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Physico-chemical characterization of water of Kalnagini creek at Kakdwip, West Bengal

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Abstract
Water samples were collected from three sites namely Nimtala Ghat, Jelepara and Banshtala Ghat of Kalnagini Creek at Kakdwip, West Bengal for six months (January to June, 2019). The pH, conductivity, TDS, salinity, temperature, and turbidity were measured using deluxe water analysis kit. Dissolved oxygen, alkalinity, and free CO_2 were estimated using standard method. The analysis of physico-chemical characterization of water of the Kalnagini creek demonstrated that during the monsoon season (May to June) the water quality was deteriorated leading to the great concern of that particular area. Water quality of the Kalnagini creek was better in winter season (January & February, 2019). The result showed availability of highest dissolved oxygen during winter season due to its low water temperature.

Keywords: Saptamukhi estuary, kalnagini creek, water, physical parameters

Introduction
The Indian Sundarban is located at the top of the Bay of Bengal (Latitude: 21°40′N - 22°40′N and longitude 88°03′E -89°07′E) and neighbour country Bangladesh is present in the east, the Hooghly River in the west, Hodge line and the Dampier in the North, and the Bay of Bengal in the south. In Indian Sundarban region several beaches, coastal dubes, creeks, estuaries, sand flats, coastal dunes, inlets and mangrove swamps are situated. Nearly 2069 km of the area is filled with creeks, estuaries, and River system which all are connected with the Bay of Bengal (Mitra *et al.*, 2009) [1]. The whole Sundarban area is distributed by an intricate network of criss cross channels and creeks dividing the area into frequent deltaic islands. These channels finally end up to the Bay of Bengal through one or other of the principal estuaries. Ghosh et al. (2002) [2] reported about the three Fluvial Circulation systems constituting the Sundarban River System as (i) the Saptamukhi Circulation Pattern, (ii) the Thakuran Circulation Pattern, and (iii) the Matla Circulation Pattern.

The Saptamukhi Estuary braids right at the sea face into the arms - The East Gully and the West Gully moving up around Lothian Island. At the northern extremity of the Prentice Island, the East and West gullies join together again to form the upper reaches of Saptamukhi River. Towards the East the major branches within Saptamukhi circulation system are mainly the Panipara, The Gobadia Link Channel, The Selemari Gang, The Barchara, The Walsh Creek, and The Curzon Creek. On the Western fringe the major branches are the Kalnagini creek, the Ghugudanga blind creek, the Hatania (Hetalia) - Doania or the Namkhana Creek, and The Chandanpiri River (Bhattacharyya *et al.*, 2013) [3].

Mangrove ecosystem has major importance because of its biological productivity and unique diversity (Dattatreya *et al.*, 2018) [4]. Research is needed to determine water quality parameters of mangrove ecosystem as they generating a huge number of product and they have significant value in breeding and nursery grounds for production of many commercially available fishes (both shell and fin fishes) (Kathiresan and Bingham, 2001) [5]. So, these creeks and estuaries are the important sources for agriculture and fishery but limited information is there regarding water and soil condition of this region. So, the present study was conducted to determine physic-chemical parameters of water and soil of three sites of Kalnagini creek namely Nimtala ghat, Banshtala ghat and Jelepara ghat for six months from January 2019- June 2019.

Materials and Methods

Site Selection

Three sites were selected for analysis of physic-chemical parameters of water of Kalnagini creek**,** which is situated at Kakdwip, West Bengal. It is directly connected with Bay of Bengal. The name of the selected sites is Nimtala Ghat (21°51'25.2" and 88°15'49.3" latitude and longitude respectively), Jelepara (22°55'41.3" and 87°18'51.2" latitude and longitude respectively) and Banshtala Ghat (19°49'31.6" and 89°11'50.1". latitude and longitude respectively), which all are located at Kakdwip, South 24 Parganas district of West Bengal.

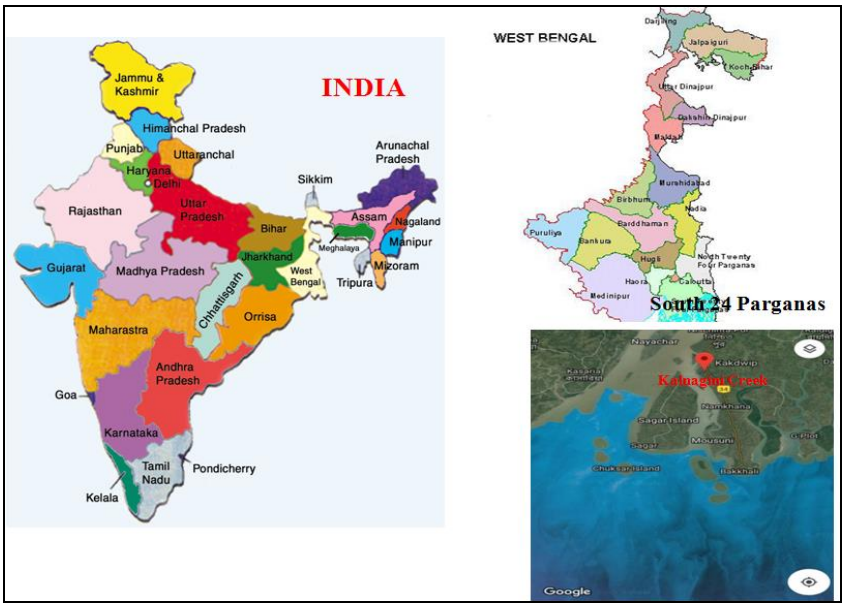

Fig 1: Location of sampling site at Kakdwip, South 24 Parganas

Fig 2: Kalnagini creek

Physico-chemical Parameter

The pH, conductivity, TDS, salinity, temperature, Dissolved Oxygen (DO), alkalinity, turbidity, and free Carbon dioxide (CO_2) of water at Nimtala Ghat, Jelepara and Banshtala Ghat of Kalnagini Creek were sampled randomly and analyzed for monthly basis from January 2019 to June 2019. The pH, conductivity, TDS, salinity, temperature, and turbidity were measured by using deluxe water analysis kit (Aristocrat, Model No. 191). Dissolved oxygen, alkalinity, and free CO_2 were examined by using standard method (Wetzel and Likens 1991; APHA 1998) [6, 7]. Monthly sampling was noted down during morning time between 07:00 AM and 10.00 AM throughout the sampling season. Analysis of soil organic carbon of the three sites were done by using standard method (Yeomans & Bremner, 1988) [8].

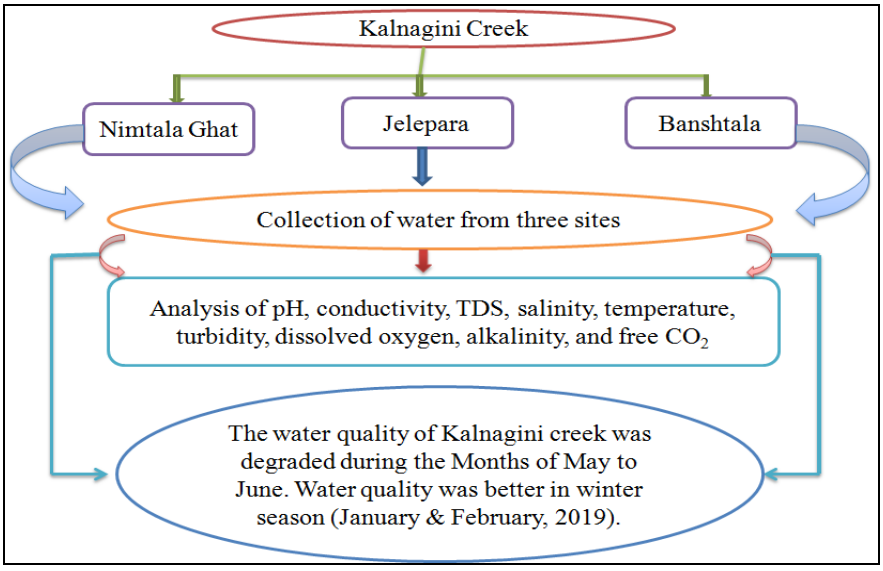

Fig 3: Overall methodology

Statistical analyses

The results were subjected to statistical analysis (mean, standard deviation, and One Way ANOVA) to determine the significant alteration in the physico-chemical parameters of water and soil of three sites. Statistical analysis was performed on SPSS-16 (p<0.5) and MS Excel.

Results and Discussions

The result on physic-chemical characterization of Kalnagini creek at the above mentioned three sampling sites (Nimtala Ghat, Jelepara and Banshtala Ghat) have been recorded (Fig. 4 – Fig. 8). The air temperature showed maximum (34.5 ± 1.93 °C) in May, 2019 at Banshtala Ghat and minimum (16.5 ± 2.25 °C) in January, 2019 at Nimtala Ghat. The water temperature of the three sites revealed to be maximum (31.5 ± 2.86 °C) in May, 2019 and minimum (13± 1.15 °C) in January, 2019 at Nimtala Ghat. Its variations between the sites were not significant (p<0.05). The nature of water quality is indicated by pH either acidic or alkaline. It has a direct connection in the biological progression of all the marine organisms (Welch, 1952) [9]. Significant variations of pH (p<0.05) were recorded in all sites (Fig.-5). Among the three sites comparatively lower pH (7.12-7.47) was recorded in the water of Nimtala from January to June 2019. In contrast, higher pH (7.2-7.74) was recorded in water of Banshtala during the study period. The notable monthly alterations in electrical conductivity were found in Kalnagini creek. Conductivity was maximum at Banshtala in June, 2019 and minimum in January, 2019 during the present study. Kalnagini Creek has high conductivity in June, 2019 which was reflected that monsoon season is being alarming in respect to its water quality.

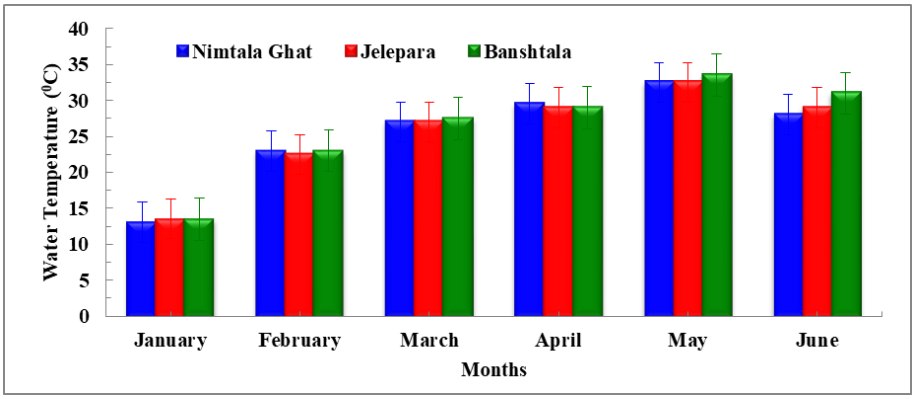

Fig 4: Variation of temperature from January to June 2019 at Nimtala Ghat, Jelepara and Banshtala

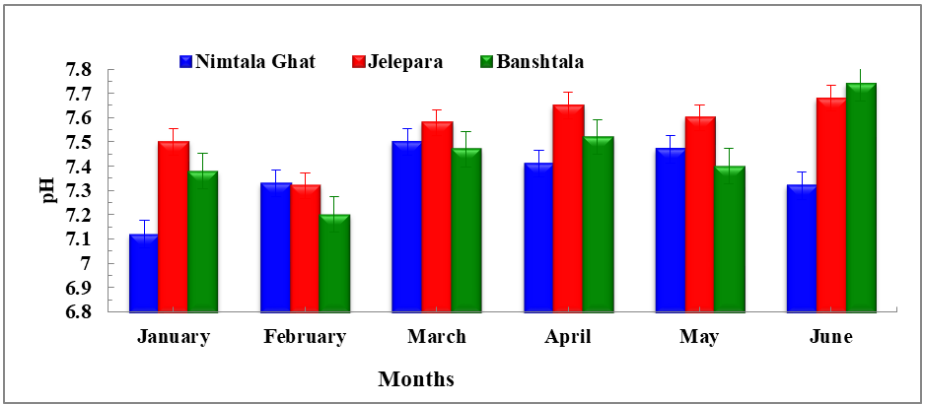

Fig 5: Variation of pH from January to June 2019 at Nimtala Ghat, Jelepara and Banshtala

Variation in TDS concentration was found to be maximum (7890 ppm) in June at and minimum (5277 ppm) at in January. The similar availability of increased level of TDS in monsoon season (in the month of June to August) was reported by Rawat *et al*., (1995) [10] on Deaoria Tal and on Chimdi lake by Surana *et al.*, (2010) [11]. In case of turbidity, maximum turbidity was observed in June (11 ± 1.17 NTU) and minimum in January (6 ± 3.20 NTU). This happened due to highest sediment deposition during rainy season (June-August) turns the creek more turbid (Jain *et al.*, 2005) [12]. Dissolved oxygen has main role in respiratory metabolism for most aquatic organisms and it has direct connection with the solubility and availability of several nutrients. Wide fluctuation (20-23‰) of salinity observed in water of all sites with highest (22 ppt) during January to March in Banshtala, but during February and March in Nimtala Ghat and Jelepra due to lowest or nil precipitation. While the lowest salinity (20 ppt) observed during April and May, 2019 [Fig.-6] of the study period in almost all sites due to unusual heavy precipitation and super-cyclone. Dissolved oxygen (DO) in saline water is generally low and varied in relation to the salinity of the water. More or less the range of DO was 4-5 mgl^{-1} in all sites [Fig.-7]. Water condition of the Kalnagini creek was better in winter season (January-February, 2019). The highest dissolved oxygen was found in winter season of the Kalnagini creek during its low water temperature (Fig.-4). In contrast, Free CO_2 was highest during March-May, 2019 (Fig.-8). Very little or insignificant variations (21-23 mgl^{-1}) were recorded during the period of study in almost all the sites. Maximum free CO_2 is available during the month of May to June, because photosynthesis is decreased during these months (Surana et al., 2010) [11]. The concentration of CO_2 was increased in the form of carbonic acid due to heavy rainfall in monsoon (Chakraborty et al., 1959) [13].

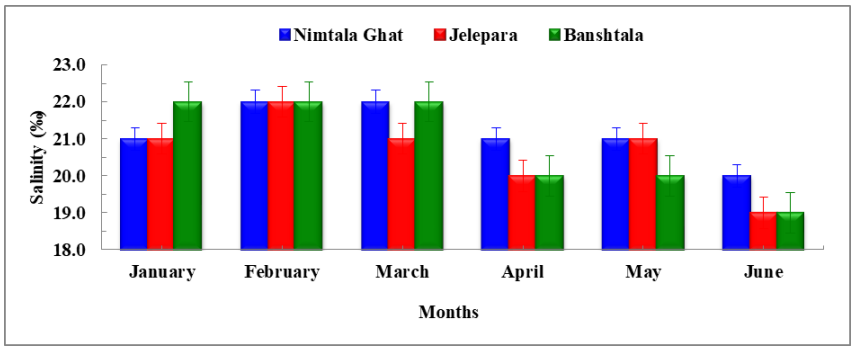

Fig 6: Variation of Salinity (‰) from January to June 2019 at Nimtala Ghat, Jelepara and Banshtala

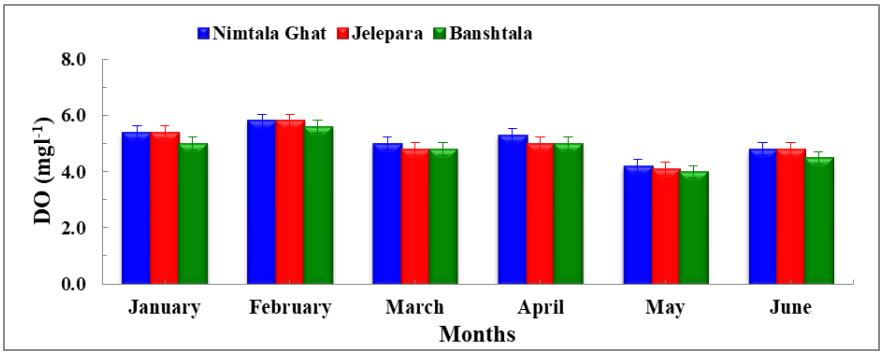

Fig 7: Variation of DO (mgl^{-1}) from January to June 2019 at Nimtala Ghat, Jelepara and Banshtala

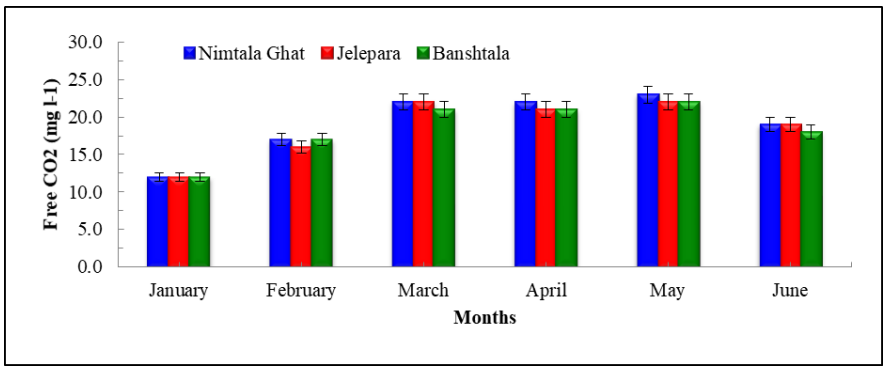

Fig 8: Variation of Free CO_2 (mgl^{-1}) from January to June 2019 at Nimtala Ghat, Jelepara and Banshtala

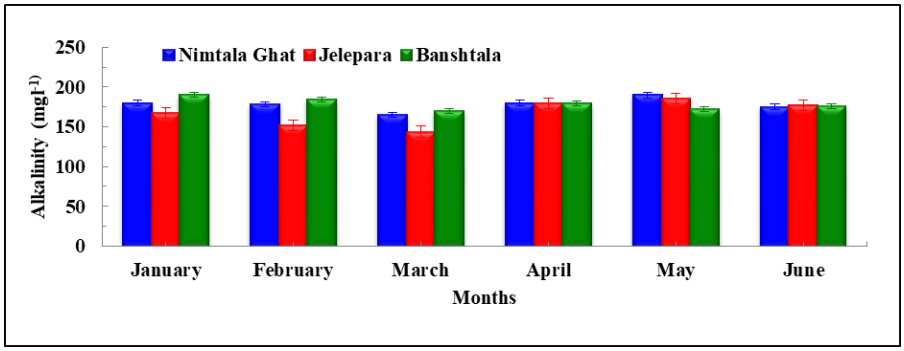

Fig 9: Variation of Alkalinity (mgl^{-1}) as $CaCO_3$ from January to June 2019 at Nimtala Ghat, Jelepara and Banshtala

Estuaries or creeks form a transition zone between river and ocean environments leading to a dynamic ecosystem. They are exposed to both marine impact, such as waves, tides and the influx of saline water and other riverine sectors. The productivity of an ecosystem is primarily depends on the favourable condition of the physical characteristics and hydrodynamic status of the estuary. Light penetration and temperature are the main physical factors for photosynthesis. The cyclonic activity died down during monsoon season (June- August) leading estuarine water to be calm and clean. The temperature also remained constant at the optimal level.

Conclusion

The present study on physico-chemical characterization of water of the Kalnagini creek revealed that the water quality of Kalnagini creek was degraded during monsoon season. The creek receives sediments and other organic pollutants in monsoon season, resulting increased level of turbidity, TDS and EC. Water quality of the Kalnagini creek was better in winter season (January & February, 2019). The maximum

dissolved oxygen was observed in winter season at the Kalnagini creek due to the availability of low water temperature.

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