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Effects of Human Activities on Water Quality and Fish Biodiversity: A Review

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Abstract: *This review analyzed the intricate relationships between human processes, the quality of water and fish biodiversity in different freshwater bodies. Aquatic ecosystems are of immense ecological significance and support vast extents of biodiversity, their degradation due to human activities is of immediate concern. Other important factors like agricultural run-offs, storm waters, urbanization, industrial discharges, deforestation, overfishing, habitat fragmentation and loss, and climate change are responsible for compromising the water quality of aquatic ecosystems, and life therein. Activities that impact freshwater systems change their temperature, pH, dissolved oxygen, turbidity and nutrients levels; resulting in alterations, degradation, eutrophication, sedimentation, and loss of plant and animal species. This review highlights the need for and suggests integrated policies that are focused on community participation and technological innovation as part of mitigative measures. There are serious and persistent gaps in basic information, especially, poorly monitored areas that require data collection and long-term ecological monitoring. Being able to deal with these challenges would help sustain the delicate balance of aquatic ecosystems that need protection from increasing environmental changes.*

Keywords: human activities, water quality, fish biodiversity

INTRODUCTION

Aquatic ecosystems, inclusive of freshwater and marine domains, play integral roles in sustaining biodiversity and providing valuable ecosystem services for humanity. They are habitats to an impressive number of life forms, amongst them, fishes, which are important ecologically and economically. Fish biodiversity contributes to food webs, nutrient cycling, global food security, livelihoods, economies, and cultural identity (Meinam *et al*., 2023; Yin *et al*., 2022). Human activities are increasingly threatening these aquatic ecosystems and the life they support. Urbanization, industrial discharges, agriculture, overfishing, damming, and climate change have combined and drastically altered water quality, habitat structure, and the biodiversity therein (Amoutchi *et al*., 2021; Larentis *et al*., 2022; Zeng *et al*., 2022). The freshwater ecosystems are greatly threatened by pollutants that alter their chemical balance and alter habitats which directly impact fish populations (Malik *et al*., 2020; Hahshmi *et al*., 2024). In the Chenab River, anthropogenic stressors have led to a loss of fish diversity which is a growing concern for the region (Hahshmi *et al*., 2024). Climate change in addition serve as a compound driver, changing water temperature, flow regimes, levels of dissolved oxygen and nutrients refluxes. These shifts intensify underlying human impacts, and strain the already vulnerable adaptive capacity of aquatic biota. In the Neotropics, streams suffering from habitat disturbances exhibit reduced fish diversity (De Santis *et al*., 2023; Su *et al*., 2021). In larger river basins like the Yangtze, multifunctional human activities have affected community structure at multiple trophic levels (Yin *et al*., 2022).

In view of the scale and immediacy of the growing issues, this study reviewed existing literature with focus on the impacts of human activities on water quality and fish biodiversity. It analyzed a wide range of studies from different regions, outlined the principal drivers of concern, and extracted broader implications for biodiversity conservation (Oribhabor, 2016; Su *et al*., 2021). The review looked into some of the intricacies in understanding the ecological impacts and the policy measures, presenting a rounded perspective on the strategic approaches needed to manage aquatic resources responsibly.

Human Activities and Aquatic Systems

Agricultural Activities

Agricultural activities have major influences on aquatic ecosystems, especially with the applications of fertilizers, pesticides, growth hormones; and run-offs from cultivated lands. Most water bodies are negatively impacted by the inflow of excess nutrients, chemicals, wastes, leachates and silts because they degrade the quality of water and alter biodiversity in the affected water bodies. In the rice paddies of An Giang Province in Southern Vietnam, agricultural run-offs have been reported to significantly impact the composition of fish species. The use of fertilizers and agrochemicals in these regions is so high that the water becomes eutrophic and depleted of oxygen, harming the most sensitive species of fish (Dinh *et al*., 2020). In addition, abundant nutrients cause algal blooms besides the increased turbidity and resultant reduced productivity which decreases fish diversity.

Urban and estuarine settings continue to experience similar impacts because of agricultural activities that surround them. Duque *et al*. (2020), pointed out the phenomenon of nutrient-driven water quality changes and fish assemblage disruption in seasonal habitats due to anthropogenic eutrophication in tropical estuaries, including Colombian Pacific estuaries. All these impacts have one thing in common, and that is, agricultural run-offs cause changes to habitats due to high nitrogen, phosphorus and other constituents, leading to eutrophic and anoxic conditions in affected water bodies. Agricultural activities like fertilizer run-offs and land use planning have been shown to increase the concentrations of nitrates and phosphates in reservoirs which lowers the available oxygen levels and negatively impacts the fish population as reported in Nigerian water bodies (Adeosun *et al*., 2016). Similarly, the Penang urban river ecosystem in Malaysia is suffering tremendously due to inputs from agricultural pollutants; the chemicals not only harm the indigenous aquatic life but also result in the disappearance of numerous native species (Feisal *et al*., 2023). Such repercussions are regarded as profound threats across the globe. Volta and Jeppesen (2021), emphasized that, the enrichment of water bodies due to agriculture is mostly responsible for the degradation of freshwater ecosystems which often results in fish kills, diminished spawning, and loss of biodiversity. Zhou (2023), in a study using path modeling analysis, cited that, heightened agricultural activities are linked to the deterioration of water quality and fish diversity in lakes near urban centers which further underpins the intricacy of land-water relationships. UNEP GEMS/Water Programme (2008), in their report, stressed that, agricultural run-offs is one of the most harmful and non-point sources of water pollution everywhere. This pollution has become chronic in 'stressed ecosystems' over time, especially in areas where riparian buffers and wetlands have been farmed. Bassem (2020), confirmed this by demonstrating that, increased nutrient supply from farmland diminishes biodiversity and tip the balance of ecosystems in riverine systems.

These observations point to the clear need for sustainable agriculture and effective buffer zones to limit run-offs, as well as, integrated management approaches to control the impacts of agricultural activities on biodiversity.

Industrialization and Urbanization

Aquatic systems have been heavily impacted by industrialization and the growth of cities due to municipal discharges of chemical wastes, heavy metals, and sedimentation resulting from urban run-offs. Dewangan (2023), noted that, industrial processes severely damage water resources and aquatic ecosystems due to chemical wastes like oil spills and poisonous metals such as, mercury, lead, and cadmium. Nepali rivers have been contaminated with metals from the heavily industrialized region, resulting in declining ichthyofaunal diversity (Chitrakar *et al*., 2024). The effects of urban run-offs from inefficient waste management and growing impervious surfaces increases sedimentation and brings additional pollutants into water bodies. Duncan *et al*. (2019), noted that in Ghana's River Densu, urban discharges and sediment inflow during construction worsened turbidity and ammonia levels which are important for fish survival.

Brondízio *et al*. (2019), discussed on how synergistic effects of industrial wastes and urban growth alter ecosystem services at a higher level. These changes fostered a shift in community structure and decreased habitat space. Keck *et al*. (2025), in their study affirmed that, these changes threaten biodiversity and compromise vital ecological processes necessary for supporting life in the water.

Deforestation and Land Use Change

Deforestation and land clearing are the main causes of erosion and the sedimentation of river systems. Deforestation and land degradation destabilize river systems. Removal of vegetation close to water bodies escalate soil erosion, causing fish habitats and spawning grounds to be altered along due to increased sediment deposition (Duncan *et al*. 2019). These tendencies are noticeable in the Old Brahmaputra River studied by Afrose and Ahmed (2016), suggesting that, deforestation together with other land degradation factors changed the riverbed structure and function, and led to diminished biodiversity.

Land clearing has an impact on hydrological cycle as well. Aggravating surface run-offs (which provides surface paths for the water cycle) and deforestation (intended for agriculture and urbanization) lower the flooding threshold. Water infiltration rates also drop which raises the rate of smoke produced during deforestation and erosion, which Brondizio *et al*. (2019), stated, reinforces the nutrient and smoke supply onto rivers while altering flow direction and habitat arrangement; fundamentally modifying water-dwelling habitats. In coastal and estuarine settings, these changes are even more pronounced. Naik (2023), stated that, sediment loads due to deforestation upstream assist in the eutrophication of lagoons along with the loss of habitats, and detailed how these change impacts on water changes.

Climate Change and Global Warming

The shift in climate conditions is a major risk to the biodiversity of freshwater fishes, as it impacts the physicochemical factors that govern the aquatic environment. Increasing temperatures partially strain the ability of water to contain oxygen, raise fish metabolism and oxygen consumption, which leads to increased chances of mortality (De Santis *et al*., 2023). In coastal lagoons and rivers, changes in temperature also affects spawning and migratory activities of fish. A study conducted by Naik (2023), explained how climate change is influencing water temperatures to distribute them more evenly, fostering the bloom and spread of alga especially harmful algal (harmful algal blooms- HABs). Thus, the changed patterns of fish species distribution with temperature changes impact the structures of the aquatic ecosystems.

In the comprehensive assessment by Brondizio *et al*. (2019), it was revealed that, anthropogenic climate change is altering the hydrological system, atmospheric precipitation, and temperature thereby, affecting biodiversity in water bodies. The degree of these impacts is severe, and in addition to pollution and loss of habitat, resources have become critically limited. Keck *et al*. (2025), performed an extensive analysis straddling various ecosystems and verified that, climate stressors are promoting the restructuring of species make up and driving down biodiversity, affecting the number of species composition in regions, further deepening the issue.

Overfishing and Aquaculture

The depletion of fish biodiversity due to overfishing occurs as stocks are being depleted at a rate that is quicker than the rate at which they can regenerate. An example is the fishing pressure on Old Brahmaputra River; intense fishing pressure has caused significant drops in species population. Afrose and Ahmed (2016), indicated that, close to fifty percent of loss in biodiversity was due to overexploitation. This has dire consequences not only on the ecological equilibrium but also poses a significant threat to the food security of people that depend on these resources. While increasing supply of fish, aquaculture creates its own set of ecological problems. This arises from unsustainable management of fish farms that result in nutrients loading, increased pathogens-diseases, and destruction of habitats that have adverse impacts on endemic fishes (Dewangan, 2023). In aquaculture, organic wastes, poor water management practices coupled with the use of chemicals lead to water pollution especially when there are discharges into water bodies close by. The issue of biosecurity in aquaculture is also an aspect of ecological concern since the impacts on species diversity are not well understood (Lelei *et al*., 2022).

Chitrakar *et al*. (2024), in their study in Nepal, noted that with aquaculture came habitat homogenization which decreases the adaptive capacity of fish populations to changing environmental conditions. In the same manner, De Santis *et al*. (2023), stated that, the encroachment of aquaculture into natural ecosystems comes with a tradeoff of increased biodiversity loss.

Sustained freshwater biodiversity is threatened by both unsustainable aquaculture and overfishing, requiring regulatory and ecological efforts targeted specifically towards the identified unsustainable practices.

Oil Extraction and Production

The Niger Delta area in Nigeria suffers from the pollution effects of artisanal crude oil refining that negatively impacts air, water and soil qualities which affects agricultural activities due to the contamination of soil and water bodies utilized for irrigation. The discharges of effluents and wastes that contain hydrocarbons and heavy metals into the rivers and streams, besides the spills through pipeline vandalization lead to pollution and toxic accumulation in the water and soil which reduces soil fertility resulting in inadequate crop yield while impairing aquatic life, and affecting biodiversity. This pollution not only impacts the water resources but also introduces toxins into the environment that are detrimental to plants, animals and the dependent communities. Farmers who carry out farming activities around are left with reduced yields and food supply, alongside economic decline and impoverishment (Eli *et al*., 2025).

Impacts on Water Quality

The quality of freshwater has important influence on the survival, reproduction, and community structure of fish species. Freshwater ecosystems and biodiversity are impacted by anthropogenic activities such as, farming, urban sprawl and deforestation because they affect key water quality parameters including pH, dissolved oxygen (DO), nitrates, turbidity and heavy metal concentrations.

pH, Dissolved Oxygen, and Nitrates

Water pH is frequently altered by the discharge of acidic or alkaline wastes. In a recent study, Larentis *et al*. (2022), reported that, the streams in the Neotropics were suffering from human induced acidity due to agricultural and urban effluents, which were negatively affecting species richness. Similarly, Oribhabor (2016), noted that, the changes in pH within the Nigerian water bodies adversely impacted fish health and breeding activities within the ecosystems. Dissolved oxygen (DO) is regarded as the most sensitive and most telling of all the water quality indicators. DO levels decrease due to increase in temperature and eutrophication (which is caused by excessive organic matter and nutrient inputs resulting in increased biological oxygen demand- BOD). Malik *et al*. (2020), emphasized that, DO depletion caused by fertilizer run-offs induced fish kills and decreased the overall habitat quality. Low oxygen zones also hamper fish dispersal and feeding according to De Santis *et al*. (2023).

Nitrates from agricultural run-offs pose yet another recognized threat. Its increasing amounts accelerate algal bloom which decreases oxygen concentration, interferes with trophic level interactions, and alters them. In the Yangtze River Basin, industrial and agricultural developments over the years have resulted in nitrate eutrophication and altered aquatic ecosystems (Yin *et al*., 2022).

Turbidity impedes light penetration into water bodies affecting photosynthesis which reduces plant growth and disturbs the balance of aquatic life. Zeng *et al*. (2022), reported increased turbidity in the Xiang River due to land-use changes and increased sediment inflow, leading to the loss of sensitive species of fish. Yen *et al*. (2022), showed that fish reproductive failures were caused by high turbidity from the suspended solids inputs from deforested areas around. From deforestation and land clearing stems sedimentation which alters riverbed structure and disrupts profundal regions of a water body. Excessive sedimentation, reduced habitat complexity result in a worldwide loss of heterogeneous fish communities. Hahshmi *et al*. (2024), reported evidence of declining fish diversity in the Chenab River as the result of increased sedimentation from river bank erosion caused by unrestricted human activities.

Pollutants Bioaccumulation

Considering the contamination by industrial pollutants and the discharges from agricultural activities, freshwater systems get burdened with heavy metals such as, lead, cadmium and mercury. These pollutants are accumulating in larger quantities than normal in the adipose tissues of exposed aquatic organisms especially fishes, hence, bioaccumulated. This not only compromises the health of aquatic organisms but also cause harm to humans who consume these affected organisms. The concerns regarding ecosystems studied by De Santis *et al*. (2023), in some American and Asian countries as regard the issues of the enduring impacts in relation to ecological and public health centered on the pervasive foreign metals in these ecosystems. Amoutchi *et al*. (2021), observed that local fishermen reported increasingly common cases of fish with distorted body shapes and diminished numbers in Cote d'Ivoire. The report supported the findings of Oribhabor (2016), on the long-term impacts of heavy metals and organic compounds on fishery resources and eco-functional reserves.

The artisanal refining of crude oil within the Niger Delta region dangerously cause damage to water quality through the release of crude oil residues and other hazardous chemicals into the adjoining rivers and wetlands. Such pollutants contain hydrocarbons, heavy metals, and some benzene derivatives that lead to ecological damage and health hazards to aquatic life and the dependent locales in the affected areas. The water is not only unfit for drinking and household purposes but also alters aquatic ecosystems thereby, decreasing species diversity and exterminating vulnerable organisms. In addition, pollutant seepage into groundwater sources undermines water safety while increasing the region's environmental and public health hazards (Eli *et al*., 2025).

General Effects of Activities

Table 1 shows the diverse effects of human actions on some physicochemical variables within the framework of specific anthropogenic activities.

Table 1: Water Quality Parameters Affected by Different Human Activities

Activity	pH Change	DO Change	Nitrate Levels	Heavy Metals	Sedimentation
Agriculture	↓	↓	↑	-	↑
Industry	Variable	↓	↑	↑	↑
Deforestation	-	↓	-	-	↑

Key: ↓= Indicates a decrease in the parameter due to the specified activity; ↑= Indicates an increase in the parameter; **-** = Indicates no significant effect or not typically associated with a change in that parameter; variable = Indicates that the effect varies depending on context, such as the type of industry or specific condition.

Agricultural practices directly relate to reduced pH and DO, and increased nitrates and sedimentation. Industrial operations are the sources of heavy metals and variable pH with increased sedimentation. Deforestation causes excessive sedimentation and hypoxia.
In general, the reduction in the quality of water as a result of anthropogenic activities synergistically influences the decline of aquatic biodiversity. Meinam *et al*. (2023), stated that, water quality monitoring is essential not only for preventing overfishing but also for supporting the resilience of the ecosystem. Actions to control pollution must focus on limiting nutrient inputs, industrial discharges, improving riparian forests, and controlling vegetation in order to stop degrading freshwater systems.

Impacts on Fish Biodiversity

The impacts of human activities such as pollution and deforestation have resulted in the significant alteration of freshwater ecosystems. This has caused shifts in fish biodiversity in different regions of the globe. More anthropogenic pressures like overexploitation, climate change, habitat degradation, and pollution have led to the loss of more sensitive fish species, the increase of tolerant fish species, and great alterations in trophic structures.

Loss of Sensitive Species

Sensitive fish species such as those that rely on clear oxygen saturated water and stable streambeds as essential environmental conditions have increased susceptibility to pollution and habitat fragmentation. Zhou (2023), noted that in lake systems, increasing nutrient loads and sedimentation correlated with significant reductions in species richness, especially among those intolerant to low oxygen or high turbidity. Agricultural augmentation and intensification has also been shown to modify native habitats. In the rice paddies of Vietnam, Dinh *et al*. (2020), described the effects of agricultural intensification which has altered the aquatic habitats and led to the extinction of indigenous fish species. In the Puerto, Duque *et al*. (2020), reported the modifications on the estuarine fish fauna due to urbanization. In the tropics, they noticed a shift in the composition of species from sensitive to pollution tolerant taxa. These changes demonstrated an increase in water pollution and loss of sensitive species, which increases ecological instability of aquatic systems.

Proliferation of Tolerant Species

With the decline of sensitive taxa, ecosystems often witness an increase in species that can tolerate poor water conditions. Feisal *et al*. (2023), highlighted how urban rivers in Malaysia experienced influx of more tolerant species such as, Tilapia, Catfish, Carp that flourish in

nutrient-rich waters with low oxygen levels. These species dominate because of their physiological adaptability and competitive edge in degraded habitats.
This homogenization of fish communities weakens ecosystem resilience and increases simplification. Bassem (2020), emphasized that these tolerant species not only dominate like the invasive fish species, but displace and supersede locally important species.

Changes in Trophic Structures
Changes in species composition directly impact the food web associated with that ecosystem. Volta and Jeppesen (2021), pointed out that, anthropogenic impacts markedly caused a shift in freshwater food web architecture from a diverse, complex mosaic to simplified, generalist dominated systems. The loss of top predators coupled with a decline in specialist feeders upset the balance of energy flow within the system's primary production, and stagnation of cycling of nutrients. This was evident in the report of Adeosun *et al*. (2016), who studied a reservoir in Nigeria where predatory fish collapsed due to pollution and changes in habitat, permitted planktivores and omnivores to dominate. This creates an imbalanced system with cascading impacts across the aquatic ecosystem, biodiversity loss, declining water quality, and reduced productivity within fisheries.

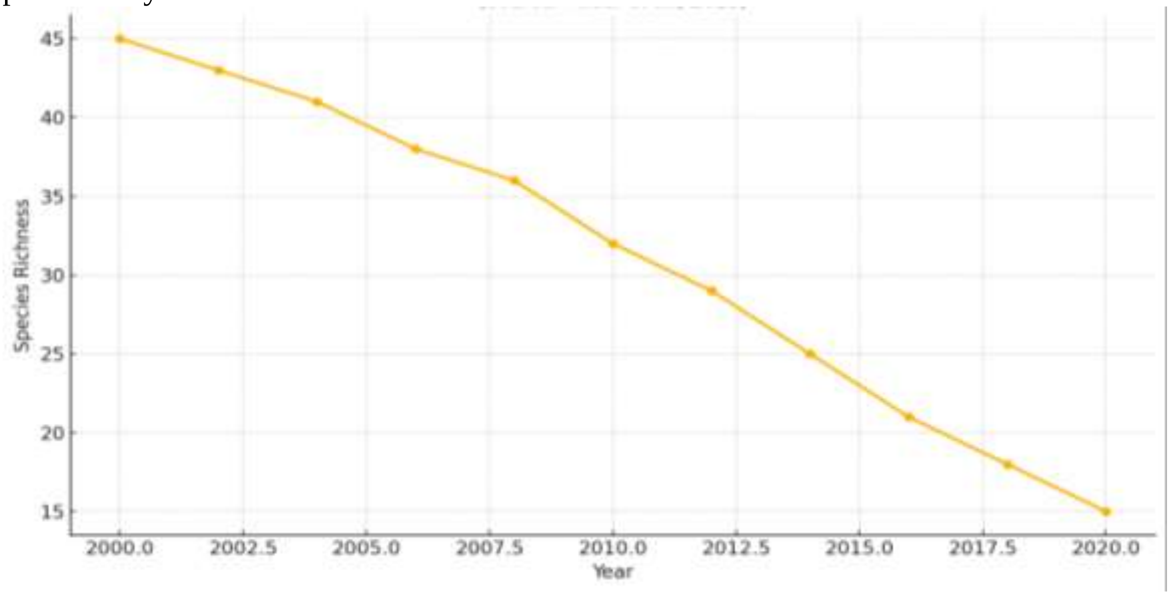

Figure 2: Fish species richness over time in a heavily impacted River System (Source: Feisal *et al*., 2023)

Table 2: Biodiversity Loss in Some Major River Systems

River System	Country	Key Human Activity	Biodiversity Impact	Source
Amazon Basin	Brazil	Deforestation	25% species decline	Bassem (2020)
Yangtze River	China	Industrial Waste	Endemic species loss	Zhou (2023)
Ganges River	India	Sewage Discharge	Fish kills reported	UNEP GEMS/Water Programme (2008)

Table 2 shows reports on the complex and pervasive effects of anthropogenic activities on the biodiversity of freshwater ecosystems. In the Amazon, rampant deforestation decreased available aquatic habitats (Bassem, 2020); industrial pollution along the Yangtze River's banks has driven many endemic species into extinction (Zhou, 2023). Untreated sewage and organic wastes pollution in the Ganges results in regular fish mortality events, and dramatically changes community composition. Untreated sewage and organic wastes pollution in the Ganges results in regular fish mortality events, and dramatically changes community composition (UNEP GEMS/Water Programme, 2008).

Interactions between Water Quality and Fish Biodiversity
Freshwater ecosystems owe their functioning to the interdependence of water quality and the biodiversity. The decline in water quality leads to a reduction in biodiversity due to detrimental changes to the vital physical, chemical, and biological aspects of water needed for supporting life. Dewangan (2023), cited poor water quality resulting from sedimentation, nutrient over-enrichment, and chemical pollution as direct causes of oxygen depletion along with habitat degradation. Both of these factors are detrimental to many freshwater species. A study on River Densu by Duncan *et al*. (2019), demonstrated the consequential impacts of increased turbidity and nutrient pollution on water quality in tandem with declining fish abundance. The findings of the study highlighted a clear reduction in dissolved oxygen along with increased ammonia levels and shifts in pH, which all combined to alter habitat with far reaching effects on the native fish beyond their tolerance limits.

The interdependence between the quality of water and biodiversity is characterized as feedback loops as reported in different studies. The decline in fish biodiversity increasingly impacts the efficiency of ecosystem processes like nutrient cycling and primary production, resulting in even greater declines in water quality. A prime example is the decline in herbivorous fish populations, which leads to unchecked algal bloom, increasing the rate of eutrophication and further decreasing the oxygen levels. This occurrence has been observed in Nepalese rivers as reported by Chitrakar *et al*. (2024).
The fish biodiversity in the Niger Delta area suffers from the decrease in water quality as a result of artisanal crude oil refining, discharge of toxic substances, and other narcotics that alter the ecological settings. Decreased quality of water with the introduction of pollutants like hydrocarbons and heavy metals may affect reproductive ability, decrease oxygen levels, and create physiological stress; resulting in greater population decline and loss of more susceptible species. All of these changes threaten the already fragile equilibrium of freshwater systems and imperil the livelihoods of locales who fish for food and income. The loss of fish populations also reduces food security and exacerbates biodiversity loss, thus, necessitating immediate intervention to protect the environment (Eli *et al*., 2025).

Furthermore, Keck *et al*. (2025), stressed that, degraded systems frequently enter a phase of 'ecological inertia', wherein, a chronic state of pollution and habitat degradation sets into motion a cyclic pattern of decline which is self-perpetuating. As a result, restoration attempts can become more challenging and further diminish the ability of aquatic ecosystems to recover from disturbances.

Mitigation and Conservation Strategies
The intersection of deteriorating water quality and declining biodiversity calls for a more comprehensive approach that integrates policies, community action and technology.

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Policy and Regulation

Legal frameworks are fundamental to the protection of aquatic ecosystems. Brondízio *et al*. (2019), reported that, international instruments like the Convention on Biological Diversity (CBD) undertake to advocate for the preservation and sustainable utilization of water resources. In most cases reported, however, the implementation on ground lags behind the formulation of the policies. Duncan *et al*. (2019), reported that, Ghana has environmental policies, but enforcement suffers due to lack of political will and funding, which is also the case with Nigeria and some other African countries.

De Santis *et al*. (2023), highlighted the adoption of dominant policies that require ecological compliance and monitoring for active changes in climate and land use, to guard the dynamically evolving risks. They maintained that, policies which seek to address any challenge must be context specific and scientifically underpinned to remain useful.

Community-Based Conservation

It is increasingly being understood that, mobilizing communities is critical towards enhancing conservation efforts. Afrose and Ahmed (2016), reported that, community-based monitoring and the creation of fish sanctuaries along the Old Brahmaputra River enhanced fish and habitat diversity. The study also demonstrated that, traditional ecological knowledge greatly facilitated the balancing of conservation intents with local economic activities. Chitrakar *et al*. (2024), are also strong proponents of participatory governance for water, and outlined how local constituents have the best interest in observing changes in the environment, and applying sustainable interventions. In addition, enforcement of rules have been noted to improve compliance towards conservation measures. This, in turn, enhances resilience at community levels.

Technological and Scientific Interventions

There is high optimism that innovative technologies can resolve water quality challenges, restore biodiversity, and even sustain ecosystems. The application of microbial communities to detoxify pollutants referred to as, bioremediation has been notable; especially their roles in the elimination of heavy metals and excess nutrients from water bodies (Naik, 2023). The design of wetlands and buffer strips are effective in eco-engineering as they stabilize sediments and filter agricultural run-offs. De Santis *et al*. (2023), highlighted successful uses of these strategies in Mediterranean and tropical systems for enhancing clarity of water and improving the spatial and structural complexities of fish habitats.Dewangan (2023), emphasized the value of real-time monitoring tools including remote sensing and biosensors for detecting early warning indicators of ecological stress. These technologies facilitate prompt action and provide support for management choices based on accurate data obtained.

Knowledge Gaps and Future Research

Despite recent researches on the influences of man on freshwater ecosystems, knowledge gaps still exist concerning geographic boundaries and ecological time-series data. Keck *et al*. (2025), stated that, Europe and North America hold extensive data, however, some biodiversity hot spots like South America and Southeast Asia along with developing Africa lack sufficient data. This bias in spatial representation stunts the progress of formulating effective conservation strategies to sustain life on earth. Brondízio *et al*. (2019), highlighted on how a multitude of global assessments fail to gauge the localized intricacies of human impacts on aquatic ecosystems. Take for instance, the inadequacy of international policy frameworks to address the unique hydrological and ecological characteristics of Nepalese rivers (Chitrakar *et al*., 2024). Even so, global datasets can conceal urgent conservation demands that are apparent from localized cases, like those in the Old Brahmaputra River in Bangladesh (Afrose and Ahmed, 2016).

Another key gap is the absence of long-term ecological records. Dewangan (2023), emphasized the problems of short-term studies in anticipating the delayed or cumulative effects of pollutants and habitat changes on fish biodiversity. Long-term monitoring is critical in recognizing ecological thresholds, predicting trends, and measuring the impacts of some interventions. As De Santis *et al*. (2023), noted, sustained ecological surveillance is equally important for assessing the effects of climate change in conjunction with human local stressors, which are expected to worsen in the coming decades. Further research can build upon new spatial and temporal dimensions, utilizing advanced monitoring technologies alongside community-based participatory approaches for tailored and contextual data collection and management.

CONCLUSION

This review integrated the findings of different studies to demonstrate how anthropogenic actions impact the quality of water and fish biodiversity of freshwater ecosystems. The findings indicated that agricultural run-offs, industrial effluents, deforestation, climate change, and overfishing synergistically impair aquatic environments and modify the chemistry of water which decreases fish diversity and disrupts the ecological processes. Researches from tropical rice paddies in Vietnam (Dinh *et al*., 2020), estuaries in Colombia (Duque *et al*., 2020), urban rivers in Malaysia (Feisal *et al*., 2023), and even highland river systems in Nepal (Chitrakar *et al*., 2024) demonstrated how water quality deterioration patterned with the degradation in biodiversity. These impacts were most severe in unsupervised and fast developing areas. These not only indicated gaps in scientific and conservation researches, but investments as well.

Tackling these problems require legislation, community mobilization, and advancement in technologies all simultaneously utilized on multiple levels. Local level guardianship as shown by Afrose and Ahmed (2016), can help supplement national and international conservation. Furthermore, technological advancements in bioremediation and real time water monitoring tools (Naik, 2023; De Santis *et al*., 2023) are also beneficial for restoration. Halting or reversing the deterioration of freshwater biodiversity requires us to fill existing knowledge gaps, enforce policies, and promote collaboration across different sectors. Combination of all beneficial efforts are required to sustain the resilience of aquatic ecosystems and sustain fish biodiversity for future generations.

REFERENCES

Adeosun, F. I., Adams, T. F. and Amrevuawho, M. O. (2016). Effect of anthropogenic activities on the water quality parameters of Federal University of Agriculture Abeokuta Reservoir. *International Journal of Fisheries and Aquatic Studies,* 4(3), 104–108.

Afrose, S. and Ahmed, N. (2016). Effect of degraded ecosystem on fish biodiversity in the Old Brahmaputra River, Bangladesh and its conservation measures. *IOSR Journal of Environmental Science, Toxicology and Food Technology*, 10(9), 37–43.

Amoutchi, A. I., Mehner, T., Ugbor, O. N., Kargbo, A. and Kouamelan, E. P. (2021). Fishermen's perceptions and experiences toward the impact of climate change and anthropogenic activities on freshwater fish biodiversity in Côte d'Ivoire. *Discover Sustainability*, 2, 56.

Bassem, S. M. (2020). Water pollution and aquatic biodiversity. *Biodiversity International Journal*, 4(1), 10–16.

Brondízio, E. S., Settele, J., Díaz, S. and Ngo, H. T. (Eds.). (2019). *Global assessment report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. IPBES Secretariat. Bonn, Germany. https://doi.org/10.5281/zenodo.3831673

Chitrakar, P., Khalid, M. A. and Labh, S. N. (2024). Spatiotemporal variability in water quality, ichthyofaunal diversity, and its conservation in the rivers of Nepal: A Mini Review. *Iranian Journal of Fisheries Sciences*, 23(4), 633–648.

De Santis, V., Jeppesen, E., Volta, P. and Korkmaz, M. (2023). Impacts of human activities and climate change on freshwater fish. *Water*, II (15), 4166.

Dewangan, M. (2023). A Review on impact of water pollution on freshwater fish species and their aquatic environment. *Shodh Samagam*, 6(4), 1293–1300.

Duncan, A. E., Oti, J. and Potakey, M. E. (2019). Impacts of human activities on the quality of river water: A case study of River Densu in Nsawam Adoagyiri of the Akwapim South District, Eastern Region of Ghana. *Open Access Library Journal*, 6, e5785.

Dinh, Q. M., Nguyen, Y. T. N., Dang, T. H., Tran, N. S. and Lam, T. T. H. (2020). The impacts of human activities on the biodiversity of fish species composition in rice paddy field in An Giang Province, Southern Vietnam. *Egyptian Journal of Aquatic Biology & Fisheries*, 24(2), 107–120.

Duque, G., Gamboa-García, D. E., Molina, A. and Cogua, P. (2020). Effect of water quality variation on fish assemblages in an anthropogenically impacted tropical estuary, Colombian Pacific. *Environmental Science and Pollution Research*, 27, 25740–25753.

Eli, A. A., Angaye, T. C. N. and Abowei, J. F. N. (2025). Environmental impact, health implications, and socio-economic consequences of artisanal crude oil refining in the Niger Delta, Nigeria: A Comprehensive Review. *International Journal of Environment and Pollution Research*, 13(1), 19–33.

Feisal, N. A. S., Kamaludin, N. H., Sani, M. F. A., Ahmad, D. K. A. A., Ahmad, M. A., Abdul Razak, N. F. and Tengku Ibrahim, T. N. B. (2023). Anthropogenic disturbance of aquatic biodiversity and water quality of an urban river in Penang, Malaysia. *Water Science and Engineering*, 16(3), 234–242.

Hahshmi, A. M., Abdullah, Z., Amjad, T., Ali, G. and Iqbal, T. (2024). The Impact of anthropogenic activities and water pollution on the fish diversity and ecosystem health of the Chenab River in the Punjab region of Pakistan. *Journal of Human Research and Review*, 4(1), 554–555.

Keck, F., Peller, T., Alther, R., Barouillet, C., Blackman, R., Capo, E. and Altermatt, F. (2025). The Global human impacts on biodiversity. *Nature*, 641, 395–403.

Larentis, C., Kotz Kliemann, B. C., Neves, M. P. and Delariva, R. L. (2022). Effects of human disturbance on habitat and fish diversity in Neotropical streams. *PLOS ONE*, 17(9), e0274191.

Lelei, K. E., Onyeche, V. O., Ebenuwah, P. O., Ihaza, E., Omeje, J., Okojie, A. L., Imaseun, P. E. and D.O. Aganagana (2022**)**. Aquaculture and Biosecurity: The Case of Fish Farming in Delta State. *In*: *Book of Proceedings of the 37th Annual Conference of the Fisheries Society of Nigeria, 30th October – 4th November, 2022,* Yola, Adamawa State, Nigeria. Pp 217-224

Malik, D. S., A. K. Sharma, A. K. Sharma, R. Thakur and M. Sharma (2020). "A Review on Impact of Water Pollution on Freshwater Fish Species and Their Aquatic Environment." *In*: *Advances in Environmental Pollution Management: Wastewater Impacts and Treatment Technologies*. Kumar, N. Kamboj, T. Payum, J. Singh, and P. Kumar (Eds.), Vol. 1 (V): 10–28. Agro Environ Media. https://doi.org/10.26832/aesa-2020-aepm-02.

Meinam, M., Singh, Y. J., Bharati, H. and Meinam, T. (2023). Importance of fish biodiversity conservation and management. *International Journal of Science and Research Archive,* 9(2), 387–391.

Naik, M. (2023). The Impacts of Human Activities and Climate Change on Coastal Lagoon Water Quality and Ecology. *J. Coast Zone Manag.*, 26:556.

Oribhabor, B. J. (2016). Impact of human activities on biodiversity in Nigerian aquatic ecosystems. *Science International,* 4(1), 12–20.

Su, G., Logez, M., Xu, J., Tao, S., Villéger, S. and Brosse, S. (2021). Human impacts on global freshwater fish biodiversity. *Science,* 371(6531), 835–838.

UNEP GEMS/Water Programme (2008). *Water quality for ecosystem and human health.* 2nd Ed. United Nations Environment Programme Global Environment Monitoring System/Water Programme. Available at https://www.unep.org/resources/report/water-quality-ecosystem-human-health

Volta, P. and Jeppesen, E. (2021). Impacts of human activities and climate change on freshwater fish. *Water,* 13(3068).

Yen, H., Zhang, Y. and Li, X. (2022). "Spatio-temporal Distribution of Ichthyoplankton and Their Relationship with Environmental Factors in the Yellow River Estuary." *Frontiers in Marine Science*, 8, 1523007. https://doi.org/10.3389/fmars.2025.1523007.

Yin, S., Yi, Y., Liu, Q., Luo, Q. and Chen, K. (2022). A Review on effects of human activities on aquatic organisms in the Yangtze River Basin since the 1950s. *River,* 1(1), 104–119.

Zeng, C., Wen, Y., Liu, X., Yu, J., Jin, B. and Li, D. (2022). Impacts of anthropogenic activities on changes of Ichthyofauna in the middle and lower Xiang River. *Aquaculture and Fisheries*, 7(2), 693–702.

Zhou, Y. (2023). *Understanding stream water quality and fish diversity in the Great Lake surrounding areas: A path modeling analysis.* Master’s Thesis, University of Michigan, University of Michigan Library, U.S.A.