Agri Articles
(e-Magazine for Agricultural Articles)
Volume: 04, Issue: 01 (JAN-FEB, 2024)
Available online at http://www.agriarticles.com
©Agri Articles, ISSN: 2582-9882

Watershed-Based Management of Fresh Water, Forests and Inland Fisheries

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A watershed, also known as a basin or catchment, is a geographical unit in hydrology where the topography directs all incoming precipitation to a common drainage point. Watersheds vary in size, with ridges typically defining their boundaries. Hydrologic unit codes (HUCs) are numerical identifiers used for data management and water resource planning, categorized into six levels based on watershed size: Region, Subregion, Basin, Subbasin, Watershed, and Sub watershed. The HUC designations help show the hierarchical structure of nested watersheds. Land use changes significantly impact hydrological processes, influencing aspects such as evaporation, surface runoff, and groundwater recharge. Understanding land use is crucial for managing water resources, predicting floods, assessing nutrient loss, and conducting biodiversity protection research. Roughly 69% of Earth's freshwater is in glaciers and polar ice caps, with around 30% as groundwater. Only about 1% is directly available for human use. Unequal global distribution results in 2.1 billion people lacking access to safe drinking water, as reported by the United Nations in 2017. The annual estimated worldwide water footprint is approximately 9 trillion tons. Conservation of forests is necessary for maintaining global food production, availability of freshwater and mitigating climate change. Forests are often managed for multiple purposes such as biodiversity conservation, recreation, and wood production. Well-kept forests not only store and filter water but also reduce the risk of flooding and surface runoff. Inland fish and fisheries serve important nutritional, economic, cultural, and recreational roles in human society (reviewed by Lynch et al., 2016). A comprehensive approach to fisheries management, watershed-based inland fish management considers the entire watershed in its strategies.

Watershed-based management of forests

Forests are frequently maintained for a variety of objectives, including the preservation of biodiversity, enjoyment, and the production of wood. In addition to storing and filtering water, healthy, well-maintained woods help lower the danger of flooding and surface runoff. Forest hydrological science, which was primarily established in the 1960s to address concerns ranging from acid rain to soil erosion, is the foundation of sound forest watershed management (Brooks et al., 2003, Black, 2005, Vose et al., 2016, Amatya et al., 2016, Jones et al., 2020). In an increasingly complicated environment, the development of forest hydrology has brought much-needed direction on sustainable watershed management (Vose et al., 2011, Vose et al., 2016). There are several benefits that forests and wooded watersheds offer. While there is still much to learn about how forest management affects water flows and climate, it is widely acknowledged that forest ecosystems are vital for supplying essential hydrological functions. When precipitation, in whatever form, happens, the water may instantly start to flow downstream or it may be temporarily trapped as ice and snow or in soil. Water flows through surface waterways like rivers and streams as runoff, and it can be stored

in lakes and marshes, and it may potentially go into groundwater in aquifers for longer-term storage. In any case instance, precipitation-fed water in a watershed eventually travels downstream through riverine system. Although surface water makes up the majority of this, some water still flows as hyporheic or subsurface (i.e., water that remains below the soil's surface) flows through beneath the surface, next to streams, are rocks and gravel. Influences of forest management surface water as well as long-term groundwater supplies and subterranean flows. The state of the watersheds—which store and channel water—has a direct impact on the amount, quality, and timeliness of the water supply. Numerous ecological, socioeconomic, and physical processes that are present in landscapes affect watersheds (Beechie et al., 1996; Dobrowolski and Thurow, 1995). Because they are easily recognisable on maps, can be inferred from remotely sensed data, and do not alter much over time, watersheds are an ideal unit for planning restoration and management initiatives (Reid, Ziemer, and Furniss, 1996; Bohn and Kershner, 2002).

Inland fisheries management

Inland fish and fisheries serve important nutritional, economic, cultural, and recreational roles in human society (reviewed by Lynch et al., 2016). Aside from the current over 950 million hungry people, there is an increasing need to increase global food production by up to 70% to feed an additional 2.3 billion people by the year 2050. This calls for the efficient and responsible use of water resources, which fisheries and aquaculture production can greatly contribute to the global economy. Despite its significance, aquaculture growth is decreasing, going from 11.8% in 1985–1995 and 7.1% in 1995–2003 to 6.1% in 2004–2006. This could be attributed to several factors, including dwindling water resources, growing environmental issues, a decline in small farmers, and the effects of global warming (Gupta, 2010). An all-encompassing method for controlling fisheries, watershed-based inland fish management takes the watershed as a whole into account. The underlying premise of this strategy is the knowledge that inland fisheries are a component of a broader social-ecological watershed system (SEWS). Particularly in nations like India, inland fisheries—which include lakes, rivers, brooks, streams, ponds, inland canals, dams, and other land-locked freshwater sources—have a major economic impact. Approximately 30% of the world's total fish production comes from them. To manage inland fisheries, the watershed-based management method supports transboundary governance and governance at the watershed scale. Guarantee pertinent and applicable monitoring and research, it entails the utilization of transdisciplinary projects and teams. This strategy aids in maintaining fisheries and enhancing their financial performance. Watershed-based inland fish management is a comprehensive approach to fisheries control that considers the watershed as a whole. The understanding that inland fisheries are a part of a larger social-ecological watershed system (SEWS) forms the basis of this strategy. Inland fisheries, comprising lakes, rivers, brooks, streams, ponds, inland canals, dams, and other landlocked freshwater sources, have a significant economic influence, especially in countries like India. They provide around 30 percent of the seafood produced worldwide. The watershed-based management approach encourages both transboundary governance and governance at the watershed scale for the management of inland fisheries. It requires the use of transdisciplinary projects and teams to provide relevant and appropriate monitoring and research. This tactic helps to preserve fisheries while improving their bottom line.

Freshwater management

A way to manage water resources that considers the watershed as a whole is known as "watershed-based freshwater management. At the watershed level, managing freshwater resources entails taking into account how different components—such as surface water, groundwater, and the land itself—are interrelated. The entire ecology inside a watershed is

examined through watershed management. This includes marshes, rivers, lakes, woods, and other topographical elements. It is feasible to handle the intricate relationships between various components by taking the system as a whole into consideration. Watershed management requires careful land use planning. To reduce the negative effects of human activity on water quality and quantity, such as industrial development, urbanization, and agriculture, regulations and planning must be in place (Edwards *et al.,* 2015). The goal of watershed management is to safeguard and enhance water quality. To stop the deterioration of water bodies, pollution from a variety of sources, including urban stormwater, agricultural runoff, and industrial discharges, must be controlled. In addition to contributing to sedimentation in rivers and lakes, soil erosion can have a substantial effect on the quality of the water. Best management practices in agriculture, reforestation, and the use of cover crops are a few examples of erosion control techniques included in watershed management. An ecosystem's ability to remain healthy depends on the watershed's biodiversity being preserved and improved. This includes controlling invasive species, repairing damaged regions, and protecting natural ecosystems. Flooding can be prevented by controlling vegetation and land use within a watershed. Wetlands and forests, among other natural features, are essential for controlling water flow and limiting runoff. It is important to include nearby communities in the management of watersheds. Stakeholders and locals alike frequently possess insightful knowledge about the region and can support sustainable management techniques. Participation in the community may help promote a sense of accountability and proprietorship. IWRM is a more comprehensive idea that frequently includes watershed management. It entails the planned use and stewardship of the land, water, and other resources to optimize social and economic well-being while maintaining the ecological sustainability of these resources.

Conclusion

Watershed-based conservation efforts are crucial for safeguarding the health and sustainability of freshwater ecosystems, forests, and inland fisheries. By recognizing the interconnectedness of these natural resources within a watershed, we can implement comprehensive strategies that address multiple conservation challenges simultaneously. Through coordinated management practices such as reforestation, sustainable land use planning, and watershed protection measures, we can mitigate the impacts of pollution, habitat degradation, and overexploitation. Additionally, fostering community engagement and collaboration among stakeholders is essential for the long-term success of conservation initiatives. Ultimately, by prioritizing watershed conservation, we can ensure the resilience and vitality of these invaluable ecosystems for future generations to enjoy and benefit from.

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