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A Comparative Assessment of Water Quality in the Pavana River: Urban vs. Suburban Locations in Pune, India

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Abstract

Water pollution continues to be a serious environmental issue that threatens human health and ecological sustainability. In this study, a comparative analysis of water pollution was conducted between urban and suburban/rural areas by identifying locations as "City" and "Outskirts," and reviewing data for the years 2017-2018 respectively. Water samples werecollected from each location and analysed for various tests like Biochemical Oxygen Demand (BOD), PH, Dissolved Oxygen (DO) and chlorine content. The analysis showed a significant difference in water pollution sources between the city and the outskirts. The city had the worst water quality in all tested parameters due to high industrial activities, urban runoffand sewage discharge. Water in the outskirts was the least polluted with water since there were few impervious surfaces and low human activities compared to the city. On the other hand, agricultural runoff or diffuse pollution was still a notable issue in suburban/rural areas. This demonstrates the complicated relationships between land use, human activitiesand environmental factors that shape the water quality situation. Such results indicate the necessity of fast pollution control initiatives and sustainable land treatment steps to reduce water pollution in urban and suburban areas. By doing so, it is possible to secure water resources for the present and the next generation.

Keywords: *Biochemical Oxygen Demand, City, Dissolved Oxygen, Outskirts, Pavana River, Water Pollution*

1.0 Introduction

The assessment of water quality is vital to the provision of a healthy environment, ecological integrity and public welfare. Pollution of water quality by various natural and anthropogenic causes has become a global problem thus necessitating comprehensive research on their understanding as well as mitigation measures. The expanding urban population, however, puts greater pressure on water and leads to faster and differing patterns in water quality degradation.

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This study aims to examine comparative trends in urban and rural water qualities with a focus on "OUTSKIRT" and "URB" CITIES based on data from 2017-2018. Typical urban settings are heavily affected by intensive infrastructure, industrial activities and high human influence while OUTSKIRTS have low population density A suburban/rural area is identified by its temperature. The pH DO, BOD and chlorine levels were considered for this study as it aims to unravel spatial variation in terms of pollution in these two types of residential areas within the cities. These water parameters are key indicators of quality, reflecting the interaction of natural processes and human activities in shaping aquatic ecosystems. Knowing the disparities in water quality within urban and suburban/rural areas is vital to the development of sound management policies and intervention measures that can protect and enhance water resources. This research aids in developing a comprehensive picture of how people's actions influence aquatic ecosystems by highlighting differentiating factors and issues regarding water quality across different landscapes and as such, supports the need for targeted interventions towards sustainable water resource management.

2.0 Literature Review

The research highlighted seasonal variations in the water quality of the Ganges, particularly in temperature and pH levels. It underscores the need to monitor and regulate both surface and subsurface waters according to pH standards outlined by the Bureau of Indian Standards (BIS)[1].This paper paints a stark picture of water pollution in India, using the Yamuna River as a prime example, crucial to Delhi's existence. The river suffers from heavy pollution, with 85% stemming from household and industrial sources. Hazardous heavy metals like copper, lead, cadmium and others pose significant health risks to humans and aquatic life[2].

The study examines industrial waste's impact on Pune's Mula, Muthaand Pavana rivers, noting seasonal variations in key parameters like temperature, DO, BOD, COD, nitrate, phosphate and pH[3].Urbanisation and population growth are putting stress on groundwater and groundwater quality and the growing water demand is exacerbating this issue. Given the Mula, Mutha and Pavana rivers, Pune faces water quality challenges[4].Despite the Ganga River's significance, originating from the Gangotri glacier and sustaining over 300 million people, industrial sewage and garbage pollution threaten its health, underscoring the urgency for conservation[5]. Despite water covering 80% of the land, freshwater supplies are decreasing due to industrialisation, population growth, water use andhuman activities[6]. Pune is severely polluted by industrial and domestic sewage. Despite a generation of 277MLD of flow, only 210MLD is treated, leaving 22MLD untreated[7]. This paper addresses the important

Table 1. Source of pollution and effects[11]

Source of Pollution	Effects
Industrial Discharges	Contamination of water bodies with heavy metals, chemicals and toxins, harms aquatic life and ecosystems.
Agricultural Runoff	Nutrient enrichment leads to algal blooms, and sediment runoff causing habitat degradation and reduced water quality.
Urban Runoff	Pollution of water bodies with oil, grease, heavy metals, and litter, impacts aquatic organisms and ecosystems.
Sewage and Wastewater	Spread of waterborne diseases, contamination of drinking water sources, and degradation of aquatic habitats.
Marine Activities	Harm to marine life through ingestion and entanglement, disruption of ecosystemsand degradation of coastal areas.

issue of water pollution in India, highlighting its negative impact on human health and the environment[8]. Rivers suffer much from pollution mostly caused by industrial agricultural activities where pesticides and metals are disposed into them along with other types of waste[9]. This research paper delves into the comprehensive issue of water pollution, exploring various mechanisms such as biological, physicaland waste disposal across rivers, lakes, oceansand groundwater[10].

3.0 Sources of Pollution

River pollution[12] results from human activities that introduce harmful substances and pollutants into river ecosystems. The most common sources of river pollution are industrial discharges, agricultural runoff, urban runoff, sewage and wastewater, illegal dumpingand mining materials Each of these processes generates pollutants such as heavy metals, chemicals, nutrients, pathogens and sediments. To protect river ecosystem sources, river pollutants for restoration and the use of effective management strategies are required. It is important to understand why water pollution has significant environmental, economic and public health impactsand is complicated due to a variety of factors. Understanding the effects of water pollution is important to assess its effects on ecosystems, aquatic organisms and human health. Common impacts of water pollution include the discharge of hazardous substances, degradation of aquatic habitats and ecosystems, spread of waterborne diseases, and degradation of water quality. This study examines the consequences of pollution and emphasises the urgency of mitigation measures and conservation efforts.

4.0 Previous Study

According to the Maharashtra Pollution Control Board (MPCB)[11] report, the following industries are present in the Pune district which might be responsible for the drastic degradation in water quality of Pavana River[8].

The MPCB states the given data for the 2017 and 2018 pollution value of the Pavana River as per the following graph:

Table 2. Industry type and no of industry

Industry type	Number of Industries
Distillery	36
Fertiliser	1
Integrated Iron and Steel	1
Pharmaceuticals	9
Pulp and Paper	1
Sugar	63

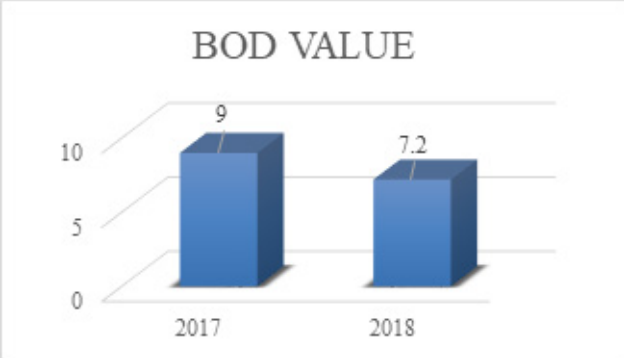


Figure 1. B.O.D during 2017 and 2018.

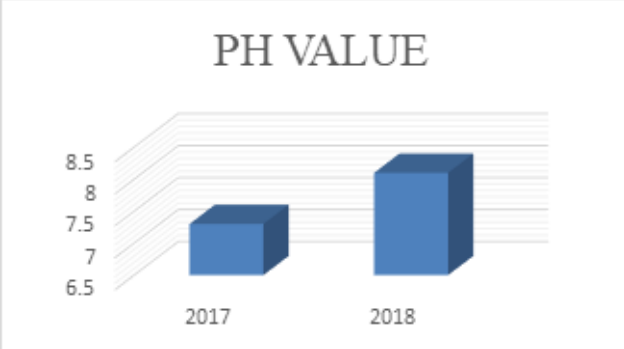


Figure 2. pH during 2017 and 2018.

5.0 Study Area

The Pavana River[13], which flows through Pune, Maharashtra, plays a crucial role in supporting both ecological and human needs. The classification of the Pavana River as a Priority 1 necessitates rigorous monitoring and management to ensure its preservation and sustainable use. To assess the pollution levels and understand the impact of urbanisation, a comparative

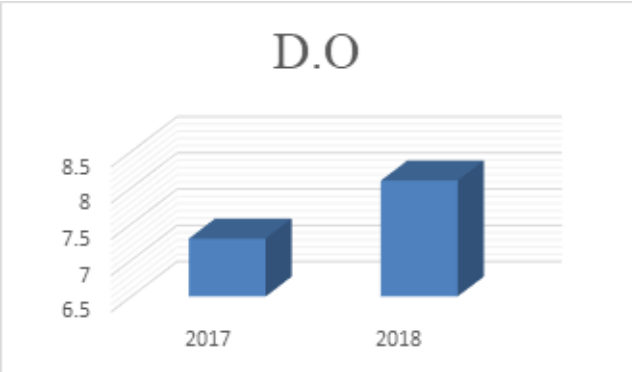


Figure 3. D.O. during 2017 and 2018.

study is conducted, by using the data of previous research and analysing water samples collected from both the outskirts and city areas along the Pavana river. Samples have been collected from various locations along the river and the appropriate testing has been done for the identification of pollutants in various locations in Pune city[14].

The observed differences in pollution levels between the outskirts and city areas of the Pavana river highlight the impact of urbanisation, industrial discharge and sewage effluents on water quality.

5.1 Spots for Sample Collection

The Pavana river originates from the Western Ghats, about 6km (3.7mi) south of Lonavala. Flowing eastwards it passes through the suburbs of Ravet, Thergaon, Chinchwad, Pimpri and Dapodi before its confluence with the Mula River near Sangvi. For this study, two monthly samples with a 15-day gap between samples from October to February were collected.

5.2 Geographical Location of Pavana River

Latitude: 18°33›59.99»N
Longitude: 73° 49› 59.99» E
Length: 58KM
Elevation: 650m (2,130ft)

For the comparative study of the Pavana river throughout Pune city, suitable locations have been selected. For the sampling of the outskirts area samples from three locations were taken and for sampling inside the city one location was selected.



Figure 4. Pavana River spans in outskirts of Pune.



Figure 5. Pavana river spans within Pimpri Chinchwad.

6. Laboratory Testing and Sample Analysis

The following tests were carried out on the collected water samples.

1. Ph
2. BOD
3. DO
4. Chlorine
5. Heavy metals.

6.1 PH

pH influences various chemical reactions in water. When pH value is lesser than the permissible limits some

heavy metals like cadmium, mercury and lead become more soluble in river water, making the water toxic for aquatic life. On the other hand, the higher pH value of river water causes algal bloom. The optimum pH for river water is around 7.4. As per Indian standards, the permissible limits for river water should be between 6.5 to 8.For the testing of water samples aquasol digital pH meter was used.

6.2 BOD

Increased levels of BOD can deplete dissolved oxygen in rivers and can cause anoxia or hypoxia causing hazardous effects on aquatic animals. Decreased levels of BOD can also cause stress or suffocation in organisms. Clean water should have a value below 1 mg/L, moderately polluted water 2-8 mg/Land treated municipal sewage 20 mg/L. BOD was calculated for the collected water sample, titrating the sample with sodium thiosulphate. 4 nutrients were added to the water sample before incubating it for 5 days.In Pavana river, the pollution situation reached a high point when the river reported a BOD above 30 mg/L.

6.3 DO

Low DO levels can degrade habitat quality in water bodies. Excessive nutrient pollution, like sewage and agricultural wastes, causes eutrophication. Algae and plants thrive, especially in warm weather. When theydie, they deplete oxygen, harming aquatic life. To maintain the required level of DO in river water, it is essential to avoid the entry of untreated water intothe river. As per the report, the DO level was found to be at 2.3mg/l, over half of the minimum required limit of 5mg/L. Drinkable water should contain DO value ranges of 4-6 mg/L. For the testing of DO, the sample was titrated against odium thiosulphate using a starch indicator.

6.4 Chorine

The acceptable limit of chlorine content and residual chlorine in river water is 250 mg/l and 0.2 mg/l respectively.The permissible limit in the absence of an alternate source is 1000 mg/l and 1 mg/l respectively. The chlorine content of the water sample was determined by a chlorine test kit using the colour chart.

6.5 Heavy Metals

Heavy metals if present in river water, tend to bioaccumulate in the food chain. Chronic exposure to heavy metals can cause various health issues, including neurological disorders, developmental delays, kidney damage, liver damageand cancer.According to a report Mutha river had cadmium and lead concentrationswhich were higher than the permissible limit declared by the World Health Organisation (WHO).As per WHO guidelines, the acceptable weekly intake levels for heavy metals are as follows: mercury (Hg) stands at 0.0016 milligrams per kilogram of body weight, lead (Pb) at 0.0025, cadmium (Cd) at 0.007and arsenic (As) at 0.015. The heavy metal test was carried out using the heavy metal test strips for the identification of metals like lead, copper, iron and mercury.

7.0 Result and Discussion

7.1 PH

The pH level of the sample taken onthe outskirts of the city is 7.8, 8.1, 7.85, and 7.9 which appears to be within

Table 3. PH value

Sr. No.	Outskirts	Within City
1	7.8	9.0
2	8.1	8.5
3	7.85	8.3
4	7.9	9.2

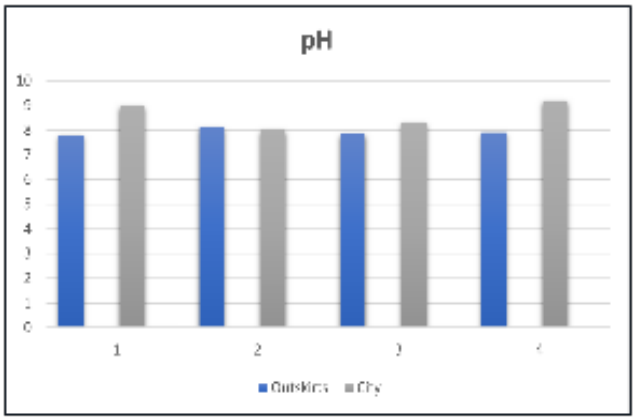


Figure 6. pH comparison.

a normal range for natural waters i.e.: 6.5 to 8.5. The pH level within the city is high compared to the Outskirts (9, 8.5, 8.3 and 9.2) which shows the sign of Alkalinity. The increase in pH level may be caused due to Industrial Discharge, Runoff from Construction sites, etc. As per the results we have got, the increase in pH level may be caused due to Industrial Discharge, Runoff from Construction sites, etc.

7.2 Dissolved Oxygen

The DO concentration for the outskirts of the city is 9, 12.9, 10.1, 12.5 which is significantly higher compared to the DO Concentration within the City (i.e.2.1, 1, 1.7, 1.4). The DO Concentration above 5 mg/L is considered good for aquatic life. Some possible causes for low DO Concentration can be due to increased decomposition of Organic wastes such as manure, food, green waste etc. Some possible causes for low DO Concentration can be due to increased decomposition of Organic wastes such as manure, food, green waste etc.

Table 4. D.O value

Sr. No.	Outskirts	Within City
1	9.0	2.1
2	12.9	1.0
3	10.1	1.7
4	12.5	1.4

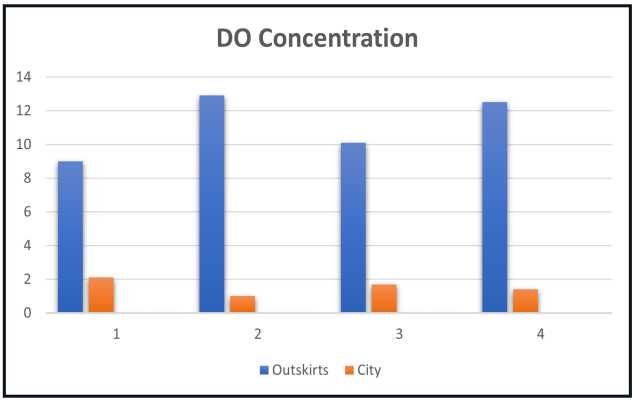


Figure 7. Do Comparison.

7.3 Biochemical Oxygen Demand

The BOD Levels in the outskirts (i.e., 6.4, 7.7, and 6.7) are significantly lower than the levels within the city, which indicates that there is a very low amount of organic matter decomposition occurring in the outskirts. This also suggests that the water quality in the outskirts is much better than the water quality within the city. The increase in BOD Levels may be caused by to Discharge of untreated sewage in the River, Industrial wastes, Urban Runoff, etc.

Table 5. B.D.O value

Sr. No.	Outskirts	Within City
1	8.0	27
2	6.4	28.1
3	7.7	27.6
4	6.7	28.5

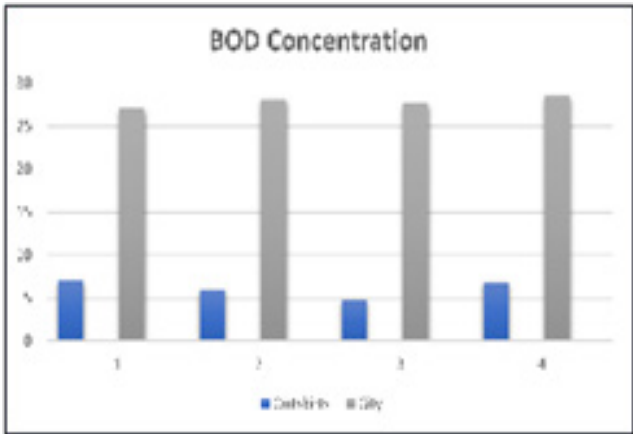


Figure 8. B.D.O Comparison.

7.4 Chlorine Content

The Chlorine Levels for the Outskirts (0.20, 0.12, 0.10, and 0.10) are within the expected range for most drinking water[13] supplies whereas the Chlorine level within the city is not detectable in the water supply. The Absence of chlorine in water may cause health issues due to lack of disinfection against harmful micro-organisms.

Table 6. Chloride content values

Sr. No.	Outskirts	Within City
1	0.2	0
2	0.12	0
3	0.10	0
4	0.10	0

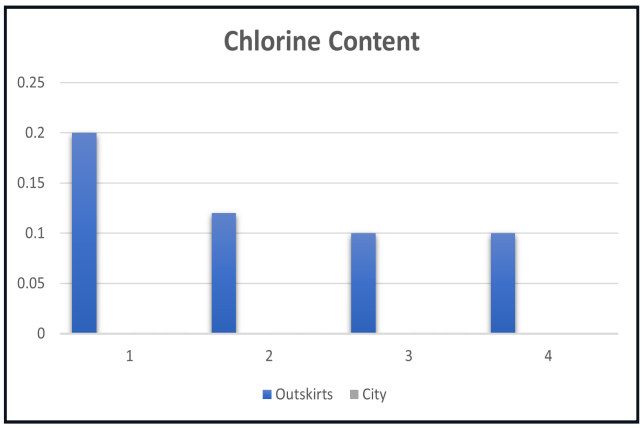


Figure 9. Chloride Comparison.

7.5 Heavy Metals

Heavy metals like Lead Copper Iron and Mercury are not present in the River water of Outskirts as well as within the city.

8.0 Conclusion

- Increased water pollution poses a significant risk to both humans and aquatic life across various rivers.
- Comparative studies conducted on water samples from the Pavana River highlight differences in water quality between rural and urban areas of Pune.
- Water samples from rural areas demonstrate good water quality characteristics, including optimal levels of dissolved oxygen (12mg/L-15mg/L), Biochemical Oxygen Demand (5mg/L-7mg/L), and neutral pH (7-8), with no presence of heavy metals or chlorine.
- Conversely, samples from urban areas exhibit alarming signs of pollution, with deviations from optimal parameters, such as elevated pH levels (8-9), significantly reduced dissolved oxygen levels (1-2 mg/L), and high Biochemical Oxygen Demand levels.
- Despite location differences, both samples show no presence of chlorine or heavy metals, indicating common pollutants.
- These findings underscore the detrimental impact of urbanization and industrialization on the Pavana River's water quality.
- Urgent efforts are needed to mitigate pollution and protect water resources, especially in urban areas, through measures such as improved wastewater treatment facilities, stricter industrial regulations, and public awareness campaigns.

9.0 References

1. Kamboj N, Kamboj V. Water quality assessment using the overall index of pollution in the riverbed-mining area of Ganga-river Haridwar, India; 2019. https://doi.org/10.1080/11104929.2019.1626631
2. Malik D, Singh S,Thakur J, Singh RK, Kaur A, Nijhawan S- Heavy metal pollution of the Yamuna River: An introspection. International Journal of Current Microbiology and Applied Sciences. 2014; 3(10):856-63.
3. Vaishnavi MVS, Gupta S.A Comparative study of water quality of major rivers of Pune for three different seasons. Environmental Science. 2018.
4. Jain N, Yevatikar R, Raxamwar TS. Comparative study of physicochemical parameters and water quality index of river. Mater Today Proc. 2021; 60(2): 859-867. https://doi.org/10.1016/j.matpr.2021.09.508
5. Paul D. Research on heavy metal pollution of river Ganga: A review. Ann Agrar Sci. 2017; 15:278-286.
6. Kendre LS,Gawande SM, Pawar A. Study of physico-chemical characteristics of Pavana river: Review. Int J Eng Res. 2017; 6(4):216.
7. Jamdade AB, Gawande SM. Analytical study of heavy metal in Pavana river and its effect on aquaculture. J Environ Eng. 2017; 6(4).
8. Mane AV,Pardeshi RG,Gore VR,Walave R L, Manjrekar SS, Sutar GN.Water quality and sediment analysis at selected locations of Pavana river of Pune district, Maharashtra. J Chem Pharm Res. 2013; 5(8):91-102.
9. Khan AS, Anavkar A, Ali A, Patel N, Alim H. A review on current status of riverine pollution in India.

BiosciBiotechnol Res Asia. 2021; 18(1). http://dx.doi.org/10.13005/bbra/2893

10. Al-Taai SAH. Water pollution has its causes and effects. IOP Conf Series. 2021; 790(1):012026. https://doi.org/10.1088/1755-1315/790/1/012026
11. Water quality of priority II polluted river stretches PAVANA, MPCB -Report on an action plan for clean-up of a polluted stretch of Pavana river; 2019.
12. Richards LA, Guo S, LapworthJD. White D, Civil W, Wilson GJL, Lu C, Kumar A, Ghosh A, Khamis K, Krause S, Polya DA, Gooddy DC. Emerging organic contaminants in the river Ganga and key tributaries in the middle Gangetic plain. India: Characterization, distribution and controls. Environ Pollut. 2023; 327:121626. https://doi.org/10.1016/j.envpol.2023.121626PMid:37054870.
13. Sharma S, Bhattacharya A. Drinking water contamination and treatment techniques. Appl Water Sci. 2016; 7(3):1043-67. https://doi.org/10.1007/s13201-016-0455-7
14. Lin L, Yang H, Xu X. Effects of water pollution on human health and disease heterogeneity: A review. Front Environ Sci. 2022; 10. https://doi.org/10.3389/fenvs.2022.880246.