Biological Forum – An International Journal **15(3): 169-175(2023)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Assessments of Coal-Based Thermal Power Plant Effluents affect Physicochemical Factors of the Bhagirathi-Hooghly River, West Bengal

Sanjoy Das[1*] and Ashis Kumar Panigrahi[2]

[1]Research Scholar, Ecotoxicology, Fisheries and Aquaculture Extension Research Laboratory, Department of Zoology, University of Kalyani, Kalyani, Nadia (West Bengal), India.
[2]Pro-vice Chancellor, University of Burdwan and Professor, Department of Zoology, University of Kalyani, Kalyani, Nadia (West Bengal), India.

(Corresponding author: Sanjoy Das)*
(Received: 13 January 2023; Revised: 16 February 2023; Accepted: 21 February 2023; Published: 22 March 2023)
(Published by Research Trend)

ABSTRACT: The most significant waterway in West Bengal, India, is the Bhagirathi-Hooghly River, but its water quality has been declined as a result of numerous anthropogenic activities. The purpose of this research is to assess the effects of Sagardighi coal-based thermal power plant's effluents on the physicochemical components of the Bhagirathi-Hooghly River. Study was conducted from January to December 2019, water were collected from three different locations upstream (denoted as Site 1), Main spot (Site 2) and downstream (Site 3) of the river to assess water quality changes, due to Sagardighi thermal power plant released waste water into the Bhagirathi-Hooghly River. Standard protocol from American Public Health Association, APHA (1995) used to measured temperature, pH, dissolve oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), hardness, nitrate, and phosphate. Water required for cooling the turbine resulting warm water or not properly treating waste water released into the river system, rise in water temperature and enrichment in nutrients like nitrate and phosphate resulting eutrophication at site 2 region, decrease in DO during summer season in all sites and particularly in site 2 region low DO level observed. BOD and COD increased in site 2 due high in organic and inorganic pollutant load into the river bed. Calcium and magnesium ions enhance the hardness of site2 and site 3. Findings from this research show that sites 2 and 3 show alterations in physiochemical factors rather than site 1, which affect the aquatic ecosystem's health. Drainage system from coal-based thermal power plants emphasizes the need for efficient wastewater treatment and pollution control to protect water supplies and ecosystem.

Keywords: Bhagirathi-Hooghly River, Coal-based thermal power plant, effluents, physicochemical parameters, eutrophication.

INTRODUCTION

India is a developing country with a massive population density that is rapidly increasing. This increase in population density is associated with the country's economic system and rising demand across all sectors (Agarwal, 2014). To fulfil this demand, development is taking place in all sectors, including industry, hydropower, thermal power plants and chemical plants. These industries, on the other hand necessitate a large amount of water that why, the majority of industries in India have developed near the banks of the country's river systems. The mighty Ganga, in particular is under tremendous strain in this regard. These industries not only rely on rivers for water but they also use the river system for waste discarding (Mishra, 2012).

On the banks of the River Ganga, many industries including food processing, chemical plants, textile mills, paper mills, fertilizer plants, thermal power plant and pharmaceutical flourished. These factories poured their waste into the river. The direct release of industrial solid waste and effluents into water bodies resulting changes in water quality parameters that create around 20% of the world's water pollution (Rai, 2013).

Not only do industries contaminate the river system, but also domestic sewage, hospital waste, municipal pollutants and the tannery industry all play a significant role in the Ganga's pollution (Hamner *et al.*, 2013). Through several channels, domestic sewage and solid or liquid waste from many cities are released into the river. Since polluted water often flows downward from many towns drainages and leaving a poisonous waste into the river and rivers are especially main susceptible to the impacts of pollution (Kumar, 2010). Although the Ganges is regarded as India's lifeline, it also sustains the ecosystem and ecology. Anthropogenic activities have significantly altered the aquatic ecology during the past few decades (Paul, 2017).

Due to the scarcity of fresh water, people in some parts of India still completely rely on the Ganga for their drinking water and believe it to be a holy river. The amount of pollution in the river is rising daily, making it unsafe for human consumption. However, many people continue to drink river water, which leads to an increase in disease outbreaks (Dasgupta, 2004). The holy river Ganga's aquatic ecosystems physical, chemical and biological parameters are all above the acceptable limit making water not suitable to drink and unhealthy for aquatic organisms to exist (Srivastava *et al*., 2016).

There are various sources of pollution in the rivers, but coal-fired thermal power plants are a significant contributor. According to Coal & Electricity - World Coal Association, 2020 globally main way of electricity generated by combustion of fossil fuel particularly coal fired thermal power plant about 37 percentage reduced down to 22 percentages in 2040 to minimized the pollution. India having 75 percent of its electricity produced by coal-based thermal plants, Ministry of Coal, Government of India, 2020. The water of the Holy Ganga River is frequently contaminated by adjacent coal fired thermal power plants. River water was utilized to supply the power plant's cooling system and untreated waste water from those thermal power stations were discharged into the river, affecting water quality parameters (Rahman *et al*., 2018). Coal mining has a negative impact on ecosystems, changing the air, soil, and water conditions as well as biomass, species deformation and biodiversity (Hossain *et al*., 2015). The discharge of hot water and ash pond effluents from Kolaghat Thermal Power Plant has an impact on water ecology and fish diversity (Spadoni *et al*., 2014; Ghorai *et al*., 2015). Waste effluent from coal-based thermal power plants, heavy metals and heated water increased the microbial activity reducing the amount of dissolved oxygen and raising the carbon dioxide levels in the aquatic ecosystem, resulting in an algal bloom (Chakraborty *et al*., 2021). Physical and chemical parameters of water body now alter and adverse effects on productivity of water body. Physical parameters being taste, pH, temperature, odour and colour and chemical parameters like DO, BOD, COD, hardness, phosphate, nitrates and ammonia above the permissible limits (Srivastava *et al*., 2016).

One of the important rivers in West Bengal is the Hooghly River and major lifelines for the inhabitants of West Bengal. The Hooghly River, also known as Bhagirathi-Hooghly River is a River Ganga's tributary that spans 260 kilometers. It is degenerated in Murshidabad from the main channel of Ganga River, where the Ganga divides into two channels, one of which flows through Bangladesh and is known as the Padma. Another channel The Hooghly River, which flows through a heavily industrialized region of southern part of West Bengal on its way to the Bay of Bengal. Hooghly River also known as Bhagirathi River in the upper part of catchment. Instead of using natural water, the Hooghly receives the majority of its water from the Farakka Feeder Canal. Lower Hooghly River reaches are supplied by the rivers Haldi, Ajay, Damodar, and Rupnarayan (Bandyopadhyay *et al*., 2014).

MATERIALS AND METHODS

A. Study areas

Water samples were collected from the River Bhagirathi-Hooghly 5 km upper side away from Sargardighi thermal power plant waste water discharged into the river system, is denoted as Sampling station 1(Site-1). Sampling station 2 (Site-2) refers as at the point thermal power plant waste water discharged into river surface runoff. From 5 km down side of the discharging point selected as Sampling station 3 (Site- 3). Table 1 showed all the sampling stations latitude and longitude and location of Sagardighi thermal power plant (Fig. 1a-1c).

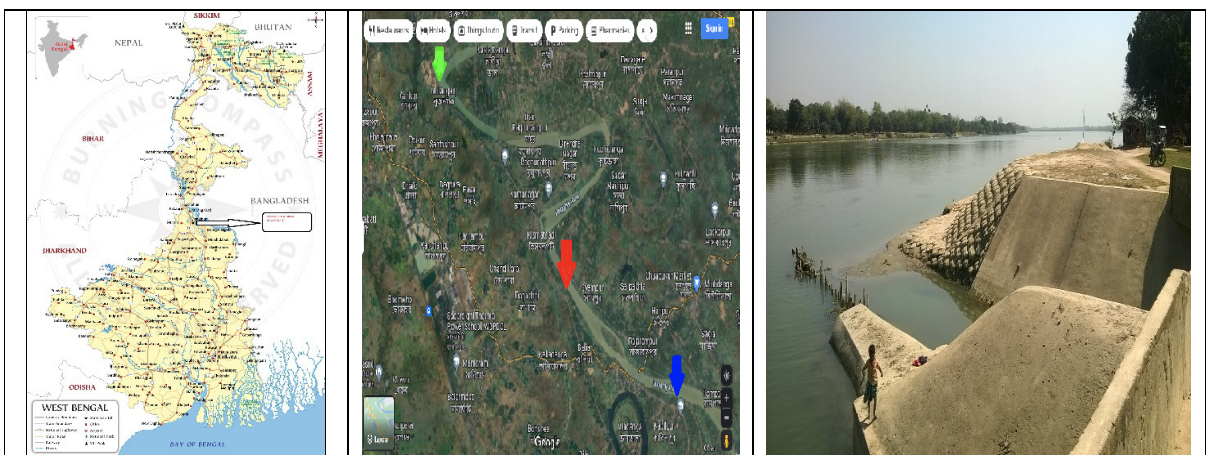
B. Sample Collection

Water samples were collected from January 2019 to December 2019 in pre cleaned polypropylene bottles by 0.5% nitric acid and washed with distilled water. The bottles were washed with water sample twice to remove excess nitric acid, after collecting sample water immediately taken to laboratory for further experiments such as dissolve oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), hardness, nitrate and phosphate etc. Temperature and pH were done at time of samples collection. Temperature ware done by thermometer and pH of water sample measured by Hanna pH meter. Physicochemical parameters of water such as DO, BOD, COD, hardness, nitrate and phosphate were determined by standard protocol of American Public Health Association, APHA (1995)**.** Throughout the year, seasonal variations in water quality such as winter (December, January, and February), summer (March, April, and May), monsoon (June, July, and August), and post monsoon (September, October and November) were observed. Statistical analysis were done by excel and SSPS.

RESULTS AND DISCUSSIONS

Eight parameters (Table 2-4), such as temperature, pH, DO, BOD, COD, hardness, nitrate, and phosphate, were chosen for the water quality analysis of the Bhagirathi-Hooghly River to detect aquatic environments suitable for aquatic inhabitants. It was monitored for one year. A vital factor in aquatic ecosystems survival is water temperature. Water temperature varies in the three different selected sites. The highest temperature recorded at site 2 was around 30.72°C during the summer season (Table 3), and the lowest temperature (Table 4) recorded at site 3 during the winter season was 13°C. Fig. 2 depicts the highest temperature recorded during the summer season at sites 1 and 2, and the lowest temperature recorded during the winter season at site 3. The release of hot water has a detrimental effect on aquatic life because many kinds of fish and other organisms are climate evolved and may not be able to live in too warm water. Thermal pollution can promote the development of phytoplankton, harmful algae and other aquatic vegetation (Zhang *et al*., 2010; Chorus and Welker 2021) resulting in a drop in dissolved oxygen levels in the water. This can make breathing more challenging for fish and other aquatic organisms (Mondal *et al*., 2016).

Thermal pollution from the coal-based thermal power plant play an important role in reduced dissolve oxygen. Water is taken from rivers, lakes, and the ocean to cool the turbines, and warm water is sent back into the water source. As the temperature of the water rises, it can affected aquatic life (Rosen *et al*., 2015). Site 2 shows high temperature rather than remaining sites, low water temperature in site 1 and moderate in site 3. Water pH of site 1 and site 3 were slightly basic in nature, and site 2 was slightly acidic in nature due to metal pollution (Fig. 2). Lowest pH (Table 3) was observed in the summer at site 2 and the highest pH (Table 4) was recorded in the winter at site 1. According to Munawer (2018), the area around coal-fired power plants observed more acid rain, and the pH in the aquatic environment went down. This affected phytoplankton and zooplankton. The most significant parameter of water quality strength is dissolve oxygen (Fig. 3). It is crucial to the health of the aquatic ecosystem. Contamination of heavy metals with warm water in the river bed influences the growth of microorganisms, mainly bacteria, which absorb dissolve oxygen and produce carbon dioxide in water, which contributes to creating a suitable environment for algal blooms (Chakraborty *et al*., 2021). Similar results observed in present study that highest dissolve oxygen measured site 1 in the winter (Table 2) season less pollution in the upstream and lowest dissolve oxygen (Table 3) in site 2 (main spot) in summer because hot waste water released into the river bed and sunlight heated the surface water. Inversely relation found in dissolve oxygen and biological oxygen demand. Generate a high level of organic and inorganic matter in the effluents of coal-based thermal power plant waste water because combustion of fossil fuel results in triggering bacterial activity to decompose organic waste and depletion of oxygen, according to (Islam *at al*., 2019) it leading to an increase in BOD. Organic pollutant minimized in the site 1 (Table 2) in the winter so, low BOD observed and maximum BOD and COD recorded in site 2 in summer (Fig. 4) and followed by site 3 because of organic and inorganic pollutant high in the both site. COD (Fig. 4) were more or less similar in all three site throughout the year inorganic pollutant drawn from agriculture, domestic, municipal sewage and industrial waste water. COD was also influenced due to the degradation of large amounts of organic and inorganic matter present in the waste, which influences algal blooms and consumes more oxygen from the aquatic environment, making it unsuitable for aquatic life's survival. Above all three site average hardness (Fig. 5) quite similar but in site 2 of summer season shows maximum and minimum in the site 1 of winter. Hardness is increased in site 2 (Table 3) due to high contamination of pollutants or thermal power plant waste water containing effluents enter into river water that alter the water strength (Pandey *et al*., 2020). Other than sites 1 and 3, the effluents from the thermal power plant in site 2 (Table 3) were causing more nitrate (Fig. 6) and phosphate (Fig. 7) accumulation at aquatic levels (Hamdhani *et al*., 2020). Growing levels of nitrate and phosphate cause eutrophication, harmful algae blooms, and a decline in the population of aquatic organisms like fish (USEPA, 2007).



(a) Sagardighi Thermal Power Plant (Source- Google) | (b) Three sites of water collection; Site 1; ↓ Site 2; ↓ site 3 ↓ | (c) Image showing Thermal power plant containing waste water released into the river system

Fig. 1.

Table 1: Water sampling station (Source- Google map).

Site Name	Latitude	Longitude	Remark
Sargardighi Thermal Power Plant	24°22'07.7"N	88°06'22.0"E	Coal based Thermal Power Plant
Up Stream or Site -1	24°24'55.3"N	88°06'00.1"E	Location of water sampling
Main Spot or Site -2	24°22'17.6"N	88°09'10.7"E	Location of water sampling
Down Stream or Site -3	24°20'45.1"N	88°12'09.0"E	Location of water sampling

Table 2: Water quality parameters of site 1.

	Winter	Summer	Monsoon	Post Monsoon
Temperature	13.17 ± 2.47	28.89 ±1.2	28.5± 1.36	23.09 ± 5.07
pH	8 ±0.1	7.61 ± 0.28	7.5 ±0.3	7.91 ± 0.66
DO	8.7 ± 0.22	6.73 ± 0.31	5.79 ±0.63	7.38 ± 0.7
BOD	1.6 ± 0.3	2.9 ±0.4	2.8 ± 0.13	2.7 ± 0.84
COD	9.92 ± 1.3	10.27 ± 2.1	10.11 ± 1.74	10.36 ± 0.85
Hardness	90.37 ± 4.46	95.47 ± 15	108.27 ± 11.2	119.37 ± 3.82
Nitrate	0.45 ± 0.16	0.31 ± 0.3	0.34 ± 0.14	0.23± 0.07
Phosphate	0.03 ± 0.001	0.035 ± 0.012	0.017 ± 0.004	0.021 ± 0.004

Table 3: Water quality parameters of Site 2.

	Winter	Summer	Monsoon	Post Monsoon
Temperature	14.43 ± 2.72	30.72 ± 0.25	30.22 ± 1.11	27.5 ± 4.09
pH	7.03 ± 0.14	6.45 ± 0.14	6.8 ± 0.61	7.3 ± 0.26
DO	6.33 ± 0.68	3.7 ± 0.33	4.11 ± 0.15	5.65 ± 0.82
BOD	2.03 ± 0.13	4.59 ± 0.46	4.1 ± 0.84	3.6 ± 0.87
COD	7.37 ± 2.28	12.51 ± 2	8.69 ± 1.54	10.13 ± 1.18
Hardness	120.8 ± 11.24	156.67 ±6.17	112.15 ± 20.16	129.5 ± 38.64
Nitrate	0.63 ± 0.28	0.92 ±0.12	0.33 ± 0.07	0.61 ± 0.18
Phosphate	0.044 ± 0.009	0.049 ± 0.007	0.03 ±0.007	0.028 ± 0.004

Table 4: Water quality parameters of Site 3.

	Winter	Summer	Monsoon	Post Monsoon
Temperature	13 ± 2.17	29.33 ± 1.04	30.39± 0.67	25.33 ± 4.86
pH	7.97 ± 0.25	7.5 ± 0.35	7.02 ± 0.56	7.43 ± 0.21
DO	7.14 ± 0.55	5.13 ± 0.1	5.48 ± 0.63	7.05 ± 0.71
BOD	1.92 ± 0.32	3.87 ± 0.32	3.82 ± 0.73	3.24 ± 1.57
COD	10.49 ± 1.85	9.54 ± 1.25	8.19 ± 1.34	11.14 ± 3.18
Hardness	107.17 ± 2.08	115.17 ± 28.8	97.17 ± 4.16	134.1 ± 20.1
Nitrate	0.38 ±0.05	0.54 ± 0.09	0.17 ±0.04	0.31 ± 0.07
Phosphate	0.042 ± 0.008	0.041 ± 0.006	0.019 ± 0.01	0.02 ± 0.006

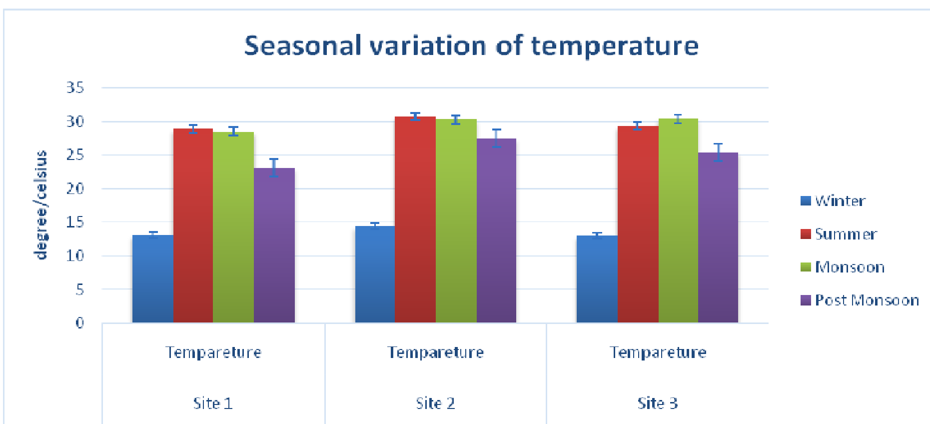


Fig. 2: Seasonal variations in the temperature of water samples from three sites.

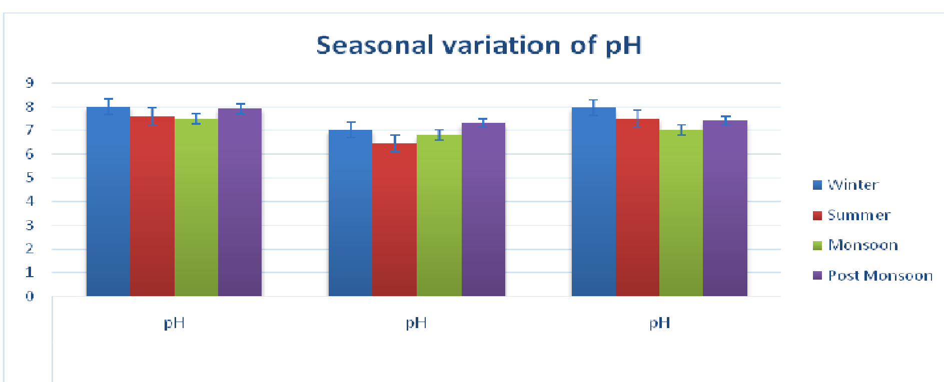


Fig. 3. Seasonal variations in the pH of water samples from three sites.

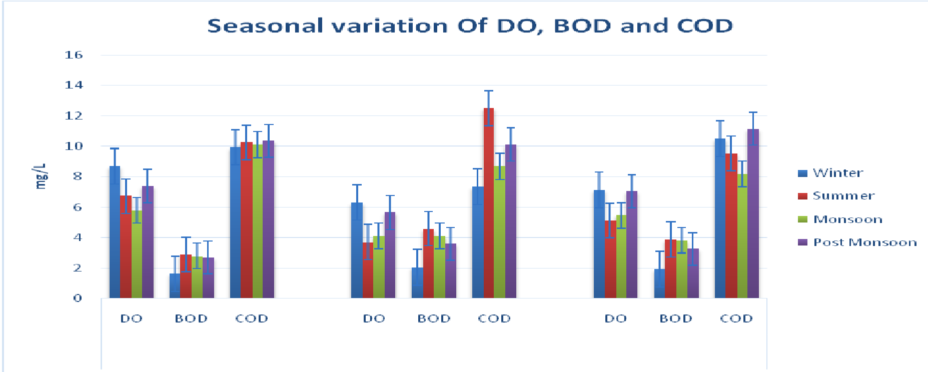


Fig. 4. Seasonal variations in the DO, BOD and COD of water samples from three sites.

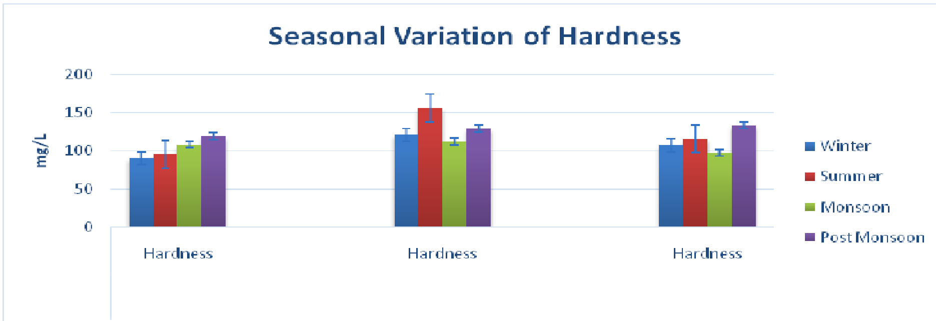


Fig. 5. Seasonal variations in the Hardness of water samples from three sites.

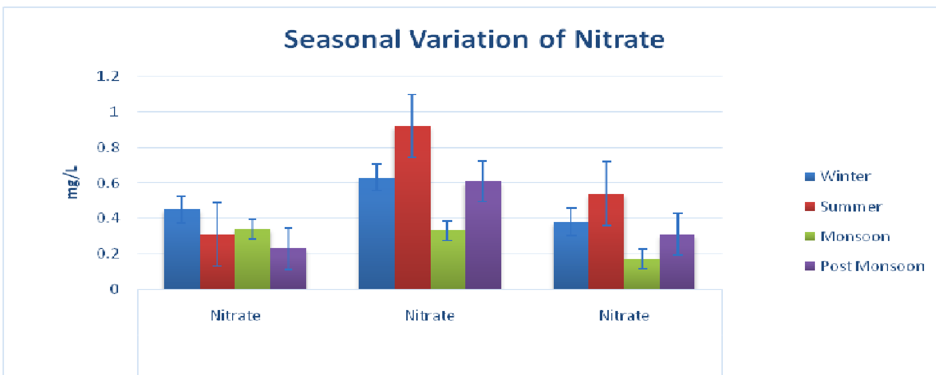


Fig. 6. Seasonal variations in the Nitrate of water samples from three sites.

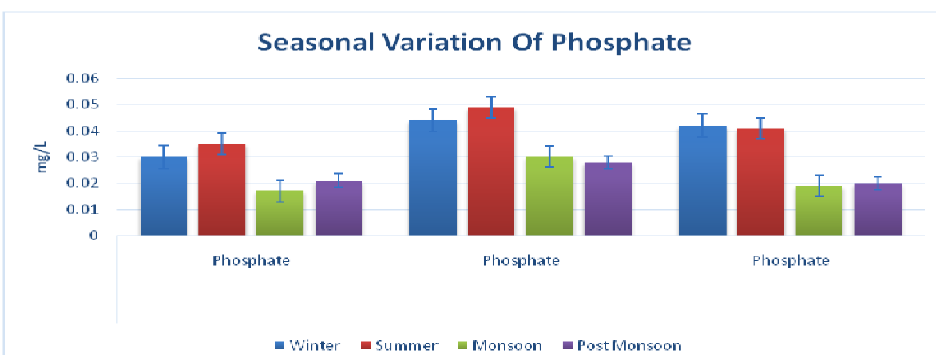


Fig. 7. Seasonal variations in the Phosphate of water samples from three sites.

CONCLUSIONS

The Ganga River or Bhagirathi-Hooghly River seems to be dying slowly because millions of tons of untreated domestic and industrial waste water flows into the river daily. The Ganga River or Bhagirathi-Hooghly suffers from myriad problems, the lean flow during dry season is one of the most significant factor (Kumar *et al.*, 2015). All waste contaminants, including agricultural runoff, domestic and municipal sewage, and industrial effluents, are deposited into the riverbed because it serves as the primary drainage route, raising the organic and mineral burden and resulting in higher BOD and COD by reducing DO. Water microbes and algae thrived due to nitrate and phosphate enrichment, resulting in eutrophication. Water is needed to chill the power plant machine, so when the water came out of the machine, it became heated, and this not properly handled hot water was sometimes dumped into the river, reducing the dissolve oxygen and slightly increasing the water temperature. Because of the increased pollution burden of river banks, waste water may contain some metals and heavy metals that increase hardness and reduce pH level, which is not appropriate for the survival of aquatic ecosystems. As a consequence, aquatic creatures, particularly plankton and fish, endure, and their variety is diminished, influencing the economy tangentially. Before discharging raw waste water into the waterway system, appropriate cleaning and monitoring were required.

FUTURE SCOPE

The present study will help researchers to find out how these effluents affect the physicochemical characteristics of the river, which can have significant effects on the environment and human health.

Acknowledgement. I would like to express my heartfelt gratitude and deep appreciation to Prof. Ashis Kumar Panigrahi, who is currently on lean of the Department of Zoology at the University of Kalyani, Kalyani, Nadia, and Pro-Vice Chancellor of the University of Burdwan, for introducing the current topic and for his inspiring guidance, constructive criticism, and valuable suggestions throughout this research work.
Conflict of Interest. None.

REFERENCES

Agarwal, S. H. U. B. H. I. (2014). Impact of India's population growth on economic development. *Paripex Indian journal of research*, *3*(5).

American Public Health Association, APHA (1995) Standard methods for the examination of water and wastewater. *American Public Health Association, American Water Works association, Water Environment Federation, Washington*.

Bandyopadhyay, S., Kar, N. S., Das, S. and Sen, J. (2014). River systems and water resources of West Bengal: a review. *Geological Society of India Special Publication*, *3*, 63-84.

Chakraborty, B., Bera, B., Adhikary, P. P., Bhattacharjee, S., Roy, S., Saha, S. and Shit, P. K. (2021). Positive effects of COVID-19 lockdown on river water quality: evidence from River Damodar, India. *Scientific reports*, *11*(1), 20140.

Chorus, I. and Welker, M. (2021). *Toxic cyanobacteria in water: a guide to their public health consequences, monitoring and management* (p. 858). Taylor & Francis.

Coal & electricity - World Coal Association. (n.d.). World Coal Association. https://www.worldcoal.org/coal-facts/coal-electricity/

Dasgupta, P. (2004). Valuing health damages from water pollution in urban Delhi, India: a health production function approach. *Environment and development economics*, *9*(1), 83-106.

Ghorai, M., BC, P., Sar, U. K., Bhattacharya, M., Jana, H. and Kar, A. (2015). The impact of coal fly ash power station on distribution and biodiversity of freshwater fishes in Rupnarayan river, West Bengal, India.

Hamdhani, H., Eppehimer, D. E. and Bogan, M. T. (2020). Release of treated effluent into streams: A global review of ecological impacts with a consideration of its potential use for environmental flows. *Freshwater Biology*, *65*(9), 1657-1670.

Hamner, S., Pyke, D., Walker, M., Pandey, G., Mishra, R. K., Mishra, V. B. and Ford, T. E. (2013). Sewage pollution of the River Ganga: an ongoing case study in Varanasi, India. *River systems*, 157-167.

Hossain, M. N., Paul, S. K. and Hasan, M. M. (2015). Environmental impacts of coal mine and thermal power plant to the surroundings of Barapukuria, Dinajpur, Bangladesh. *Environmental monitoring and assessment*, *187*, 1-11.

Islam, M. M. M., Shafi, S., Bandh, S. A. and Shameem, N. (2019). Impact of environmental changes and human activities on bacterial diversity of lakes. In *Freshwater Microbiology* (pp. 105-136). Academic Press.

Kumar, A. M. (2010). A river about to Die: Yamuna. *Journal of water resource and protection*, *2010*.

Kumar, P., Kaushal, R. K. and Nigam, A. K. (2015). Assessment and management of Ganga river water quality using multivariate statistical techniques in India. *Asian Journal of Water, Environment and Pollution*, *12*(4), 61-69.

Ministry of Coal, Government of India. (n.d.). Ministry of Coal, Government of India. https://coal.nic.in/en/major-statistics/generation-of-thermal-power-from-raw-coal

Mishra, P. (2012). Important studies of the assessment and impact of industrial effluents of balotra town of Barmer district on the quality of surface and underground water. *Int. J. Basic Appl. Chem. Sci.*, *2*(4), 68-73.

Mondal, I., Maity, S., Das, B., Bandyopadhyay, J. and Mondal, A. K. (2016). Modeling of environmental impact assessment of Kolaghat thermal power plant area, West Bengal, using remote sensing and GIS techniques. *Modeling Earth Systems and Environment*, *2*, 1-12.

Munawer, M. E. (2018). Human health and environmental impacts of coal combustion and post-combustion wastes. *Journal of Sustainable Mining*, *17*(2), 87-96.

Pandey, V., Ray, M. and Kumar, V. (2020). Assessment of water-quality parameters of groundwater contaminated by fly ash leachate near Koradi Thermal Power Plant, Nagpur. *Environmental Science and Pollution Research*, *27*, 27422-27434.

Paul, D. (2017). Research on heavy metal pollution of river Ganga: A review. *Annals of Agrarian Science*, *15*(2), 278-286.

Rahman, M. M., Hossain, M. A. and Howladar, M. F. (2018). Evaluating the Impact of Coal Fired Thermal Power Plant on Water: A Case Study of Barapukuria Dinajpur, Bangladesh.

Rai, B. (2013). Pollution and conservation of Ganga river in modern India. *International Journal of Scientific and Research Publications*, *3*(4), 1-4.

Rosen, M. A., Bulucea, C. A., Mastorakis, N. E., Bulucea, C. A., Jeles, A. C. and Brindusa, C. C. (2015). Evaluating the thermal pollution caused by wastewaters discharged from a chain of coal-fired power plants along a river. *Sustainability*, *7*(5), 5920-5943.

Spadoni, M., Voltaggio, M., Sacchi, E., Sanam, R., Pujari, P. R., Padmakar, C. and Wate, S. R. (2014). Impact of the disposal and re-use of fly ash on water quality: the case of the Koradi and Khaperkheda thermal power plants (Maharashtra, India). *Science of the Total Environment*, *479*, 159-170.

Srivastava, V., Prasad, C., Gaur, A., Goel, D. K. and Verma, A. (2016). Physico-chemical and biological parameters investigation of river Ganga: from source to plain of Allahabad in India. *Eur Exp Biol.*, *6*, 6.

USEPA (2007). Biological Nutrient Removal Processes and Costs. *J Exp Psychol Gen.* 2007.

Zhang, J., Mauzerall, D. L., Zhu, T., Liang, S., Ezzati, M. and Remais, J. V. (2010). Environmental health in China: progress towards clean air and safe water. *The lancet*, *375*(9720), 1110-1119.

How to cite this article: Sanjoy Das and Ashis Kumar Panigrahi (2023). Assessments of Coal-Based Thermal Power Plant Effluents affect Physicochemical Factors of the Bhagirathi-Hooghly River, West Bengal. *Biological Forum – An International Journal, 15*(3): 169-175.