades water quality, jeopardizing ecosystem health and human well-being.

Habitat modification and biological invasions further exacerbate ecological degradation, disrupting native communities and ecosystem processes.

Efforts to mitigate these impacts require interdisciplinary approaches and innovative management strategies.

RESEARCH GAPS

There is a need for further research to understand the cumulative effects of multiple stressors on urban water bodies and the long-term implications for ecosystem resilience.

More studies are required to evaluate the efficacy of management strategies, such as green infrastructure and invasive species control, in restoring and conserving urban aquatic ecosystems.

Limited understanding exists regarding the social and economic dimensions of urban water management, including the role of community engagement and stakeholder involvement.

Emerging pollutants and their impacts on urban water quality and biodiversity warrant investigation to inform effective mitigation measures.

RECOMMENDATIONS FOR FUTURE RESEARCH AND POLICY

Promote interdisciplinary research to address knowledge gaps and develop holistic approaches to urban water management.

Enhance monitoring efforts to assess the effectiveness of management interventions and track long-term trends in urban water quality and biodiversity.

Foster collaboration between researchers, policymakers, and stakeholders to develop evidence-based policy interventions and adaptive management strategies.

Prioritize public education and community engagement to raise awareness about the importance of urban water conservation and stewardship.

III. ACKNOWLEDGEMENT

I would like to express my heartfelt gratitude to all the individuals and organizations who have contributed to the successful completion of my research paper. I feel indebted to my supervisor, Ar. Sarang Bhide, for his invaluable guidance, motivation, and support throughout the research process. His insights and suggestions have been instrumental in shaping my ideas and refining my work. I also extend my sincere appreciation to my research guides, whose cooperation, expertise, and feedback were crucial in steering me in the right direction.

I would be remiss if I didn't acknowledge the support of my colleagues and friends. Their unwavering encouragement, suggestions, and assistance have been a source of strength and motivation throughout this journey. Their constructive criticism and valuable inputs have helped me to overcome obstacles and refine my ideas. Without their support and encouragement, this work would not have been possible, and for that, I am truly grateful.

IV. REFERENCES

- https://www.jstor.org/stable/resrep37849
- https://www.researchgate.net/publication/259715563_A_Review_of_Urban_Water_Body_Challenges_and_Approaches_1_Rehabilitation_and_Remediation
- https://www.researchgate.net/publication/259715563_A_Review_of_Urban_Water_Body_Challenges_and_Approaches_1_Rehabilitation_and_Remediation
- https://www.researchgate.net/publication/341452586