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Seasonal Variation of Nagavali River Water Quality at the Vicinity of Paper Mill near Jaykaypur, Odisha, India

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Abstract

An extensive survey is conducted into the physicochemical aspects with seasonal variation of the Nagavali river water at the vicinity of JK Paper mill near Jaykaypur in Rayagada district of Odisha. Pulp and paper industry play an important role in India. JK Paper mills Rayagada situated on the back of river Nagavali is one of the large scale paper mills producing high grade of quality papers. The effluent generated in this paper mill is subjected to various treatments by activated sludge process and discharged into river Nagavali. The river water influences the inhabitants of this area in many ways. The present work deals with a comparative study of the physicochemical characteristics of the water quality of Nagavali river on seasonal variation at the vicinity of Paper mill. Studies on different parameters such as pH, conductivity, hardness, DO,COD,TDS and TSS of the river water on seasonal variation reveals that there is significant fluctuation of these water quality parameters on seasonal variation.

Keywords: Effluent, pulp and paper, physicochemical characteristics, water quality.

Introduction

Water is the basic essential substance for the existence of life. The quality of water is a vital factor for mankind as it is directly related to human health. Though the purity of water decreases by human activities, increasing industrialization, urbanization and growth of mechanization are also the main factors for water crises. Now-a-days the pollution in water increases day by day. The major riverine system is getting polluted continuously[1]. The relationship of man with the environment is from the very beginning of ancient history[2]. During the last few centuries the relationship of man with the environment drastically changed. Rapid industrialization affects the environment from time to time[3-4]. The effluents of industries with partly treated or untreated allow mixing with the near streams and rivers causing serious water pollution and people of the surrounding are affected by different water-borne diseases. Worldwide about 2.3 billion people suffer from water born diseases[5]. The effluents of pulp and paper mills contain a wide variety of chemicals like lignin, degraded lignin, caustic soda, sodium sulphate, sodium sulphide, chlorine, chlorine dioxide, fillers like talcum, precipitated calcium carbonate, titanium oxide, aluminium sulphide etc[6-7].

The river Nagavali is present in eastern slopes of the Eastern Ghats near Lakhbahal in the hilly regions of Kalahandi district of Orissa, at an elevation of about 1,300 meters. The geographic co-ordinates of the river are north latitudes 18°10' to 19° 44' and east longitudes of 82° 53' to 84° 05'. The total length of the river is about 256 kilometres, and its catchment area of the basin is 9,510 square kilometres. The major use of the river is for irrigation of crops like paddy, sugarcane, wheat, potato, and cotton in the district of Koraput, Rayagada and paddy, ground nut and sugarcane in the district of Srikakulam. The tribal peoples of Rayagada district not only use the Nagavali river water for agriculture and bathing purpose but also for drinking purpose.

JK Paper mill is one of the oldest paper mills in India and it is situated on the bank of river Nagavali of Rayagada district. This paper mill produces different grade of quality papers by using hard wood and bamboo as raw material. The effluents generated from JK Paper mills after treatment in effluent treatment plant (E.T.P) is allowed to mix with river Nagavali near Jaykaypur. As a result, the Nagavali river water is expected to be polluted. In the present work an attempt has been made to study the seasonal variation in the physicochemical characteristics of Nagavali river water at the vicinity of JK Paper mill, Rayagada, Odisha. The water quality is monitored by studying the changes in parameter such as pH, temperature, electrical conductivity, turbidity, TSS, TDS, hardness, , chloride, dissolved oxygen and chemical oxygen demand.

Material and Methods

The water samples are collected from the river Nagavali in two selected stations, upstream (before mixing the effluents of JK Paper mills) and downstream (Near village Komtilpeta) which is two kilometres after mixing the effluents of JK Paper mills, during the year-2011-2012. The river water samples are collected in clear polythene bottles at low temperature (putting ice in box). The pH, temperature and electrical conductivity testes are carried out at sampling sites. The other parameters are measured by the procedure given by APHA[8]. The investigation

period is divided into three seasons i.e. pre-monsoon, monsoon and post-monsoon. Some of the tests like pH, conductivity, temperature, dissolved oxygen etc. are carried out with the help of the instrument microprocessor water and soil analysis kit [MODEL LT-59]

Results and Discussion

The studies on physicochemical characteristics of river Nagavali at the vicinity of JK Paper mill, Odisha suggests that the various parameters are depending upon the hydrochemistry of the study area and also on the waste water released from different nallas to the river. The physical factors such as temperature, pH, alkalinity, conductivity etc. play a significant role in maintaining water quality. The pH of water is directly related to carbonate and bicarbonate ions present in it which is closely associated with CO_2 pressure and the ionic strength in the aquatic solutions. The chemical oxygen demand is of great importance in water quality assessment. The results achieved during the course of present study, are given in the figure 1 to 10. The result of physicochemical properties obtained during present study is found to be fluctuated with the standard values of water quality parameters given by world health organisation (WHO) and Bureau of Indian Standards (BIS).

Study of pH: It is well known that the pH is an important parameter in evaluating the acid-base balance of water[9-10]. The pH value of water at sewage discharge points near Paper mill area is found be usually higher than that of the river water. Water having pH greater than 8 contains carbonates and pH range 4.5-8 contains bi-carbonates and carbonic acids. Waters having pH less than 4.6 contains carbonic acid. The Bureau of Indian Standards (BIS) limits of pH for drinking water are 6.5-8.5. The pH of Nagavali river water samples of upstream and downstream at the vicinity of discharge point during premonsoon, monsoon and post monsoon are found to be in the range 7.2 to 7.6 , 6.5 to 7.1 and 6.9-7.5 respectively. It is observed that the samples of downstream are slightly alkaline in nature. The results are shown in figure-1.

Study of temperature: The temperature of water is an important physical parameter affecting other water quality parameters[11]. As the solubility of oxygen in water is inversely proportional to temperature, dissolved oxygen (DO) of water at a higher temperature would be reduced. This affects adversely the growth and survival of aquatic life. The temperature of water bodies increases by mixing heated industrial discharges. The temperature of Nagavali river water samples of upstream and downstream during premonsoon, monsoon and post monsoon period are found to be 32 to 34.5ºC , 29 to 31.2ºC and 28.3-31.7ºC respectively. The downstream water samples have slightly higher temperature than the upstream water samples during the research period which is shown in figure-2.

Study of electrical conductivity (EC): The measurement of electrical conductivity is an excellent indicator of TDS, which affects the taste of potable water[12-13]. The electrical Conductivity of water sample of upstream and downstream of Nagavali river during pre monsoon, monsoon and post-monsoon period are observed to be in the ranges of 201-210, 241-298 and 137-140 µmho/cm respectively .The electrical conductivity of downstream samples are higher than the upstream samples which is given in figure-3.

Study of turbidity: The turbidity of water is an important parameter, which influences the light penetration[14]. It is mainly due to the presence of colloidal or finely divided suspended matter which does not readily settle. The turbidity values of Nagavali river water sample during premonsoon, monsoon and post monsoon period are found to be in the range of 8.6-12.5,14.5-16.2 and 9.5-11 NTU respectively which is given in the figure-4.

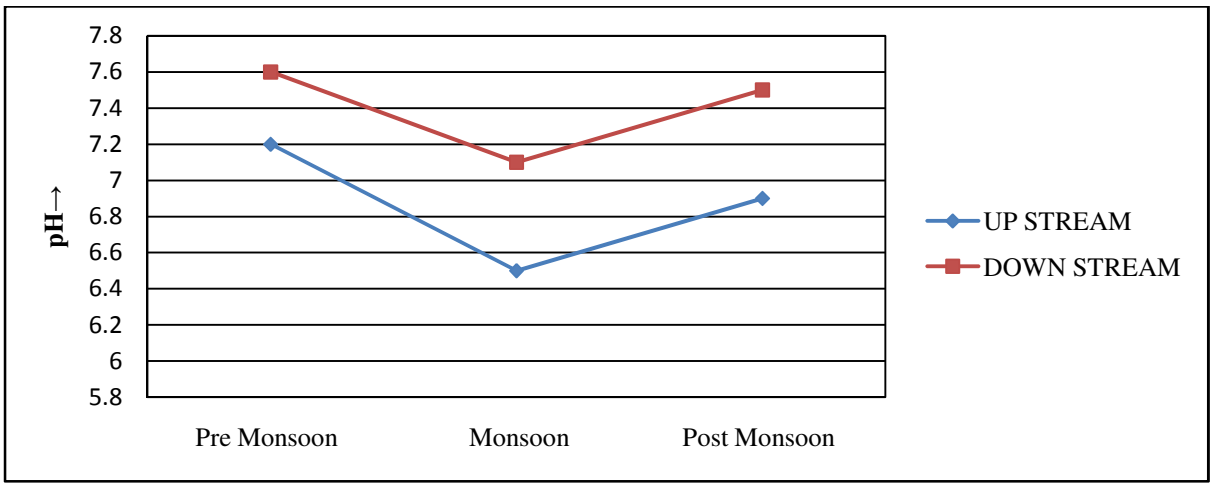

Figure-1
Comparative analysis of pH

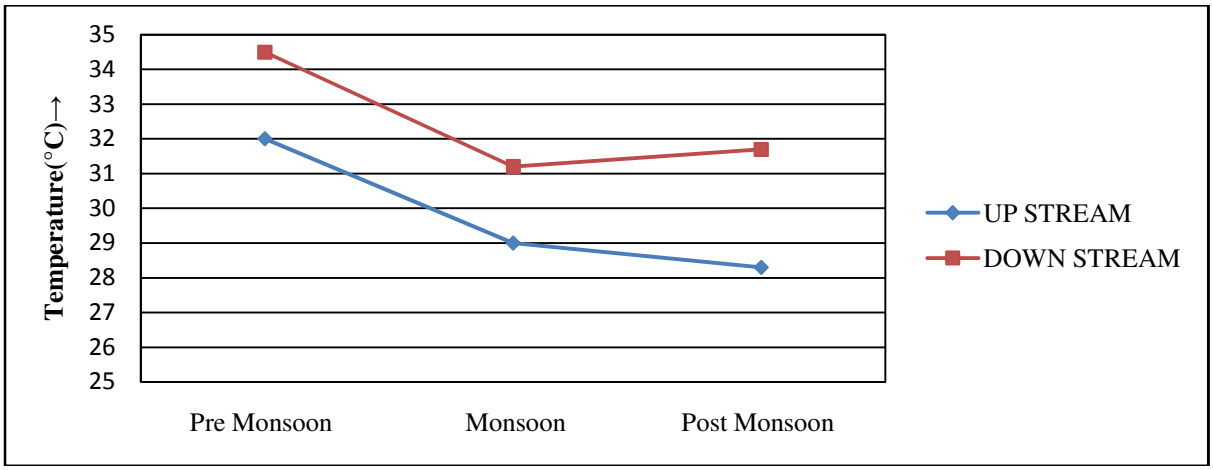

Figure-2
Comparative analysis of temperature

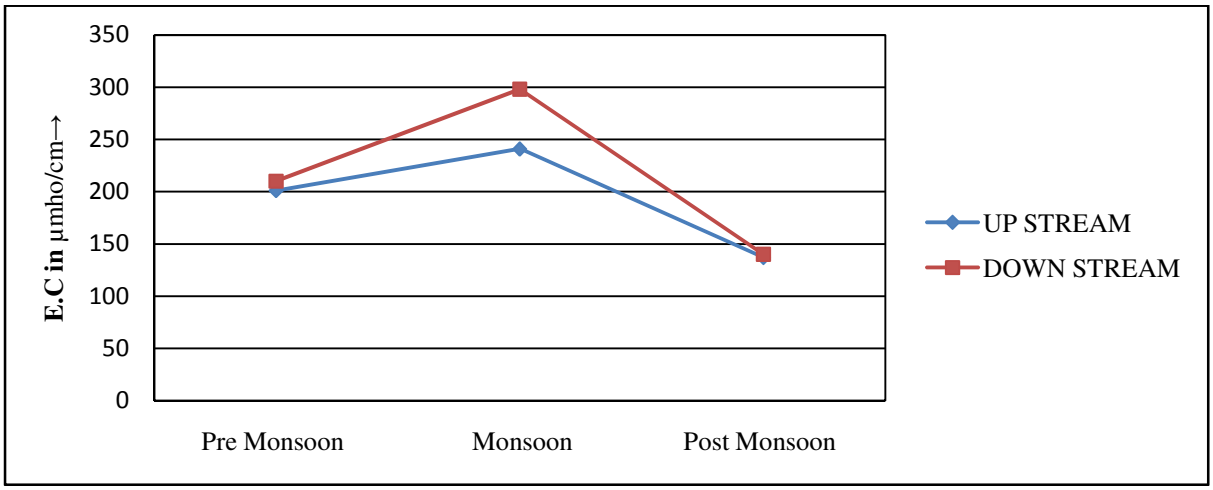

Figure-3
Comparative analysis of electrical conductivity

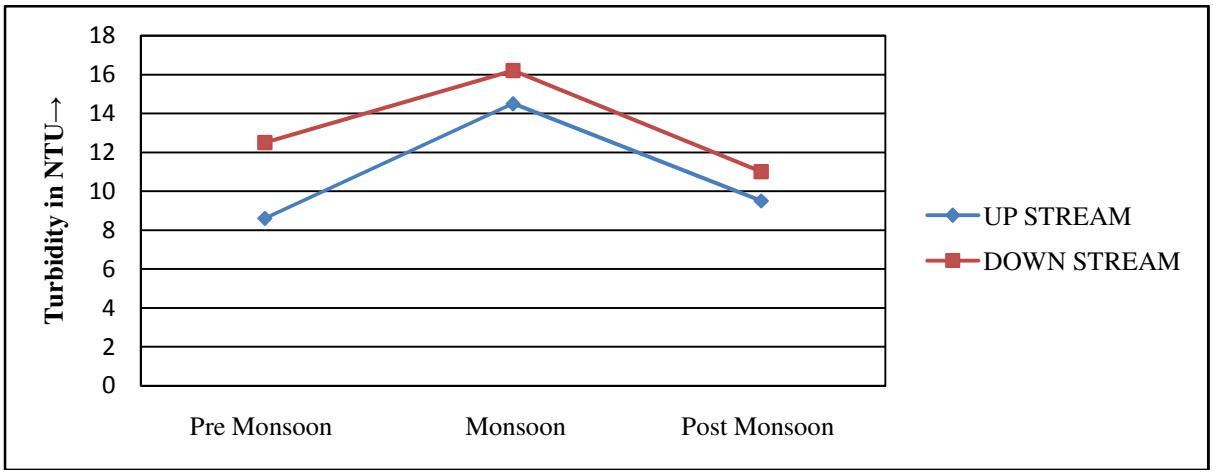

Figure-4
Comparative analysis of turbidity

Study of total suspended solid [TSS]: The total suspended solids may be organic or inorganic and include soil, mineral partials from the land by storm and flood water[15]. Suspended solids deposited on the bed of the water bodies changes the nature of the bed and affects the fauna and flora. Certain organic matter such as fibres and fines from paper mill wastes increase the C.O.D and B.O.D. The total suspended matters in Nagavali river up-stream and down-stream water sample during premonsoon, monsoon and post monsoon are found to be in the range of 44-115 , 82-142 and 38-125 mg/lit respectively. The suspended solids at the monsoon periods samples are slightly higher. Again the downstream samples have more suspended particles then upstream samples as shown in figure-5.

Study of total dissolved solids [TDS]: Fresh water contains various kinds of inorganic minerals as well as some organic materials in dissolved state. Higher dose of these substances creates pollution. Dissolved solids do not contain gas and colloids. In natural water dissolved solids are mainly contains minerals[16-17]. In drinking water it is an important parameter which gives particular test to water. The Nagavali river samples have higher dissolved solids at monsoon period again downstream samples have higher dissolved particles than upstream particles which are observed during the research period shown in figure-6.

Study of hardness: Hardness of water is a measure of its capacity to produce lather with soap[18]. Hardness is mainly due to presence of divalent cations like Ca^{++}, Mg^{++}, Sr^{++}, Fe^{++} and Mn^{++} which may be present in the combination with various anions like CO_3^{--}, HCO_3^{-}, SO_4^{--}, Cl^{-}, NO_3^{-}, SiO_3^{--}etc. The calcium occurs in water due to presence of lime stone, gypsum, dolomite and gypsiferrous matters. Calcium and magnesium are the major scale forming constituents in raw water. Calcium is an essential element for man (about 2 gm daily) and for plant growth. Magnesium is an essential element for human beings, but higher levels of magnesium are harmful as they act as cathartics and diuretics in man. The maximum permissible value of total hardness in drinking water is 300-600 mg/lit (as per BIS). The total hardness of Nagavali river water at the up-stream and down-stream during the premonsoon, monsoon and post monsoon are found to be in the range of 50-61, 72-88 and 71-77.8 mg/lit respectively which is shown in the figure-7.

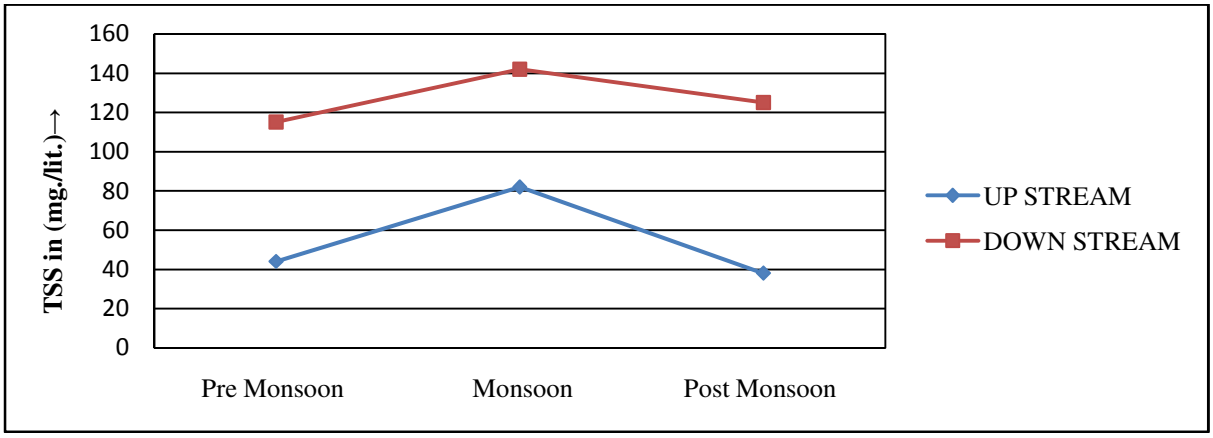

Figure-5
Comparative analysis of TSS

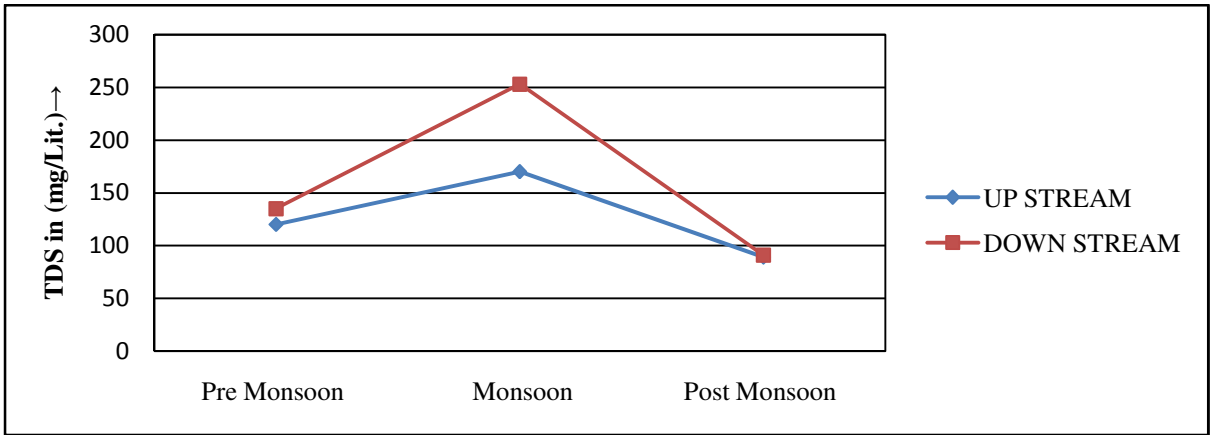

Figure-6
Comparative analysis of TDS

Chloride: Chloride (Cl^-) is one of the major inorganic anion in water and waste water[19-20]. The concentration of chloride in Nagavali river up-stream and down-stream water sample during pre-monsoon, monsoon and post monsoon are found to be in the range of 14.2-25.5, 13.99-31.99 and 13.5-24.7 mg/lit respectively, which is shown in the figure-8.

Study of dissolved oxygen [DO]: Dissolved oxygen in natural and waste water depends on the physical, chemical and biological activities in the water bodies[21-23]. The WHO (World Health Organization) suggested the standard value of DO is >5.00 mg/lit The concentration of DO in Nagavali river upstream and downstream water sample at the vicinity of discharge point during premonsoon, monsoon and post monsoon period are found to be in the range of 4.8- 4.2, 5.5- 4.5 and 5.2- 4.0 mg/lit respectively. It is observed that the dissolved oxygen slightly decreases in downstream water samples as shown in figure-9.

Study of chemical oxygen demand [COD]: The chemical oxygen demand mainly depends upon the organic impurity present in the water[24-26]. The paper mill effluents have higher COD due to the presence of degraded cellulose and lignin materials in the effluent. The COD level of Nagavali river upstream and downstream water sample during pre-monsoon, monsoon and post-monsoon was found to be in the range of 26-32, 46-56 and 30-45 mg/lit respectively which is shown in the figure-10.

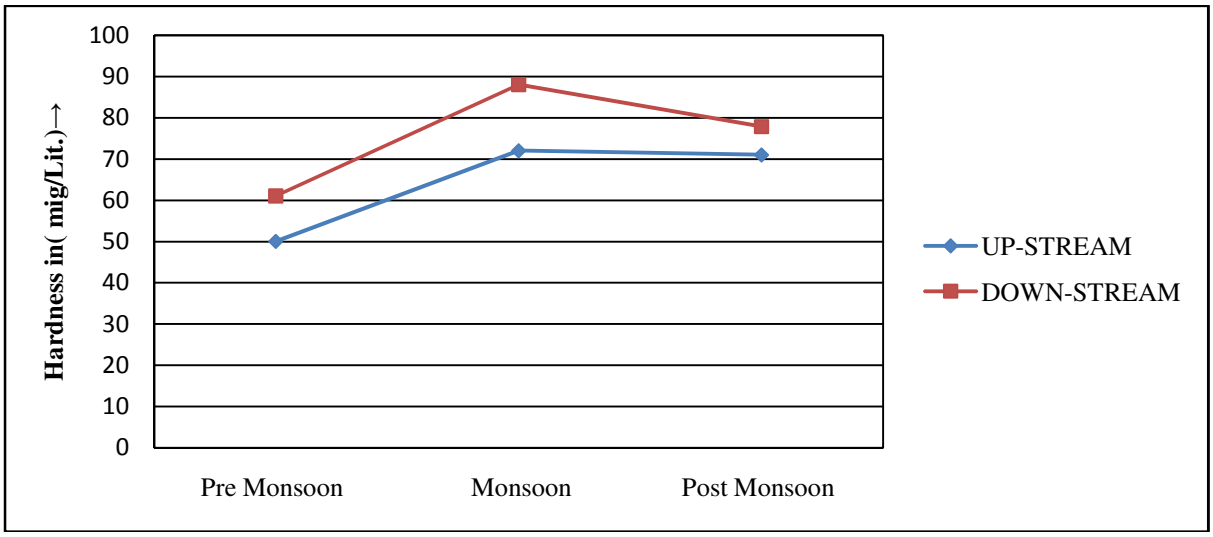

Figure-7
Comparative analysis of hardness

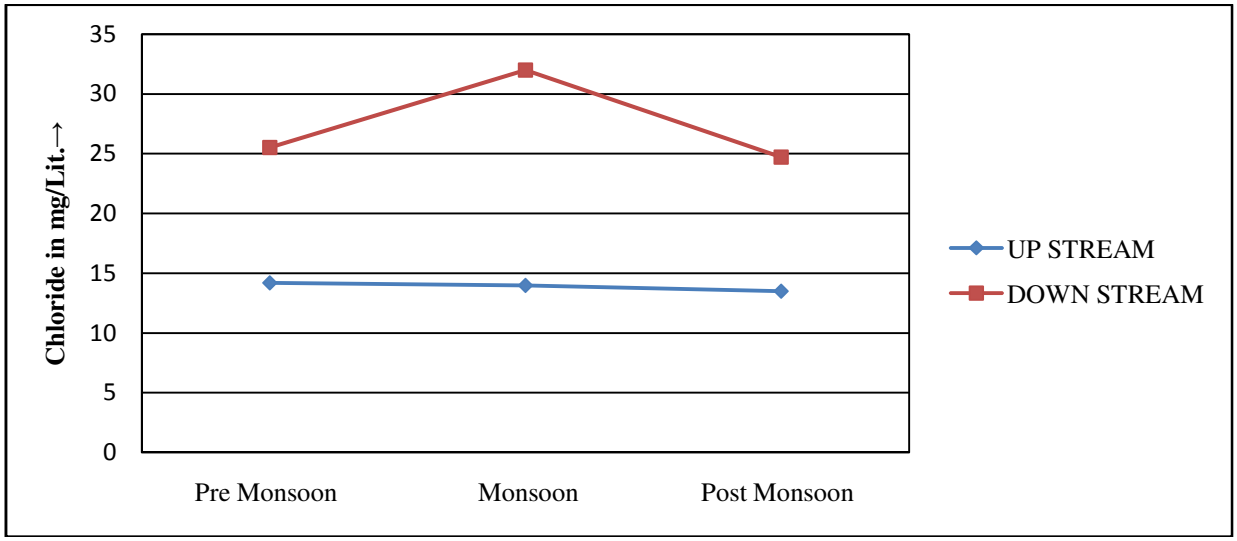

Figure-8
Comparative analysis of Chloride

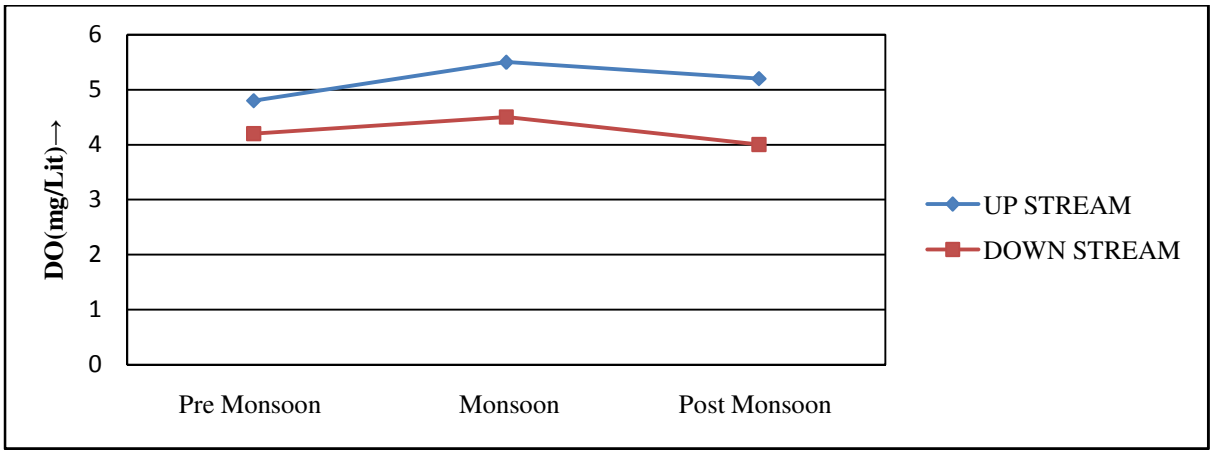

Figure-9
Comparative analysis of DO

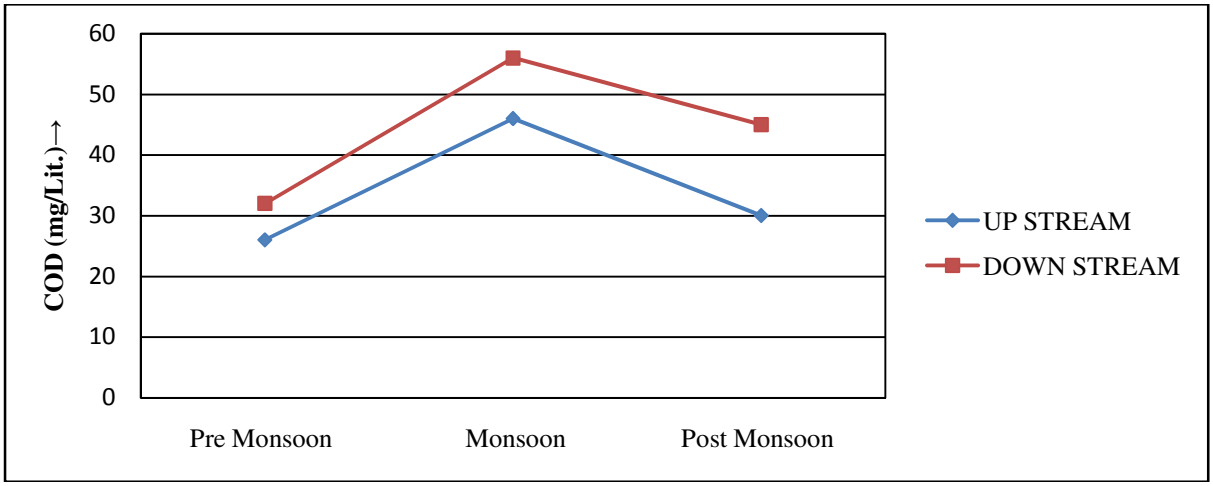

Figure-10
Comparative analysis of COD

Conclusion

This study provides an informative data and helps to understand the contamination of water in the river Nagavali due to the discharge of effluents from pulp and paper industry in Jaykaypur. The present study reveals that physicochemical characteristics like TSS, TDS, EC, and COD of Nagavali river at the downstream of discharge point near JK Paper mills increases at the monsoon period but the pH decreases at the same time. This may be due to mixing of rain water from the periphery areas and industrial effluent which contains dissolved metal ions, organic materials and colloidal particles. The changes in all the water quality parameters bring about a disturbance to the river ecosystem. On comparing upstream and downstream water samples of river Nagavali at the vicinity of JK Paper mills, the downstream samples have slightly higher value of parameters like temperature, pH, electrical conductivity, total suspended and dissolved solids and chemical oxygen demand while the dissolved oxygen [DO] in downstream water has slightly lower than upstream samples indicating that the water of Nagavali river is not grossly polluted. But to aware every individual and their participations to protect human health for sustainable development, it recommends an extensive study of river water of Nagavali at the vicinity of Jaykaypur.

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