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Biodiversity Conservation and Phytodiversity Assessment in the Catchment Area of Runjh Dam, Panna (M.P.)

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Abstract

The effect of the dam catchment on the phytodiversity of the Runjh Dam, constructed in Ajaygarh Tehsil, submerges around 39 villages and also changes the land usage. Quadrat, transect-based vegetation analysis supported by satellite imagery and layers in GIS mapping, has shown that there are immense Changes in the distribution of plant species, abundance, and diversity indices. Although due to the greater availability of water, there has been an enhanced potential of agroforestry, soil moisture, and vegetation recreation at domains where there were, in previous times, none. Forest submergence has also resulted in the disappearance of the endemic fauna and native species, discontinuity of the habitats, and changes in soil chemistry. This ecological stress is also aggravated by the invasion of exotic species and the alteration of the microclimate. It is recommended that afforestation programs be undertaken, buffer zones be formed, invasive species be tracked, and the tracking/surveillance of the same and long-term ecological surveillance. The paper is one of the activities that add to the larger debate on ecological change caused by dams, and the need to have a biodiversity-based development strategy. Local knowledge and community-based conservation should be integrated to make an impact in halting ecological destruction and making such developmental projects sustainable.

Introduction

Dams are known to be the drivers of economic growth and agricultural increase especially in regions with unreliable rainfall and without reliable irrigation systems. But in recent decades, an increasing number of environmental scientists and ecologists are expressing doubt about the undesirable ecological effects of large dams (Glasson et al., 2012; Singh et al., 2000). One of such is the Runjh Medium Irrigation Project situated in Ajaygarh Tehsil of Panna District in Madhya Pradesh because it is a perfect example of the intricate nature of development versus biodiversity conservation. The Runjh dam is built on the Runj River, which is the tributary of the Bhagain River and the total length of the dam is 1182 meters. It has a spillway section of 8 bays, earthen dams on both sides and a left main canal that is 41.94 km long with the capacity of irrigating more than 12, 550 hectares of land through irrigation of 39 villages with the irrigation intensity of 126.25 percent (MPPCB, 2024). This infrastructural work will make a significant difference to crop output in both the Kharif and Rabi seasons.

These advantages are, however, associated with tremendous loss of forest land and a change in the natural drainage patterns and rural displacement of local flora and fauna. According to the Environmental Impact Assessment (EIA) Report (MPPCB, 2024), the project catchment area is surrounded by a number of ecologically sensitive areas namely the agricultural fields, scrub forests and the wild animal inhabited areas. The reservoir covers many forest lands which have various flora and fauna like sloth bears, tigers, antelope etc. but a major part has been endangered because of the habitat dissection, jungle clearance and human activities. Uniyal and Singh (1993) note that the vegetation that is naturally inhabited by the dam reservoir is directly lost and the ecosystem functions, like pollination and seed spreading, nutrient circulation are disturbed. The same trend of biodiversity loss has emerged in some other earlier projects like Tehri Dam and Sardar Sarovar Project where plant species richness have gone down by substantial figures after project submergence (Vijayakumar & Mohapatra, 1991; Maudgal, 1988). The other serious issue is the spread of invasive plants like Lantana camara and Parthenium hysterophorus, which tend to prevail on the disturbed ecology, draining the resources of endemic flora. Moreover, the alterations in soil moisture, salinity, and pH in the impacted areas will most presumably modify the structures of the plant communities and make the ecosystems less capable of coping with climate variability (Glasson et al., 2012; IUCN, 2000). That is why, considering these ecological challenges, an ecological

analysis of phytodiversity in the catchment area of the dam is necessary. This work will have the purpose of comparing and contrasting alterations in vegetation structure through scientific methods of sampling.

Assess changes in biodiversity with standardized indices Report environmental variables that impact on plant life; and provide sustainable methods of biodiversity conservation and restoration of the ecosystem.This study is based on field surveys, GIS mapping, and consultation to the stakeholders, combining both quantitative and qualitative outlooks. The findings of the study will assist the environmental planners and environmental policymakers to make a policy decision to ensure that development in the form of water infrastructure does not undermine the ecological integrity of one of the key areas of biodiversity in Madhya Pradesh.

It is crucial to acknowledge that the Runjh Medium Irrigation Project remains under construction, and as such, the ecological effects noted during this study represent both the current and expected outcomes of the ongoing developments. Environmental reviews have indicated in many parts of the world that dam schemes provide great interference with biodiversity (Glasson et al., 2012; Singh et al., 2000). The exemplified cases of water-borne diseases, sedimentation, and loss of habitat occurred around the Aswan Dam in Egypt and the Akosombo Dam in Ghana after construction (Schalie, 1979; Smithsonian Institution, 1974). The Tehri and the Narmada projects have been well researched on as to their negative ecological impacts in India (Uniyal & Singh, 1993; Vijayakumar & Mohapatra, 1991). The World Commission on Dams upholds the need to plan at the landscape level, cumulative impact and permanent or permanent monitoring of post-construction, to limit the damage (Singh et al., 2000).

According to the MPPCB Environmental Report (2024) of the Runjh project, the issue of submergence of forests, accompanied by the displacement of people will result in the loss of biodiversity unless mitigated through afforestation as well as community-based forestry schemes. The ecological balance is threatened by loss of plant habitats, invasion of exotic species such as Lantana camara and alteration of water-soil interactions they have. In this way, the review warrants a comprehensive analysis of biodiversity and emphasis on the effectiveness of employing ecological indicators, remote-sensing instruments, and community knowledge to inform conservation.

Objectives:

To determine the effects of the Runjh Dam on the diversity of local plants and the integrity of the ecosystem. To study such environmental parameters as soil, water, and microclimate changes. To provide suggestions on biodiversity conservation measures and encourage the local population to participate. To record changes in species composition and vegetative cover by employing scientific sampling.

Methodology

Study Area

The area chosen for this research is the catchment region of the Runjh Medium Irrigation Project, situated in Ajaygarh Tehsil, Panna District, Madhya Pradesh. The dam is built on the Runj River, which is a tributary of the Bhagirathi River, and is located roughly 20 kilometers north of Panna town. The adjacent landscape features agricultural fields, forested hills, barren plateaus, and riverine areas, contributing to a rich ecological diversity. This region is classified within a semi-arid to sub-humid climatic zone, characterized by hot summers and moderate monsoon seasons. The average annual precipitation varies from 800 mm to 1000 mm. The predominant vegetation type consists of tropical dry deciduous forests, interspersed with scrub and agricultural lands. The main tree species found in this area include Tectona grandis (Teak), Butea monosperma (Palash), and Acacia catechu (Khair).

Additionally, shrubs and herbs such as Lantana camara, Parthenium hysterophorus, and various grasses are prevalent. The biodiversity in this region is facing threats due to construction activities, forest submergence, and fluctuations in water availability. The submergence has modified the soil moisture levels and composition, impacting both native and invasive plant species. This study concentrated on vegetation in upstream (submergence zone), downstream (discharge-affected zone), and control (undisturbed) areas to assess the ecological changes brought about by the dam's construction.

Data Collection

To evaluate the effects of the Runjh Medium Irrigation Project on local phytodiversity, a systematic data collection was performed at selected sites. This process utilized both primary and secondary data sources. For the primary data collection, comprehensive field surveys were conducted across three distinct zones: the upstream area (submergence zone), the downstream area (water discharge zone), and undisturbed control areas. Within each of these zones, plant species were documented using the Quadrat method (1 m × 1 m) and Transect Line Sampling techniques. In each quadrat, the species name, number of

individuals, height, and canopy cover were meticulously recorded. Soil samples were gathered from each zone to assess physical and chemical parameters, including moisture content, pH level, salinity, and organic matter. Soil was extracted using a soil auger at a standardized depth of 15–20 cm and placed in labeled bags for subsequent

Laboratory analysis.

Microclimatic variables, such as temperature, humidity, and light intensity, were measured with portable devices. Observations of water availability and sedimentation patterns were conducted visually and corroborated with data from the local irrigation department. Furthermore, semi-structured interviews were held with local farmers, forest guards, and traditional healers to record ecological changes and identify plant species of cultural significance. Critical observations were documented through photographic means and GPS tagging. Secondary data, including forest cover maps, vegetation records, and species checklists, were sourced from the Madhya Pradesh Pollution Control Board (MPPCB) Environmental Impact Assessment Report and earlier ecological surveys about the Runjh Dam.

GIS Mapping and Remote Sensing

Five bands of satellite images were studied to identify any vegetation alterations during the construction of the dam in the catchment area.

Review of Historical Data

Local records, herbarium specimens, and environmental reports were used to collect data about the native plant species and their old vegetation patterns.

Field Sampling Techniques

Quadrat Sampling (1m x 1m): It was implemented close to the upstream, downstream, and non-affected control locations. Transect Lines: 100-meter transects at every point to note the aspect of vegetation. Point Intercept: Point intercept was used to identify the presence of species on specific points.

An Analysis of Environmental Variables

The moisture and nutrient content in soil, as well as the salinity, were established in the sunken and peripheral zones. In the reservoir and canal systems, the PH of the water and the sedimentation were tested. A microclimate change was recorded in terms of temperature and humidity records. Biodiversity Indices. In rating diversity, the Shannon-Wiener Index (H') is used.

E: Simpson Index (D) of dominance.

Stakeholder Engagement

Embodiment of local conservation and traditional knowledge on the uses of plants.

Results and discussion

Positive Effects

Greater growth of vegetation is caused by better retention of moisture in the soil by the irrigation canals. The village forestry programs have helped to raise the capacity of Agroforestry. The canal irrigated soils received more soil conservation.

Negative Effects

The inundation of native forest land causes the loss of native species of plants forever. Isolation of plant communities due to habitat fragmentation, which lessens resiliency in response to climate stress. Salinization in soils is identified in poorly drained areas. Increase in loss of the seed dispersal and pollination network, which influences the regeneration.

Invasive plants such as Parthenium hysterophorus and Lantana camara.

Complex ecological changes are observed in the data presented by both the hydrological and anthropogenic factors. On the one hand, the agricultural productivity and vegetation cover in some regions have increased; on the other, the area of degradation of biodiversity is significant in areas where there is flooding and in transition areas. This has been the same case as was observed in the Tehri project (Uniyal & Singh, 1993), where the endemic vegetation was lost forever. The diminution of species richness and evenness in the concerned regions are verified by environmental indices. According to soil analysis, decomposing salinity and nutrient wear is particularly seen in downstream wetlands. Habitat Fragmentation leads to so-called island effects, whereby genetic flow is severely limited which, in turn, makes the organisms susceptible to disease and climate change. The afforestation programs run by the Forest Department with proper species and right implementation of the programs do give hope, though. The recommendation made by the MPPCB report concerning the incorporation of village and social forestry should be extended. The restoration of livelihood security and ecology can be assisted by qualifying ecologically and financially through agroforestry models, which entail indigenous crops and trees. There is ineffective utilization of community knowledge systems, particularly referring to medicinal and culturally important plants. This experience can be used in participatory restoration programs to utilize site-specific conservation. In this way, the Runjh project poses a

threatening challenge due to the necessity to put into practice the principles of eco-development whereby infrastructure development does not jeopardize the long-term sustainability of the environment.

Conclusion

This study shows that the effects of a dam modifying the environment are complex. Although there is better coverage with vegetation and irrigation in some of the zones, the core forest areas have lost a significant level of biodiversity. The impact should be curtailed by measures such as afforestation, the establishment of a buffer zone, and even the control of invasive species. This includes incorporating the local communities in the protection of biodiversity and provision of constant monitoring, which are the main factors leading to sustainability. The Runjh Dam project is both prospective and threatening. It is both an improvement of water access and agricultural productivity as well as natural habitat fragmentation and changes in phytodiversity patterns. Sound scientific evidence and knowledge of the Louisiana residents are the basis of the balanced ecological approach advocated in this paper. The Panna sustainable development should place an emphasis on sustainable development, where the biodiversity should be healthy in the long run, without the sustainable development coming at a cost of deteriorated environments.

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