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ARTICLE

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INSIGHTS INTO THE PHENOMENON OF FOAM FORMATION IN RIVER NUNIA AT GHAGARBURI

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Foam formation in various aquatic environments often triggers concerns about pollution and jeopardizes river-dependent organisms and local biodiversity. In Asansol, West Bengal, residents are curious about the profuse foam at the Ghagarburi Site in River Nunia. A year-wide comprehensive study of 15 water quality parameters and the Water Quality Index indicates significant pollution at the site. Organic matter decomposition, microbial activity, sulphate and phosphate ions (often from detergents), etc. contribute to foam formation. The rocky topography, where water cascades, intensifies foaming.

Introduction

Aquatic bodies and their adjacent areas support huge biodiversity, which faces threats today due to pollution and urbanization[1,2]. Foam formation is a multifaceted phenomenon observed across various aquatic environments, often triggering concerns about environmental health and its impact on humans[3]. While the sight of foam may lead to immediate assumptions of pollution, it is imperative to delve deeper into the underlying causes, considering both natural processes and human activities. In pristine environments, foams can emerge as a consequence of the natural occurrences of the decomposition of organic matter, the metabolic activities of microbial communities, and the existence of specific plant materials. With these factors, the interaction of anthropogenic factors can enhance the intensity of foaming.

River Nunia has a notable pollution level[4]. Considerable foam accumulation along a particular section near Ghagarburi has drawn attention. This phenomenon has intrigued residents, prompting the investigation. While the occurrence of foam may suggest pollution, it is essential to consider both natural and anthropogenic influences contributing to its formation. Understanding the interplay of these factors is crucial for effective management and conservation efforts in aquatic ecosystems.

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Materials and Methods

Study Site: The Nunia River is one of the important tributaries of the Damodar River that passes by the significant industrial city of Asansol in Paschim Bardhaman, West Bengal. The sampling site is situated near Ghagarburi (23°412 003 N 87°002 243 E) beside a renowned temple and tourist spot of cultural significance and spiritual importance (Fig.1).

Sample Collection and Analysis: Water samples were collected in sterile plastic bottles and maintained at 4°C for subsequent physicochemical analysis after adding appropriate reagents to preserve their integrity. On-site measurements of electrical conductivity (EC), pH, and total dissolved solids (TDS) were conducted using portable instruments. Further physicochemical parameters such as

Table 1: Seasonal variation of water quality parameters and WQI.

Parameters	Unit	Summer	Monsoon	Winter
pH		7.1	7.4	7.1
TDS	mg/L	385.3	158	403.3
EC	mg/L	836	321.7	818
DO	mg/L	0.5	5.3	1.7
BOD	mg/L	29	1	27
COD	mg/L	80	8.9	100
TH	mg/L	230.5	149.5	238.4
Alkalinity	mg/L	376	121.6	352
Nitrate	mg/L	9.5	7.8	54.2
Phosphate	mg/L	3.6	1.6	2.1
Calcium	mg/L	75.9	49.7	86.3
Magnesium	mg/L	9.9	6.2	5.6
Sulphate	mg/L	41.7	34.3	61.2
CO_2	mg/L	24.7	6.7	30.3
TC	CFU	$172X10^5$	$77X10^3$	$235X10^4$
Calculated WQI		323.1	53.8	351.8

dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), total hardness (TH), carbon dioxide (CO_2), total coliform (TC), phosphate, etc. were determined in the laboratory utilizing standard protocols[5]. All experiments were conducted in triplicate to maintain consistency and validate results, and the data were averaged to enhance precision and minimize experimental variability.

Water Quality Index (WQI): The WQI was derived from the mean values of parameters for the summer, monsoon, and winter seasons using the standard formula[6,7].

Foaming Area: The area of the foam-covered surface across three consecutive seasons was measured manually to assess the fluctuation of foaming intensity throughout the year and its potential drivers.

Results and Discussion

The outcomes of the 15 physicochemical and bacteriological analyses are presented in Table 1. BOD, COD, phosphate, and sulphate are crucial factors influencing foam formation in water bodies[8-10]. Elevated levels of BOD and COD indicate high organic and chemical pollutant concentrations in the water, which can contribute to foam formation by providing nutrients and facilitating microbial growth. Phosphate and sulphate, often derived from detergents and industrial effluents, can also promote foam formation by altering surface tension and facilitating the stabilization of foam bubbles. Parameters show significant fluctuations across seasons. Lower levels of most parameters during monsoons suggest effective pollutant dilution due to rainwater.

Calculated foam coverage on the river surface at the study spot reveals significant seasonal variation, with the maximum in summer (835 sq. ft.), followed by a decrease during the monsoon season (291 sq. ft.), and again an upsurge in winter (890 sq. ft.) (Fig. 2). These fluctuations suggest a potential correlation between seasonal factors like temperature, precipitation, and pollutant levels, influencing foam formation dynamics in the water body. This variation can be attributed to lower COD, phosphate, and

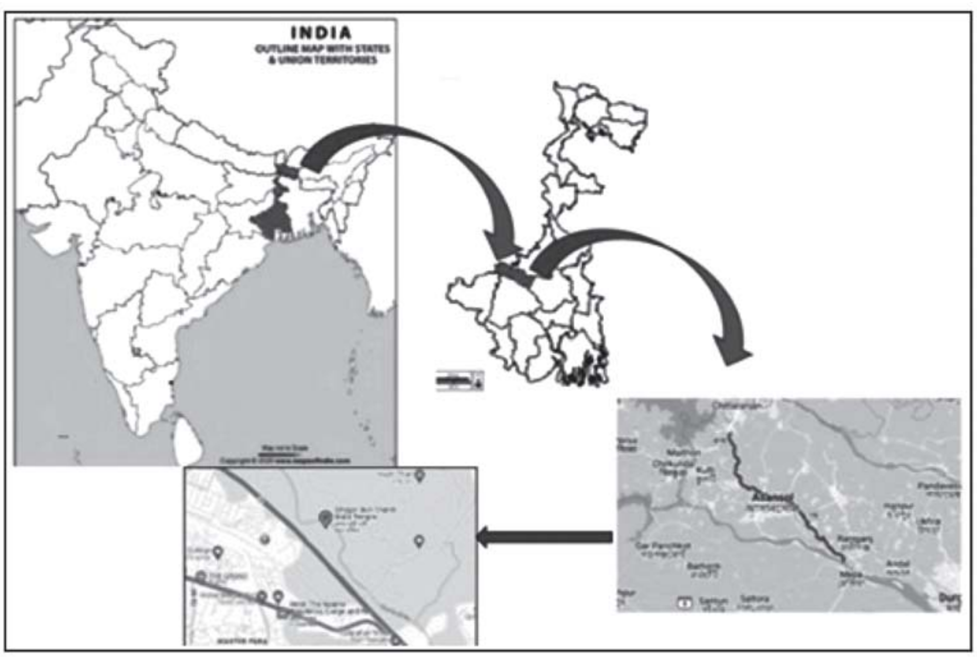

Fig. 1: Location of the Study Area (retrieved from Google Maps).

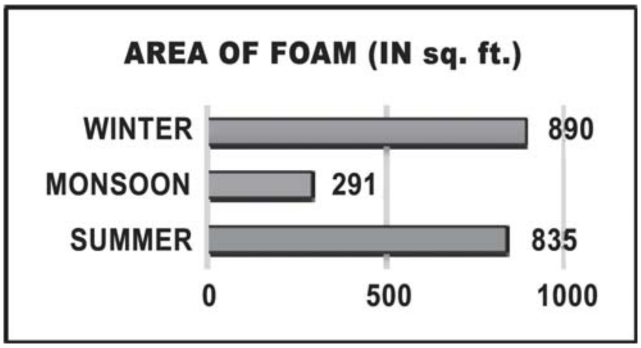

Fig. 2: Seasonal Variation of Foaming Area

sulphate concentrations during the monsoon in comparison to the summer and winter. Reduced levels of COD, phosphate, and sulphate contribute to diminished foam formation during the monsoon season.

The occurrence of detergents and surfactants, indicated by elevated TDS levels, suggests contamination from these substances, which can contribute to foam formation in water bodies. Detergents and surfactants reduce surface tension, leading to the stabilization of foam bubbles and enhancing foam formation. Additionally, nutrient pollution, characterized by increased levels of nitrate and phosphate from agricultural runoff, promotes algal growth and exacerbates foam formation. The excess nutrients act as fertilizers for algae, leading to algal blooms, which contribute to the production of organic matter and foam in water bodies.

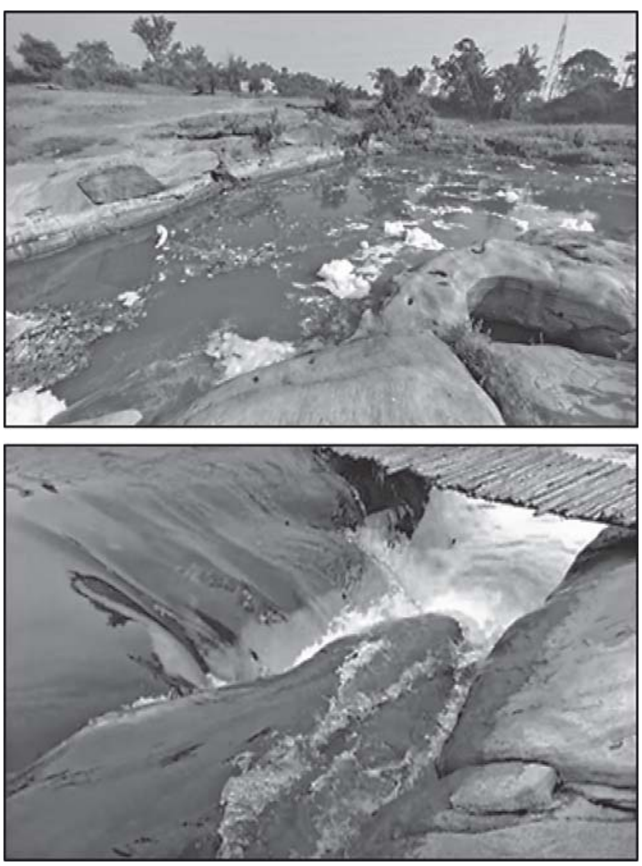

Fig. 3: Geographical Features of the Foaming Area

The area's uneven terrain, characterized by rocky surfaces and creeks, fosters forceful water movement and turbulent flow, resulting in cascading waterfalls and vigorous agitation (Fig. 3). The presence of creeks within rocky areas enhances aeration and promotes the entrapment of air bubbles, which is crucial for foam formation. Additionally, the forceful movement of water over rocky surfaces and the uneven topography create eddies and turbulence, further facilitating foam production. Evidence of foam formation in other areas of the river is scant.

Conclusion

The results depict that the phenomenon of foam formation in the Ghagarburi Site of Nunia River ecosystems is influenced by a combination of natural and anthropogenic factors. While rocky terrain plays a vital role in foam formation, elevated levels of organic pollutants contribute to a stable foam presence, aided by excessive detergent use and other pollution. These may pose threats to river ecosystems and associated biodiversity. It highlights the necessity of raising awareness and adopting preventive measures against human-induced factors. With the decline of biodiversity being linked to pollution, the need for the implementation of strategies to decrease pollution is critical[11]. The removal of human-induced pollutants has long been recognized as beneficial for the improvement of aquatic ecosystems[12]. To ensure a sustainable environment, reduction of the use of chemicals and eco-friendly management with modern technologies are crucial[13-15]. ❒

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