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Study on Hydrographic properties in the coastal waters along South East Coast of India

James Balgan Anand D[1], Mary Jelastin Kala S[2]
[1]*Research Scholar, Research Department of chemistry, St. Xavier's College, Palayamkottai, TamilNadu, India*
[2]*Assistant Professor, Department of chemistry, St. Xavier's College, Palayamkottai, TamilNadu, India*

ABSTRACT: *Coastal waters are considered to be the pillar and essential of Marine life. The study of Hydrographic properties of coastal environments is important, because the variations in the instantly influence on the floral and faunal production. The variations affect the species diversity, pattern of diversity, breeding, survival and other activities. To maintain optimum level of water quality parameters is better for the species survival and healthy ecosystem. The present study was carried out to determine the Hydrographic variations in coastal Waters of Mandapam, Thoothukudi, Arumuganeri and Kanyakumari along the south east coast of India. The sampling of coastal water was carried out from January 2014 to December 2014. The hydrographical parameters like temperature, salinity, pH, dissolved oxygen, inorganic nitrite, nitrate, phosphate, silicate, and chlorophyll -a were analyzed in the coastal waters. The results showed decline in the quality of water during the non-monsoon season compared to that in the monsoon season. The DO and nutrients was found to be low in summer and high during monsoon season. Similarly temperature, pH and salinity were low during monsoon and high during summer season. The hydrographic properties have exhibited considerable seasonal and spatial variations.*

Keywords *-Hydrographic properties; Nutrients; Seasons; Coastal water; East Coast of India*

I. INTRODUCTION

The coastal ecosystems provide food and other incomes, also used for waste disposal, recreation and inspiration. Water is very essential for all Living being. It is available in different forms in our environment. Coastal environment is vital for all human activities including industrial growth. Without the coastal environment, success of any community or nation is impossible. In the other hand coastal water is always considered as an easily available and everlasting resource for the biota. Coastal Zone is influenced by the interaction between land and sea. The environmental conditions such as topography, water movement, salinity, oxygen, temperature and nutrients characterizing particular water mass also determine the composition of its biota [1]. Thus the nature and distribution of flora and fauna in an aquatic system are mainly controlled by the fluctuations in the hydrographical parameters of the water body [2]. Coastal zone offers an important buffer zone and filtering system for the ecosystem.

Generally Marine environment is a complex system and mainly influenced by various physical chemical and biological process. The open ocean is more stable compare to the near shore waters where the interaction with terrestrial and makes the variations in hydrographical properties [3]. The water quality depends on both natural processes, such as precipitation erosion, weathering of crustal materials and anthropogenic processes like urbanization, industrialization, mining and agricultural activities [4]. These two parameters play a dynamic role in nutrient cycling, eutrophication, biota abundance and overall food web dynamics in the estuarine and the coastal ecosystem, whereas surface runoff is a seasonal phenomenon largely affected by the monsoon rainfall (Figure 1).

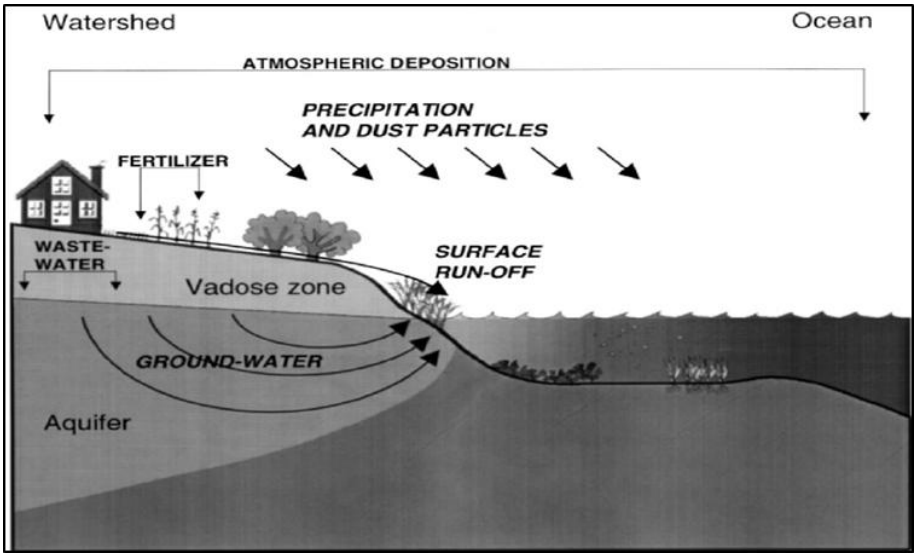

Figure: 1 Pathways of Nutrients Entry into the Coastal Water [5]

The coastal hydrography is much complicated due to the dynamic nature of the ecosystem. Changes in the hydrographical parameters such as salinity, dissolved oxygen, dissolved carbon dioxide; nutrients affect the activities and growth of the organisms in the ecosystem [6].It plays a major role in forecasting, localizing, and manipulating the marine resources [7].Coastal Water quality is an indicator which gives the necessary information about the marine waters and their ability to support the marine species to live in the marine environment. It shows how activities on land affect marine water quality.

Hence the hydrological study is very much essential to understand the relationship between its different trophic levels and food webs. Usually in the coastal waters exhibit considerable seasonal variations depending on the local conditions of rainfall, tidal incursions, various abiotic and biotic processes, quantum of freshwater inflow affecting the nutrient cycle of different coastal environments [8].

II. DESCRIPTION OF THE STUDY AREA

The study area Mandapam (latitude 9°16’14”N; longitude 79°7’10”E), Thoothukudi (latitude 8°46’26”N; longitude 78°10’9”E), Arumuganeri (8°59’40”; 78°13’71”) Kanyakumari (latitude 8°4’45”N; longitude 77°32’38”E) are located in the Gulf of Mannar zone along the South East Coast of India. Mandapam (nearby by Rameswaram) is situated near to Bay of Bengal and close to Gulf of Mannar Biosphere. The Biosphere contains 21 islands and also rich in marine biodiversity with estuaries, mudflats, beaches, forests of the near shore environment, including marine components like algal communities, sea grasses, coral reefs, salt marshes and mangroves. The closest tourism destination of Mandapam is Rameswaram.

Thoothukudi and Arumuganeri are the major industrial areas contains major chemical industries like SPIC, Copper smelting plant, Dharangadhara chemicals ,salt pans, Thermal power station, and hundreds of small scale industrial units in Thoothukudi SIPCOT complex. Thoothukudi is well known for pearl, fishery and shipbuilding. It is one of the important major Port having a number ship movement. The movement of ships and fishing operation by mechanized boats also release oil effluents and petrochemical products into the sea. The Thermal power station directly dumps its ash into the sea. Now it is under expansion with Neyveli Lignite Corporation (NLC) Likewise the other industries also discharge their wastes into the sea. The effluents from industries in and around Thoothukudi and Arumuganeri coastal region are discharged directly or indirectly into the sea and it may affect the hydrographic properties.

Kanyakumari (formerly known as Cape Comorin), lies at the southernmost tip of East coast of India. Part of the fascination, it is the end point of the Indian peninsula where the meeting of the Bay of Bengal, the Arabian Sea and the Indian Ocean. It is one of the important Tourist Spot as well as Pilgrim place (Figure 2).

Figure.2 Sampling Locations and Sampling Points

III. MATERIALS AND METHOD

The Temperature (surface and water) was measured using a standard centigrade mercury thermometer. Salinity was measured with the help of a Digital Refractometer PR-100SA (ATAGO) and the seawater pH was measured using HACH portable pH meter. Dissolved oxygen was estimated by the modified Winkler's method and expressed as mg/l. For the analysis of nutrients, surface water samples were collected in clean polyethylene bottles, kept in an ice-box, and transported immediately to the laboratory. The water samples are filtered through the Millipore filtering system (MFS) for the required filtered sample. The Nutrients and Chlorophyll-a were determined by the standard methods prescribed by Strickland and Parsons (1972) [9] and Grasshoff et al (1999) [10], further the sample were analyzed using SHIMADZU (UV-2600) UV-VIS Spectrophotometer. Nutrient concentrations were expressed in µMoles /L. Monthly variations of Physico -chemical parameters viz., temperature, salinity, pH, dissolved oxygen, nitrite, nitrate, ammonia, total phosphate, reactive silicate and Chlorophyll –a were recorded from January 2014 to December 2014. Based on the cyclic phenomena of meteorological events, four seasons are broadly indicated as month wise and they are (1) Post –Monsoon (January to March) (2) Summer (April to June) (3) Pre- Monsoon (July to September) (4) Monsoon (October to December).

IV. RESULTS AND DISCUSSION

4.1 TEMPERATURE

The temperature was basically important for its effects on the chemistry and biological activities of organisms in water. Temperature was known to influence in the determination of other factors like pH, conductivity, dissolved gases and various forms of alkalinity. Generally, the surface water temperature is influenced by the intensity of solar radiation, evaporation, freshwater influx and cooling and mix up with ebb tide and the water flow from adjoining neritic zone waters [11]. The water temperature during Monsoon season (October to December) was low because of strong land sea breeze and precipitation and the recorded high value during summer season (April to June) could be attributed to high solar radiation [12, 13]. The seasonal variation in the water temperature depends upon the wind force, freshwater discharge influx of the inshore water and atmospheric temperature (Figure 3).

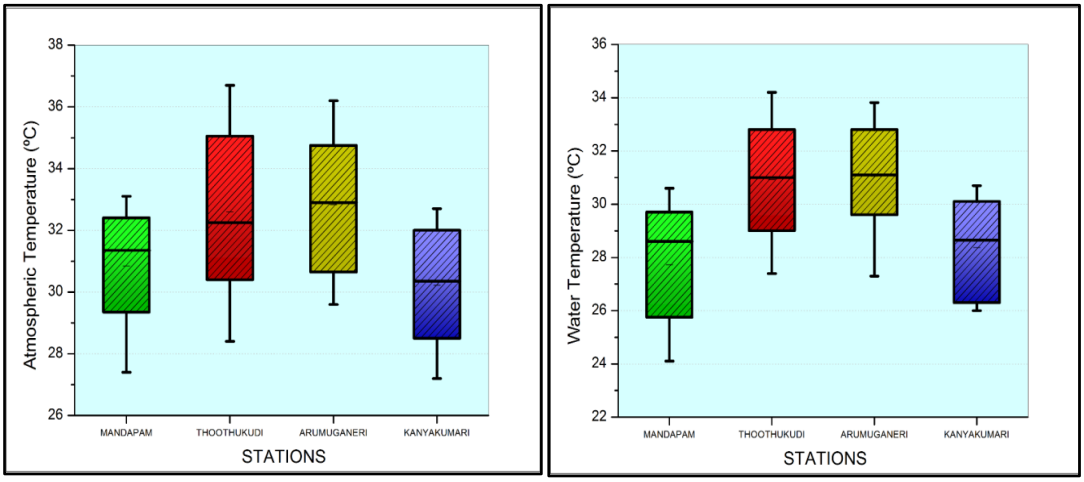

Figure.3 Atmospheric and Water Temperature at Different Stations

4.2 SALINITY

The salinity acts as a limiting factor in the distribution of living organisms, and its variation caused by dilution and evaporation is most likely to influence the fauna in the intertidal zone [14]. Salinity is regarded as the second important physical characteristic of the marine environment. This salinity factor has high influence on the fauna. Less wave and tidal action with decreased freshwater inflow and land drainage may also be considered fluctuations in salinity [12]. The changes in the salinity in the coastal waters are due to the influx of freshwater from river, by land runoff caused by monsoon, or by tidal variations. Higher values in summer season 36.07 (‰) at Kanyakumari could be attributed to high degree of evaporation with decreased freshwater inflow and land drainage (Figure 4). Drop in salinity during monsoon season 31.54 (‰) at Mandapam is related to heavy showers and consecutive floodwater from up streams [15, 16].

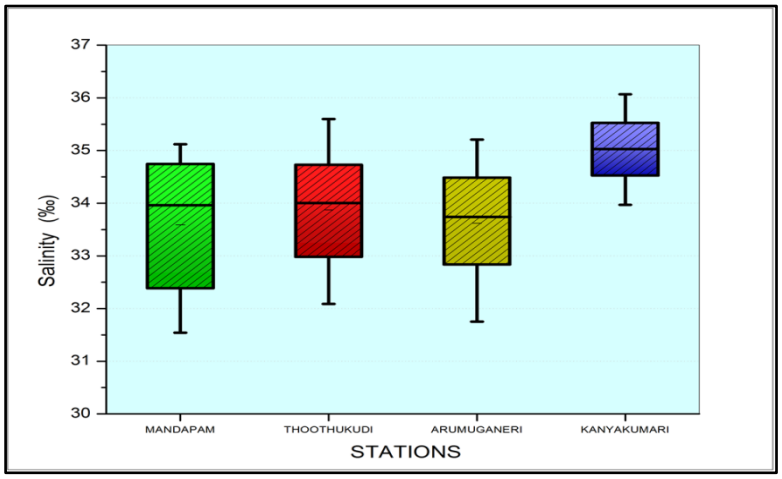

Figure.4 Salinity at Different Stations

4.3 HYDROGEN ION CONCENTRATION (pH)

Hydrogen ion concentration or pH as one of the vital environmental characteristics decides the survival, metabolism, physiology and growth of aquatic organisms. pH is influenced by acidity of the bottom sediment and biological activities [17]. pH may be affected by total alkalinity and acidity, run off from surrounding rocks and water discharges [18].The pH of the natural water system depends on the concentration of carbonate, bicarbonate and hydroxyl ion present. pH is known as the master variable in water since many properties, processes and reaction are pH dependent. Due to the buffering capacity of the sea water, generally the pH ranges from 7.8 to 8.3 in the coastal water [19]. The low pH 7.96 at Thoothukudi is due to the dilution of seawater by fresh water flow and runoff during the monsoon season [20]. Generally, fluctuations in pH values during different seasons of the year is attributed to factors like removal of CO_2 by photosynthesis through bicarbonate degradation, dilution of seawater by freshwater influx, reduction of salinity and temperature and decomposition of organic matter[21,22]. The recorded high pH value 8.31at Kanyakumari during summer season might be due to the influence of seawater penetration and high biological activity like photosynthesis by dense phytoplankton blooms (Figure 5).

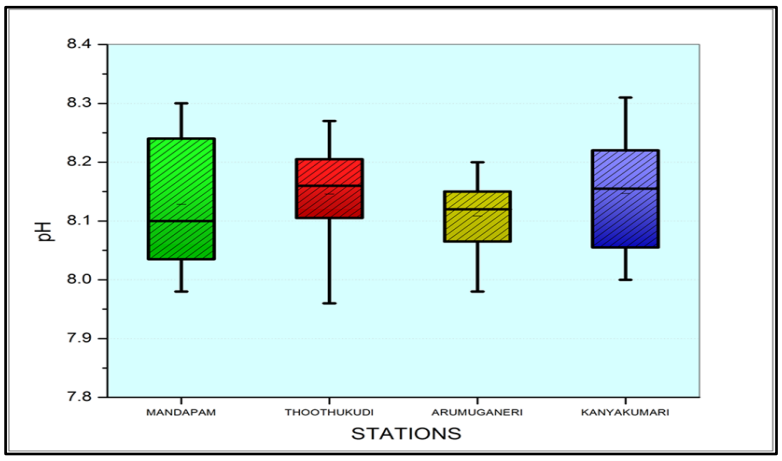

Figure.5 Hydrogen Ion Concentration (pH) at Different Stations

4.4 DISSOLVED OXYGEN

The dissolved oxygen is very essential for the respiratory metabolism of all aquatic animals. It favors the stability and availability of nutrients to the animals. Therefore, it increases the productivity of the ecosystems. Usually the dissolved oxygen content in the water samples depends on the temperature and seasons. Two main sources of dissolved oxygen are diffusion of oxygen from the air and photosynthetic activity. It has been observed that the dissolved oxygen concentration was low in summer and high in monsoon. During the monsoon period the inflow of freshwater from the adjacent water sources having higher oxygen content, the coastal waters showed an increased level of dissolved oxygen [23, 23]. Dissolved oxygen can be removed from the water by discharges of the oxygen demanding anthropogenic wastes, other inorganic reductants like hydrogen sulphide, ammonia, ferrous, nitrate and other oxidizable substances tends to decrease dissolved oxygen in water. It is well known that the temperature and salinity affect the dissolution of oxygen [24]. In the present investigation, higher values of dissolved oxygen 5.95 mg/l at Kanyakumari were recorded during monsoon season might be due to the cumulative effect of higher wind velocity coupled with heavy rainfall and the resultant freshwater mixing attributed that seasonal variation of dissolved oxygen is mainly due to freshwater flow and terrigenous impact of sediments[11,25]. The dissolved oxygen shows an inverse trend against the temperature and the salinity. Dissolved oxygen was observed to be low 4.27 mg/l at Thoothukudi during summer season, which could be due to the gradual saline water incursion and increasing temperature (Figure 6) [26].

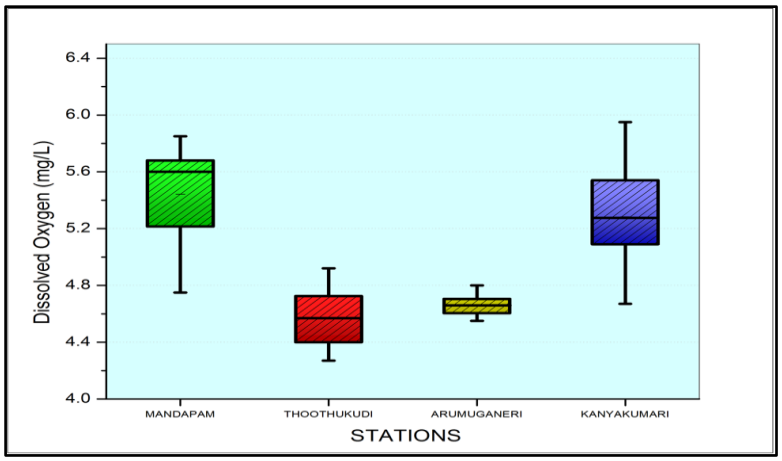

Figure.6 Dissolved Oxygen at Different Stations

4.5 NUTRIENTS

Nutrients are considered as one of the most important parameters in the aquatic environment prompting growth, reproduction and metabolic activities of marine species. Distribution of nutrients is mainly based on the season, tidal conditions and freshwater flow from land source. The marine systems are generally nitrogen limited, excessive nitrogen inputs can result in water quality degradation due to toxic algal blooms, oxygen deficiency, habitat loss, decreases in biodiversity and fishery losses. The main cause of eutrophication involves the enrichment of water by excess nutrients. It can cause serious problems in the coastal zone through disturbance of ecological balances and fisheries, ultimately interfering with recreational activities, and also the quality of marine life [27].

4.6 DISSOLVED INORGANIC NITRITE

Nitrite, the intermediate oxidation state between ammonia and nitrate, it can appear as a transient species by the oxidation of ammonia or by the reduction of nitrate [28]. The higher value 1.28 µM/l of nitrite recorded at Thoothukudi during monsoon season is due to various reasons including variations in phytoplankton excretion, oxidation of ammonia and reduction of nitrate and by recycling of nitrogen and bacterial decomposition of planktonic detritus present in the environment. It is also due to denitrification and air sea interaction exchange of chemicals [7]. The recorded low nitrite value 0.31µM/l at Arumuganeri during summer seasons may be due to high salinity and temperature effect (Figure 7) [29].

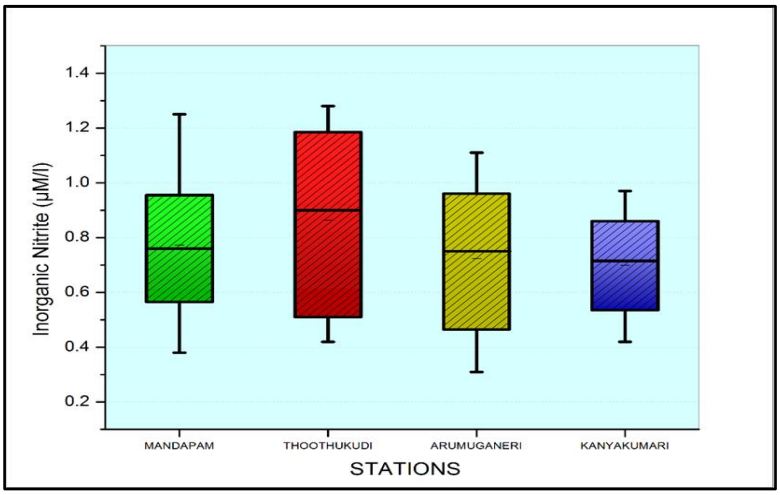

Figure.7 Dissolved Inorganic Nitrite at Different Stations

4.7 DISSOLVED INORGANIC NITRATE

Nitrate is one of the most important indicators of pollution of water which represents the highest oxidized form of nitrogen. It plays a significant role in sustaining the aquatic life in marine environment. The increased nitrates level 10.17 µM/l at Thoothukudi during Monsoon season is due to fresh water inflow, to leaching of rocks, fertilizer, chemical industries, domestic and municipal sewage, organic matter decomposition and terrestrial run-off during the monsoon season [10] [30,31].. Another possible way of nitrates entry is through oxidation of ammonia form of nitrogen to nitrite formation [11]. The recorded low value 2.45 µM/l at Mandapam during summer period may be due to its utilization by phytoplankton as evidenced by high photosynthetic activity and the dominance of neritic seawater having a negligible amount of nitrate (Figure 8) [30, 32].

4.8 DISSOLVED INORGANIC PHOSPHATE

The dissolved inorganic phosphate is an important nutrient for marine phytoplankton, marine biota actively involved in the activities [33]. Inorganic phosphate concentration is the useful index of eutrophication in the coastal water. Water receiving raw or untreated sewage, agriculture drainage and certain industrial waste usually contain significant concentration of phosphate. Phosphorus is as soluble reactive component and readily forms organic phosphorus and polyphosphate [34]. Phosphate concentration in coastal waters depend upon its concentration in the freshwater that mixed with the seawater within the sea-land interaction zone, upwelling, and microbial decomposition of organic matters[35]. Coastal waters except those receives freshwater contaminated with domestic wastes containing detergents as well as wastes from agro field rich with phosphate-phosphorous fertilizers and pesticides[36]. The observed high monsoonal phosphate value 1.91 µM/l at Thoothukudi might be due to the regeneration and release of total phosphorus from bottom mud into the water column by turbulence and mixing [29]. Moreover, the bulk of weathering of rocks, soluble alkali metal phosphates in the upstream area are also one of the sources. The addition of super phosphates applied in the agricultural fields as fertilizers and alkyl phosphates used in households, as detergents can be other sources of inorganic phosphates during the season [32]. The summer low value 0.35 µM/l could be attributed to the limited flow of freshwater, high salinity and utilization of phosphate by the marine organisms. The variation may also be due to the processes like adsorption and desorption of phosphates and buffering action of sediment under varying environmental conditions (Figure 9) [22].

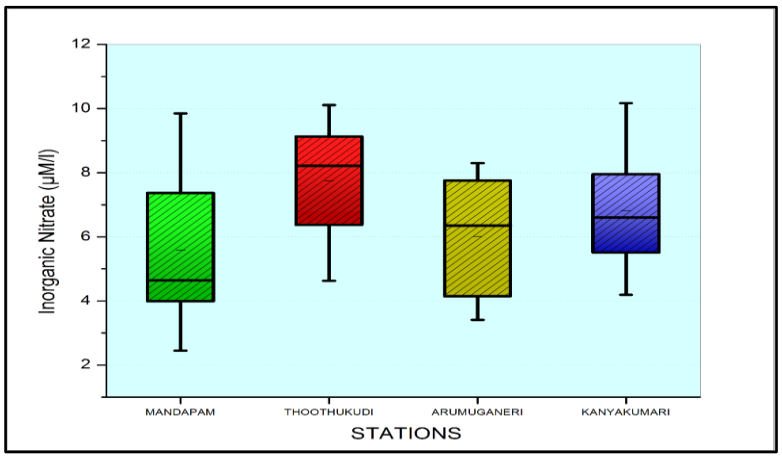

Figure.8 Dissolved Inorganic Nitrate at Different Stations

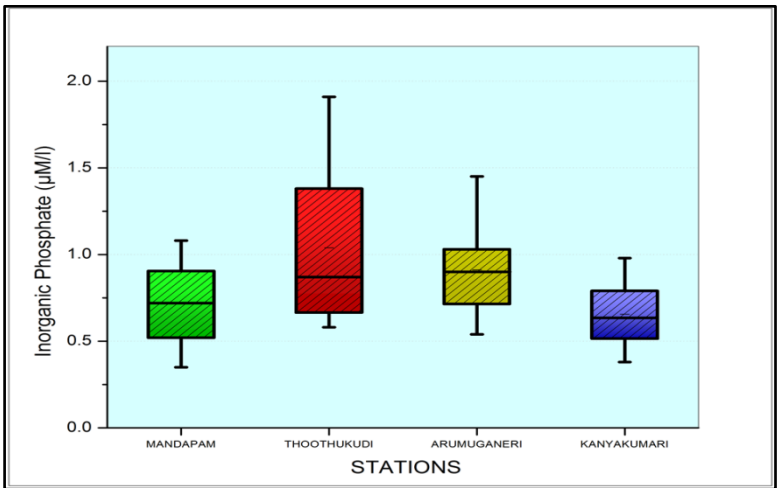

Figure.9 Dissolved Inorganic Phosphate at Different Stations

4.9 REACTIVE SILICATES

Silicate is one of the important nutrients which regulate the phytoplankton distribution in the coastal water. The variation of silicate in coastal water is influenced by physical mixing of seawater with freshwater, adsorption into sedimentary particles, chemical interaction with clay minerals, co-precipitation with humic components, and biological removal by phytoplankton, especially by diatoms and silicoflagellates [28]. The silicate content was higher than that of the other nutrients and the recorded high monsoon values 41.33 µM/l at Kanyakumari could be due to heavy influx of freshwater derived from land drainage carrying silicate leached out from rocks and also from bottom sediments exchanging with overlying water due to the turbulent nature of water in the coastal water (Figure 10) [22, 11]. Higher rainfall influenced land runoff and high fresh water inflow also increased silicate concentration. The low concentration of silicate value 7.10 µM/l at Arumuganeri is observed during summer season is due to the utilization by marine organisms and algae for their biological activity [24, 31]. Part of silicate depletion is due to the adsorption and co-precipitation of soluble silicon with humic and Iron compounds [37].

4.10 AMMONIA

Ammonium is the nitrogenous end product of the bacterial decomposition of natural organic matter containing nitrogen. In the presence of high ammonium concentrations, the phytoplankton Productivity should be high by using NH^{4+} rather than NO^{3-} [38]. The possible sources of ammonia input into the waters could be from land runoff, zooplankton excretion, or demineralization of organic matter [39]. Ammonium (NH4 +) represented 80% of Dissolved Inorganic Nitrogen (DIN) and its highest values were always associated with fresh water inflow [40]. The spatial and temporal variation in ammonia concentration is due to its oxidation to other forms or reduction of nitrates to lower forms in coastal waters [29]. The higher ammonia concentration 7.13 µM/l was observed at Thoothukudi during the monsoon season and the lower values 0.62 µM/l were found at Mandapam during the summer season (Figure 11). The surface runs off wastes, agricultural wastes washed and show maximum value in the monsoon. Excess ammonia indicates polluted water and maximum algal growth. The recorded higher concentration could be partially due to the death and subsequent decomposition of phytoplankton and also due to the excretion of ammonia by planktonic organisms [41].

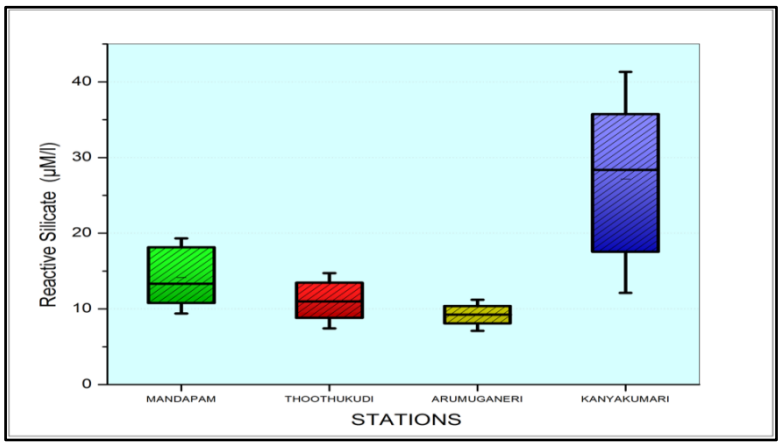

Figure.10 Reactive Silicate at Different Stations

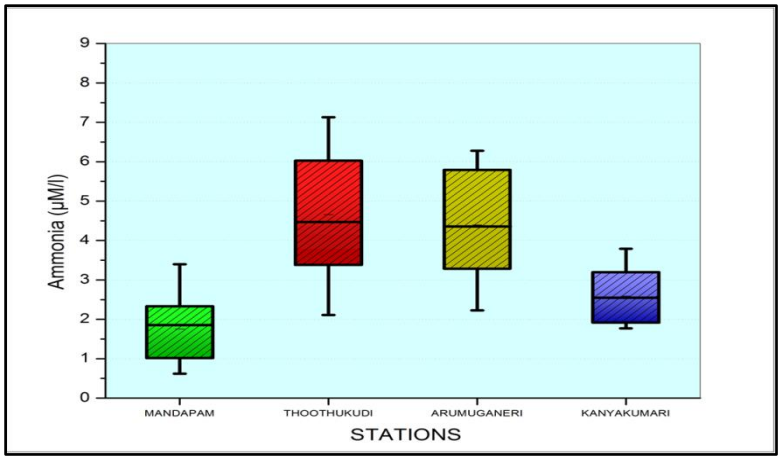

Figure.11 Ammonia at Different Stations

4.11 CHLOROPHYLL –a

Chlorophyll a is considered as the most reliable index of phytoplankton biomass. Fresh water influx and land runoff resulted in low Chl-a concentration during the monsoon with decreasing salinity conditions [42]. Primary productivity potential of the marine environments depends upon the phytoplankton, which alone contributes 90% of the total marine primary production. Thus chlorophyll-a which constitutes the chief photosynthetic pigment of phytoplankton, is an index that provides the primary production potential upon which the biodiversity, biomass and carrying capacity of that system depends upon [43]. A higher value of Chlorophyll-a 17.27 mg/m^3 was recorded at Kanyakumari during summer and the low value 2.93 mg/m3 at Arumuganeri during monsoon season (Figure 12). The reduction in Chlorophyll- a during monsoon season may be due to freshwater discharges from the landslides causing turbidity and less availability of light [41, 44]. Therefore the investigation on variations of Chlorophyll- a is very important to the study of water quality and marine pollution. Its maximum and minimum concentration can reflects the physical and chemical characters of the environment.

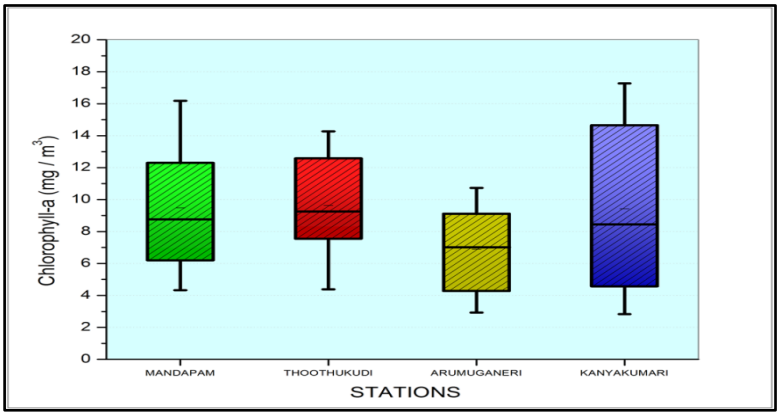

Figure.12 Chlorophyll-a at Different Stations

V. STATISTICAL INTERPRETATION OF HYDROGRAPHICAL PROPERTIES

5.1 MANDAPAM

In this station seasons influence all the hydrographical properties. Water temperature is strongly correlated to pH, salinity. Salinity also negatively correlated to Silicate and phosphate. Chlorophyll-a negatively correlated with Dissolved Oxygen (Table.1).Biplot also supported the same. In the Biplot (Figure.13) summer and Monsoon season shows strongest variation pattern. Major nutrients influenced in the monsoon season and have similar response. Biplot shows that NO_2-N and PO_4 distinguish the other parameters in the monsoon and Post monsoon season.

Table .1 Correlation coefficient values between the Hydrographical parameters at Mandapam

Parameters	*Air Temp (ºC)*	*Water Temp (ºC)*	*pH*	*Salinity (‰)*	*Dissolved Oxygen (mg/l)*	*NO2-N (µM/l)*	*NO3-N (µM/l)*	*SiO2 (µM/l)*	*PO4 (µM/l)*	*NH4 -N (µM/l)*	*Chlorophyll-a (mg/m3)*
Air Temp	1										
WaterTemp	0.9246	1									
pH	0.8565	0.9743	1								
Salinity	0.9786	0.9801	0.9438	1							
Dis.Oxygen	-0.8324	-0.8715	-0.9347	-0.8951	1						
NO2-N	-0.9169	-0.8015	-0.8006	-0.8949	0.9153	1					
NO3-N	-0.9793	-0.8419	-0.7368	-0.9189	0.7149	0.8746	1				
SiO2	-0.9698	-0.8738	-0.8475	-0.9506	0.9059	0.9864	0.9327	1			
PO4	-0.9422	-0.9949	-0.9466	-0.9816	0.8312	0.7932	0.8780	0.8748	1		
NH4 -N	-0.9453	-0.8412	-0.8292	-0.9259	0.9166	0.9968	0.9040	0.9963	0.8368	1	
Chl-a	0.9210	0.8614	0.8762	0.9285	-0.9622	-0.9891	-0.8531	-0.9835	-0.8442	-0.9907	1

5.2 THOOTHUKUDI

In Thoothukudi coastal water salinity was positively correlated with pH, Temperature and Chlorophyll-a and negatively correlated with NH4-N and other nutrients (Table.2). In the Biplot (Figure.13) Monsoon and summer shows strongest variation pattern. The Biplot shows Monsoon season was strongly influenced by DO and other nutrients. This shows that Land run-off and sewage penetration is more than the other stations. In the Biplot Temperature, salinity in the Pre-Monsoon season and PO_4, DO, NO_3-N in the monsoon season has the similar response pattern. NO_2-N, and NH_4-N distinguish the other parameters in the monsoon season (Figure.13).

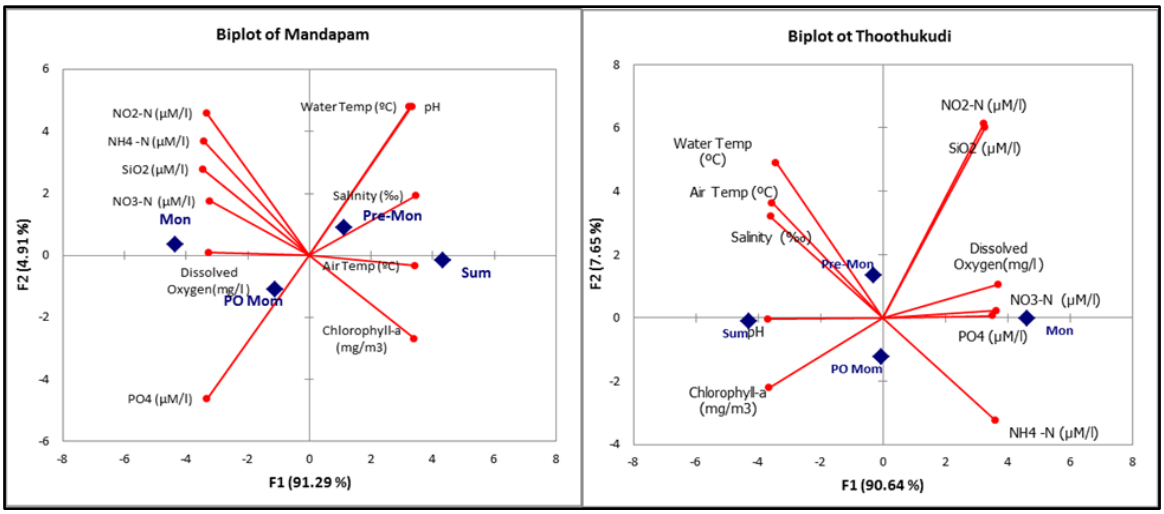

Figure.13 Biplot of Mandapam and Thoothukudi Stations

Table. 2 Correlation coefficient values between the Hydrographical parameters at Thoothukudi

Parameters	*Air Temp (ºC)*	*Water Temp (ºC)*	*pH*	*Salinity (‰)*	*Dissolved Oxygen (mg/l)*	*NO2-N (µM/l)*	*NO3-N (µM/l)*	*SiO2 (µM/l)*	*PO4 (µM/l)*	*NH4 -N (µM/l)*	*Chlorophyll-a (mg/m3)*
Air Temp	1										
WaterTemp	0.9894	1									
pH	0.9343	0.9160	1								
Salinity	0.9983	0.9887	0.9528	1							
Dis.Oxygen	-0.9282	-0.8889	-0.9886	-0.9434	1						
NO2-N	-0.7060	-0.6202	-0.8523	-0.7279	0.9080	1					
NO3-N	-0.9462	-0.8917	-0.9393	-0.9486	0.9737	0.8819	1				
SiO2	-0.7029	-0.6336	-0.8817	-0.7320	0.9165	0.9875	0.8563	1			
PO4	-0.8771	-0.8788	-0.9821	-0.9038	0.9468	0.7967	0.8578	0.8547	1		
NH4 -N	-0.9959	-0.9904	-0.9579	-0.9993	0.9434	0.7227	0.9405	0.7328	0.9159	1	
Chl-a	0.8937	0.8427	0.9732	0.9103	-0.9954	-0.9438	-0.9698	-0.9470	-0.9267	-0.9090	1

5.3 ARUMUGANERI

In this station Chlorophyll-a was strongly correlated with salinity, pH and Temperature, and negatively correlated with DO and other nutrients (Table.3). In the Biplot (Figure.14) summer, Post-Monsoon, Monsoon season shows strong variation pattern. Temperature and Chlorophyll-a distinguish the other parameters Pre-monsoon and summer season. Likewise NO_2-N and PO_4 distinguish the other parameters in the monsoon season. DO, NH_4-N, NO_3-N, SiO_2, and NO_2-N shows similar response in the monsoon season (Figure.14).

Table .3 Correlation coefficient values between the Hydrographical parameters at Arumuganeri

Parameters	*Air Temp (ºC)*	*Water Temp (ºC)*	*pH*	*Salinity (‰)*	*Dissolved Oxygen (mg/l)*	*NO2-N (µM/l)*	*NO3-N (µM/l)*	*SiO2 (µM/l)*	*PO4 (µM/l)*	*NH4 -N (µM/l)*	*Chlorophyll-a (mg/m3)*
Air Temp	1										
WaterTemp	0.9246	1									
pH	0.8565	0.9743	1								
Salinity	0.9786	0.9801	0.9438	1							
Dis.Oxygen	-0.8324	-0.8715	-0.9347	-0.8951	1						
NO2-N	-0.9169	-0.8015	-0.8006	-0.8949	0.9153	1					
NO3-N	-0.9793	-0.8419	-0.7368	-0.9189	0.7149	0.8746	1				
SiO2	-0.9698	-0.8738	-0.8475	-0.9506	0.9059	0.9864	0.9327	1			
PO4	-0.9422	-0.9949	-0.9466	-0.9816	0.8312	0.7932	0.8780	0.8748	1		
NH4 -N	-0.9453	-0.8412	-0.8292	-0.9259	0.9166	0.9968	0.9040	0.9963	0.8368	1	
Chl-a	0.9210	0.8614	0.8762	0.9285	-0.9622	-0.9891	-0.8531	-0.9835	-0.8442	-0.9907	1

5.4 KANYAKUMARI

In Kanyakumari coastal waters Temperature positively correlated with pH, salinity and chlorophyll-a and negatively correlated with DO, NH_4-N and other nutrients (Table.4). In Kanyakumari Chlorophyll-a shows negative correlation with DO, SiO_2, PO_4, this shows that the utilization of nutrients for the photosynthetic activity. Biplot shows that summer season strongly influenced by pH and salinity. DO and nutrients are influenced by Post-Monsoon and Monsoon season. NO_2-N and NH_4-N distinguishes the other parameters during Post Monsoon and Monsoon season (Figure 14).

Table .4 Correlation coefficient values between the Hydrographical parameters at Kanyakumari

Parameters	*Air Temp (ºC)*	*Water Temp (ºC)*	*pH*	*Salinity (‰)*	*Dissolved Oxygen (mg/l)*	*NO2-N (µM/l)*	*NO3-N (µM/l)*	*SiO2 (µM/l)*	*PO4 (µM/l)*	*NH4 -N (µM/l)*	*Chlorophyll-a (mg/m3)*
Air Temp	1										
WaterTemp	0.9979	1									
pH	0.9698	0.9709	1								
Salinity	0.9651	0.9666	0.9998	1							
Dis.Oxygen	-0.9697	-0.9731	-0.8896	-0.8817	1						
NO2-N	-0.8458	-0.8389	-0.6904	-0.6768	0.9345	1					
NO3-N	-0.9438	-0.9583	-0.9773	-0.9784	0.8888	0.6677	1				
SiO2	-0.9649	-0.9517	-0.9741	-0.9714	0.8763	0.7277	0.9062	1			
PO4	-0.9837	-0.9906	-0.9334	-0.9279	0.9917	0.8808	0.9404	0.9025	1		
NH4 -N	-0.9331	-0.9465	-0.9806	-0.9827	0.8630	0.6280	0.9979	0.9109	0.9204	1	
Chl-a	0.9889	0.9788	0.9345	0.9275	-0.9664	-0.8878	-0.8848	-0.9613	-0.9641	-0.8718	1

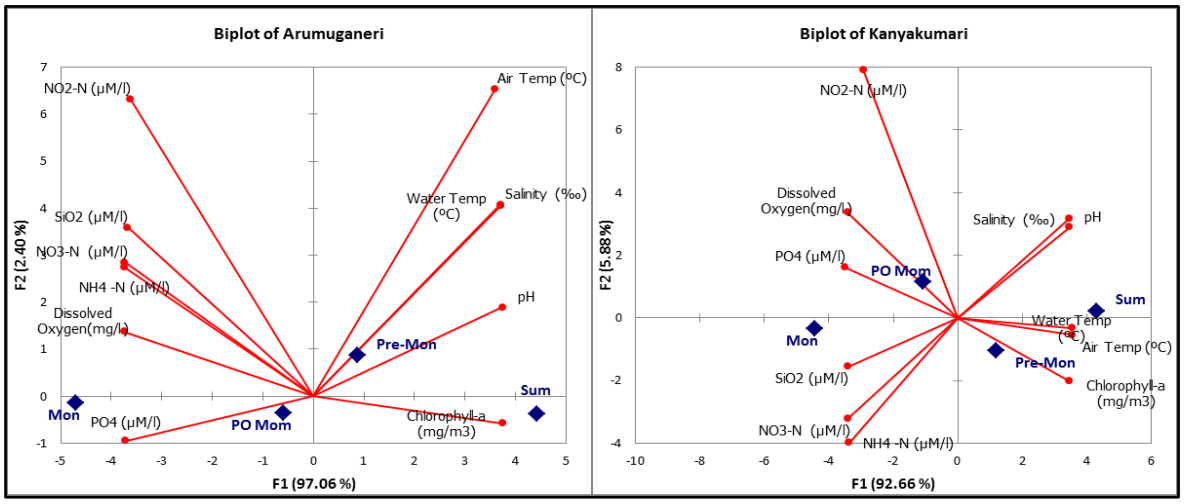

Figure.14 Biplot of Arumuganeri and Kanyakumari

VI. CONCLUSION

The result shows that the hydrographical parameters exhibited distinct variations by different seasons. Occurrence of high concentrations of nutrients in the study areas can be reasonably due to the Land runoff and anthropogenic input. The fluctuation of Temperature, pH, salinity, and Dissolved Oxygen are seen in the Monsoon and Non-Monsoon seasons. Salinity was found to be low along the monsoon season; it is due to the large amount of fresh Water input along the coast during the northeast monsoon. The increase of Chlorophyll-a during the summer season is attributed due prominent increase of salinity, pH and reduction of turbidity. The knowledge of nutrients, related to their sources, availability and the utilization levels gives us the information about the productivity potential and health of the Marine Ecosystem. The present baseline information is useful for the further Ecological Monitoring and assessment along the coastal waters.

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