

## Geochemical Evaluation of an estuarine environment: A case study on Udayavara Estuary South West Coast of Udupi, India

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**Abstract:** Udyavara estuary is located in Udyavara basin, Udupi District of Karnataka State, South West Coast of India. The study area is defined by the Tunga basin to the east, the Arabian sea to the west, Sita-Swarna basin to the north and the Mulki Hole to the south. The temporal and spatial distribution of temperature, turbidity, DO, pH, Hardness, TDS and Conductivity of surface water collected from seven different points in Udyavara Estuary were measured and estimated on a post monsoon season. Chlorides and ammonical nitrogen were collected from 5 different points and measured. There was no change in any of the patterns or any parameter. Each parameter had a specific behavior, However, Pangala station showed the best results. Unlike this the first three stations showed the worst results. The sediment analysis did not show any traces of ammonical nitrogen.

### Introduction:

An estuary is a coastal body of water, semi-enclosed which has a free connection with the sea and mixes with fresh water drainage from the ground (Odum, 1988). This ecosystem has specific characteristics such as high nutrient levels which mean high productivity and high biomass. That is the reason they can harbor unique plant and animal communities. Due to their geomorphologic and physico-chemical properties estuaries are potential deposit areas for anthropogenic sediments such as radioactive pollutants, heavy metals, pesticides, insecticides, hydrocarbons and toxic chemicals adding additional stress to this highly productive ecosystem (Mahapatroet *al.*, 2011). Prasana & Panda (2010) enhance the importance of monitoring these ecosystems through parameters such as salinity, turbidity, pH, temperature and the amount of oxygen dissolved.

Located along the west coast of India are a number of estuarine channels that connect the Arabian Sea to the rivers that originate in the Western Ghats mountain range (Sundar & Shetye, 2005) and Western Ghats is a conspicuous and significant morphological element in the landscapes of Peninsular India (Subrahmanya, K. R., 1994, Maddodi, 1996). To follow the large expansion of the estuaries are forests of salt-tolerant trees and shrubs that grow in the shallow tidal waters which is called mangroves. This specific flora is among the most threatened habitats in the world and researchers believe that more than 50% of the original mangrove forests have been lost (Mahapatroet *al.*, 2011). Research contributes to our understanding of the estuary and can identify better ways to manage our activities so that the ecosystem remains healthy and that is the aim for the onset for this study.

### Experimental Investigation:

#### Materials:

#### Study area:

Udupi district is a fast growing region of coastal Karnataka along the west coast of India. Udupi district, as demonstrated in Figure 1, lies between longitude 74°35' E to 75°10' E and latitude 13°5' N to 14°N, and falls in the Survey of India Top sheets No.48K/9, 10, 11, 12, 13, 14, 15, 16 and 48O/2, 3, & 4. Udyavara estuary is located in Udyavara basin, Dakshina Kannada, District of Karnataka State, India. The study area is defined by the Tunga basin to the east, the Arabian sea to the west, Sita-Swarna basin to the north and the Mulki Hole to the south. To this study were named seven stations as L1, L2, L3, L4, L5, L6 and L7 (Figure 1) from Kemmannu to Pangala.

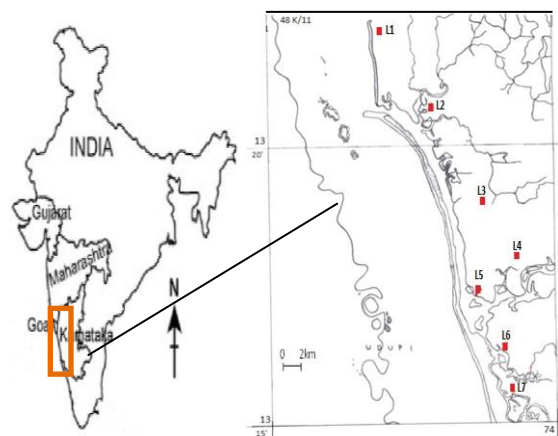


Figure 1 – Location map of Udyavara estuary. Depicting sample and station distribution

It is not possible to understand the dynamic of estuary without knowing the lithology of the study area. According to Balasubhrmanya 1978, Maddodi, 1996, the principal lithological assemblages of the basin are the granitic gneisses of the Peninsular Gneissic complex, laterites and alluvial sand the most distinctive feature is the presence of the Kanara batholiths in the central and eastern parts of the basin. Table-1 shows the main lithology for each location. It is not possible to understand the dynamic of estuary without knowing the lithology of the study area. According to Balasubhrmanya 1978, Maddodi, 1996, the principal lithological assemblages of the basin are the granitic gneisses of the Peninsular Gneissic complex, laterites and alluvial sand the most distinctive feature is the presence of the Kanara batholiths in the central and eastern parts of the basin. Table-1 shows the main lithology for each location.

Table 1 – Lithological characteristics for each location. Source: Maddodi, 1996.

Location number	Area/City	Main lithology
L1	Kemmannu	Sand
L2	Malpe	Sand
L3	Katpadi	Sand
L4	Udyavara	Sand
L5	Pitrodi	Sand
L6	Mattu	Sand
L7	Pangala	Sand

In Every location sand is the main lithology, and this has influence in water infiltration and adsorption of anthropogenic materials. These are the foremost rationales to study this kind of parameters in water and sediments estuary samples.

**Sampling Methodology:**

Water and sediments samples were collected on 5 October 2013 and all parameters were calculated on the next 5 days. Surface water samples were collected with clean bottles and sediments samples with specific plastic bags. The only parameter that was measured on the site was the temperature using a thermometer.

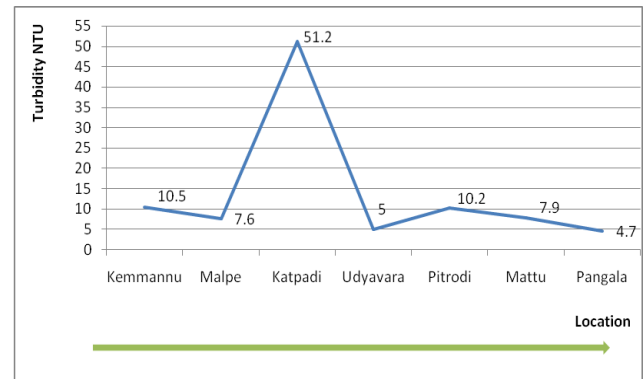
The samples were analyzed for 9 parameters – 7 parameters to water samples and 2 parameters to sediments samples. pH level was measured using a pH analyzer (LI 612 pH ANALIZER, version1), Turbidity with Nephelometer (ELICO CL52D Nephelometer) and Conductivity and TDS was measured with the same analyzer (CM183 EC-TDS Alanizer version 2.3). To determine the dissolved oxygen Winkler’s method was used and total hardness was estimated by the complex metric titration with

standard EDTA solution using Eriochrome Black-T as indicator.

For sediments samples Chlorides and Ammonical Nitrogen of 5 locations was measured. It was not possible to collect sediments for Kemmannu and Malpe stations. Before starting measured these parameters was dissolved 30 g of sediments in 0.30L on distilled water. After filtration the water was possible determinate chlorides and ammonical nitrogen. To determine the chlorides Argent metric method was used (Mohr’s method) and ammonical nitrogen was measured by titration.

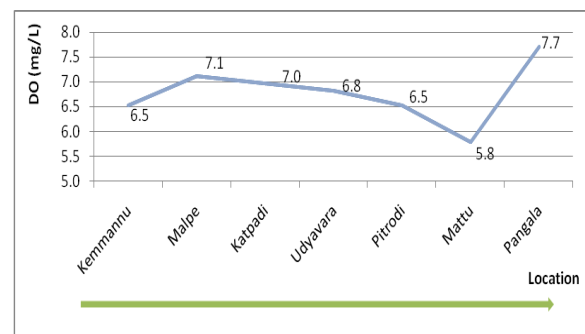
**Results and Discussions:**

The temperature was the same in every locations, 22.5°C except for Pangala that had 0.5°C less (22.0°C). The average of turbidity was 13.9 NTU and values varied from 4.7-51.2 NTU. The maximum level was determinate in Katapadi station and the lowest in Pangala (Graph 1).



Graph 1 - Turbidity for different locations

Dissolved oxygen (DO) levels varied from 5.8-7.7 mg/L which means that throughout the estuary there is no stress and it is well oxygenated. DO is correlated to temperature (the higher temperature the lowest solubility of oxygen) and because of that the highest level was measured in Pangala (graph 2).

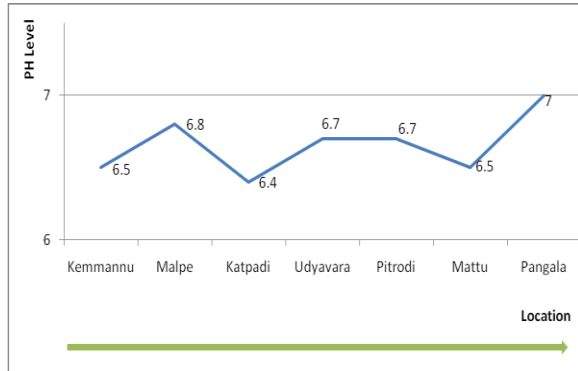


Graph 2 – DO for different locations

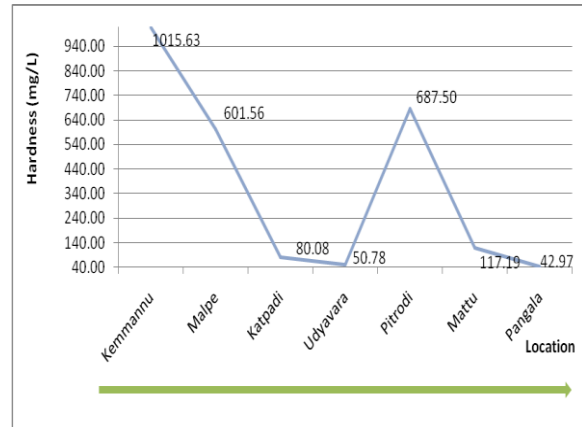
The pH level of surface water was alkaline and fluctuated between 6.4 and 7.0. They are not well within the limits (ICMR Standard; 7-8.5). It is possible to see (graphic 3) that there is no pattern trough the estuary. The station with the lowest level is

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Katpadi (6.4) and the location with the highest level is Pangala, the last station analyzed.



Graph 3 – pH level for different locations



Graph 4– Total hardness for different locations

Total hardness range from 42.97-1015.63 mg/L, the highest and the lowest were at Kemmannu and Pangala, respectively (graphic 4). According to the hardness scale Kemmannu, Malpe and Pitrodi stations have very hard water, Katpadi and Mattu have moderately hard water and Udyavara and Pangala have soft water. Only Udyavara and Pangala have water that is quite safe and tolerable for drinking purposes (<75 mg/L).

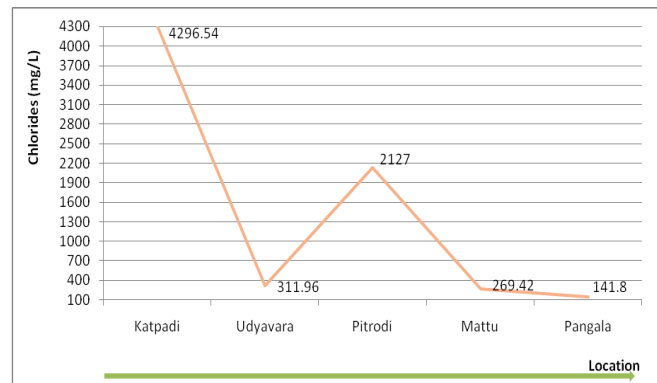
The TDS value was maximum at Kemmannu station as well as conductivity and minimum was observed at Pangala station. TDS and conductivity decrease from L1 to L4 but after that there is no pattern for these parameters. Knowing that TDS and conductivity are related in view of the following formula [1]\* is easily understood the values above (table 2). In the same table is shown the final results for all parameters in water samples.

\*[1] TDS = 0.640C

Table2 – Different water quality parameters of Udyavara Estuary

Location		Physical Parameters		Chemical Parameters				
		Temp. (°C)	Turbidity NTU	DO (mg/L)	pH level	Hardness (mg/L)	TDS	Conductivity
Kemmannu	L1	22.5	10.5	6.5	6.5	1015.63	3.301ppt	5.834mS
Malpe	L2	22.5	7.6	7.1	6.8	601.56	2.207ppt	3.373mS
Katpadi	L3	22.5	51.2	7.0	6.4	80.08	247.9ppm	445.1uS
Udyavara	L4	22.5	5.0	6.8	6.7	50.78	117.9ppm	243.1 uS
Pitrodi	L5	22.5	10.2	6.5	6.7	687.50	2.359ppt	4.859mS
Mattu	L6	22.5	7.9	5.8	6.5	117.19	502.8ppm	770.1uS
Pangala	L7	22.0	4.7	7.7	7.0	42.97	76.83ppm	167.3uS

Chlorides were measured in sediments for L3 to L7 stations. The graphic above shows that Katpadi has the highest level of this ion (Cl<sup>-</sup>) and Pangala the lowest level. It is known that if water samples contain too much chloride, then it is either contaminated by the sewage or it is in contact with sea water.



Graphic 5 - Chlorides for different locations

Table 3 – Different sediments quality parameters of Udyavara Estuary

Location		Sediments Samples	
		Chlorides (mg/L)	Ammonical Nitrogen (mg/L)
Katpadi	L3	4296.5	Free
Udyavara	L4	312.0	Free
Pitrodi	L5	2127.0	Free
Mattu	L6	269.4	Free
Pangala	L7	141.8	Free

**Conclusion:**

There was no significant change in the pH value throughout the Udyavara estuary: the observed values were in the range from 6.4 to 7. However, Pangala exhibits to be a station with the best results, both in its physical parameters and chemical parameters. Pangala station (L7) has the lowest level for turbidity, hardness, TDS, conductivity and chlorides, and also with the highest levels for DO & pH. This result may be conditional as one of the reasons to explain the results, because of the distance between this station (L7) and pollution sources. This may be the justification for the first three locations presenting the worst results, Kemmannu, Malpe and Katapadi which is near to the anthropogenic activities.

Any ecosystem needs time to recover from the damage caused by anthropogenic activities. This case is no different, so that harmful activities near to the estuary and its associated ecosystems should be reduced or completely stopped. Udayavara estuarine ecosystem as on present form is free for any harmful and toxic elements. The study with water and sediment sample have proved estuarine environment to be improved from natural self cleaning process with a caution in two station where anthropogenic activities has started effecting the study area.

**References:**

- [1] Maddodi, B. S. (1996). Evaluation of the fluvial and coastal geomorphometric and sedimentologic systems: A study of the Udyavara Basin, west coast, India. Department of Marine Geology, Mangalore University.
- [2] Mahapatro, D., Panigrahy, R. C., Naik, S., Pati, S. K. and Samal, R. N. (2011). Macrobenthos of shelf zone off Dhamra estuary, Bay of Bengal. *Journal of Oceanography and Marine Science*, **2(2)**, 32-42.
- [3] ODUM, E. P. (1988). *Fundamentals of Ecology*. Institution Calouste Gulbenkian, Lisboa.
- [4] Prasanna, M. B. and Panda, C. R. (2001). Physico chemical properties of water collected from Dhamra estuary. *International Journal of Environmental Sciences*, **1**.
- [5] Sundar, D., Shetye, S. R. (2005). Tides in the Mandovi and Zuari estuaries, Goa, west coast of India. *J. Earth Syst. Sci.*, 114, 493-503.