Chapter 4
Assessment of Water Quality from the Gundlakamma Estuary, Andhra Coast, Southeast Coast of India

U. Suresh and B. C. Sundara Raja Reddy

Abstract Twenty-four marine water samples in three seasons (premonsoon-2016, monsoon-2016, and premonsoon-2017) from Gundlakamma estuary, Prakasam district, Southeast coast of India, were collected using shallow water sampler at 1 m below the surface. The physicochemical properties were determined. The results for the studied parameters revealed that the water composition of the study area is pH 7.0–8.9; TDS 25.16–64,972 ppm; Salinity 28.92–47.85 ppt; DO 4.04–40.04 ppm; Ca 412.50–1577.50 ppm; Cl 16,012–26487.50 ppm; Na 3023–17454.50 ppm; and K 85–186.5 ppm. Statistical treatment of Factor Analysis (FA) for the distribution of physicochemical parameters shows that they exhibit a strong affinity among several parameters of the study area. In the typical context, water composition may be fresher in some part of upstream and more concentrated near estuary. The impact of anthropogenic as well as natural input, as a source of physicochemical parameters, is lethal. However, a comprehensive investigation is warranted to assess the health of the fragile estuarine ecosystem.

Keywords Physicochemical parameters · Water quality · Gundlakamma estuary · Southeast coast of India

4.1 Introduction

Water is one of the most important components of the ecosystem (Priyanka et al. 2009). Water quality can be described by chemical and microbiological properties (Manjare et al. 2010). Significant correlation is possible among these studied variables, and thus be useful in indicating the health of the watery (Sreenivasulu et al.

U. Suresh (✉) · B. C. Sundara Raja Reddy
Department of Geology, Sri Venkateswara University, Tirupati, Andhra Pradesh, India

N. Jayaraju et al. (eds.), *Coasts, Estuaries and Lakes*,
https://doi.org/10.1007/978-3-031-21644-2_4

2015). Even when there is no pollution, the waters of rivers and lakes keep changing with the seasons and geographical areas. The specific ways that chemical constituents enter the marine environments are land runoff in the coastal zone via rivers and other anthropogenic effluents (Jayaraju et al. 2011). Pollution in a river first affects its chemical quality before destroying the environment and disturbing the delicate food chain. Pollution severely limits the diverse uses of rivers, and even polluters such as industry suffer as a result of rising river pollution (Dhirendra et al. 2009). As a result, a detailed understanding of water quality is required to determine the health status of the environment and its impact on biological fertility (Poonam and Rahul 2012).

The biochemistry of a water body is heavily influenced by physicochemical characteristics. Subtle changes in physical conditions can have a significant impact on the water quality of the studied system, affecting the geographical and temporal distribution of nutrients and/or biological populations. As a complex system, the marine environment is primarily influenced by physicochemical and biological processes. In recent years, industrial operations, economic upwelling, and urbanization in cosmopolitan city centers across the world have developed fast, and huge amounts of pollution have been pushed and flushed into rivers, estuaries, and marine marginal water bodies (Ravichandran and Manickam 2012). The scientific community is paying more attention to estuarine sediment contamination, which is known to contribute greater measure to the ecosystem health stress (Riba et al. 2002). Marine water, which serves as a habitat for many aquatic organisms, is contaminated with a variety of harmful and poisonous compounds, including heavy metals. As a result, they are regarded as key carriers and serve as sinks of pollutants (Ho et al. 2010). This reflects the system's current quality, thus providing information on the pollution status and sources. Thus, this serves as a natural archive of recent changes in environmental settings (Kruopiene 2007).

The present study involves the analysis of water described by its physicochemical variables of Gundlakamma estuary, Andhra coast, India. It is also aimed to know the quality of water sources with respect to physicochemical variables. In addition, the data sets were treated with statistical methods in order to understand the possible correlation among several environmental variables.

4.2 Study Area

The area under study is situated on the eastern part of Prakasam district. It is situated between latitude 15°31′ and 15°32′ N and longitude 80°12′ and 80°15′ E (Fig. 4.1). The river (Gundlakamma River) flows through the east-central region of Andhra Pradesh, India. It originates in the Nallamala Hills, a component of the Eastern Ghats. As it flows down the densely covered hills, it is joined by several mountain streams. Gundlakamma is the largest of all the rivers that originate from the Nallamalla Hills. The mean annual precipitation declines from 1270 mm (eastern extremity) to 762 mm (western extremity) of the basin. The NE monsoon arrives in October and leaves by November. The mean extreme temperature ranges from

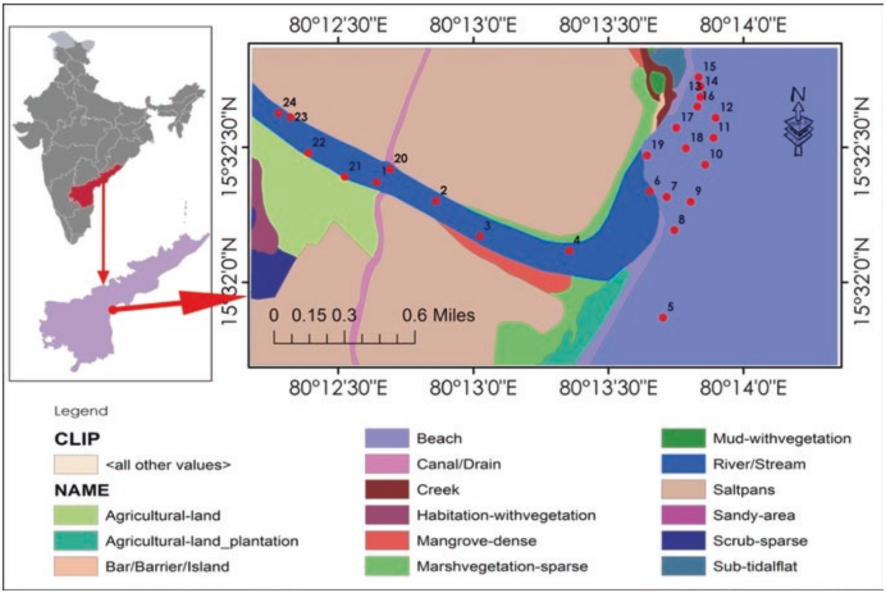

Fig. 4.1 Location map of the study area

30–32 °C, with the lowest temperature ranging from 22.5–25 °C in the catchment. The region around the study area is composed of deposits of recent origin such as sand bars, dunes, and mudflats. These are the outcome of regression of the sea and modified by in part by fluvial process.

4.3 Methodology

Twenty-four marine water samples in three seasons (premonsoon-2016, monsoon-2016, and premonsoon-2017) from Gundlakamma estuary, Prakasam district, Southeast coast of India, were collected using shallow water sampler at 1 m below the surface. The physicochemical properties were determined. The sampling stations were located precisely by using Global Positioning System (GPS) (Table 4.1). The bottom water samples were stored in polyethylene bottles that had already been cleaned by soaking in 5 M HCl for more than 3 days and thoroughly washing with distilled-deionized water before use. Salinity was measured using Atago refracto meter (Arumugam and Sugirtha 2014). Pye Unicam model 292 m (after standardization with buffer solution at pH 4.0, 7.0, and 9.0) was used for pH determination. Gravimetric (evaporation) method for TDS and EDTA Titrimetric method for Ca were used. Mohr titrimetric and chloride metric were used for Cl analysis and Flame photometer was used for Na and K. Dissolved Oxygen was measured using standard laboratory methods (APAH 1995). The data are obtained by statistically analyzing Factor loadings using XL STAT-2022.

Table 4.1 GPS locations of sampling stations

Sample	Longitude	Latitude
1	15°32′11.47″	80°12′ 38.55″
2	15°33′30.06″	80°12′51.76″
3	15°32′10.21″	80°13′01.45″
4	15°32′07.08″	80°13′21.32″
5	15°32′28.17″	80°13′38.56″
6	15°32′20.25″	80°13′39.21″
7	15°32′18.99″	80°13′42.96″
8	15°32′17.91″	80°13′48.32″
9	15°32′11.61″	80°13′44.65″
10	15°32′26.15″	80°13′51.52″
11	15°32′32.13″	80°13′53.36″
12	15°32′36.56″	80°13′53.86″
13	15°32′41.20″	80°13′50.44″
14	15°32′43.51″	80°13′46.38″
15	15°32′43.51″	80°13′46.38″
16	15°32′39.08″	80°13′45.08″
17	15°32′34.36″	80°13′45.12″
18	15°32′29.83″	80°13′00.48″
19	15°32′28.21″	80°13′38.56″
20	15°32′25.18″	80°12′41.54″
21	15°32′23.45″	80°12′31.46″
22	15°32′28.78″	80°12′23.36″
23	15°32′36.70″	80°12′19.36″
24	15°32′19.64″	80°12′24.01″

4.4 Results and Discussion

Physicochemical properties of marine water in three seasons (premonsoon-2016, monsoon-2016, and premonsoon-2017) were determined according to the standards of the American Public Health Association (APHA) and other standard methods. The common physicochemical parameters of water like pH, Total Dissolved Solids (TDS), Salinity, Dissolved Oxygen (DO), Calcium (Ca), Chloride (Cl), Sodium (Na), and Potassium (K) have been determined. The variation in significant physicochemical parameters along these transects is shown in Tables 4.2, 4.3, 4.4, and Fig. 4.2 has been explained as below;

Table 4.2 Physicochemical parameters during premonsoon-2016

Sample	pH	TDS (ppm)	Salinity (ppt)	DO (ppm)	Ca (ppm)	Cl (ppm)	Na (ppm)	K (ppm)
1	7.5	37,774	31.95	4.04	1222.5	17,687	3745	216
2	7.6	36,657	30.32	19.79	1382.5	16,787	3389	199
3	7.5	36,245	29.10	40.04	1247.5	16,112	3620	204
4	7.3	36,678	28.92	26.66	1257.5	16,012	3518	194
5	7.5	36,766	29.19	31.91	1387.5	16,162	3225	209
6	7.5	46,878	32.94	16.56	1237.5	18,237	3479	218
7	7.6	40,619	34.79	19.79	1112.5	19,262	3769	216
8	7.8	37,422	33.39	35.13	1152.5	18,487	3926	215
9	7.8	49,234	33.67	10.50	1192.5	18,637	3627	215
10	7.8	54,471	34.03	20.20	1097.5	18,837	3218	209
11	7.9	64,972	34.79	17.7	1107.5	19,262	3060	199
12	7.9	37,575	32.94	4.04	1107.5	18,237	3806	216
13	7.9	38,008	32.49	14.94	1122.5	17,987	3538	212
14	7.7	45,826	31.95	14.94	1137.5	17,687	3578	225
15	7.7	47,236	31.99	18.98	997.5	17,712	3676	217
16	7.7	35,669	33.39	22.22	987.5	18,487	3758	210
17	7.6	39,556	33.71	12.92	1182.5	18,662	3493	215
18	7.8	33,835	34.61	13.33	1172.5	19,162	3664	206
19	7.2	34,956	33.85	20.60	1052.5	18,737	3023	218
20	7.0	37,526	33.48	17.37	1112.5	18,537	5533	195
21	7.2	34,863	33.44	21.01	1187.5	18,512	5338	150
22	7.4	37,769	32.18	21.01	1232.5	17,812	5262	156
23	7.5	39,116	32.49	18.58	1167.5	17,987	4906	157
24	7.7	37,217	33.35	8.08	1227.5	18,462	4468	153

4.4.1 Potential Hydrogen (pH)

The pH represents the balance among various types of carbonic acid. These changes are accompanied by changes in other physicochemical parameters, which influence water quality. In the present study, pH ranged 7.0–7.9 during premonsoon-2016, whereas 8.6–8.9 and 7.9–8.4 during monsoon-2016 and premonsoon-2017, respectively. The average pH of sea water is 8.2; however, it can range from 7.5 to 8.5 based on the geographical conditions. Human activities, such as sewage overflows or runoff, can create severe short-term pH variations, with long-term consequences that can be extremely detrimental to plants and animals. Extreme pH shifts can stress local creatures, causing many species to abandon the area or die. Here, the pH values were increased during monsoon between 8.6 and 8.9. This may be due to rainwater runoff during the monsoon.

Table 4.3 Physicochemical parameters during monsoon-2016

Sample	pH	TDS (ppm)	Salinity (ppt)	DO (ppm)	Ca (ppm)	Cl (ppm)	Na (ppm)	K (ppm)
1	8.6	37.22	42.56	5.64	1557.5	23562.5	5910	175.5
2	8.7	37.56	47.85	14.94	1497.5	26487.5	5765	177.0
3	8.8	43.99	42.65	14.94	1327.5	23612.5	5873	177.0
4	8.9	44.29	41.70	39.60	1287.5	23087.5	5856	178.5
5	8.8	47.62	41.52	26.66	1392.5	22987.5	5834	180.0
6	8.6	45.94	41.80	21.01	1272.5	23137.5	6186	175.0
7	8.8	45.69	40.60	18.58	1222.5	22487.5	6265	179.5
8	8.8	41.13	43.10	8.08	1192.5	23862.5	5801	182.0
9	8.8	42.82	44.01	10.50	1362.5	24362.5	5831	179.5
10	8.7	34.65	42.65	20.20	1352.5	23612.5	5841	180.4
11	8.8	36.90	41.48	17.7	1307.5	22262.5	6063	182.3
12	8.8	48.30	39.31	4.45	1047.5	21762.5	5768	182.4
13	8.8	36.17	42.56	19.79	1052.5	23562.5	6070	181.2
14	8.6	37.33	47.17	18.98	1577.5	26112.5	6196	180.3
15	8.6	40.95	36.10	22.22	1167.5	19987.5	5655	182.5
16	8.7	40.97	35.79	21.01	1162.5	19812.5	6239	181.0
17	8.8	33.02	34.30	31.91	1227.5	18987.5	6075	180.8
18	8.7	44.35	31.68	16.56	1097.5	17537.5	6281	179.5
19	8.8	25.16	35.16	19.79	1282.5	19462.5	6471	183.6
20	8.8	55.20	32.72	35.13	1212.5	18112.5	6186	186.5
21	8.7	34.51	33.71	12.92	1177.5	18662.5	6046	183.6
22	8.7	33.77	34.16	13.33	1107.5	18912.5	6214	182.6
23	8.7	39.00	35.16	20.60	1327.5	19462.5	6217	183.0
24	8.8	46.07	35.88	17.37	1227.5	19862.5	6273	184.2

4.4.2 Total Dissolved Solids (TDS)

TDS is typically low for freshwater sources, at less than 500 ppm. Brackish water and seawater contain 30–40,000 and 500–30,000 ppm, respectively. TDS in water refers to dissolved organic matters and inorganic salts, including sodium, potassium, calcium, magnesium, chloride, bicarbonates, and sulfates (Zhang et al. 2010). Human activities such as agriculture, water use, industry processes, and mining can increase the TDS level in waterbody. Excess amount of TDS is hazardous to aquatic biosphere (Peng et al. 2020). In this study, TDS values ranged between 33,835 and 64,972 ppm during premonsoon-2016. 33.02–47.62 and 32.31–48.19 ppm was reported during monsoon-2016 and premonsoon-2017, respectively. The values are decreased drastically during monsoon and continued due to fresh water source from the seasonal rains.

Table 4.4 Physicochemical parameters during premonsoon-2017

Sample	pH	TDS (ppm)	Salinity (ppt)	DO (ppm)	Ca (ppm)	Cl (ppm)	Na (ppm)	K (ppm)
1	7.9	36.92	32.58	5.96	527.5	18037.5	13,535	103.9
2	8.1	45.11	33.21	7.04	447.5	18387.5	13,947	98.8
3	8.1	41.70	33.30	19.79	467.5	18437.5	5198	104.8
4	8.1	39.49	33.35	18.98	492.5	18462.5	16,352	100.7
5	8.2	36.38	33.48	19.79	502.5	18537.5	17,355	85.2
6	8.2	41.58	33.30	35.13	452.5	18437.5	13,865	106.7
7	8.3	33.19	33.35	12.92	442.5	18462.5	17,454	102.7
8	8.3	34.03	31.23	8.08	472.5	18287.5	16,303	96.7
9	8.2	34.46	32.94	10.50	552.5	17237.5	14,183	106.8
10	8.3	32.62	33.03	20.20	467.5	18287.5	17,231	95.9
11	8.3	32.31	33.58	17.7	532.5	18587.5	15,861	107.7
12	8.3	32.52	34.57	14.94	427.5	19137.5	13,801	99.6
13	8.4	43.13	32.72	14.94	482.5	18112.5	16,361	101.6
14	8.4	32.48	33.30	36.27	512.5	18437.5	12,096	98.1
15	8.3	33.78	32.99	26.66	482.5	18262.5	15,616	100.0
16	8.2	35.68	33.30	21.01	457.5	18437.5	13,600	95.0
17	8.3	34.42	33.12	18.58	4.7.5	18337.5	13,940	102.1
18	8.2	48.19	33.53	13.33	427.5	18562.5	14,433	100.4
19	8.1	46.77	33.03	20.60	422.5	18287.5	14,928	106.1
20	8.0	44.26	34.07	17.37	442.5	18862.5	13,426	104.1
21	8.2	34.52	33.48	22.22	427.5	18537.5	14,807	104.3
22	8.1	33.07	33.44	21.01	412.5	18512.5	13,218	108.0
23	8.0	36.85	33.58	31.91	427.5	18587.5	13,032	106.0
24	8.1	46.28	34.30	16.56	427.5	18987.5	15,992	107.3

4.4.3 Salinity

Salinity in surface waters is reasonably steady around 3.6 percent, regulated by precipitation and evaporation. It averages between 31.5 and 34.5 ppt (Tomascik et al. 1997). Due to heavy rains, the freshwater is added at the surface and dilute the denser seawater, thereby reducing the salinity obviously and the seawater becomes less denser. Seawater can also be less saline near shore coastal zones and estuaries. In the study area, the salinity ranged 28.92–34.79, 31.68–47.85, and 31.23–34.57 ppt during premonsoon-2-16, monsoon-2016, and premonsoon-2017, respectively. A variation in the ranges of salinity was observed from upstream to the estuary and premonsoon to monsoon.

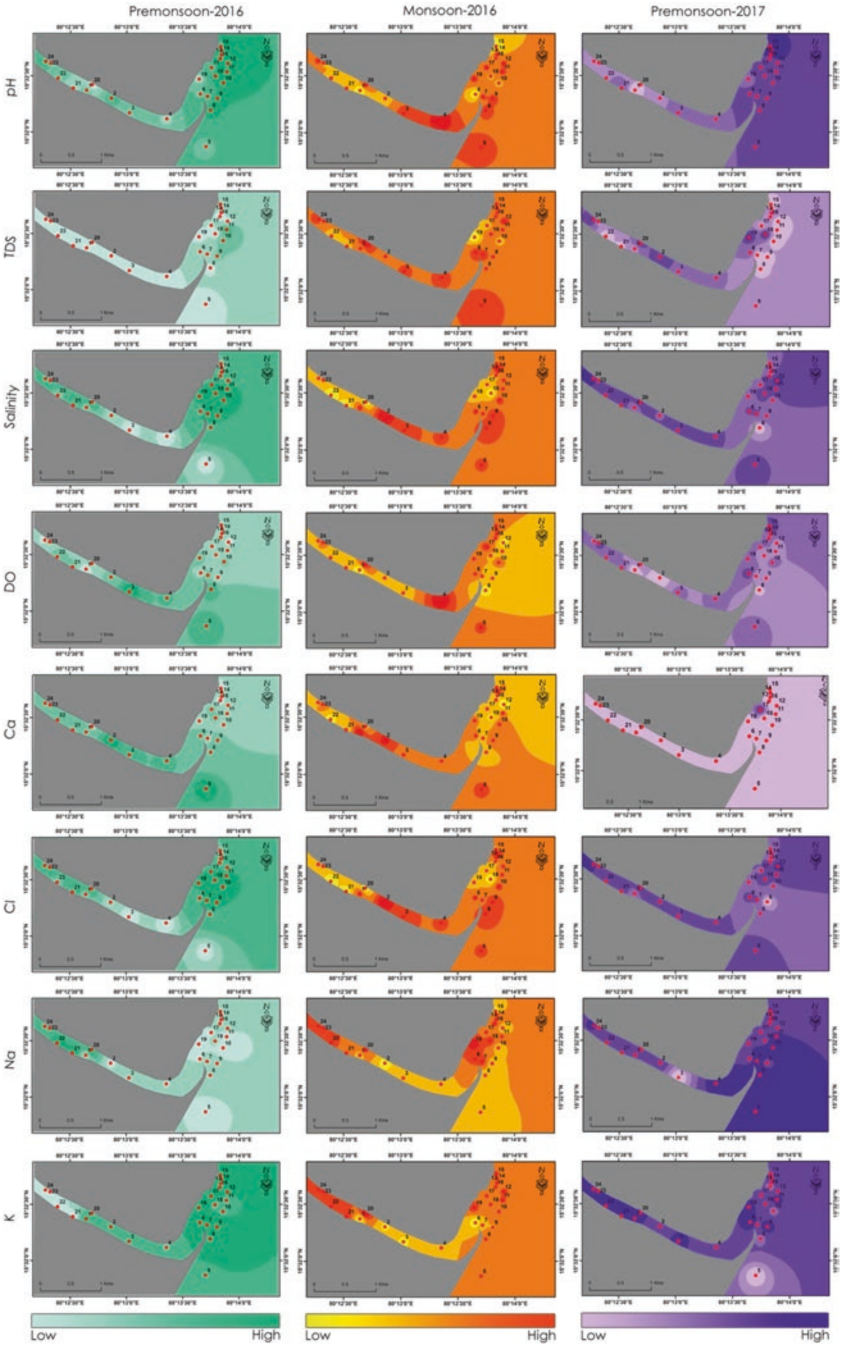

Fig. 4.2 Contour maps showing the vitiations in the distribution of physicochemical parameters in different seasons

4.4.4 Dissolved Oxygen (DO)

The seas contain several dissolved gases that are key to biosphere, particularly oxygen (O_2). Oxygen is required for respiration of biosphere including phytoplankton. They cannot survive for long in water with Dissolved Oxygen less than 5 ppm (Sreenivasulu et al. 2015). The low level of DO in water indicates contamination and is an important factor in determining water quality. Several investigations observed that 4–9 ppm of DO is the value. This will support a large extent of biosphere population (Abdus-Salam et al. 2010). However, at 2.5 ppm, the larvae of less sensitive species of crustaceans may start to die, and the growth of crab is hampered. But <2 ppm, some juvenile fish and crustaceans that cannot survive outside may die. Further, below 1 ppm, fish totally avoid the area or begin to die in huge stocks (USEPA 2000). The highest value of Dissolved Oxygen 40.04 ppm was reported from the study area during the premonsoon-2016. During premonsoon-2016, DO ranged between 4.04 and 40.04 ppm; 4.45–39.60 and 5.96–36.27 ppm were reported during monsoon-2016 and premonsoon-2017, respectively.

4.4.5 Calcium (Ca)

Seawater is reported to be almost saturated in calcium carbonate in the form of calcite or aragonite. Calcite is found in cooler seas, whereas aragonite is found in tropical conditions (Andersson et al. 2008). Ca is a conservative element in saltwater, which implies that its concentration in current seawater is rather stable. The calcium content of seawater is roughly 400 ppm. The natural occurrence of calcium in the earth's crust is one of the primary causes for its abundance in water. Calcium is another component of coral. Rivers typically contain 1–2 ppm Ca, but in lime areas, calcium values may reach to 100 ppm. In the present study, the calcium concentration was reported 987.50–1387.50, 1047.50–1577.50 and 412.50–552.50 ppm during premonsoon-2016, monsoon-2016, and premonsoon-2017 respectively. The concentration of Ca was increased from premonsoon-2016 to monsoon-2016 in 67% of the sampling stations. Decreasing trend with lowest values among the three seasons was observed during premonsoon-2017.

4.4.6 Chloride (Cl)

Chloride is primary inorganic anions (negative ions) in both salt and freshwater. It is formed by the dissolution of salts in water, such as NaCl or $CaCl_2$. A rise in chloride content can have a number of ecological consequences in both aquatic and terrestrial ecosystems. Salt has also been demonstrated to change the structure of microbial communities at low concentrations. However, the evolution of improved water desalination processes over the previous few decades has greatly lowered this barrier. Contamination of chlorides in bottom water may occur as a result of adjacent salt storage or salty rocks, mixing of freshwater with sea water, dissolving of salty industrial wastes, and other factors. The chloride ion concentration in seawater is around 19,400 ppm (a salinity of 35 ppt). Chloride levels in brackish water in tidal estuaries can range between 500 and 5000 ppm. The optimum limit of chloride in water is <250 ppm. During premonsoon-2016, chloride concentration was reported between 16,012 and 19,262 ppm. The highest concentration was reported from the estuary (stations 7 and 11), whereas the lowest values of 16,012 ppm from upstream. 17537.50–26487.50 and 17237.5–19137.50 ppm was reported during monsoon-2016 and premonsoon-2017, respectively. During monsoon-2016, the highest value of 26487.50 ppm was reported from the upstream (station 2), whereas lowest from the estuary (station 18).

4.4.7 Sodium (Na)

Sodium (Na) is a widely distributed cation in sea water. Usually, the salts of the seawater are greatly of sodium (Na^+) and chloride (CL^-) called NaCl. It constitutes about 85% of the salts in seawater. Sea water contains an average of 30.59% sodium as a percentage of its total salinity. The Na:Cl ratio is usually altered near estuaries. In this study, Na ranged between 3023 and 5332 ppm during premonsoon-2016. 5765–6471 ppm was reported during monsoon-2016. During premonsoon-2017, 5198–17,454 ppm of Na was reported during premonsoon-2017. A highest value of 17,454 ppm was reported during premonsoon-2017 from the estuary (station 7), whereas the lowest value of 3023 ppm was reported during premonsoon-2016.

4.4.8 Potassium (K)

Potassium is the fourth most abundant cation, but its concentration is only a few percent that of sodium. Although K is rarely measured directly, it appears to have a very consistent connection with chlorinity (Thompson and Robinson 1932). However, biological agents can influence potassium content because some organisms, notably large algae, concentrate potassium to a significant extent. Dilution with river water can also change the potassium to chlorinity ratio. The K reacts with clay and colloidal particles carried to the sea by freshwater outlets, influencing the ratio. From the study area, K ranged between 153 and 218 ppm during premonsoon-2016. Lowest value of 153 ppm was reported from upstream station 24. The highest value of 218 ppm was reported from two locations of the estuary (stations 6 & 19). During monsoon-2016, it showed the ranges between 175 and 186.5 ppm whereas 85–108 ppm during premonsoon-2017. During monsoon, the lowest and highest values of 175.5 and 186.5 ppm, respectively, were reported from upstream stations

(stations 1 and 20, respectively). The lowest value of 85.2 ppm was reported during premonsoon-2017 from the station 5.

4.5 Factor Analysis (FA)

The studied variables during three seasons, i.e., premonsoon-2016, monsoon-2016, and premonsoon-2017, were subjected to a statistical treatment such as Factor Analysis (FA). The analysis generated three factors for each season from the data of the study area.

During premonsoon-2016, the analysis generated three factors from the data of study area, namely, Factor 1 (39.23%), Factor 2 (26.65%), and Factor 3 (11.15%) (Fig.4.3). Factor 1 was represented by Salinity (0.769) and Cl (0.770) and was assigned as Salinity-Cl assemblage. Salinity and Cl showed lowest values of 28.92 and 16,012 ppm, respectively, during premonsoon-2016. Factor 2 was enveloped with Na (0.820) and K (0.566) and termed as Na- K assemblage. Na showed higher value of 5533 ppm at station 20 and the lower value of 4906 ppm at station 23. K showed higher value of 195 ppm at station 20, whereas lower (157 ppm) at station 23. In this factor, Na and K showed both lower and higher values at estuarine environment of the study area. Factor 3 was composed of DO (0.287) and Ca (0.287) and is called DO-Ca assemblage. DO showed highest value of 22.22 ppm, whereas the Ca showed lowest (987.5 ppm) at a station 16.

In monsoon-2016, factor loadings indicate three dominant assemblages: Factor 1 (41.96%), Factor 2 (18.38%), and Factor 3 (12.74%) (Fig. 4.4). Factor 1 envelops two distinct, Salinity (0.881) and Cl (0.886) named as Salinity-Cl assemblage. Salinity and Cl showed highest values of 47.85 and 26487.50 ppm, respectively, at station 2, whereas moderate at station 9. Factor 2 represented two districts, pH

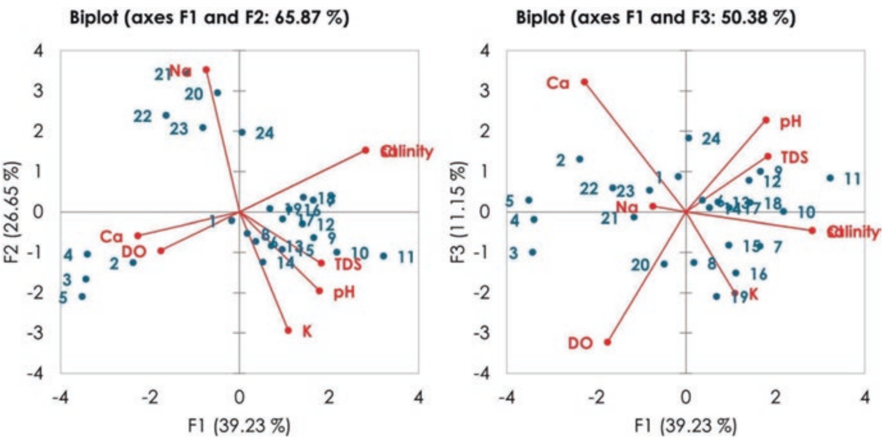

Fig. 4.3 Factor loading during premonsoon-2016 (F1, F2, and F3)

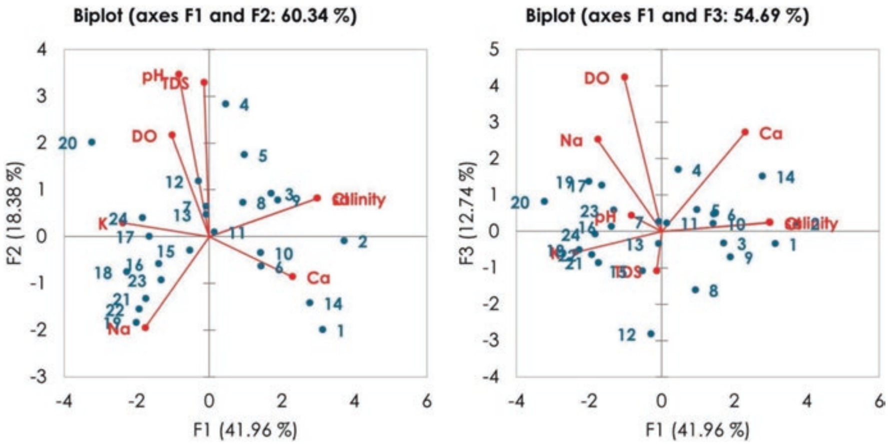

Fig. 4.4 Factor loading during monsoon-2016 (F1, F2, and F3)

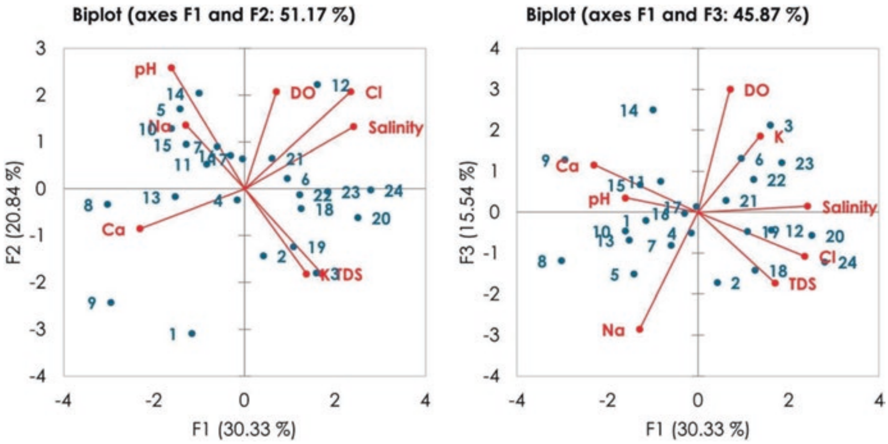

Fig. 4.5 Factor loading during premonsoon-2017 (F1, F2, and F3)

(0.527) and TDS (0.476). Therefore, it is termed as pH- TDS assemblage. pH showed highest value of 8.9 at station 4, whereas TDS showed highest value at station 5. Factor 3 includes DO (0.545) and Na (0.194) and it is called DO- Na assemblage. DO and Na showed lowest values of 4.04 and 5768 ppm at station 12 during monsoon-2016.

In premonsoon-2017, factor loadings indicate three dominant assemblages: Factor 1 (30.33%), Factor 2 (20.84%), and Factor 3 (15.54%) (Fig.4.5). Factor 1 is represented by two variables, Salinity (0.540) and Cl (0.513). Hence, it is named as Salinity-Cl assemblage. The assemblages were termed according to their most important physicochemical parameters. Salinity showed higher values (34.07 & 34.30) from the estuarine environment (stations 20 & 24). Factor 2 is represented by two variables, pH (0.426) and TDS (0.208). Hence, it is named as pH-TDS assemblage. pH showed both lower (7.9) and higher (8.3) values from the stations 1 and 12, respectively. TDS showed the lower values (32.52 ppm) at station 12. Factor 3 envelops two variables, DO (0.427) and Na (0.385). It is called DO-Na assemblage. DO show both lower and higher values from the stations 2 and 14, respectively. The distribution shows that physicochemical parameters have a strong affinity with marine water samples of the study area.

4.6 Conclusions

The health of the water in terms of its physicochemical parameters of Gundlakamma estuary, Andhra coast, Southeast coast of India, was assessed. The results for the studied parameters revealed that the water composition of the study area is pH 7.0–8.9; TDS 25.16–64,972 ppm; Salinity 28.92–47.85 ppt; DO 4.04–40.04 ppm; Ca 412.50–1577.50 ppm; Cl 16,012–26487.50 ppm; Na 3023–17454.50 ppm; and K 85–186.5 ppm. Statistical treatment of Factor Analysis (FA) for the distribution of physicochemical parameters shows that they exhibit a strong affinity with waters of the study area. In the typical context, water composition may be fresher in some part of upstream and more concentrated near estuary. The impact of anthropogenic as well as natural input, as a source of physicochemical parameters in the study area, is alarming. However, a detailed study is warranted to evaluate the status of health of the estuarine environment which will form a baseline data for future investigations.

References

Abdus-Salam N, Adekola FA, Apata AO (2010) A physico-chemical assessment of water quality of oil producing areas of Ilaje, Nigeria. Adv Nat Appl Sci 4(3):333–344

Andersson A, Mackenzie F, Bates N (2008) Life on the margin: implications of ocean acidification on Mg-calcite, high latitude and cold-water marine calcifiers. Mar Ecol Prog Ser 373:265–273

APHA/AWWA/WEF (1995) Standard methods for the examination of water and wastewater, 19th edn. American Public Health Association, Washington, DC

Arumugam A, Sugirtha PK (2014) Evaluation of physico-chemical parameters and nutrients in the Mangrove ecosystem of Manakudy Estuary, Southwest coast of India. Int J Latest Res Sci Technol 3(6):205–209

Dhirendra MJ, Kumar A, Agrawal N (2009) Studies on physico-chemical parameters to assess the water quality of River Ganga for drinking purpose in Haridwar District. Rasayan J Chem 2(2):195–203

Ho HH, Swennen R, Damme AV (2010) Distribution and contamination status of heavy metals in estuarine sediments near CuaOng Harbor, Ha Long Bay, Vietnam. Geol Belg 13(1–2):37–47

Jayaraju N, Sundara Raja Reddy BC, Reddy KR (2011) Heavy metal pollution of Tambaraparni River estuary, East Coast of India. J Chem Ecol 27(4):337–350

Kruopiene J (2007) Distribution of heavy metals in sediments of the Nemunas River (Lithuania). Pol J Environ Stud 16(5):715–722

Manjare SA, Vhanalakar SA, Muley DV (2010) Analysis of water quality using physico-chemical parameters of Tamdalge tank in Kolhapur district, Maharashtra. Int J Adv Biotechnol Res 1(2):115–119

Peng J, Kumar K, Gross M, Kunetz T, Wen Z (2020) Removal of total dissolved solids from wastewater using a revolving algal biofilm reactor. Water Environ Res 92:766–778. https://doi.org/10.1002/wer.1273

Poonam B, Rahul K (2012) Status of seawater quality at few industrially important coasts of Gujarat (India) off Arabian Sea. Indian J Geo-Mar Sci 41(1):90–97

Priyanka T, Amita B, Sukarma T (2009) Evaluation of water quality: physico-chemical characteristics of Ganga River at Kanpur by using correlation study. Nat Sci 1(6):91–94

Ravichandran R, Manickam S (2012) Heavy metal disrtibution in the coastal sediment of Chennai coast. IIOAB J 3(2):12–18

Riba I, DelValls TA, Forja JM, Go'mez-Parra A (2002) Influence of the Aznalco'llar mining spill on the vertical distribution of heavy metals in sediments from the Guadalquivir estuary (SW Spain). Mar Pollut Bull 44:39–47

Sreenivasulu G, Jayaraju N, Sundara Raja Reddy BC, Lakshmi Prasad T (2015) Physico-chemical parameters of coastal water from Tupilipalem coast, Southeast coast of India. J Coastal Sci 2(2):34–39

Thompson TG, Robinson RJ (1932) Chemistry of the sea. Physics of the earth. In: Oceanography, vol 5. National Research Council, Bull., no. 85, 1932, Washington, D.C., pp 95–203

Tomascik T, Mah AJ, Nontji A, Moosa MK (1997) The ecology of the Indonesian seas, the ecology of Indonesia series, vol 7. Periplus Editions (HK) Ltd., Singapore, 1388 p

USEPA (2000) Risk-based concentration table. United States Environmental Protection Agency, Philadelphia

Zhang S, Zhou Q, Xu D, Lin J, Cheng S, Wu Z (2010) Effects of sediment dredging on water quality and zooplankton community structure in a shallow of eutrophic lake. J Environ Sci 22:218–224