DOI: 10.5281/zenodo.14237247

CHAPTER 22

Freshwater Resources and Conservation

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Received: 10 August 2024; Received in revised form: 31 August 2024; Accepted: 05 September 2024; Available online: 28 November 2024

Abstract

Fresh water sustains more than 100,000 species, or around 6% of all known species, even though it only makes up 0.01% of the world's water and 0.8% of its surface. There are many different sectors that benefit economically, culturally, artistically, scientifically, and educationally from freshwater biodiversity and inland waterways. Preserving and preserving these resources is very beneficial for individuals, countries, and governments alike. Compared to terrestrial ecosystems, freshwater ones are losing biodiversity at a faster rate. Freshwater ecosystems are unique and home to a wide variety of species, which makes them particularly susceptible to human interference, as this article explains. We monitor threats to freshwater biodiversity on a global scale. There are five main types: overexploitation, water contamination, altered flows, habitat loss or degradation, and invasive species. Population decreases have

Interdisciplinary Research in Life Sciences: A Path Towards Sustainability (Vol. 2) - Jayvardhan V. Balkhande & Jalander Vaghmare (Eds.)

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https://doi.org/10.5281/zenodo.14237247

resulted from their combination and synergistic effects. The variety of aquatic life is dwindling on a worldwide scale. Endemism, non-substitutability, and the geographical placement of rivers and wetlands as "receivers" of land-use effluents all work against biodiversity conservation initiatives. There are numerous regions in the globe where fresh water is a scarce and competitive resource. The complex interplay between upstream drainage, adjacent land, riparian zones, and aquatic species migrating downstream makes freshwater biodiversity protection a formidable conservation problem. Very seldom are these conditions satisfied. Time is of the essence when chances to preserve whole river and lake ecosystems inside expansive protected areas arise. Amid human demand for ecosystem products and services and efforts to preserve freshwater biodiversity, a delicate equilibrium must be maintained over most of the Earth's landmass. Efforts to mitigate species loss must continue, and we support them. Nevertheless, there are several cases when we support a more moderate approach that puts human livelihoods, ecological resilience and functioning, and biodiversity conservation first. This method's ultimate goal is to provide the groundwork for the permanent preservation of freshwater resources.

Keywords: Freshwater, Over-exploitation, Water pollution, Freshwater biodiversity

Introduction

Throughout history, humans have exploited freshwater resources from rivers, lakes, groundwater, and wetlands for a variety of urban, agricultural, and industrial applications. However, in this process, the significance of freshwater in sustaining ecosystems has been disregarded. Aquatic ecosystems are undergoing significant modifications or complete destruction at a more rapid pace than ever before in human history, surpassing the rate at which they are being recovered. (Wilson and Carpenter 1999) Freshwater is essential for human survival and social welfare.

There are many advantages to using renewable sources of fresh water (Postel and Carpenter 1997). The cultivation of aquatic life, shellfish, and fish, as well as water for irrigation and industrial purposes, fall under this category. In addition to producing hydroelectric power and providing a home for aquatic life, freshwater systems provide several instream advantages, such as flood control, transportation, leisure, waste processing, and habitat. (Fig 1). To achieve benefits like agriculture and hydroelectric generation, dams and water diversions significantly change the flow regime and the routes of water flows (Rosenberg et al. 2000). These hydrological changes often undermine two instream benefits - the support of aquatic life and the preservation of water quality appropriate for human use - and hence have negative repercussions (Naiman et al. 1995). Consequently, freshwater ecosystems have historically emphasized its use for human consumption, agricultural irrigation, and transportation, often at the expense of other resources and functions. However, the fact that biologically diverse and operational aquatic ecosystems provide a number of economically significant functions and long-term advantages to society is becoming more and more apparent. When natural ecosystems and the organisms inside them are able to support and meet human requirements, this is called an ecosystem service, according to daily. The immediate benefits include ecosystem products and services such as drinkable water, nourishment, flood mitigation, human and industrial wastewater purification, and flora and fauna habitat protection. (Scaetiane 2004). These advantages are very significant and difficult, if not impossible, to replace.

Our instructional techniques are insufficient to effectively address the problem of sustainable water resource management. Hydrologists, engineers, and water managers, who are responsible for designing and overseeing our country's water resource systems, often do not get education on the impact of their decisions on ecosystems. Similarly, ecologists are not educated to consider the crucial role of water in human civilization. (Vitousek et al. 1997). Economists, developers, and politicians sometimes fail to adequately consider the possible environmental consequences of their short-term objectives due to a lack of long-term foresight. Most Americans are unaware of the infrastructure responsible for delivering clean tap water and managing trash disposal. Furthermore, only a small number of individuals comprehend the ecological compromises that were necessary to enable these luxuries. How can civilization effectively use water supplies without compromising the vital inherent diversity and adaptive potential of freshwater ecosystems.

According to many studies (Chao 1995), freshwater systems will undergo significant changes in the next century in terms of the social, economic, and ecological advantages they provide, as well as the balance between instream and consumption benefits. Both the total volume of water extracted by people and the area of land that has been irrigated have increased at an exponential rate throughout the last century. Sustainable water usage requires a worldwide view of water withdrawals, yet this view is inadequate for local and regional stability. The key to long-term success in water management is improving practices at the basin and watershed levels. (Rose 2000).

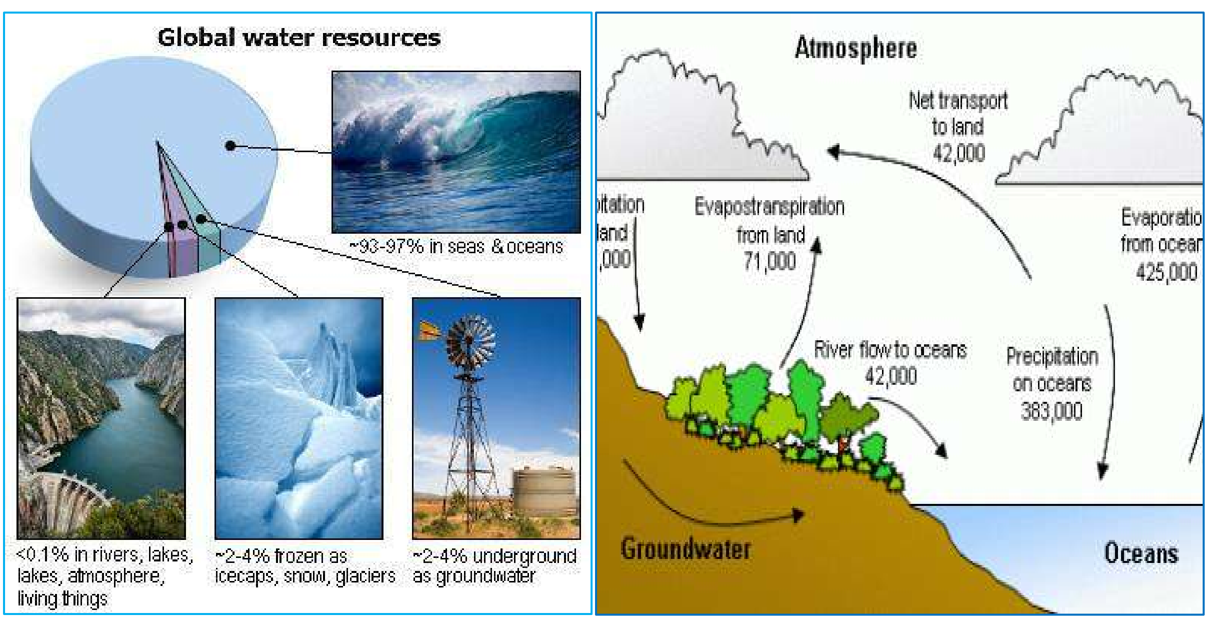

Fig. 1. global water resources (photos.google.com)

 ISBN: 978-93-95369-81-7 |

Human activities and the requirements of freshwater ecosystems often come into conflict. With our current biological knowledge of freshwater ecosystems, we can determine the timing, amount, and quality of water flow that are necessary for these ecosystems to function. An important first step in taking freshwater ecosystem demands into account when allocating resources in the future is getting the word out to a wide audience about these requirements. The following has been identified by prior research on the overall state of freshwater resources: The way water moves through the biosphere is significantly altered by human activity. (NRC 1992); humans use water extensively there is a widespread issue of poor water quality (Carpenter et al. 1998); and societal activities disproportionately endanger freshwater organisms. Various evaluations suggest that freshwater ecosystems are under stress and are in a vulnerable state. Evidently, there is a want for novel management methodologies. This research aims to elucidate the correlation between the integrity of freshwater ecosystems and the sufficiency, quality, timing, and temporal variability of water flow. Articulating these needs in a thorough but broad way provides a stronger basis for their incorporation in ongoing and future discussions on the distribution of water resources. By adopting this approach, the requirements of freshwater ecosystems may be duly acknowledged and resolved. We furthermore propose strategies for safeguarding, preserving, and revitalizing freshwater environments. To sustain the natural processes that provide ecosystem services and tradable and non-tradable commodities, this article lays out the needs of freshwater ecosystems for water that meets certain criteria, including quantity, quality, timeliness, and temporal variability. We recommend actions to be done in order to get back on track. The report finishes by offering suggestions for the preservation and upkeep of freshwater ecosystems.

We draw the following available scientific evidence: (1) more than half of the world's freshwater runoff is already used for human purposes; (2) Many people rural and urban areas do not have access to safe drinking water; (3) the per capita availability of freshwater will decrease in the next century due to population growth outpacing increases in available freshwater; (4) in the next 100 years, the Earth's hydrological cycle will be generally intensified by climate change, with increased precipitation, evapotranspiration, and storm frequency, as well as substantial changes in biogeochemical processes impacting water quality. (Jackson et al. 2000)

Many people throughout the globe do not have access to even the most basic forms of water, despite the obvious necessity of water to human life and well-being. Research must immediately be linked to better water management in order to meet the increasing demands on freshwater resources.

The water cycle will undergo significant changes in the next century as a result of climate change and an increasing disparity in the availability, usage, and population of freshwater. Water scarcity and poor quality are already problems in many parts of the globe. Despite predictions of a one-third increase in the world's population, accessible runoff is unlikely to see an increase of more than 10% in the next 30 years. (Gessner and Van Ryckegem 2003), Reduced freshwater ecosystem services, more aquatic species in danger of extinction, and increased fragmentation of wetlands, rivers, deltas, and estuaries are all consequences of this imbalance that will worsen until water use efficiency improves.

Methodology & Discussion

Abundance of Freshwater Resources

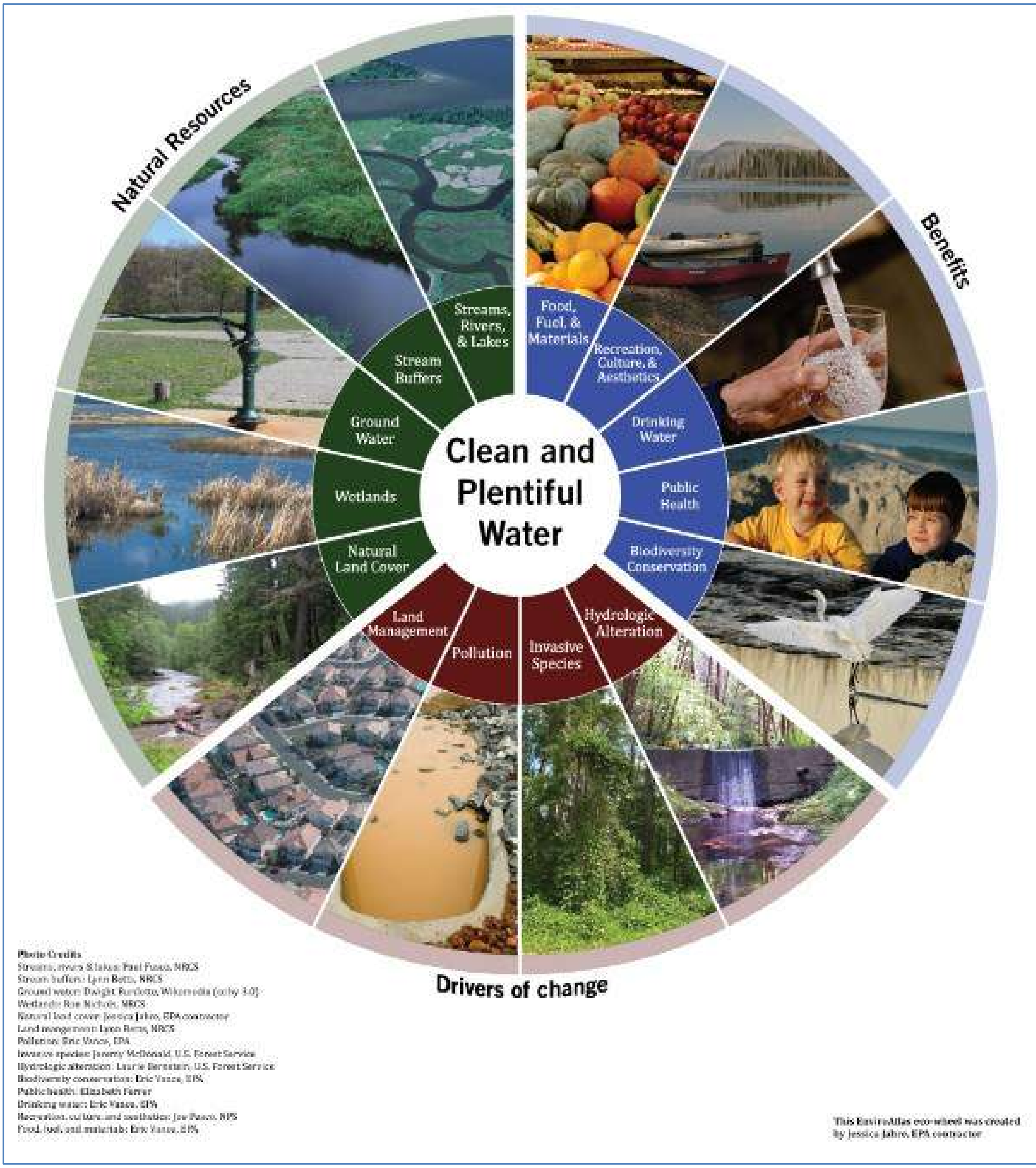

Fig. 2. water ways -production & consumption (photos.google.com)

Surface freshwater ecosystems comprise a mere 0.01% of the total global water volume and occupy a little 0.8% of the Earth's surface area (Gleick, 1996). Another perspective to consider is to enquire: what is the number of species documented by scientists that inhabit freshwater environments? The estimated number of species is roughly 100,000 out of a total of over 1.75 million, which accounts for nearly 6% of the total. Additionally, it is believed that there may be an additional 50,000 to 100,000 species living in groundwater (Gibert & Deharveng, 2002). Considering the pace at which people are causing deterioration in freshwater resources, it is undeniably accurate to say that when it comes to the loss of biodiversity and efforts for preservation, the means by which the information is conveyed has significant importance (Stiassny, 1999). Our understanding of the broad range of variety in fresh waterways is severely lacking, especially when it comes to invertebrates and microorganisms. This is particularly true in tropical regions, which are home to the majority of the world's species. (Fig. 2). The available information on microbial biodiversity is incomplete, despite the significant role that microorganisms play in influencing the Earth's biogeochemical cycles. The taxonomic richness of most prokaryotes remains largely unknown (Curtis & Sloan, 2004). Recent genomic investigations, such as the study conducted by (Zwart et al. 2003) indicate that the richness of aquatic microorganisms is far more than what was previously estimated based on traditional, non-molecular data. The findings of a number of studies that make use of a variety of methodologies indicate that several protists, also known as ciliates, may have limited geographic distributions. This suggests that these protists may be more diverse than had been assumed by researchers who assumed that they had global biogeographies. According to (Johns and Maggs 1997) it is very probable that the abundance of microalgae and fungus that are found in freshwater environments has been underappreciated.

Primitive Risks to Freshwater Biodiversity

The threats to global freshwater biodiversity can be categorised into five interacting groups: overexploitation, water pollution, flow modification, habitat destruction or degradation, and invasion by exotic species. These threats have been extensively studied by various researchers.

Global-scale environmental changes, such as nitrogen deposition, warming, and alterations in precipitation and runoff patterns, are affecting all of these hazard categories. These changes are happening on a large scale and are being added on top of the existing threats. Overexploitation predominantly impacts vertebrates, particularly fishes, reptiles, and some amphibians. In contrast, the other four hazard categories have implications for all forms of freshwater biodiversity, ranging from microorganisms to megafauna.

The issue of pollution is widespread, and while certain developed nations have made significant advancements in mitigating water pollution from both domestic and industrial sources, the risks associated with excessive nutrient enrichment and other chemicals like endocrine disruptors are increasing (Colburn, Dumanoski & Myers, 1996). Habitat degradation occurs due to a variety of interconnected processes. It may include both direct affects on the aquatic environment, such as the removal of river sand via excavation, as well as indirect consequences that arise from changes in the drainage basin. Forest clearing often results in adjustments to surface runoff and an increase in river sediment loads. These changes may lead to various ecosystem modifications, including coastal erosion, the suffocation of littoral habitats, the obstruction of river bottoms, and floodplain aggradation. Several of the greatest rivers in the world are now experiencing periods of drought or are expected to do so due to extensive water extraction (Postel & Richter, 2003). The effects of global climate change are expected to worsen flow alterations due to an increase in the frequency of floods and droughts. This will lead to an increase in water-engineering interventions. While not discussed in detail here, it is probable that the effects on river biota, such as fish, will be significant (Xenopoulos et. al., 2005).

The extensive infiltration and intentional introduction of non-native species exacerbates the physical and chemical effects caused by human activities on freshwater ecosystems. This is mostly due to the fact that non-native species are more likely to thrive in freshwater environments that have already been altered or harmed by human actions (Kromm, 2004). There are numerous instances of significant and striking impacts caused by non-native species on native species. For example, the introduction of Nile perch (Lates niloticus) in Lake Victoria, the crayfish plague in Europe, and the presence of salmonids in lakes and streams in the Southern Hemisphere have all had profound effects. These impacts are expected to intensify in the future, according to Sala et al. (2000). Exotic terrestrial plants, including Tamarix spp. (Tamaricaceae), may have indirect affects by changing the water patterns in riparian soils and influencing stream flows in Australia and North America (Turner 1994). The vulnerability of freshwater biodiversity is due to the fact that freshwater is a resource that may be exploited, diverted, controlled, or polluted by people, which can negatively impact its value as a home for creatures. Occasionally, the effects have endured for hundreds of years. The size of most freshwater systems is not limited to the area covered by water, but also includes the surrounding area from which water and debris are collected (Naiman & Latterell, 2005). Lakes and rivers, due to their location in the terrain, often in valley bottoms, serve as receptacles for garbage, sediments, and pollutants carried by runoff. This principle also applies to seas and oceans, but, inland water bodies often have a smaller amount of open marine waters, which restricts their ability to disperse pollutants or alleviate other consequences.

Furthermore, in several regions around the globe, there is intense rivalry among various human stakeholders for access to fresh water. This struggle may become so severe that violent conflicts may emerge when water resources are scarce and rivers cross political borders (Poff et al., 2003). There are a total of 263 international rivers, which together drain about 45% of the Earth's geographical surface. The fact that this region sustains almost 40% of the world's human population is a clear indicator of the magnitude of the problem. In most disputes about the many uses of water, whether they occur at an international or local level, the preservation of aquatic biodiversity is often overlooked when deciding how to distribute the water. In China and India, which are home to almost 55% of the world's big dams (W. C. D., 2000), little attention has been paid to the distribution of water downstream for the purpose of preserving biodiversity.

The Prerequisites for Freshwater Ecosystems That Are Functionally Intact

The form and function of freshwater ecosystems are intricately connected to the watershed, also known as the catchment, in which they exist (Likens 1984). Water travels through freshwater systems in

 ISBN: 978-93-95369-81-7 |

three spatial dimensions: longitudinal (upstream-downstream), lateral (channel-floodplain or wetland-lake edge), and vertical (surface water-groundwater) as it makes its journey to the sea. The dimensions mentioned below depict the functional connections between different parts of an ecosystem over a period of time, as described by (Ward in 1989). Freshwater bodies get materials from the landscape and are thus significantly affected by terrestrial processes, including human alterations of land (Moyle and Leidy 1992).

There are five dynamic environmental factors that control the form and function of aquatic ecosystems. However, the significance of these factors may vary depending on the kind of aquatic ecosystem. The interplay of these factors in both spatial and temporal dimensions determines the dynamic characteristics of freshwater ecosystems.

Fig. 3. freshwater ecosystems provide economically valuable commodities and services to humans (drinking water, irrigation, transportation, recreation, etc.), as well as habitat for plants and animals (photos.google.com)

1) The flow regime determines the speed and routes by which precipitation enters and moves within river channels, lakes, wetlands, and connected groundwater, as well as the duration that water stays in the ecosystem.
2) Sediment and organic matter inputs contribute to the formation of physical habitat structure, refugia, and nutrient storage and provision.
3) Thermal and light properties control the metabolism, activity level, and production of organisms in an environment.
4) The chemical and nutritional features of a substance control the pH level, productivity, and quality of water.
5) The composition of living organisms affects the pace of ecological processes and the structure of the community.

All five of these drivers exhibit natural yearly periodicity in naturally operating systems, which is determined by seasonal variations in temperature and day duration, resulting in a range of variance (fig.

Ecosystems and species have adapted to the regular patterns of these factors, and they have also created survival strategies for dealing with occasional dramatic changes in water levels produced by floods and droughts, which may not happen every year. When assessing the integrity of freshwater ecosystems, it is necessary to examine all five factors together, rather than focusing on individual variables (Flather 1998). Examining components of a healthy aquatic environment individually will not provide an accurate representation.

Flow Regime

Currently, several rivers have a resemblance to intricate plumbing systems, where the flow of water is meticulously regulated, similar to water from a tap, in order to optimise the advantages of these rivers for human use. However, whereas modern engineering has achieved remarkable achievement in delivering water to people and crops in a timely and location-specific manner, it has not been able to safeguard the essential biological role of rivers and aquatic systems.

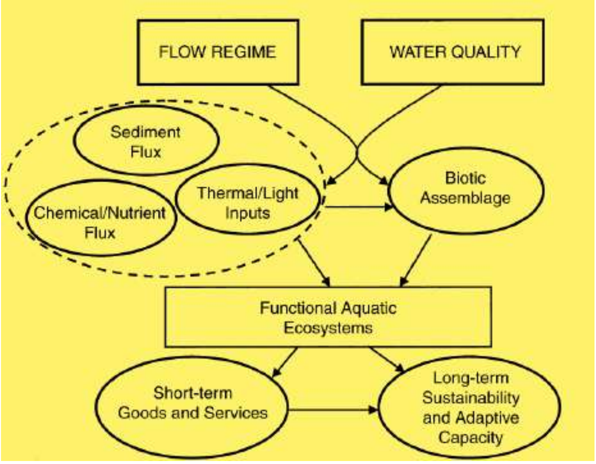

Fig. 4. conceptual model of major driving forces that influence freshwater ecosystems

Sediment and Organic Matter Inputs

Human activities have significantly modified the natural rates of sediment and organic matter delivery to aquatic systems, resulting in both increased and decreased inputs. Inadequate agriculture, logging, or home development practices contribute to elevated levels of soil erosion. The accumulation of silt behind dams reduces the usual flow of material to downstream regions, causing erosion of streambeds, degradation of habitat, and preventing flood events from replenishing wetland and riparian areas (Patten et al., 2001). According to Smith (195), about 1.23 billion cubic meters of silt accumulate annually in reservoirs throughout the United States. Siltation resulting from agricultural, urban, construction, other unidentified non-point sources is responsible for the degradation of 25% of all lakes that fail to fulfil their water quality criteria. Channel straightening, excessive grazing of riparian areas, and removal of streamside vegetation decrease the amount of organic matter entering the water, but also often lead to an increase in erosion.

Thermal and Light Characteristics

The characteristics of light and heat are affected by the climate and geography, as well as the chemical composition, suspended sediments, and primary productivity of a waterbody. The temperature of water directly controls the levels of oxygen, the metabolism of organisms, and the related life processes. The temperature regime has a significant impact on the fitness of organisms and thus affects the distribution of species in terms of both geographical location (along latitudinal and altitudinal gradients) and time. The absorption of solar energy and its dissipation as heat play a crucial role in the formation of thermal structure and water circulation patterns, especially in lakes (Wetzel 1983). These traits subsequently impact the process of nutrient cycling, the dispersion of dissolved gases and organisms, and the behavioral adaptations of living beings.

Chemical/Nutrient Characteristics

The natural nutritional and chemical conditions are determined by the specific characteristics of the local climate, bedrock, soil, plant type, and terrain. Natural bodies of water may vary from transparent, low-nutrient rivers and lakes that are situated on crystalline bedrock, to more fertile and chemically enhanced freshwater in areas with productive soils or limestone bedrock. Cultural eutrophication is the phenomenon in which human activities introduce extra nutrients, leading to a significant increase in productivity compared to the original condition (Carpenter et al., 1998).

Biotic Assemblage

The composition of species communities in aquatic ecosystems is influenced by the regional species pools, which are determined by the biogeographic history. Additionally, the ability of species to colonise and thrive in these environments is also a factor (Tonn et al. 1990) for more information). The appropriateness of an ecosystem for a specific species is determined by the limits of environmental variation set by factors such as flow, sediment, temperature conditions, light availability, nutrient levels, and the existence of other species and their interactions within the system. Both living (biotic) and non-living (abiotic) factors work together to regulate and influence the presence of a wide variety of species that play important roles in essential ecosystem activities such as primary production, decomposition, and nutrient cycling. The ability to adjust to future changes in the environment is influenced, to some extent, by the seeming duplication of ecological services carried out by different species. Having a high level of apparent redundancy, such as biodiversity, provides a kind of protection that ensures ecological services will persist even under environmental strain (Mulder et al. 2001).

Are Conservation Strategies Designed for Land-Based Ecosystems Suitable for Preserving Freshwater Biodiversity?

Terrestrial conservation methods often priorities regions with excellent habitat quality that can be clearly defined and safeguarded. The approach of "fortress conservation" is unlikely to succeed in protecting freshwater ecosystems and may even have negative effects (Dunn, 2003) for rivers or lakes that are part of larger, unprotected drainage basins, unless the boundaries are defined at the catchment scale, which is rarely done (Naiman et. al., 2005). The issue of defining boundaries hinders effective local management of freshwater biodiversity. This is because protecting a specific part of the river's living organisms and their habitat necessitates control over the upstream drainage network, the surrounding land, the riparian zone, and, in the case of migrating aquatic fauna, the downstream areas. protection efforts at the watershed size, which include linked landscape units, are necessary for terrestrial species that undergo seasonal migrations. However, the limitations of fortress protection are especially problematic for freshwater biodiversity.

The Significance of Freshwater Biodiversity

Regarding terrestrial ecosystems, as stated by Hooper et al. (2005). Nevertheless, the specific effects of biodiversity change will differ depending on the kind of ecosystem and the processes and attributes being examined. While our understanding of freshwater ecosystems is limited compared to terrestrial ecosystems, there is evidence suggesting that changes in biodiversity might affect ecosystem processes (Covich et al., 2004). Furthermore, the loss of species is likely to result in an increase in the variability of process rates, even if the average rates stay the same. Predicting the impact of human pressures on ecosystem functioning is feasible in some circumstances (Jonsson et al., 2002). However, in the majority of instances, there is a lack of enough knowledge to generate well-informed forecasts. Recognizing the importance of freshwater biodiversity is crucial for maintaining its overall health and prosperity. Scientists will undoubtedly If politicians and policy-makers are unable or unwilling to assign a value to the ecosystem's "free" products and services, then they are neglecting to recognise their importance. This will be interpreted as a 'value of zero'. The resources that are likely to be safeguarded are those that are valued. Water should cease to be a freely or inexpensively available resource, as it is now seen in the majority of nations (Clark & King, 2004). Accurate economic assessments of water as a home for freshwater biodiversity, and the benefits that such biodiversity offers, will play a crucial role in influencing societal perspectives.(fig 5). The first assessment of the worldwide values of ecosystem products (such as food in the form of fish) and ecosystem services the significance of inland waterways is expected to rise as ecosystems face more strain and their resources and benefits become increasingly rare.

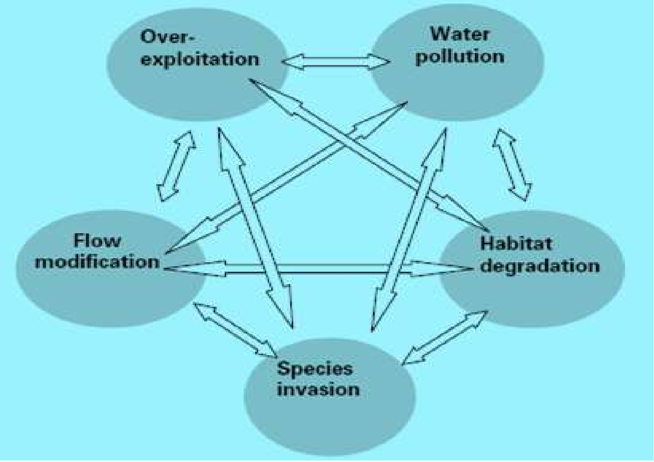

Fig. 5. potential interactive impacts on freshwater biodiversity

Conclusions

Only 0.01% of the Earth's water is fresh water, and it only spans 0.8% of the Earth's surface. However, this little amount of global water sustains over 100,000 species out of roughly 1.75 million, which is nearly 6%. Unsurprisingly, due to their geographical location and significance as a natural asset, freshwater bodies are seeing significant reductions in biodiversity, surpassing even the decreases seen in the most impacted terrestrial ecosystems. The losses in question seem to be particularly severe in some tropical latitudes, primarily impacting big fishes and other species.

The risks to global freshwater biodiversity may be classified into five main categories: excessive exploitation, water pollution, alteration of natural water flow, loss or deterioration of habitats, and invasion by non-native species. Their collective and interdependent impacts on biodiversity have now spread globally, and are intensified by large-scale environmental changes such as nitrogen deposition and climate change. Scientists are becoming more aware of these concerns, but they are not being adequately integrated into water-resource development. Therefore, there is a need for broader distribution and focus on this knowledge.

There is a lack of comprehensive data on freshwater biodiversity in many regions, particularly in tropical areas. Additionally, the present estimates of species loss may be lower than the actual rates. A prompt and collaborative initiative should be undertaken to evaluate the worldwide biodiversity of freshwater, particularly significant areas of high species richness. This effort should be conducted in collaboration with prominent non-governmental organisations, research institutes, and scientific societies. This exercise should be conducted simultaneously with the continuous development of strategies for the preservation and control of freshwater biodiversity.

Freshwater resources face intense competition among many human stakeholders in several places, and significant conflicts may emerge when water supplies are scarce or cross political borders. The conservation of biodiversity is further complicated by the geographical location of rivers and wetlands, which act as recipients of land use effluents. Additionally, challenges arise from the presence of endemic species with restricted geographic ranges and non-substitutability.

Preserving freshwater biodiversity is a significant conservation problem as it necessitates the management of the whole upstream drainage network, the surrounding land, the riparian zone, and, in the case of migratory aquatic species, the downstream areas. These requirements are seldom fulfilled and will need the establishment of comprehensive management partnerships at suitable sizes, specifically focused on drainage basins. The intricate concerns related to the construction and maintenance of protected areas for freshwater need the focused and creative efforts of academics.

Aquatic biodiversity is influenced by water regimes via several interconnected processes that operate at different geographical and temporal ranges. Preserving the natural fluctuations in water flows and levels is crucial for supporting efforts to protect freshwater biodiversity and ecosystems. To achieve this, it is necessary to construct a hydrological regime that replicates the natural fluctuations in water flows and levels, rather than just prioritising minimum levels. Currently, experts are unable to determine the amount of water that can be removed or the fluctuations in flow that can be tolerated for the majority of freshwater systems and species. Immediate research is required on the topic of environmental water allocations. Additionally, it is crucial that the allocation of water flows necessary for the conservation of biodiversity be given equal priority to engineering considerations and other objectives during the planning of water-resource improvements.

Freshwater biodiversity offers a diverse range of significant resources and benefits for human civilisations. Certain individuals possess qualities or characteristics that cannot be substituted or replicated. However, there is a lack of empirical evidence that demonstrates the comparison between the value of products and services received by preserving ecosystems in their original state vs converting them for human use. The many applications of freshwater, including nonconsumptive use, highlight the significance of taking into account the viewpoints of a diverse group of stakeholders in environmental assessment and in the formulation of efficient conservation strategies.

The preservation of biodiversity is a crucial measure to determine whether water use and alterations to ecosystems are sustainable. Implementing comprehensive conservation measures that safeguard all components of freshwater biodiversity would ensure the sustainable use of water resources for human needs. In contrast, the extent of the endangerment and depletion of biodiversity serve as a measure of the degree to which existing behaviour are not sustainable.

Employing a combination of solutions will be crucial in order to preserve the variety of freshwater organisms over an extended period of time. The plan should incorporate reserves that safeguard crucial water bodies with high biodiversity, particularly those with significant species diversification, and their surrounding areas. Additionally, it should include strategies that prioritise the conservation of biodiversity and the sustainable use of water resources within human-altered ecosystems. Simultaneously, scientists should enhance their communication efforts to convey the significance and worth of freshwater biodiversity to stakeholders and policy makers. This will ensure that all relevant knowledge on freshwater biodiversity is appropriately used to guarantee its preservation.

Acknowledgments

We are grateful to Prof. Vidyavati, former Vice Chancellor of Kakatiya University, Warangal for her valuable suggestions and constant encouragement.

Disclosure of Conflict of Interest

The authors declare no conflict of interest.

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