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STUDY ON GODAVARI RIVER WATER QUALITY ASSESSMENT

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ABSTRACT

River is a natural flowing watercourse, usually freshwater, which is flowing towards an ocean, sea, lake or another river. In some cases, a river flows into the ground and becomes dry at the end of its course without reaching another body of water. The five longest rivers of the world are *Nile* (flows from South to North through earth Africa), *Amazon* (flows in South America), *Yangtze* (flows in China), *Mississippi* (flows in North America) and *Yenisei* (flows from central Russia) river. The World Rivers have a special role to carry water and nutrients to areas all around the Earth. They play a very important part in the water cycle, acting as drainage channels for surface water. Rivers provide excellent habitat and food for many of the earth's organisms. The rivers of India play an important role in the lives of Indian People. River systems provide irrigation, potable water, cheap transportation, electricity, as well as provide livelihood for a large number of people all over the country. Rivers are important for a country's economy because they play an important role in the irrigation and industrial field. An irrigation and industrialization sector boosts countries economy. The rivers of India play an important role in the lives of the people and nearly all the major cities of the country are located by the banks of it. The river also has an important role in the Hindu Religion and is considered *holy* by all *Hindus* in the country. India has seven major rivers along with their numerous tributaries make up the river system of the country. This study applied principal component analysis and principal factor analysis of *Godavari* river basin from two monitoring stations. The objective was to identify monitoring stations that are important in assessing annual variations of river water quality. Two stations were used for the evaluation of physical, chemical and biological parameters. Results show that 2 monitoring sites *Godavari* River water is polluting.

KEYWORDS: *Analysis, River, Pollution, Population, Effluents*.

INTRODUCTION

India is a land of many rivers and mountains. Some of the Indian rivers are considered as the most notable rivers in the world (Balasubramanian, 2013). Rivers are water bodies which flow in a definite direction in a channelized way and affect our culture and civilization. The rivers were the only source of water during the early phases of human evolution. This is the only reason why all the ancient civilizations evolved along the banks of rivers e.g., the Indus valley civilization at Indus, Egypt at Nile (Dhruv Sen Singh, 2018). River water quality has a considerable importance for the reason that these water resources are generally used for multiple matters such as: drinking domestic and residential water supplies, agriculture (irrigation), hydroelectric power plants, transportation and infrastructure, tourism, recreation, and other human or economic ways to use water (Venkatramanan *et al.*, 2014). Rivers carry water and nutrients to areas all around the earth. They play a very important part in the water cycle, acting as drainage channels for surface water. It is found that rivers drain nearly 75% of the earth's land surface and provide excellent habitat and food for many of the organisms. The quality of potable water sources like rivers, wells and lakes is polluted with pathogens, toxic metal, chemical compounds such as pesticides, herbicides and other industrial waste (Begum & Harikrishna, 2008). In India during the passage of time, humans interacted and started performing various social, ritual, religious and festival activities along the bank of the rivers. The rapidly growing population, urbanization, and industrialization are no longer in equilibrium with the river and its environment and thus, adversely affect the society and the lifeline river. In the last few decades, there has been a tremendous increase in the demand of freshwater due to rapid growth of population and the accelerated pace of industrialization (Ramakrishnaiah *et al.*, 2009). In this way, the river which served as a boon has now become to the society (Singh, 2009). Okeke (2003) noted that human health is threatened by most of the agricultural development activities particularly in relation to excessive application of fertilizers and

unsanitary conditions. The present study was aimed at analyzing physico-chemical and biological characteristics of *Godavari* river water located at Gangakhed in Maharashtra State (India). There are various activities along the river flow, including the existence of settlements, ritual, social, festivals, holy, restaurants, agricultural, domestic from where effluents enter the river. The purpose of this study was to determine the concentration of effluents in the river water and how they affect the physico-chemical and biological parameters.

Rivers of India

The rivers of India play an important role in the lives of the Indian people. River systems provide irrigation, potable water, cheap transportation, electricity, as well as provide livelihoods for a large number of people all over the country. The major cities of India are located by the banks of rivers. The rivers also have an important role in *Hindu mythology* and are considered *holy* by all *Hindus* in the country. The seven major rivers along with their numerous tributaries make up the river system of India. Most of the rivers pour their waters into the Bay of Bengal. Some of the rivers whose courses take them through western part of the country and towards the east of the state of Himachal Pradesh empty into the Arabian Sea (NIH). The rivers of India can be classified into four groups viz., Himalayan rivers, Coastal rivers, and Rivers of the inland drainage basin (*KnowIndia*). Indian large river systems constitute one of the most important continental geomorphic systems that have sustained civilizations for more than 5000 year (Rajiv Sinha *et al.*, 2012).

Tab. 1: Table showing types of rivers in India.

Himalayan rivers ***(Himalayan Rivers are formed by melting snow & glaciers, flow throughout year)***	**Coastal rivers** ***(Coastal Rivers are short in length & have limited catchment's areas)***	**Inland drainage basin** ***(Inland basins are few & most of them are of an ephemeral (short period) character)***
1. Ganga (2525 km) 2. Indus (1114 km) 3. Brahmaputra (916 km)	Flowing into the Bay of Bengal: 1. Bramhaputra 2. Yamuna 3. Gomti 4. Chambal 5. Mahanandi 6. Godavari 7. Krishna 8. Cavery	1. Indus River Basin 2. Ganga River Basin 3. Brahmaputra River Basin 4. Narmada River Basin 5. Tapti River Basin 6. Mahanadi River Basin 7. Godavari River Basin 8. Krishna River Basin 9. Pennar River Basin 10. Cauvery River Basin 12. Mahi River Basin 13. Sabarmathi River Basin
-Originate from Himalayan mountain ranges -Receive water from melting ice -These three rivers flow towards west	Flowing into the Arabian Sea: 1. Indus 2. Narmada 3. Tapti	-There are numerous coastal rivers, which are comparatively small -Such rivers drain into the sea

Treats to Indian Rivers

Rivers and their associated floodplains, groundwater, wetlands are in crisis. Globally these are the world's most damaged ecosystems, losing species at the rate that far outstrips the decline of biodiversity in terrestrial and marine ecosystems (Dudegeon et al., 2006). A new synthesis of threats to the world's rivers (Vorosmarty *et al.*, 2010) has found that over 83% of the land surface surrounding aquatic systems has been significantly influenced by the 'human footprint'. The interference of human activities is manifest as widespread catchment disturbance, deforestation, water pollution, river corridor engineering, impoundments and water diversions, irrigation. This threat level exceeds past estimates of human appropriation of accessible freshwater runoff and is approaching the 70% level anticipated by 2050 (Postel *et al.*, 1996). Vorosmarty (2010) documented that the worldwide pattern of anthropogenic threats to rivers and estimates that at least 10,000-20,000 freshwater species are extinct or at risk.

Conservation of Rivers

Rivers support diverse assemblages of plants and animals, including many species that have unique adaptations to specific habitats, microhabitats, or food sources. Besides increased flow-regulation, the River's has been under increasing anthropogenic stress from discharge of mostly untreated domestic and industrial wastewaters, and from other activities in the basin. Indian Rivers are severely polluted by domestic and industrial effluents especially developed cities. It was noted that water extraction and consequently low flow has affected the self-purification capacity of most Rivers in India. Saving Rivers in the Third Millennium is a single source of information on environmental flows – "*the quantity, timing and quality of water flows required to sustain freshwater and estuarine ecosystems and human livelihoods and well-being that depend upon these ecosystems*" (Brisbane Declaration 2007). Developing countries typically need to use their water resources for traditional social benefits and economic

gain (Naiman *et al.*, 2006). Almost all the Indian rivers are under the severe despoliation caused by anthropogenic sources (Trivedi, 1988).

MATERIALS AND METHODS

The present study was conducted during January 2019 to December 2019. During this study river water samples were collected from upstream, midstream and downstream. The sampling was consisted at 2 points. Sampling station I is located near residential area were pilgrim visits regular for a holy bath and other aesthetic ritual activities, but this area is still far away from the domestic sewage runoff. Sample station II was 8 km away from the residential area (out of city). The physico-chemical parameters such as *pH value, Dissolved oxygen, Dissolved Carbon dioxide, Total dissolved solids, Total Hardness, Turbidity, Phosphates, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD)* were analyzed by using standard methods referred by (APHA, 2000). The samples were collected at monthly intervals covering three seasons.

About Godavari River

The *Godavari* is a major river of southern India originating in the Deccan traps, covers a total area of 312,812 km^2 and occupies 9.5% of the total geographical extent of the nation. Geologically, from source in Nasik district to Nanded district of Maharashtra (Babar, 2018). It flows east for 1465 km, draining the states of Maharashtra (48.6%), Telangana (18.8%), Andhra Pradesh (4.5%), Chattisgarh (10.9%) and Odisha (5.7%). The river ultimately empties into the Bay of Bengal through an extensive network of tributaries. The *Godavari* is the largest peninsular India, and has been dubbed as the *Dakshin Ganga*. In Maharashtra state where it takes origin, the river has an extensive course, the upper basin of which lies entirely within the state, cumulatively draining an area as large as 152,199 km about half the area of Maharashtra.

Godavari River located at Gangakhed, Dist. Parbhani (MS)

Gangakhed is a city on the banks of Godavari River and it is also known as *Dakshin Kashi*. It Coordinates at 18.95°N 76.75°E. The city is situated on the bank of Godavari river it has the largest number of temples on the bank of the holy river.

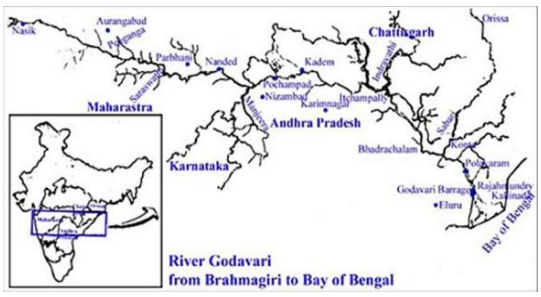

Fig. 1 Flow of Godavari River in Maharashtra & other states.

RESULTS AND DISCUSSIONS

The concentrations of water quality parameters at *Godavari* Rivers.

pH

pH is a quantitative measure of the acidity or basicity of liquid solutions. pH translates the values of the concentration of the hydrogen ion. In the present study fluctuated values of pH were recorded at both the sites. Monthly flow at both the sites was recorded during the assessment period (January to December 2019), pH value showed fluctuations mainly at *site I* and it was in normal range at *site II*. Although there were significant differences between data, the range of values recorded during the continuous sampling at ***site I*** 6.2 to 8.2), it was greater than the normal range and at ***site II*** 7.2 to 7.5 it was in normal range. The pH water was alkaline at site I River water generally has a pH in the range of 6.5-8.5 (Hem, 1989). Due to photosynthesis process by aquatic organisms, pH fluctuation may occur, and the maximum pH value can reach as high as 9.0 (Stumm & Morgan, 1981). Day time pH values were greater in the surface water while pH drops at night hours as photosynthesis declines (Welch *et al*., 1998). The range of pH was greater at *site I* was due to the human activities. Similar types of results were noted by different hydrogeologists.

DO

Dissolved oxygen concentration is inversely related to water temperature. Presence of oxygen in water indicates its purity. Decrease of dissolved oxygen concentration in water is generally due to respiration of biota, biodegradation of organic matter, rise in temperature, oxygen demanding wastes and inorganic reluctance (Sahu *et al.*, 2000). In the present study there were fluctuations recorded in oxygen level at both sites. The recorded values of dissolved oxygen were ranging at ***site I*** 2.2 - 3.6 mg/l whereas at ***site II*** 4.4 – 8.6 mg/l. At *site II* oxygen level was in normal range. At two measurement sites the lowest concentrations were measured during the period October through March, the months with highest water temperature and high biological respiration.

DCO2

Dissolved carbon dioxide is present in all-natural waters. The concentration of CO2 varies in acidic soft water and alkaline hard water. Bicarbonate and carbonate constitute the major buffers in most natural waters. Free CO2 is the most dynamic of the constituents dissolved in carbon and is the dominant acid in most natural waters (Jonathan, 2014). In the present study measurement of dissolved CO2 was ranging from ***site I*** 4.2-9.6 mg/l and at ***site II*** 1.2-1.8 mg/l. The highest values were recorded during September to December. Pilgrimage and human activities may be responsible for the increase in dissolved CO2.

Total Dissolved Solids (TDS)

Total dissolved solids is a parameter that counts all dissolved minerals in the water. Calcium, Magnesium and Potassium are minerals that are introduced as a beneficial mineral for the aquatic biota. The most commonly occurring cation in fresh water is calcium. The limits of cations may affect on the fertilization and egg development process among fishes. In the present investigation recorded TDS ranging from ***site I*** 280-826 mg/l and at ***site II*** 81-202 mg/l. Fluctuations in TDS during the assessment period changes in the ionic composition of water exclude some species while promoting population growth of others.

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Total Hardness

Water hardness is defined as the sum of the normalities of all multivalent cations. Hardness is a concern in municipal industrial water supplies. Usually, the main cations that contribute are Ca and Mg, but in some circumstances Fe and Al can also be important. In present study hardness was recorded at ***site I*** 221-403 mg/l and at ***site II*** 26-144 mg/l. In natural waters total hardness includes both temporary and permanent caused by the Ca and Mg, of which water is categorized as soft or hard and very hard (Sengupta, 2013).

Turbidity

Turbidity is a measure of the degree to which the water loses its transparency due to the presence of suspended particulates. Turbidity is considered as a good measure of the quality of water. In the present investigation values of turbidity were at ***site I*** 11.2-36.2 NTU and at ***site II*** 3.2-18.2 mg/l.

Phosphates

Phosphates are the naturally occurring form of the element phosphorus, found in many phosphate minerals. Phosphate containing compounds create serious problems when released in water bodies. Phosphates are major nutrients needed by microorganisms for their physiological processes. However, they are considered pollutants if their concentration is more then the recommended limit. In the present investigation phosphates were recorded at ***site I*** 4.2-12.6 mg/l and at ***site II*** 0.3-1.6 mg/l.

Nitrate and phosphate containing compounds create serious problem when released in water bodies without treatment. Phosphate and nitrate are major nutrients needed by living microorganisms for their physiological processes. However, they are considered as pollutants if their concentration is more than recommended limit. Heavy nutrient load (nitrate and phosphate) containing water bodies favour the growth of aquatic plants, and create negative effect on water quality by accelerating the growth of algal clump, bad odour, and decoloration. Such conditions create problems in its use for recreational and asthetic purposes. Excessive growth of aquatic life causes problems in navigation and aeration. Ultimately dead phytoplanktons and macrophytes get settled at the bottom of the water body. Nitrate and phosphate containing compounds create serious problem when released in water bodies without treatment. Phosphate and nitrate are major nutrients needed by living microorganisms for their physiological processes. However, they are considered as pollutants if their concentration is more than recommended limit. Heavy nutrient load (nitrate and phosphate) containing water bodies favour the growth of aquatic plants, and create negative effect on water quality by accelerating the growth of algal clump, bad odour, and decoloration. Such conditions create problems in its use for recreational and asthetic purposes. Excessive growth of aquatic life causes problems in navigation and aeration. Ultimately dead phytoplanktons and macrophytes get settled at the bottom of the water body.

Biological Oxygen Demand (BOD)

Biological Oxygen Demand is the most important parameter to determine the degree of pollution in lakes, streams and rivers at any time and their self-purification capacities, assess the biodegradable organic load of the wastewaters. In the present investigation of Godavari river water, the recorded BOD values ranging at ***site I*** 32-56.2 mg/l and at ***site II*** 1.2-16.2 mg/l. Mathur has studied the status of pollution in Ganga river and observed that generally the load of pollution was higher to its downstream with very high value BOD. Similarly, in the present investigation at ***site I*** BOD values were high.

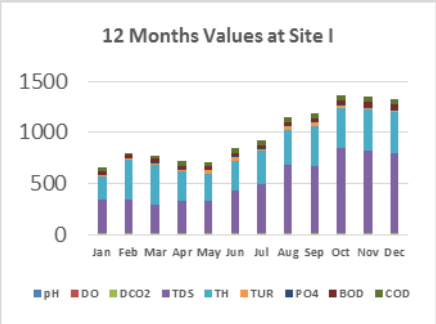
Chemical Oxygen Demand (COD)

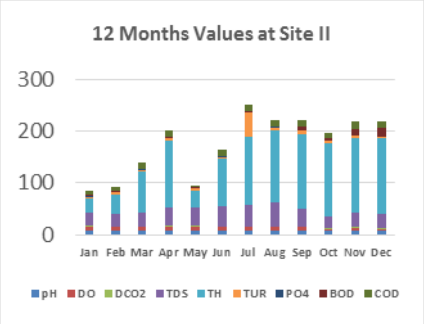
Chemical Oxygen Demand is a measurement of the oxygen required to oxidize soluble and particulate organic matter in water. COD can be measured in real-time with our COD analyzers to improve wastewater process control and plant efficiency. In the present work COD values were ranging at ***site I*** 30-52.6 mg/l and at ***site II*** 1.8-14.6 mg/l. *Site I* shows high values of COD, it indicates the load of pollution was higher.

Results of Physico-chemical parameters of the river water

Table 2: Physico-chemical properties and calculation of water quality Index of Godavari River.

Parameters	Minimum		Maximum		Mean		WHO Limit
	SITE I	SITE II	SITE I	SITE II	SITE I	SITE II	
pH	6.2	7.2	8.2	7.8	7.2	7.5	6.5-8.5
DO	1.2	4.4	3.6	8.6	2.4	6.5	6.0 *mg/l*
DCO2	4.2	1.2	9.6	1.8	6.9	1.5	--
TDS	280	81	826	202	553	141.5	300-1500 *mg/l*
TH	221	26	403	144	312	85	300-600 *mg/l*
TURBIDITY	11.2	3.2	36.2	18.2	23.7	21.1	5-25 NTU
PO_4	4.2	0.3	12.6	1.6	8.4	0.95	4.0-6.0 *mg/l*
BOD	32.0.	1.2	56.2	16.6	44.1	8.9	2-8 *mg/l*
COD	30.0	1.8	52.6	14.6	41.3	8.2	4-10 *mg/l*





CONCLUSION

The water quality of Godavari River varies based on the seasons. According to APHA water parameters were analyzed at two sites. The parameters like pH, DO, DCO2, TDS, TH were in normal range as prescribed by WHO. Fluctuations and readings were high at *site I*. High level at *site I* was due to human interference and domestic sewage. At *site I* pollutants of varied nature due to ritual activity deteriorate the water quality thus making it unfit for consumption as sage drinking water and other uses. The parameters like turbidity, PO4, BOD and COD levels show a little higher. In present Godavari River water quality is still under control, but due to human interference and climate change the ultimate challenge may be dangerous in future.

Due to human interference and climate change the ultimate challenge and the role of environmental flows as a means to sustain the benefits of freshwater biodiversity and the ecological goods and services of healthy freshwater ecosystems. Eventually, the analysis indicated that the river water quality is slightly polluted. Therefore, the river water can be used for pilgrimage ritual activities, irrigation with precaution, and it is in need for any form of treatment to be used for domestic purposes.

Preserving the biodiversity and ecological services of rivers: new challenges and research opportunities

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