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"Restoring Balance: Wetland Biology And Flood Regulation In A Rapidly Urbanizing Vijayawada"

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Abstract

Vijayawada, a fast-growing city at the Krishna River, has witnessed rising flood frequency and intensity over the past decades. This study explores the ecological role of wetlands in mitigating flood impacts, with specific emphasis on the modified wetland processes of the region. Wetlands like Kolleru and surrounding marshlands traditionally acted as hydrological buffers, controlling water levels and soaking up surplus rain [1]. The destruction and encroachment of these wetlands have severely impaired their ability to contain floodwaters [3]. This study, based on an examination of wetland biology—focusing on aquatic vegetation, benthic microbes, and faunal interactions—identifies the biological processes which facilitate flood resilience. The results emphasize the importance of incorporating wetland conservation and restoration into urban flood management plans. The study promotes a nature-based strategy that integrates wetland ecosystem services into the urban planning of Vijayawada in a bid to improve climate resilience and ecological sustainability [4,5].

Keywords:

Vijayawada, Wetlands, Floods, Wetland biology, Urban planning, Ecosystem services, Nature-based solutions, Krishna River etc.

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1. Introduction

Vijayawada, located within the Krishna River basin in Andhra Pradesh, is becoming more susceptible to seasonal and unseasonal floods because of increased urbanization, climatic changes, and anthropogenic disturbance of natural hydrological systems [3]. In the past, the wetlands and low-lying floodplains of Vijayawada acted as natural reservoirs, which absorbed and stored excess rain and river water [1,2]. Infrastructural encroachments and pollution have drastically changed these ecosystems.

Knowledge of wetland biology is essential to determine their function in flood event regulation. Wetlands are highly heterogeneous ecosystems that maintain high biodiversity and provide various ecosystem services, such as retention of water, purification, and regulation of flow [1]. The present study seeks to:

- Analyze the flood patterns in Vijayawada over the past three decades of development.
- Evaluate the spatial and biological status of wetlands in and around Vijayawada.
- Examine how biological components of wetlands contribute to hydrological stability.
- Make necessary recommendations for ecological and planning interventions for sustainable flood management.

2. Materials and Methods

2.1 Study Area

The Krishna River passes through Vijayawada and discharges into the Bay of Bengal. Key wetland systems in the area are portions of the Kolleru Lake system, urban wetlands, irrigation tanks, and river corridors [2].

2.2 Data Collection

• Hydrological Data: From the India Meteorological Department (IMD), Andhra Pradesh State Disaster Management Authority (APSDMA), and Krishna Basin Water Board.

• Remote Sensing and GIS: Satellite information from NRSC (Bhuvan), Landsat, and Sentinel-2 were utilized to map wetland extent change for the period from 1990 to 2024 [5].

• Ecological Surveys: Impromptu field visits were made to witness wetland vegetation and wildlife, especially aquatic vegetation, macroinvertebrates, and the presence of microbes during the pre-monsoon and post-monsoon periods [1,4].

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2.3 Methodology

• Measuring biodiversity through Shannon-Wiener and Simpson's indices.
• Samples of soil and water were taken to determine nutrient levels, organic matter, and microbial diversity.
• Hydrological modeling was conducted in order to model the retention and discharge potential of wetlands with HEC-HMS software [4].

3. Results

3.1 Flood Trends

Flood data analysis between 1990 and 2024 indicates a significant rise in the frequency and severity of floods in Vijayawada, especially since 2005 [3].

3.2 Wetland Loss and Degradation

Analysis of satellite images indicated that almost 35% of wetlands in the Krishna basin around Vijayawada have been lost or fragmented [2]. Housing, agricultural, and road encroachments are major causes [3].

3.3 Biological Assessment

• Aquatic Vegetation: Typha spp., Eichhornia crassipes, and Cyperus spp. dominate, supporting water retention and sediment trapping [1].

• Macroinvertebrates: Existence of bioindicator species such as Chironomus larvae and Lymnaea spp. reflects moderate water quality [1].

• Microbial Profiles: Extensive organic matter decomposition by facultative anaerobic bacteria is responsible for nutrient cycling [1].

Satellite imagery analysis revealed that nearly 35% of wetland areas in the Krishna basin near Vijayawada have been lost or fragmented. Encroachments for housing, agriculture, and road construction are key contributors.

3.4 Hydrological Functions

Simulations suggest that intact wetlands can reduce peak flood flow by up to 28% during high rainfall events [4]. Restored wetland patches showed better performance in water holding capacity and delayed runoff [4].

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4. Discussion

Wetlands of Vijayawada contribute irreplaceable hydrological and ecological services. Yet degradation has drastically weakened their buffering potential. The findings suggest that wetland plant cover and microbial communities synergistically contribute to absorbing, filtering, and slowly releasing floodwater [1,4].

Comparison with engineered flood mitigation measures in cities such as Chennai and Kolkata illustrates that restoration of natural wetlands is usually more efficient and cost-effective than engineered alternatives. Incorporation of wetland biology into the urban master plans is essential. Policy-level suggestions include wetland zoning, afforestation, community management programs, and development of wetland-linked green infrastructure [5].

5. Conclusion

The research verifies that Vijayawada wetlands profoundly affect flood behavior through their hydrological and biological processes. Conservation and restoration of these ecosystems is what can be used to improve urban flood resilience [1,3]. It is the responsibility of policymakers to acknowledge the environmental value of wetland biology and include it as part of Vijayawada's urban planning and disaster readiness initiatives [4,5].

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7. Compliance with Ethical Standards

- **Conflict of Interest**: The author declares no conflict of interest.
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- **Data Availability**: The datasets generated during the current study are available from the corresponding author on reasonable request.

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