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*Research Article*

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# Impact of Sand Dredging on Water Quality Parameters of Nethravathi Estuary, Mangaluru

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**ABSTRACT**

*An attempt has been made to study the impact of sand dredging on water quality of Nethravathi estuary, Mangaluru. The samples were collected from five different identified stations viz S1, S2 and S3 are dredged sites and stations S4 and S5 are un-dredged sites during October 2014 to April 2015. Study revealed that the dredging operation has impact on water quality. Among the water parameters the effects on surface water temperature, pH, dissolved oxygen and salinity were negligible whereas the total suspended solids and turbidity showed higher levels at dredged stations. Further, the results showed reduced Secchi transparency levels at dredged stations. Similarly, the lower concentrations of nutrients at dredged stations due to the indiscriminate removal of sand and organic sediment showed a clear impact of dredging.*

***Key words:*** *Nethravathi estuary, Sand dredging, Temperature, Salinity, Water quality.*

## INTRODUCTION

Estuaries are widely recognized as highly productive and biologically diverse systems[22]. Inflow of both seawater and freshwater provide high levels of nutrients in both the water column and sediments, making estuaries among the most productive natural habitats in the world[10].

Dredging activities have the potential to impact the water quality of aquatic systems. Depending upon the nature of the dredged material, its disturbance from the sea bed may lead to changes in the chemical composition of the water[16].

Excessive in-stream sand dredging causes the degradation of rivers and estuaries. In- stream mining lowers the stream bottom, which may lead to bank erosion. Depletion of sand in the stream, bed and along coastal areas causes, the deepening of rivers and estuaries and the enlargement of river mouths and coastal inlets. It may also lead to excess saline - water intrusion from the nearby sea. Such anthropogenic dredging activities have impacts on the surface water quality of the affected rivers, estuaries which harbors aquatic life[7].

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Any volume of sand exported from streambeds and coastal areas is a loss to the system. This practice has caused a number of environmental impacts including altered topography and hydrology, acidification and water contamination, which has resulted in vegetation damage and fish kill[12].

Excavation, transportation and disposal of soft bottom material lead to various adverse impacts on the marine environment[1]. Considering the ecological importance of Nethravathi estuary, the study was undertaken to evaluate the changes in water quality parameters caused by sand dredging from the period of October 2014 to April 2015.

## MATERIAL AND METHODS

The present study was carried out at Nethravathi estuary located in Mangalore, Dakshina Kannada district, Karnataka. Prior to investigation, a pilot survey was done to identify the dredging sites along Nethravathi estuary. Altogether, five stations were selected *viz*; stations S1, S2 and S3 are the three locations where major sand dredging is being carried out by the private agencies. Station S4 has been identified as non- dredging site located in between the roadway and railway bridge crossing the Nethravathi estuary. A reference station S5 was selected where there no any sand dredging activities are been observed (Fig. 1).


**Fig. 1: Google earth top view of map showing the selected stations at Nethravathi estuary**

To assess the impact of sand dredging, fortnightly sampling was carried to determine various physico-chemical characteristics of water for a period of six months from October 2014 to April 2015.

Surface water temperature was recorded immediately after the collection of water sample from different stations using a standard mercury centigrade thermometer. The pH of water was measured using a digital pH meter (WTW pH320). Turbidity was measured by using Systronics Turbidity Meter 135. Transparency of the water was recorded by using Sacchi disc[4] and is expressed in meters. Salinity of water samples was analysed in the laboratory by following Mohr's method[20]. The water sample for DO were fixed immediately after collection and then determined by Wrinkler's method. Total suspended solid (TSS) content and Total dissolved solid (TDS) of water samples were analyzed using Millipore filtration assemblage following standard method[2].

The nutrients such as, Ammonia-nitrogen ($NH_3$-N by using phenol-hypochlorite method) and Phosphate-phosphorus ($PO_4$-P by using ammonium molybdate method) were estimated. The absorbance for different parameters was measured using a Systronics UV-VIS spectrophotometer 119.

## RESULTS AND DISCUSSION

The water temperature ranged between 26.8 and 31.9ºC with a variation of 5.1ºC. The minimum water temperature was observed in the month of January at S1 while maximum was observed in the month of April at S4 (Fig 2).

The minimum water temperature was observed in the month of January (post-monsoon season) at dredging sites, however all the stations recorded, maximum water temperature was observed during pre-monsoon season. The highest temperature was recorded in April has been influenced by the high intensity of solar radiation coupled with evaporation. Lowest surface water temperature recorded during post monsoon season could be due to the cloud over and reduction in solar radiation on the day of sampling.

Therefore the recorded high pre-monsoon and low post-monsoonal values can be ascribed to meteorological phenomenon *i.e.*, high solar radiation and precipitation respectively.

Shruthi and Rajashekhar[19] opined that the surface water temperature ranged from 27.5ºC to 31.5ºC from the same study area. The recorded low temperature during monsoon could be due to overcast sky and strong sea breeze, which could be in accordance with the earlier reports[13,9,5].

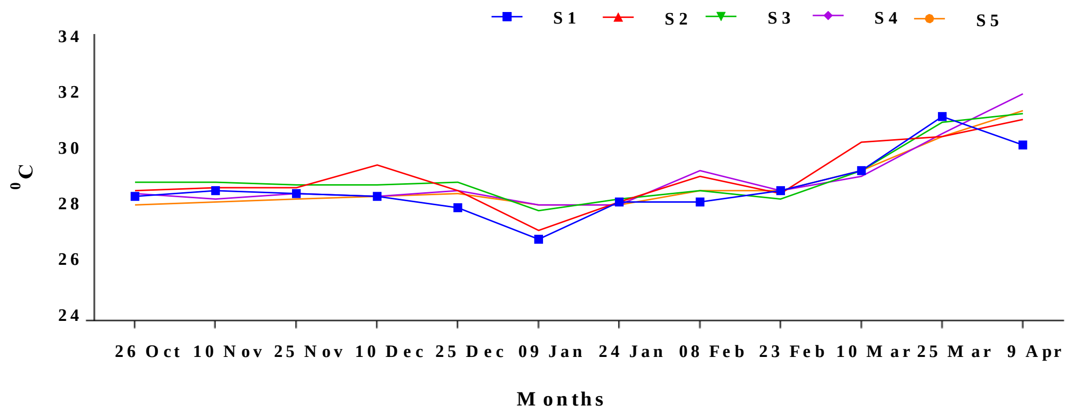


**Fig. 2: Variation of water temperature ($^0$C) at different stations during the study period**

The pH ranged between 6.8 and 8.4 with a variation of 1.6. The minimum pH was observed in the month of November at S4 and S5 while the maximum was observed in the month of April at S2 (Fig 3).

The observed pH maxima during pre-monsoon could be attributed to the high rate of evaporation under high temperature conditions and higher photosynthetic activity. The observed post-monsoon minima can be ascribed to rainfall, resultant freshwater mixing. However, previous studies indicated that Nethravati-Gurupur estuarine waters are well buffered with pH ranging from neutrality to slightly alkaline. Several investigators[13,17,23].

while working on the hydrography of Nethravati-Gurupur estuary have reported lower values of pH during post-monsoon season. Tripathi[23] documented a pH range of 7.2 to 8.4 in Nethravati-Gurupur estuarine waters.

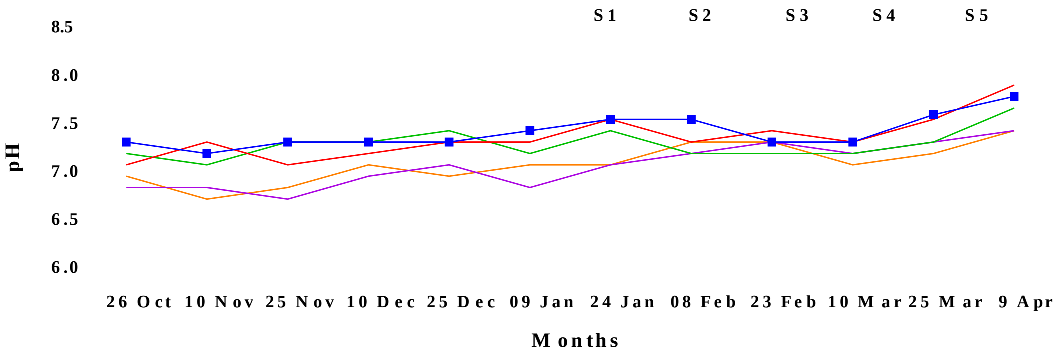


**Fig. 3: Variation in Water pH recorded at different stations during the study period**

The turbidity ranged from 10.4 to 56.6 NTU with a variation of 46.2 NTU. The minimum turbidity was recorded in the month of January at S5 while maximum was noted in the month of October at S1 (Fig 4).

During the study period, there was a significant difference observed in turbidity between the dredged and un-dredged stations. The higher turbidity values *i.e.* 56.6 NTU were observed at S1 (dredged site) during post-monsoon season and lower values (10.4 NTU) were observed at S5 (undredged site) during pre-monsoon season with a variation of 46.2 NTU. The higher values could be due to the disturbance of bottom sediment particles mainly clay and silt. Turbidity plumes have been reported to negatively impact estuarine organisms during dredging and disposal of dredged spoils, causing dredging of primary productivity[3]. High turbidity induced by sand mining was reported to contribute to deterioration in water quality in the Kelantan river[26].

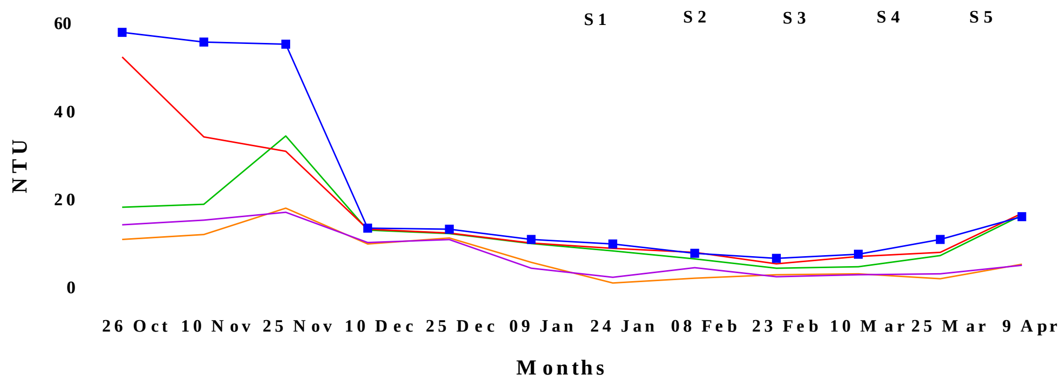


**Fig. 4: Variation in turbidity (NTU) at different stations during the study period**

The transparency or Secchi disc length was ranged from 0.6 to 2.3 m with a variation of 1.7 m. The minimum value was observed in the month of October at S2 while maximum was observed in the month of February at S5 (Fig 5).

Changes in transparency reflect the impact of human activity in the aquatic system. The Secchi transparency showed minimum values (0.6m) during the post-monsoon season at the stations where sand dredging was being done regularly, whereas the high transparency values (2.32m) were recorded at un-dredged sites during pre-monsoon season. This could be mainly due to unsustainable sand mining activities which causes the reduced the water clarity. Similar results were found by Iwuoha and Osuji[6] where the water transparency decreased by 25 to 50% over a distance of 12km and the effect was persistent for 18 months after dredging. Shiyang *et al.*[18] revealed a decreasing trend in Secchi transparency in the water column due to the sediment dredging which intern reduced the Chlorophyll-*a* content and algal biomass.

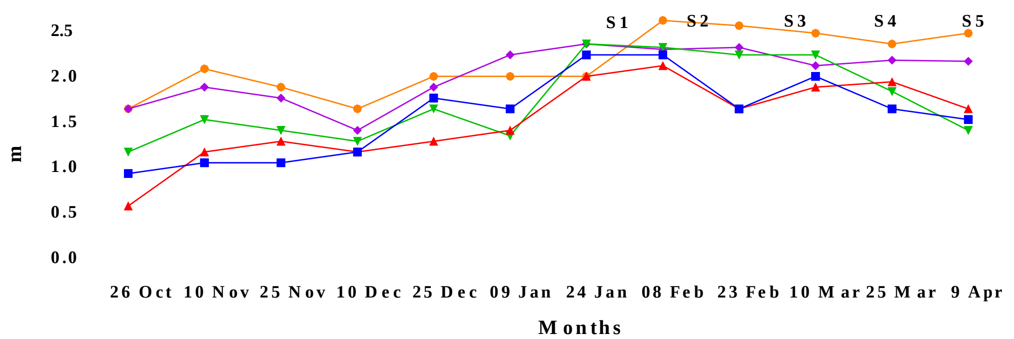


**Fig. 5: Transparency (m) recorded at different stations during the study period**

The salinity varied from 7.5 to 31.9 PSU with a variation of 24.4 PSU. The minimum salinity was observed in the month of October at S2 while maximum value was observed in the month of April at S4 and S5 (Fig 6).

It is well known that salinity is determined by the factors like precipitation, run-off, evaporation and the degree of dilution caused by the mixing of sea and river water. In the present study also the salinity showed an increasing trend from station S1 to S5 i.e. from river to sea side. Earlier reports given by Puranik[13], registered an annual difference between highest and lowest salinity in Nethravathi estuarine waters. As reported by earlier worker like Sudhir[21] in the Nethravathi estuary, higher salinity was recorded during March, April, and May while lower values were registered during the July and August. In present study, the effect of dredging was not significant on salinity. The variation in salinity was considered due to seasonal variations as suggested by earlier workers.

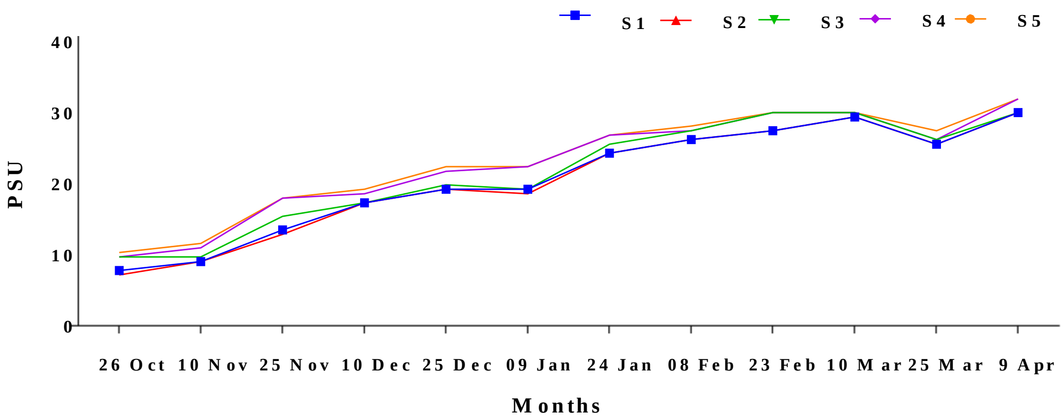


**Fig. 6: Variation in Salinity (PSU) at different stations during the study period**

The dissolved oxygen concentration ranged from 3.04 to 8.14 mg/l with a variation of 5.1 mg/l. The minimum concentration was recorded in the month of April at S3 while maximum was recorded in the month of October at S4 (Fig 7).

The observed high values might be due to the effects of higher wind velocity, increased turbulence coupled with heavy rainfall. However, in estuarine waters the resultant freshwater mixing through river run-off also might have resulted in high DO content. The low dissolved oxygen concentration could be attributed to high biological activity besides, low solubility of oxygen under high temperature and salinity conditions. The observation of dissolved oxygen showed an inverse trend against temperature and salinity. It is well known that temperature and salinity affect dissolution of oxygen in seawater[25].

The monthly variation in the dissolved oxygen concentration observed in the present study was almost similar to that of reported by Puranik[13].

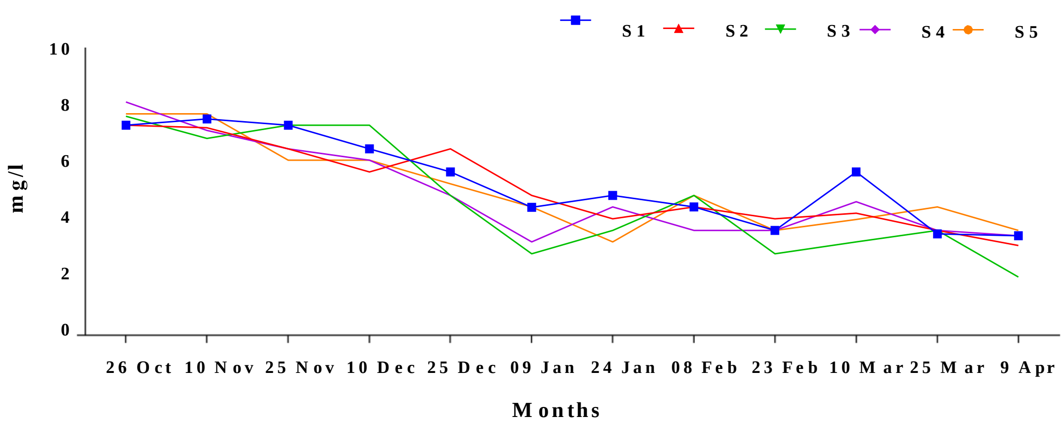


**Fig. 7:Variation in Dissolved oxygen (mg/l) concentration at different stations during the study period**

The TSS varied from 20 to 128 mg/l with a variation of 108 mg/l. The minimum value was observed in the month October at S5 while maximum was observed in the month of April at S2 (Fig 8).

The present study indicated the strong influence of sand dredging on TSS levels and found that the TSS levels were high (128 mg/l) at the dredged sites compared to un-dredged sites where the TSS levels were comparatively lower (4 mg/l). The similar result s were observed by Zati *et al.*[27]. They found the increased TSS load (142 mg/l) was associated with sand mining activities and flooding thereby reduction in the transparency.

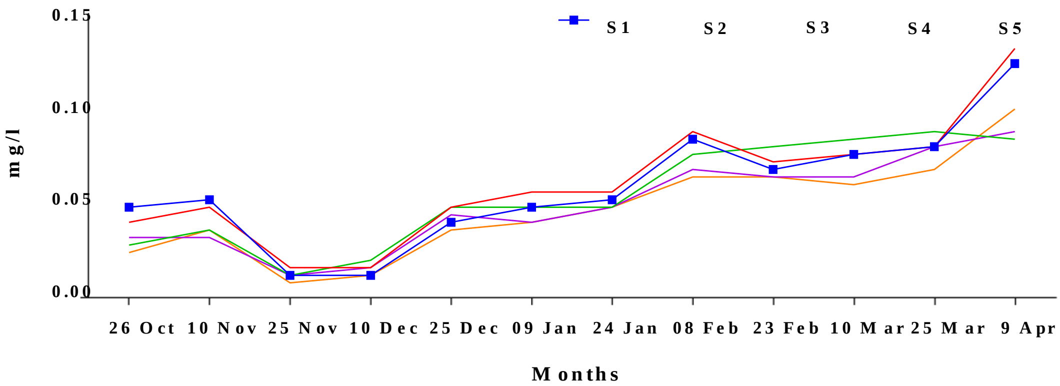


**Fig. 8: Variation of TSS (mg/l) recorded at different stations during the study period**

The TDS varied from 0.60 to 28.58 g/l with a variation of 32.88 g/l. The minimum value was recorded in the month of October at S1 while maximum was recorded in the month of February at S4 (Fig 9).

TDS values in different stations showed an increasing trend during the study period. The minimum value was observed in the month of October at S1 which could be attributed to the lower salinity levels caused by the influx of freshwater. Comparatively higher values were recorded in all the stations in the month of April with the increase in salinity due to the increased temperature causing evaporation of water. Comparatively the concentrations were slightly more at stations S4 and S5. This corroborate to salinity wherein it consists of some of the ions constituting TDS[14].

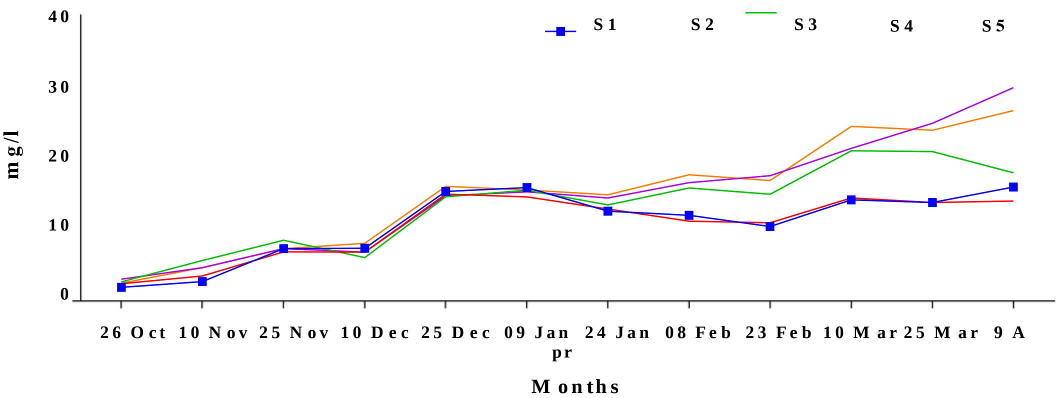


**Fig. 9: Variation of Total Dissolved Solids (g/l) at different stations during the study period**

The Ammonia level was ranged from 1.02 to 15.78 µg at/l with a variation of 14.75 µg at./l. The minimum concentration was reported in the month of January at S2 while maximum was reported in the month of October at S5 (Fig 10).

Ammonium may be more readily bio-available for plant growth than nitrate[8]. The observed low ammonia-nitrogen values during the study period could be due to the uptake by phytoplankton, which might have influenced the dissociation of total ammonia, thereby resulting in its low level and high values during post-monsoon might be due to influx of nutrient laden terrestrial and river run-off. With respect to dredging activities, the Ammonia levels were found less at dredging stations compared to un-dredged sites. This could be due to the effect of dredging which intern reduced the internal nutrient load and correspondingly decreased the amount of nutrients released to the water column. Shiyang *et al*.[18] reported a decreasing trend for levels of nitrogen level in water column during survey period due to the dredging operation in Lake Yuehu, China. Similar results were observed by Tripathi[23], in the reported ammonia in the waters of Nethravati-Gurupur estuary.

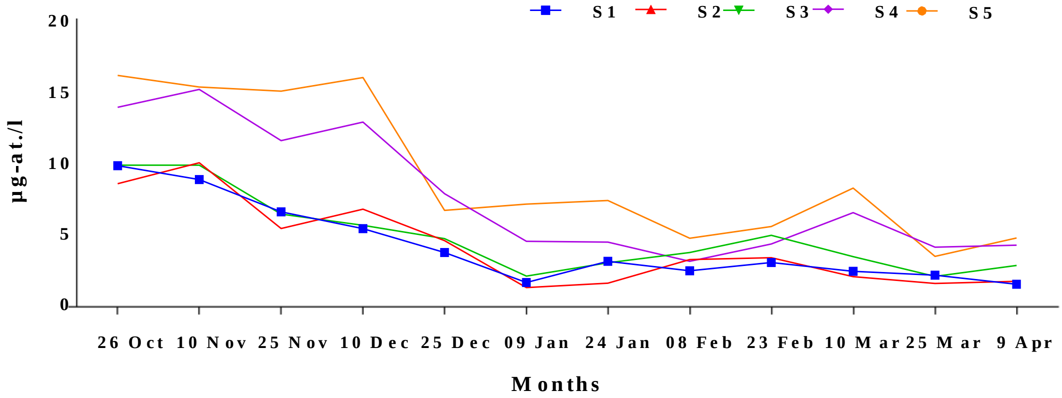


**Fig. 10: Variation in Ammonia-nitrogen (µg at./l) concentration at different stations during the study period**

The Phosphate-phosphorous content was ranged between 0.05 and 7.32 µg at./l with a variation of 7.27 µg at./l. The minimum value was observed in the month of January and February at S2 and S1 while maximum was observed in the month of February at S5 (Fig 11).

The minimum concentration of Phosphate-phosphorous was observed at S1 and S2 in the months of February and January, which could be attributed to increased suspended solids which adsorb the phosphorous. Shiyang *et al.*[18] reported that phosphorus could be absorbed by suspended solids and deposited to the sediment. According to Lurling[11], the sediment dredging is an effective way of reducing phosphorous and nitrogen.

The maximum concentration of phosphorous in Nethravathi estuarine waters was observed in the month of February at reference station (S5). The weathering of rocks results in soluble alkali metal phosphates, which may be carried along with land run-off into these waters. Mathew (1994) in brackish water ponds of Nethravathi estuary recorded highest phosphate level as (4.82 µg at./l). Shruthi and Rajshekhar[19] reported the levels for phosphate ranged between 0.01 and 4.02 µg at./l. Vedamurthy[24] and Sahu[15] recorded a higher concentration during monsoon and post monsoon seasons.

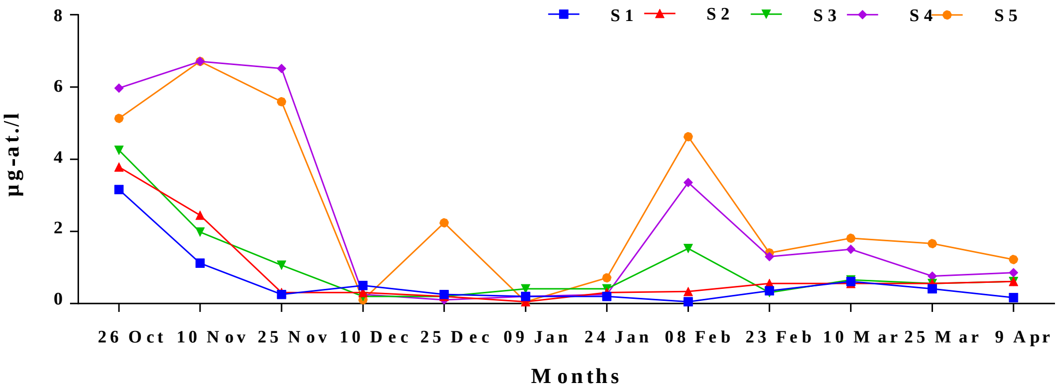


**Fig. 11: Variation in Phosphate-phosphorous (µg at./l) concentration at different stations during the study period**

## CONCLUSION

The sand dredging has huge impact on total suspended solid, turbidity, transparency and nutrient availability near dredged sites where as, surface water temperature, pH, dissolved oxygen and salinity were not affected by dredging process. Hence impacts are site specific and difficult to quantify exactly.

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