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Biotic and Abiotic Components of The River

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ABSTRACT

This study offers a comprehensive analysis of the physico-chemical parameters of the Sarodha Dam in Kabirdham, Chhattisgarh, over three distinct periods: pre-autumn, autumn, and post-autumn of 2007. Key parameters examined include temperature, velocity, total solids, total suspended solids, total dissolved solids, turbidity, pH levels, dissolved oxygen content, free CO2 concentration, biochemical oxygen demand (BOD), chemical oxygen demand (COD), alkalinity, chlorides, sulphate levels, and fish species identification. The research identified 36 distinct fish species within the dam, underscoring the biodiversity present. Historically, water has been a crucial resource for human survival and development, with rivers playing a vital role globally. However, pollution from sewage and industrial effluents threatens these vital water bodies, leading to significant environmental and health issues. Despite advances in water treatment, urban piped water often remains contaminated, resulting in waterborne diseases such as jaundice, cholera, typhoid, and gastroenteritis. Pollution impacts rivers through chemical degradation and disruption of ecosystems, highlighting the need for interdisciplinary approaches to monitor and manage water quality effectively.

Keywords : Dissolved Oxygen, Turbidity, pH Levels, Seasonal Variations, Water Resource Management, Ecological Health

I. INTRODUCTION

The Saroda Dam, situated in the heart of Kabirdham district in Chhattisgarh, India, is not merely a feat of engineering but a pivotal nexus of human enterprise and ecological dynamism. This introduction delves into the multifaceted dimensions of the Saroda Dam, exploring its role in water resource management, hydroelectric power generation, and its profound impact on the local environment and communities.

The Saroda Dam stands tall amidst the serene landscape of Kabirdham district, embodying the culmination of human ingenuity and hydraulic engineering prowess. Constructed to address critical regional needs, the dam serves as a bastion of water resource management and hydroelectric power generation. Its architectural design, comprising robust concrete and masonry elements, reflects meticulous planning to withstand the hydraulic forces exerted by its reservoir. Strategically located, the dam's structural integrity and efficient water storage mechanisms mitigate the perennial risks of floods and droughts, safeguarding both life and property in the region.

Since its inception, the Saroda Dam has catalyzed profound socio-economic transformations in its vicinity. One of its primary objectives was to alleviate the water scarcity plaguing local agriculture. The reservoir's stored waters now irrigate vast agricultural lands, enhancing crop productivity and ensuring food security for local farmers. Moreover, the provision of reliable irrigation facilities has enabled farmers to cultivate multiple crops throughout the year, leading to socio-economic upliftment and poverty reduction.

Beyond agriculture, the dam fulfills the essential need for clean drinking water, supplying nearby villages and towns with a dependable water source. This provision has significantly improved public health outcomes by reducing waterborne diseases and enhancing overall quality of life. Furthermore, Saroda Dam's hydroelectric power generation capabilities contribute significantly to regional energy security, providing clean and renewable electricity to support industrial development, job creation, and economic growth.

While celebrated for its socio-economic benefits, the construction and operation of Saroda Dam have not been without environmental consequences. The transformation of natural river ecosystems due to the dam's impoundment, alteration of water flow regimes, and fragmentation of aquatic habitats pose significant challenges to local biodiversity. These changes impact aquatic flora and fauna, necessitating careful environmental management strategies to mitigate adverse effects.

Additionally, the displacement of communities residing in the dam's reservoir area underscores the need for sensitive resettlement and rehabilitation efforts. Addressing these socio-environmental concerns requires a balanced approach that ensures sustainable water resource management while safeguarding ecological integrity and respecting the rights of affected communities.

The Saroda Dam symbolizes a pivotal nexus of human progress and environmental stewardship in Kabirdham district. Its role in enhancing water resource management, agricultural productivity, and regional energy security underscores its significance as a vital infrastructure asset driving socio-economic development. However, the challenge lies in ensuring equitable and sustainable utilization of water resources while minimizing environmental impacts. By addressing these challenges through comprehensive planning, adaptive management, and community engagement, Saroda Dam can continue to serve as a beacon of progress while preserving the ecological balance for present and future generations.

II. LITERATURE REVIEW

Water quality and ecology in Himalayan river systems have drawn considerable attention due to their ecological significance and the increasing pressures of anthropogenic activities. This literature review synthesizes studies focusing on various aspects of water quality, hydrobiology, and ecological health of rivers in the Himalayan region, particularly in the Garhwal and Kumaon Himalayas.

Standard Methods for Examination of Water and Wastewater (20th ed.) by American Public Health Association, American Water Works Association, & Water Pollution Control Federation (1998) provides standardized protocols for water quality analysis, offering a foundational framework for subsequent research in this field.

Hydrobiology of the river Alakhnanda of Garhwal Himalaya (Badola & Singh, 1981) offers insights into the ecological dynamics of the Alakhnanda River, contributing to our understanding of the hydrobiological aspects of Himalayan river systems.

Ecology of Limnoflora in river Koshi of the Kumaon Himalaya (U.P.) (Bhatt, Bisht, & Negi, 1984) sheds light on the limnological aspects of the Koshi River, enriching our knowledge of the diverse flora in Himalayan river ecosystems.

Ecological study of Suswa River: modeling DO and BOD (Bhutiani & Khanna, 2007) presents a modeling approach to understand the ecological dynamics of the Suswa River, emphasizing the importance of dissolved oxygen (DO) and biochemical oxygen demand (BOD) in assessing water quality.

Interactions and interrelations between human and water (Biswas, 1970) explores the intricate relationship between human activities and water resources, highlighting the need for sustainable water management practices in the Himalayan region.

A quantitative survey of plankton and physiological conditions of the river Yamuna at Allahabad (Chakrabarty, Ray, & Singh, 1959) provides valuable data on plankton abundance and physiological conditions in the Yamuna River, informing ecosystem health assessments.

Seasonal variation in the microbial ecology of river Ganga at Hardwar (Chugh, 2000) investigates seasonal variations in microbial communities in the Ganga River, underscoring the dynamic nature of microbial ecology in response to environmental changes.

Some aspects of physico-chemical characteristics of western Ganga canal near Jwalapur at Haridwar (Joshi & Bisht, 1993) focuses on physicochemical parameters of the Ganga Canal, offering insights into water quality variations in anthropogenically influenced stretches.

Sulphate content in bore well water of Bhopal city (Kataria, 1966) examines sulphate levels in bore well water, highlighting potential groundwater quality issues in urban areas.

Physicochemical analysis of water of Kubza river of Hoshangabad (Kataria et al., 1995) provides data on physicochemical parameters of the Kubza River, contributing to the understanding of water quality in the Hoshangabad region.

Describes seasonal variation in some physicochemical parameters of Ganga (Kaur & Joshi, 2003) investigates seasonal variations in physicochemical parameters of the Ganga River, emphasizing the importance of temporal dynamics in water quality assessments.

Ecology and Pollution of Ganga River (Khanna, 1993) offers a comprehensive overview of ecological and pollution issues in the Ganga River, synthesizing decades of research on the subject.

Fish fauna of the river Ganga at Hardwar (Khanna & Badola, 1991) documents the fish fauna of the Ganga River at Hardwar, providing valuable information for conservation and management efforts.

Worked on limnological status of Satikund pond at Hardwar (Khanna & Bhutiani, 2003) assesses the limnological status of Satikund pond, highlighting the importance of localized studies in understanding ecosystem dynamics.

Water analysis at a glance (Khanna & Bhutiani, 2004) provides a concise overview of water analysis techniques and parameters, serving as a valuable resource for water quality monitoring initiatives.

Published a book on pond fish ecology and economics (Khanna & Singh, 2002) explores the ecological and economic aspects of pond fishery, offering insights into sustainable aquaculture practices.

Fishes and their ecology of river Suswa at Raiwala (Dehradun) (Khanna et al., 1999) examines the fish diversity and ecological dynamics of the Suswa River, highlighting the importance of riverine ecosystems in supporting aquatic biodiversity.

Study of assessment of water quality of river Ganga in distt. Bulandshahar (U.P.) (Khanna et al., 2003) evaluates water quality in the Ganga River, emphasizing the need for localized assessments to inform management strategies.

Studied the diseases caused because of polluted water in New Delhi (Kudesia, 1988) investigates waterborne diseases in New Delhi, highlighting the public health implications of water pollution.

Seasonal variation in the nutrients of the river Bhavani at Sirumugai, Coimbatore district, Tamil Nadu (Logankumar et al., 1989) examines seasonal variations in nutrient levels in the Bhavani River, contributing to our understanding of riverine nutrient dynamics.

Observation on fluctuations in abundance of plankton in relation to certain hydrological conditions of river Ganga (Pahwa & Mehrotra, 1966) explores plankton dynamics in the Ganga River in relation to hydrological conditions, elucidating the factors influencing plankton abundance.

A preliminary study on the physico-chemical quality of water of the river Kosi (Pandey et al., 1993) provides preliminary data on the physicochemical quality of the Kosi River, highlighting potential water quality concerns in the region.

Studies on water pollution on Yamuna river at Agra (Sangu & Sharma, 1985) investigates water pollution in the Yamuna River at Agra, emphasizing the need for pollution control measures to safeguard river health.

Environmental Science (Santra, 2004) offers a comprehensive overview of environmental science concepts, including water quality, pollution, and ecosystem dynamics. Water quality assessment of sacred Himalayan Rivers of Uttarakhand (Semwal & Akolkar, 2006) evaluates water quality in sacred Himalayan rivers, highlighting the importance of preserving these ecologically sensitive ecosystems.

Chemical and Biological method for water pollution studies (Trivedi & Goel, 1986) provides methodologies for chemical and biological assessments of water pollution, offering practical tools for researchers and practitioners.

Studied the monitoring and control of river pollution (Trivedy, 1990) focuses on monitoring and controlling river pollution, underscoring the importance of proactive management strategies in mitigating environmental impacts.

Present status of Ichthyofaunal diversity of Garhwal Himalayan river Bhilangna and its tributaries with reference to changing environment (Agarwal et al., 2011) assesses the ichthyofaunal diversity of the Bhilangna River, highlighting the impact of environmental changes on aquatic biodiversity.

Bhilangana River Impoundment Consequences to Riverine Environment (Agarwal et al., 2018a) examines the environmental consequences of Bhilangana River impoundment, emphasizing the need for sustainable river management practices.

Bhilangana River Regulation for Tehri Hydro Power Project in Central Himalaya: Impact on Planktonic Assemblages (Agarwal et al., 2018b) investigates the impact of river regulation on planktonic assemblages in the Bhilangana River, highlighting the ecological implications of hydroelectric projects in the Himalayan region.

III.Comparison Table

Findings

The results of a number of studies that were conducted on the water quality, hydrobiology, and ecological health of Himalayan river systems reveal a variety of important and diverse insights. Research such as the hydrobiology of the Alakhnanda River sheds light on the river's abundant biodiversity and the complex interactions between its various species, thereby highlighting the river's ecological significance. Investigating the limnoflora in the Koshi River reveals an abundance of flora diversity as well as the ecological roles that these plants play, which are essential for maintaining the integrity of the ecosystem. Within the context of the Suswa River, model-based approaches highlight the significance of dissolved oxygen and biochemical oxygen demand in determining the quality of the water and the ecological health of the river. Plankton surveys in the Yamuna River provide insights into the composition of the community and their responses to environmental conditions. On the other hand, microbial ecology studies in the Ganga River at Hardwar reveal dynamic seasonal variations that are influenced by changes in the environment. In the vicinity of Haridwar, physicochemical evaluations of the Ganga Canal have revealed the presence of anthropogenic influences on water quality parameters, which calls for the implementation of efficient management strategies. Studies conducted on fish fauna in rivers such as the Suswa shed light on the difficulties associated with the conservation of biodiversity. On the other hand, nutrient dynamics in rivers such as the Bhavani shed light on the seasonal variations that affect ecosystem productivity. Observations made on the fluctuations of plankton in the Ganga River establish a connection between hydrological conditions and the abundance of plankton, which in turn informs the practices of river management. In order to protect the health of rivers, it is imperative that pollution control measures be implemented immediately, as evidenced by assessments of water pollution in rivers such as the Yamuna around Agra. Taking everything into consideration, these findings collectively contribute to a comprehensive understanding of the ecosystems that are found in the Himalayan rivers. This understanding will guide conservation efforts and sustainable management practices for these essential natural resources.

Conclusion

The conclusion is that the compilation of research that focusses on water quality, hydrobiology, and ecological health in Himalayan river systems offers a nuanced understanding of the intricate dynamics and critical issues that are affecting these vital ecosystems. The findings from a number of different studies highlight the significant ecological importance of Himalayan rivers. These rivers are home to a wide variety of flora and fauna, and they also provide for the livelihoods of millions of people who are dependent on them for water, agriculture, and other important aspects of their lives.

These studies have provided important insights that highlight the rich biodiversity and species interactions that occur in rivers such as the Alakhnanda and the Koshi. These findings also highlight the necessity of conservation efforts in order to preserve these one-of-a-kind ecosystems. When it comes to evaluating and managing water quality, the ecological modelling approaches that are applied to rivers like the Suswa demonstrate the crucial role that environmental parameters like dissolved oxygen and biochemical oxygen demand play.

In addition, research conducted on the ecology of microorganisms in rivers such as the Ganga reveals dynamic seasonal variations that are influenced by environmental factors. This highlights the susceptibility of these ecosystems to the effects of human activity. Different rivers have been subjected to physicochemical evaluations, which have revealed varying degrees of pollution and the necessity of implementing sustainable management practices in order to prevent further degradation.

Furthermore, the findings are indicative of challenges such as fluctuations in nutrient levels that have an effect on the productivity of ecosystems, as well as the effects of impoundments and hydroelectric projects on riverine environments. Given the problems associated with water pollution in rivers such as the Yamuna, there is an immediate and pressing requirement for efficient pollution control measures and integrated management approaches in order to guarantee the long-term health and sustainability of these essential bodies of water.

When it comes to protecting the ecosystems of the Himalayan rivers, the comprehensive review of the relevant literature highlights the significance of taking all-encompassing and scientifically-based approaches. It encourages researchers, policymakers, and local communities to work together in order to implement conservation strategies, effectively monitor water quality, and promote sustainable development practices that strike a balance between the needs of humans and the protection of the environment. Taking preventative measures to address these challenges will allow us to guarantee the resilience and continuity of the Himalayan rivers, which are vital resources for both the current generation and the generations to come.

IV. REFERENCES

[1]. American Public Health Association, American Water Works Association, & Water Pollution Control Federation. (1998). Standard methods for examination of water and wastewater (20th ed.). American Public Health Association.

[2]. Badola, S. P., & Singh, H. R. (1981). Hydrobiology of the river Alakhnanda of Garhwal Himalaya. Indian Journal of Ecology, 8(2), 269-276.

[3]. Bhatt, S. D., Bisht, Y., & Negi, U. (1984). Ecology of Limnoflora in river Koshi of the Kumaon Himalaya (U.P.). Proceedings of the Indian National Science Academy, 50(4).

[4]. Bhutiani, R., & Khanna, D. R. (2007). Ecological study of Suswa River: modeling DO and BOD. Environmental Monitoring and Assessment, 125(1-3), 1-3.

[5]. Biswas, J. (1970). Interactions and interrelations between human and water. Indian Journal of Environmental Health, 14, 297-309

[6]. Chakrabarty, R. D., Ray, P., & Singh, S. B. (1959). A quantitative survey of plankton and physiological conditions of the river Yamuna at Allahabad. Indian Journal of Fisheries, 6(1), 186-203.

[7]. Chugh, T. (2000). Seasonal variation in the microbial ecology of river Ganga at Hardwar (Doctoral dissertation, Gurukula Kangri University)

[8]. Joshi, B. D., & Bisht, R. C. S. (1993). Some aspects of physico-chemical characteristics of western Ganga canal near Jwalapur at Haridwar. Himalayan Journal of Environmental Zoology, 7(1), 76-82.

[9]. Kataria, H. C. (1966). Sulphate content in bore well water of Bhopal city. Ultra Scientist: Physical Sciences, 8(1), 97-100.

[10]. Kataria, H. C., Jain, O. P., Gupta, S. S., Srivastava, R. M., & Shandilya, A. K. (1995). Physicochemical analysis of water of Kubza river of Hoshangabad. Oriental Journal of Chemistry, 11(2), 157-159.

[11]. Kaur, S., & Joshi, B. D. (2003). Describes seasonal variation in some physicochemical parameters of Ganga. Himalayan Journal of Environment & Zoology, 17(1), 45-55.

[12]. Khanna, D. R. (1993). Ecology and Pollution of Ganga River. Ashish publication House.

[13]. Khanna, D. R., & Badola, S. P. (1991). Fish fauna of the river Ganga at Hardwar. Aquatic Environment, Ashish Publishing House.

[14].Khanna, D. R., & Bhutiani, R. (2003). Worked on limnological status of Satikund pond at Hardwar. Indian Journal of Environmental Sciences, 7(2), 131-136.

[15].Khanna, D. R., & Bhutiani, R. (2004). Water analysis at a glance. ASEA Publications.

[16].Khanna, D. R., & Singh, S. (2002). Published a book on pond fish ecology and economics. Daya Publishing House.

[17].Khanna, D. R., Seth, T. R., Malik, D. S., & Singh, R. K. (1999). Fishes and their ecology of river Suswa at Raiwala (Dehradun). Sw. Eco. Sys. and Env., 105-110.

[18].Khanna, D. R., Singh, S., Gautam, A., & Singh, J. P. (2003). Study of assessment of water quality of river Ganga in distt. Bulandshahar (U.P.). Journal of Natural Conservation, 15(1), 167-175.

[19].Kudesia, P. R. (1988). Studied the diseases caused because of polluted water in New Delhi. Indian Journal of Ecology, 12(4), 236-254.

[20].Logankumar, K., Sivakumar, A. A., Logasamy, S., & Aruchami, M. (1989). Seasonal variation in the nutrients of the river Bhavani at Sirumugai, Coimbatore district, Tamil Nadu. Indian Journal of Ecology, 16(1), 60-63

[21].Pahwa, D. V., & Mehrotra, S. M. (1966). Observation on fluctuations in abundance of plankton in relation to certain hydrological conditions of river Ganga. Proceedings of the National Academy of Sciences, 36B(2), 157-159.

[22].Pandey, B. N., Kumar, K., Lala, A., & Das, P. K. L. (1993). A preliminary study on the physico-chemical quality of water of the river Kosi. Journal of Ecobiology, 5, 237-339.

[23].Sangu, R. R. S., & Sharma, K. D. (1985). Studies on water pollution on Yamuna river at Agra. Indian Journal of Environmental Health, 27(3), 257-261.

[24].Santra, S. C. (2004). Environmental Science. New Central Book Agency (P) Ltd.

[25].Semwal, N., & Akolkar, P. (2006). Water quality assessment of sacred Himalayan Rivers of Uttarakhand. Current Science, 91(4).

[26].Trivedi, R. K., & Goel, P. K. (1986). Chemical and Biological method for water pollution studies. Environmental Publications.

[27].Trivedy, P. K. (1990). Studied the monitoring and control of river pollution. Water pollution and management

[28].Agarwal, N. K., Singh, G., & Singh, H. (2011). Present status of Ichthyofaunal diversity of Garhwal Himalayan river Bhilangna and its tributaries with reference to changing environment. Environment Conservation Journal, 12(3), 101-108.

[29].Agarwal, N. K., Singh, H., Singh, G., & Charak, S. R. (2018a). Bhilangana River Impoundment Consequences to Riverine Environment. Water Biology. Discovery Publishing House Pvt. Ltd.

[30].Agarwal, N. K., Singh, H., Singh, A., & Singh, G. (2018b). Bhilangana River Regulation for Tehri Hydro Power Project in Central Himalaya: Impact on Planktonic Assemblages. Biojournal, 13(1), 1-10.

[31].Alex, J. H., Rodney, J., Hubert, L., Bill, F., & Marc, B. (2019). Hypolimnetic oxygenation 2: oxygen dynamics in a large reservoir with submerged down-flow contact oxygenation (Speece cone). Lake and Reservoir Management, 323-337. DOI: 10.1 080/ 10402381.2019.1648612

[32].APHA (American Public Health Association). (2005). Standard methods for the examination of water and wastewater (21st ed.). American Public Association, AWWA, WEF.

[33].Atobatele, O. E., & Ugwumba, O. A. (2008). Seasonal variation in the physicochemistry of a small tropical reservoir (Aiba reservoir, Iwo, Osun, Nigeria). African Journal of Biotechnology, 7(12), 1962-1971.

[34].Badola, S. P. (1979). Ecological studies on the Ichthyofauna of some freshwater resources of

Garhwal region (Doctoral dissertation, Garhwal University).

[35].Baoli, W., Cong-Qiang, L., Fushun, W., Xiao-Long, L., & Zhong-Liang, W. (2015). A decrease in pH downstream from the hydroelectric dam in relation to the carbon biogeochemical cycle. Environ Earth Sci, 73, 5299–5306. DOI 10.1007/s12665-014-3779- 3.

[36].Eker, E., Georgieva, L., Senichkina, L., & Kideys, A. E. (1999). Phytoplankton distribution in the western and eastern Black Sea in spring and autumn 1995. ICES Journal of Marine Science, 56, 15–22.

[37].Hitchings, S. P., & Beebee, T. J. C. (1998). Loss of genetic diversity and fitness in common toad (Bufobufo) populations isolated by inimical habitat. Journal of Evolutionary Biology, 11, 269–283.

[38].Hoeinghaus, D. J., Winemiller, K. O., & Agostinho, A. A. (2008). Hydrogeomorphology and river impoundment affect food-chain length in diverse Neotropical food webs. Oikos, 117, 984–995.

[39].ICOLD. (2000). Dams and the Environment. International Commission on Large Dams.

[40].Jhingran, V. G. (1982). Fish and fisheries of India (2nd edition). Hindustan Publishing Corporation (India), Delhi.

[41].Jayaram, K. C. (2010). The freshwater fishes of the Indian region. Narendra Publishing House.

[42].Johnson, P. T. J., Olden, J. D., & Zanden, M. J. V. (2008). Dam Invaders: impoundments facilitate biological invasions into freshwaters. Frontiers in Ecology and the Environment, 6, 357–363.

[43].Kondolf, G. M. (1997). Hungry Water: Effects of Dams and Gravel Mining on River Channels. Environmental Management, 21(4), 533-551.

[44].Lakra, V. S., Sarkar, U. K., Kumar, R. S., Pandey, A., Dubey, V. K., & Gusain, O. P. (2010). Fish diversity, habitat ecology and their conservation and management issues of a tropical River in Ganga basin, India. Environmentalist. DOI 10.1007/s10669-010- 9277-6.

[45].Larsen, T. H., Williams, N. M., & Kremen, C. (2005). Extinction order and altered community structure rapidly disrupt ecosystem functioning. Ecology Letters, 8, 538–547.

[46].Ligon, F. K., Dietrich, W. E., & Trush, W. J. (1995). Downstream Ecological Effects of Dams. Bioscience, 45(3), 183-192.

[47].Liu, J. K., & Yu, Z. T. (1992). Water quality changes and effects on fish populations in the Hanjiang River, China, following hydroelectric dam construction. Regulated Rivers: Research & Management, 7(4), 359-368.

[48].Mitra, A., & Zaman, S. (2016). Physical Processes in the Marine and Estuarine Ecosystems. In: Basics of Marine and Estuarine Ecology. Springer.

[49].Needham, J. G., & Needham, R. R. (1962). A guide to the study of freshwater biology. Holden-Day, Inc.

[50].Noël, S., Ouellet, M., Galois, P., & Lapointe, F. J. (2007). Impact of urban fragmentation on the genetic structure of the eastern red-backed salamander. Conservation Genetics, 8, 599–606.

[51].Okogwu, O. I., & Ugwumba, O. A. (2013). Seasonal dynamics of phytoplankton in two tropical rivers of varying size and human impact in Southeast Nigeria. Rev. Biol. Trop. Int. J. Trop. Biol., 61(4), 1827-1840.

[52].Pathak, S. K., & Mudgal, L. K. (2005). Limnology and Biodiversity of fish fauna in Virla Reservoir M.P. (India). Environment conservation journal, 6(1), 41-45.

[53].Singh, H. (2015). Impoundment of the Bhilangana River for the Tehri Dam Reservoir: Hydro-biological study with special reference to Habitat alteration and Fisheries development (Doctoral dissertation, Garhwal University)

[54].Singh, H. (2018). Habitat fragmentation due to Tehri dam construction reduces fish species diversity among Bhilangana river, Uttarakhand,

India. The Asian Journal of Animal Science, 13(2), 62-67.

[55].Singh, H. R., Badola, S. P., & Dobriyal, A. K. (1987). Geographical distributional list of Ichthyofauna of the Garhwal Himalaya with some new records. J. Bombay Nat. Hist. Soc., 84(1), 126-132.

[56].Sugunan, V. V. (1991). Changes in the Phytoplankton species diversity indices due to the artificial impoundment in river Krishna Nagarjuna Sagar. J. Inland Fish. Soc. India, 23(1), 64-74.

[57].Tilak, R. (1987). The Fauna of India, Pisces (Teleostomi), Subfamily Schizothoracinae. Zoological Survey of India.

[58].Trivedy, R. K., & Goel, P. K. (1986). Chemical and biological methods for water pollution studies. Environmental publications.

[59].Ward, J. V., & Stanford, J. A. (1995). Ecological connectivity in alluvial river ecosystems and its disruption by flow regulation. Regulated Rivers: Research & Management, 11(1), 105–119.

[60].Wang, L., Chen, X., Huang, Q., & Li, J. (2021). Impacts of dam construction on river ecosystem services: A global review. Journal of Environmental Management, 294, 112950. DOI: 10.1016/j.jenvman.2021.112950

[61].Hu, M., Xie, Z., & Zhang, Y. (2020). Effects of damming on the fish assemblage structure in the upper Yangtze River basin, China. Ecological Engineering, 155, 105958. DOI: 10.1016/j.ecoleng.2020.105958

[62].Li, Y., Wei, Z., Xu, J., & Wang, J. (2019). Impacts of dam construction on water quality and aquatic biodiversity: A case study in the Jinsha River basin, China. Science of the Total Environment, 654, 831-842. DOI: 10.1016/j.scitotenv.2018.11.011

[63].Xu, L., Hu, S., Tang, C., & Chen, X. (2018). Impacts of dam construction on riverine ecosystem: A review. Ecological Engineering, 111, 46-60. DOI: 10.1016/j.ecoleng.2017.12.008

[64].Cai, L., Zhu, Y., Li, W., & Yang, Z. (2017). Impacts of dam construction on river morphology and sediment transport: A case study of the Lancang River, China. Geomorphology, 297, 50-63. DOI: 10.1016/j.geomorph.2017.08.032