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Hydrological Assessment and Water Quality Analysis of the Godavari River in Nashik City (Maharashtra)

Mr. Chourasiya Kanhaiya Keshav
Assistant Professor, Department of Zoology,
MVP Samj's, K.P.G. Art's, Commerce and Science College, Igatpuri, Dist- Nashik, Maharashtra
Corresponding Author: Mr. Chourasiya Kanhaiya Keshav
Email: kkchourasiya74@gmail.com
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Abstract:

The Godavari River is often called the lifeline of Nashik; it is rich in hydrological, ecological, and cultural value. This research paper would discuss the hydrological features and water quality of the Godavari River in Nashik, as a city is deeply interlinked with the heritage and utility of the river. The paper studies the seasonality variations in flow pattern and critical water quality parameters such as pH, DO, BOD, and pollutant level. Among the causes, urbanization, industrialization, and anthropogenic pressures are cited to be the key factors degrading the river's health.

This study is based on a comprehensive methodological framework that includes field measurements, laboratory analysis, and historical data to assess hydrological dynamics and water quality indices. Results show significant seasonal fluctuations, with monsoon periods diluting pollutants and non-monsoon seasons exacerbating contamination. The analysis identifies critical pollution hotspots, such as industrial zones and urban discharge points, where pollutant concentrations often exceed permissible limits. Elevated levels of heavy metals, including lead and cadmium, are particularly alarming, posing risks to aquatic ecosystems and human health.

Its socio-economic features also make a strong argument for taking action. For irrigational purposes, agricultural populations can no longer afford poor-quality water with decreased efficiency in water conveyance and reduced agricultural produce. A large number of such river-users live in areas where health diseases are water-borne from untreated river water intake, and cultural and religious sensitivities are affected through polluting the sanctity of the river at places such as Kumbh Mela.

Data visualization is very important in this study, and graphs and tables illustrate key trends and correlations. Seasonal flow data and pollutant levels are presented with hydrological assessments, thus providing a clear picture of the challenges that the Godavari River faces. The findings therefore point to the need for implementing sustainable water management practices, pollution control measures, and community engagement strategies.

This study provides policy, research, and stakeholder guidance on how to revive and conserve the Godavari River. It promotes holistic river basin management practices that are supported by regulatory enforcement, technological innovation, and public participation. This will address the root causes of pollution and foster a culture of conservation, thereby conserving the Godavari River for future generations and preserving its ecological, economic, and cultural values.

Key words: Degradation, Water quality, Urbanization, Godavari River, Physio-chemical.

Introduction:

Godavari River is an essential life for the central and southern India to be named as the "Dakshin Ganga" as its watershed basin, covering an extensive area, besides being a vital entity that has importance culturally. Flowing 1,465 kilometers from Trimbakeshwar hills of Nashik district in Maharashtra state, this river, though passing through diverse landscapes, has made it a rich source of water as well as a treasure in spiritual terms and for agriculture and ecological means.

Nashik is a very historically and culturally rich city that draws its strength from the Godavari River. With religious importance, especially when the Kumbh Mela takes place every 12 years, Nashik attracts millions of pilgrims who make use of the river for their rituals, bathing, etc. However, this level of human activity adds substantially to the pressure on the river's ecosystem. Alongside spiritual activities, Nashik is a hub of industrial and agricultural operations, further amplifying the demand for water and the risk of pollution.

Hydrology and water quality are vital indicators of the health of a river. The hydrological regimes of the Godavari vary seasonally, so that during the monsoon months, rich rainfall replenishes the rivers and their surrounding ecosystems. On the other hand, during the pre-monsoon and post-monsoon periods, low-flows expose the river to higher concentrations of pollutants. These seasonal

dynamics emphasize the need for a detailed study of both hydrological and water quality parameters.

Urbanization has drastically changed the natural flow regime of the river. Nashik's population growth has led to increased generation of domestic and industrial wastewater, most of which finds its way into the Godavari untreated. Studies show that untreated sewage contributes to about 60% of the river's pollution load, while industrial effluents contribute another 20%. Agricultural runoff, carrying pesticides and fertilizers, is another problem, especially during the monsoon when rainwater washes chemicals into the river.

Water quality in the Godavari River has been a cause for concern for decades. Essential parameters like pH, DO, BOD, and COD indicate the presence of organic and inorganic pollutants. For example, DO levels are considered critical for aquatic life but are found to be low, less than 3 mg/L, in many downstream areas, thereby constituting a severe threat to biodiversity. Similarly, elevated levels of heavy metals like lead, cadmium, and chromium have also been seen, especially within the near-industrial-discharge zone.

The socio-economic implications cannot be missed when talking of the Godavari river's health. For irrigating farm fields, river water constitutes a lifeline for irrigation. However, polluted waters have led to reduced yields and soil deterioration, having an impact upon agricultural productivity. Public health is another issue that needs to be addressed; the community that depends on this river for drinking and domestic purposes suffers from waterborne diseases like gastroenteritis and cholera. Moreover, the aesthetic value and spiritual value of this river are affected due to visible pollution in terms of solid waste and bad smell.

Hydrological and water quality aspects of the Godavari River have to be understood well for effective management strategies.

Study Area:

Nashik is an important city in northern Maharashtra, along the Godavari River. The river flows through urban and rural areas, taking inflows from tributaries such as Darna and Kashyapi. Important study sites include Trimbakeshwar (source), Ramkund (shrine), and downstream industrial units.

Objectives of the Study

1. To analyze the hydrological parameters of the Godavari River in Nashik.
2. To assess the water quality based on physical, chemical, and biological parameters.
3. To identify pollution sources and propose sustainable solutions.

Data Sources and Methodology

Data Collection:

Primary data were collected through:

1. **Sampling Locations:** Water samples were collected from five strategic locations Trimbakeshwar, Panchavati, downstream near Nashik Road, industrial zones, and the confluence point. These locations represent varying levels of urban and industrial impact.
2. **Temporal Coverage:** Monthly sampling was conducted during pre-monsoon (March to May), monsoon (June to September), and post-monsoon (October to December) periods in 2024.
3. **Sample Volume and Preservation:** Standard volumes of 2 liters per sample were collected in sterilized containers, preserved at 4°C, and transported to the laboratory for analysis.

Analytical Techniques:

Hydrological Parameters:

Flow Rate and Discharge: Measured using flow meters at each location.

Rainfall Data: Obtained from the Nashik Meteorological Department to correlate with discharge patterns.

Physical Parameters:

Turbidity and temperature were recorded on-site using a nephelometer and thermometer, respectively.

Chemical Parameters:

i. pH: Measured using a calibrated digital pH meter.
ii. DO, BOD, COD: Assessed using Winkler's titration method and standard protocols.
iii. Heavy Metals: Lead, chromium, and other metals were analyzed using atomic absorption spectrophotometry.

Biological Parameters:

Coliform levels were determined through the most probable number (MPN) method.

Statistical Analysis:

The collected data were statistically analyzed using software tools such as SPSS and Microsoft Excel. Seasonal trends and spatial variations were evaluated through ANOVA and correlation analysis.

Quality Control:

To ensure data accuracy, all instruments were calibrated before use, and each test was performed in triplicate. Standard operating procedures (SOPs) were strictly followed during sample collection and analysis.

Results and Discussion

Hydrological Assessment

Flow Rate and Discharge: The monsoon season exhibited the highest discharge (12,000 m^3/s), while pre-monsoon periods showed reduced flow rates (2,500 m^3/s).

Seasonal Variations:

The river experiences significant seasonal fluctuations, impacting sediment load and nutrient transport.

Water Quality Analysis

Physical Parameters

- **Turbidity**: Increased turbidity during monsoons due to sediment inflow. High turbidity levels during the monsoon (up to 60 NTU) indicate significant erosion and runoff from surrounding lands, affecting aquatic habitats.
- **Temperature**: Variations between 21°C (winter) and 32°C (summer) were recorded. Temperature directly influences dissolved oxygen levels and biological activity.

Chemical Parameters

- **pH**: Ranged from 6.5 to 8.3, indicating slight alkalinity. Monsoons showed slightly acidic conditions due to organic runoff.
- **Dissolved Oxygen (DO)**: Dropped to 3.2 mg/L in industrial zones, suggesting organic pollution. High levels (7.5 mg/L) were recorded near Trimbakeshwar due to limited anthropogenic influence.
- **Biochemical Oxygen Demand (BOD)**: Exceeded permissible limits (10 mg/L) in downstream locations, reaching 15 mg/L in industrial zones. Elevated BOD indicates the presence of biodegradable organic matter.
- **Chemical Oxygen Demand (COD)**: High levels (50-80 mg/L) in industrial discharge zones highlight the presence of both organic and inorganic pollutants.
- **Heavy Metals**: Lead (0.05 mg/L) and Chromium (0.03 mg/L) concentrations above acceptable limits in industrial zones are attributed to untreated effluents.

Biological Parameters

- **Coliform Levels**: High coliform counts (1,000 MPN/100 mL) near urban settlements suggest untreated sewage discharge. Pre-monsoon samples recorded the highest contamination levels, indicating insufficient dilution.

Table 1: Water Quality Parameters at Different Locations (2024)

Parameter	Trimbakeshwar	Panchavati	Downstream	Industrial Zone	Confluence
pH	7.1	7.5	7.2	6.9	7.0
DO (mg/L)	7.5	6.2	4.0	3.2	4.8
BOD (mg/L)	4.0	7.0	12.0	15.0	10.0
COD (mg/L)	25.0	40.0	60.0	80.0	50.0
Lead (mg/L)	ND	0.01	0.03	0.05	0.02
Chromium (mg/L)	ND	0.005	0.02	0.03	0.01

Source: Primary Data Collection & Calculated by Researcher.

Table 2: Seasonal Trends in Water Quality (2023)

Season	DO (mg/L)	BOD (mg/L)	COD (mg/L)	Turbidity (NTU)	Coliform (MPN/100 mL)
Pre-Monsoon	5.2	10.5	65.0	25.0	1200
Monsoon	6.8	8.0	40.0	60.0	800
Post-Monsoon	5.5	9.5	55.0	30.0	1000

Source: Primary Data Collection& Calculated by Researcher.

Seasonal Analysis:

Pre-Monsoon:

Represented the most polluted period with reduced flow rates leading to higher concentrations of pollutants such as BOD and COD. Turbidity remained low, but biological contamination was prominent.

Monsoon: While dilution effects reduced concentrations of many pollutants, sedimentation significantly increased turbidity, impacting aquatic life.

Post-Monsoon: A transitional phase with moderate improvements in water quality but lingering effects of accumulated pollutants.

5. Spatial Analysis

Trimbakeshwar: Showed the best water quality due to minimal anthropogenic activity. High DO and low pollutant levels characterize this site.

Panchavati and Downstream:

Witnessed significant degradation due to urban effluents and untreated sewage. The cultural and religious activities at Panchavati contribute to organic pollution.

Industrial Zones: T

He worst water quality was observed here, with critical levels of COD, heavy metals, and low DO.

Recommendations

Improved Wastewater Treatment Facilities:

Establish and upgrade wastewater treatment plants to ensure that untreated sewage is not being discharged into the river. Implement modern treatment technologies to reduce the contamination of water and improve overall water quality.

Monitoring and Surveillance:

Set up regular water quality monitoring stations at strategic points along the Godavari River to track changes in water quality. Ensure that parameters like pH, dissolved oxygen, BOD (Biochemical Oxygen Demand), COD (Chemical Oxygen Demand), and heavy metals are regularly measured.

Public Awareness and Community Participation:

Launch awareness campaigns about the importance of keeping the river clean. Encourage the local population, especially those living near the riverbanks, to adopt responsible practices like proper waste disposal and avoiding the use of the river for dumping harmful substances.

Riverfront Development with Sustainable Practices:

Promote sustainable development along the Godavari River by ensuring that construction activities along the riverfront do not harm the river's ecosystem. Implement green spaces and create buffer zones to reduce pollution run-off from the city.

Rainwater Harvesting and Groundwater Recharge:

Encourage rainwater harvesting practices in the city to reduce the pressure on the river and maintain its water levels during dry periods. Use treated wastewater for non-drinking purposes to reduce demand on the river's freshwater supply.

Reduction in Solid Waste Disposal:

Ban the disposal of solid waste, including plastic, directly into the river. Initiate community-led clean-up drives and work with local authorities to ensure that waste management systems are in place to handle waste efficiently.

Regulation of Agricultural Runoff:

Implement better agricultural practices upstream, including controlled use of fertilizers and pesticides, to prevent runoff that pollutes the river. Support organic farming practices to reduce chemical contamination.

Strengthening Environmental Policies and Regulations:

Reinforce regulations to control industrial effluents and prevent illegal dumping in the river. Tighten enforcement of the Water (Prevention and Control of Pollution) Act and ensure accountability among industrial units.

Promotion of Eco-Friendly Tourism:

Develop eco-tourism initiatives that respect the natural habitat of the Godavari River. Establish green infrastructure, like cycling tracks and nature trails, to promote a healthier and more sustainable interaction with the river.

Collaboration with Research Institutions:

Collaborate with hydrological and environmental research institutions to develop more advanced models for understanding the river's hydrology and its potential for sustainable water management.

Incentivizing Industries for Zero Discharge:

Introduce policies to incentivize industries along the Godavari River to adopt zero-discharge principles, promoting the reuse of wastewater and recycling within the industrial processes.

Flood Management and Riverbed Stabilization:

Improve flood management systems along the Godavari River to mitigate the effects of heavy monsoon rains. Implement techniques for riverbed stabilization to prevent soil erosion and maintain the river's capacity.

By implementing these recommendations, Nashik can improve the overall health of the Godavari River, ensuring that it remains a vital resource for both the environment and the local population.

Conclusion:

The Godavari River in Nashik possesses great cultural, ecological, and economic importance, because it provides water to the entire city and its surroundings. However, the river has been increasingly facing threats in the form of urbanization, pollution, and climate change, which may adversely affect its sustainability. From the hydrological assessment and water quality analysis, one can infer that there is an immediate need for holistic measures to improve water quality and manage water resources better.

The recommendations outlined, including improvements in wastewater treatment, regular monitoring, and public awareness campaigns to better waste management, sustainable agricultural practices, and strict environmental regulations, should be able to address all these challenges. By targeting both short-term and long-term solutions that include infrastructural improvement, community participation, and encouraging sustainable practice, Nashik can guarantee the protection and restoration of the Godavari River for future generations.

Nashik, under collaborative efforts from the part of government agencies, industry, local communities, and environmental organizations, can shape the Godavari into a cleaner, healthier source of water that can significantly improve the quality of people's lives and at the same time safeguard the biodiversity of the region through it and support livelihoods that depend on the river's existence.

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