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Pragyambu

cGanga
Centre for Ganga River Basin Management and Studies

The purpose of this quarterly digest brought out by the Centre for Ganga River Basin Management and Studies (cGanga) led by the Indian Institute of Technology Kanpur is to disseminate valuable traditional and scientific knowledge assimilated from national and international sources on various aspects of management of water and river restoration and conservation among concerned institutions and citizens.

SAMARTH GANGA, FERTILE LAND

To solve any problem, we need to understand the real nature of the problem. This holds good for river problems as much as for other real-world problems. Hence before formulating conservation and restoration plans for rivers, the real issues of rivers and their causes need to be identified. Otherwise, we may be trying to resolve issues that are only superficially important but which are actually of minor importance for rivers. By doing so, we can keep our attention focused on the main factors that affect rivers adversely. Adopting this premise, we discussed several common anthropogenic activities that are considered important for their impacts on rivers in India. In the 4th issue of Volume 2 of Pragyambu, we analyzed the effect of religious and cultural ceremonies on rivers. In the 1st issue of Volume 3, we examined the effects of last rites on rivers. Taking this series forward, in this issue we discuss the connection between agriculture and "nirmalta" of Indian rivers.

Agriculture is generally considered as one of the major human actvities that adversely impacts the water quality of rivers. In the past few years, it has often been said in public discourses and media that much of the chemical fertilizers and pesticides used in modern agriculture wash away with rainwater and reach waterbodies, including rivers, thereby negatively impacting river water quality in India. In particular, nitrogen and phosphorus (N and P) present in chemical fertilizers are said to reach rivers in significant amounts, enhancing the nutrients N and P in river waters which boost the growth of aquatic plants and weeds. Likewise, salts, toxic chemicals and heavy metals present in pesticides are also held to reach rivers, which harms the river water quality and affects river flora and fauna.

World over modern agriculture is often held responsible for the river pollution due to nutrients like nitrogen and phosphorus and, sometimes, also due to chemical pesticides. In this issue of *Pragyambu*, we will assess these factors in the Indian context and try to understand the role of agriculture on the quality of our river waters. For if river water quality is indeed being adversely affected by agriculture, then we need to find ways to mitigate it.

Agriculture is the foundation of rural economy of our country. Therefore, before attributing poor river water quality to agriculture and suggesting related changes in agriculture, we need to examine the main causes of poor river water quality by dividing it into three categories -- quality of river water in urban areas, in rural areas, and in industrial areas. In the absence of clear and segregated data for different river stretches, it will be inappropriate to hold agriculture responsible for affecting river water quality. This principle of segregation may be illustrated by the example of the Yamuna river in Delhi. The 22 km stretch of Yamuna river between Wazirabad Barrage and Okhla Barrage is the most polluted portion of this large river. In this 22 km stretch, Yamuna flows through urban areas. This is 2 percent of the total length of Yamuna river and accounts for 80 percent of the pollution of the river in Delhi. Thus, agriculture is obviously not the main cause of Yamuna river's poor water quality. According to a report published by the Central Pollution Control Board some time back, agriculture does not appear to be the primary factor responsible for the degradation of river cleanliness.

Although the condition of River Yamuna is widely discussed, only after gathering similar data for other rivers and river stretches can we ascertain the contribution of agriculture in affecting the pollution level of such rivers, but prima facie modern agriculture may not be a grave factor affecting the water quality of many Indian rivers. For years, however, it has been reiterated that various fertilizers and pesticides used in agriculture are carried by rainwater runoff and surplus irrigation waters into rivers, which fuels excessive growth of aquatic plants such as water hyacinth, moss, and cyanophytes (e.g. blue-green algae) due to higher nutrient (N and P) availability that leads to eutrophication – a process by which a waterbody becomes overgrown with plants that deplete dissolved oxygen (as the excess plant biomass degrades) and also prevents the penetration of sunlight and hence subsurface photosynthesis. Thus the natural balance of aquatic ecosystems is disrupted, with native aquatic plants and animals even choking to death or disappearing. In short, the waters becomes putrefied, and in case of a river, the river resources and services that humans obtain from them are vastly reduced.

It is also said that the pesticides used in agriculture dissolve in water and reach rivers and other waterbodies thereby increasing the pollution of waterbodies. This contention has been often reiterated in environment- and river-related discussions all over the world. Let us examine this possibility in the Indian context. In most parts of India monsoon lasts only two to four months. If pesticides are being carried by rainwater runoff and polluting these rivers, then the level of pollution should reduce at the end of monsoon because surface run-off does not reach rivers after the end of monsoon. Outside of the monsoon season, there is no pathway or medium through which the pesticides used in agriculture could reach rivers in India. This is because agriculture in our country is not done in a way which would result in drains flowing from irrigated fields and causing excess irrigation water to reach rivers.

IS RETURN FLOW THE REASON?

The problem of agricultural fertilizers reaching rivers is not limited to a specific region but is observed in several countries worldwide. This is particularly common in areas where excess water is used for agriculture, and the surplus water flows back towards rivers, and this water is called 'return flow'. In the Indian context, the scenario of return flow is not common, which makes it less likely for agricultural chemicals to reach rivers. In fact, apart from the monsoon season, there are no pathways or mediums through which these chemicals could reach the rivers. Monsoon or rainy season is a natural cleansing process, where high flow washes away pollutants from land. And high-speed water flow in rivers during this season, regardless of nutrient levels in the water, significantly reduces the growth possibility of water hyacinths and other aquatic plants which otherwise flourish in stagnant or quiescent flows.

Due to rapid eutrophication given a surfeit of nitrogen and phosphorus in water, plant chlorophyll and plenty of sunlight, waterbodies reach a moribund state when the water is almost stagnant such as in ponds and lakes, or behind check dams, etc. There are many small rivers in our cities, which have now become wastewater drains. These rivers are flowing with wastewater consisting of several types of chemicals. In these flowing wastewater drains, however, water hyacinth or algae are not seen; i.e., eutrophication does not take place in these drains because eutrophication is possible only when water is (almost) stagnant.

In this issue of Pragyambu, our discussion and analysis are focused on the "nirmalta" of rivers, in which water is constantly flowing. It can be broadly said that growth of water hyacinth is not a major problem for flowing rivers. If water hyacinth is present near the banks of the river or in its vicinity, then it should be seen as a natural cleansing agent. But, if the same water hyacinth is present inside the river, then its monitoring and control are necessary.

The flow of several rivers in our country now face obstructions due to dams, barrages, accumulated garbage and construction wastes, etc. Any hindrance to the flow of rivers is a big obstacle in maintaining nirmalta. When river waters stagnate then the possibility of eutrophication in rivers increases. Certain vegetation species considered as weeds tend to grow rapidly and proliferate in such waters when the circumstances are favorable. The number of water hyacinth plants in standing water increases a hundred times in merely 23 days. Instead of attributing the fertilizers used in agriculture for this challenging situation, there is a need to broaden our perspective so that we understand all aspects of this problem and then take measures for its resolution.

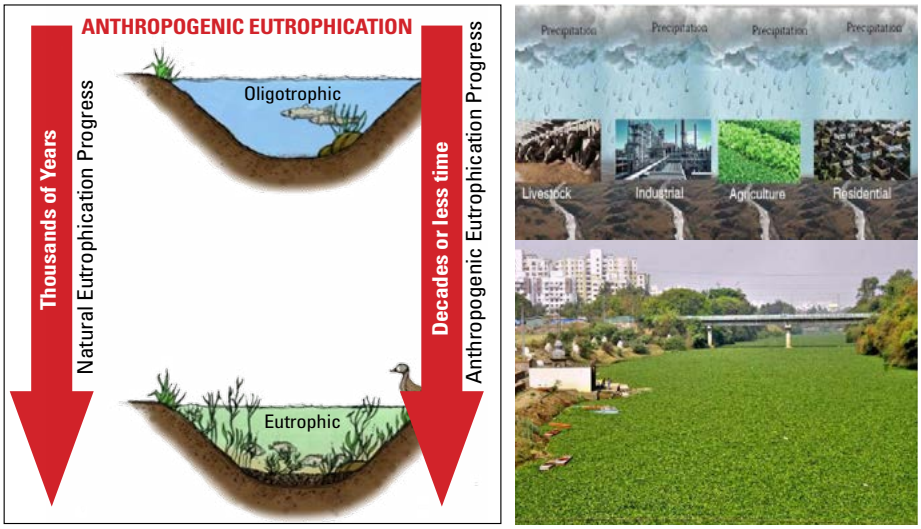

Fig 1. Cross-section of water body showing time scales of natural eutrophication, and anthropogenic/ cultural eutrophication process. Eutrophication speed increases multi-fold as a result of human activities that add nutrients to aquatic habitats.

LESS AGRICULTURE, MORE WATER HYACINTH

In India, the state facing most problems due to water hyacinth is Assam, though Assam comes only at the 8th position in the list of states in terms of agricultural production. If agricultural chemicals were the primary reason triggering eutrophication in water sources, then the problem of water hyacinth would have been highest in states where agricultural production and fertilizer usage are also highest. In fact, we observe the opposite scenario. The problem of water hyacinth is rampant in Assam, a state with comparatively less agriculture than many other states. But there are 712 areas of marshy land and 1125 waterlogged areas in Assam. In these places, water accumulates and stagnates, creating conditions ideal for the growth of water hyacinth. Thus, water

FLOW, STAGNATION AND DEAD ZONES OF RIVERS

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hyacinths are found in abundance in Assam. And now the people of this state are seeing these water hyacinths as an opportunity instead of a problem. How these people converted this challenge into opportunity will be discussed in the next issue of Pragyambu.

IS AGRICULTURE AFFECTING AQUIFERS?

It has been widely publicized on various platforms that the chemicals used in agriculture dissolve in irrigation water and eventually reach groundwater aquifers. This endangers the possibility of contaminating rivers as well by virtue of groundwater seeping into rivers in dry seasons. After conducting a thorough examination on various scales, it was found that it is inappropriate to attribute groundwater or aquifer water quality being affected by agriculture. Let us see why and how we make this assertion. The nature of soil in different states in our country is different. In many large plains of the country, the surface soil is black cotton soil, which is underlain by basalt and a layer of subsoil. Aquifers are further below, at some places aquifers are at a depth of about 70 feet whereas at other places they are at depths of 100 to 200 feet. In such cases, it is not at all possible that excess irrigation water reaches aquifers. This water is absorbed by the roots of plants and surrounding soils. In modern times, irrigation is also often done by techniques such as sprinkler and drip irrigation. Due to this, the water can neither flow over the soil surface and reach rivers directly nor can it reach down to the aquifers. On the contrary, it can be said that groundwater was overexploited in past decades along with the drying of small rivers and waterbodies in large river basins. Consequently, there is a drop in groundwater level today. For example, several villages in the basin of Hindon river, a tributary of Yamuna, are struggling with this problem. Three decades ago, they used Hindon water for irrigation. When Hindon dried up, then groundwater was used for irrigation. Today the groundwater level in Hindon basin has dropped so much that there is a crisis of drinking water availability. There are only two ways to deal with this problem -- adoption of modern techniques of agriculture so that better yield could be obtained with less water and second, revival and rejuvenation of small rivers.

WHAT DO THE DATA TELL

Let's have a quick look at the numbers. Maharashtra comes in fifth position in the list of top five states of high agricultural production. Uttar Pradesh and West Bengal come in first and second positions, respectively, whereas Madhya Pradesh and Karnataka are in third and fourth positions. But if we now consider river pollution, then Maharashtra tops the list. According to a report released by the Central Pollution Control Board, there are 55 polluted rivers (river stretches) in Maharashtra, which is the maximum in the country. According to this same report, the number of polluted river stretches in Uttar Pradesh, the state with highest agricultural production, is 17. The water quality of rivers in all states was regularly monitored before preparation of this report, and rivers were categorized based on Biological Oxygen Demand (BOD) as scale. Based on this report, we can say that it is illogical to consider agriculture as the main culprit for river pollution.

While releasing the report mentioned above, the Central Pollution Control Board clarified that the report was based on the results of monitoring, testing and examination conducted between 2019 to 2022, in which data of 2020 was not included because many industries were closed due to lockdown on account of the COVID pandemic. Consequently, industrial wastewater discharges were not reaching rivers.

It is worth pondering that during COVID, we were regularly getting news of rivers becoming clean and restored. Similar news and images were emerging for famous rivers of nearly all states, which showed that the natural state of rivers was returning due to lockdown. Here it is important to note that despite the nationwide lockdown which led to the shutdown of industries and halted many construction works, agricultural activities continued to operate in full steam throughout the country. If rainwater or irrigation water flowing out of agricultural fields was the main reason for pollution in rivers, then we obviously would not have found our rivers becoming surprisingly clean and sparkling during the lockdown.

THERE ARE OTHER EXAMPLES ALSO

The Allayur lake of Bengaluru, which is also called Halasuru in local parlance, is a victim of eutrophication. Due to unwanted growth of blue-green algae in the lake and consequent biochemical balance, several fishes died and their species vanished altogether from the lake. This lake is situated in the industrial megacity Bengaluru, where there is no possibility of water from agricultural fields reaching it. If there is no agricultural activity in the vicinity, then there is no possibility of agricultural fertilizers or pesticides reaching the lake. Evidently, this lake became a victim of eutrophication due to the urban wastes that reached it through urban drains. The high nutrient content in these wastes promoted the growth of blue-green algae on the surface of the lake, which almost suffocated it. The local administration has for considerable time now been making valiant efforts to clean up this lake. This lake, which had lost its wholesomeness due to the abundance of nutrients, illustrates the fact that agriculture may not be the main reason for

S No	State	Govern-ment-owned waterbodies surveyed	Status of water bodies					
			Functional		Dried		Eutrophic	
			Number	%	Number	%	Number	%
1	Uttar Pradesh	329	174	53	122	37	33	10
2	Jharkhand	53	38	72	7	13	8	15
3	Bihar	39	15	38	12	31	12	31
4	West Bengal	147	107	73	16	11	24	16
5	Uttarakhand	10	3	30	5	50	2	20
Ganga Basin		578	324	56	162	28	92	16

Table 1. Status of government-owned water bodies in Ganga Basin

Source: Quality Control of India, Year 2021

the problem of river pollution in India. It is also worth noting that eutrophication is not the sole issue affecting this lake. In numerous tests, it was discovered that the concentration of heavy metals in its water also exceeded acceptable limits. This proves that pesticides used in agriculture are not the only factor responsible for the increase in the amount of heavy metals in river waters.

THERE ARE OTHER SOURCES ALSO

Several factors can be responsible for the abundance of nutrients like nitrogen and phosphorus in rivers. For instance, large quantities of phosphates are discharged from the soap industry, which can make their way to larger rivers through industrial drains, urban drains, or small rivers. Additionally, detergents used for washing clothes, dishes, and utensils often contain high quantities of phosphates. Wastewater from millions of households, passing through various channels and routes, eventually flows into our rivers. Thus, significant amounts of phosphorus may get transported to rivers. Likewise, wastewaters discharged from dairies and food processing industries also contain much nitrogen and phosphorus, which may deliver large amounts of nutrients to rivers.

WHAT IS THE SOLUTION?

Eutrophication is a natural process that occurs in still waters under certain conditions. When this process is balanced and under control of nature, it can be considered to be a part of the natural nutrient cycle. When there is an increase in eutrophication due to human intervention and the mixing of anthropogenic wastes in natural waters, it not only poses a danger to the water bodies but also affects humans. Due to this process, water, a most precious natural resource , is no longer usable for humans. When waterbodies are impacted by eutrophication, it can lead to problems in water transport. For example, when water hyacinths and blue-green algae dominate a particular waterbody, tourism in that area can decline. Additionally, resources obtained from that particular waterbody can also vanish.

Now the question arises -- how to resolve this problem? Should new treatment plants be set up? Should new bans be imposed on soap, dairy and food processing industries? Should drains and small rivers that carry nutrients be stopped from discharging into large rivers? The answer to all these questions is -- NO'. It is not logical to set up new treatment plants to minimize nitrogen and phosphorus contents in sewage merely to stop eutrophication, neither is it logical to bring changes to the existing treatment plants. Construction and management of sewage treatment plants all over the country is in progress, and adding techniques for reducing nitrogen and phosphorus in sewage will increase the cost of these plants by approximately one and half times. Considering the tropical weather of our country, it cannot be assured with certainty that eutrophication could be controlled by implementing this suggestion. Instead, by better management, the process of eutrophication can be used to improve the health of waterbodies. Consequently, in present circumstances, the idea of setting up new treatment plants or modifying old treatment plants for eliminating nitrogen and phosphorus from wastewaters is not worth implementing.

It is also wrong to stop small rivers and drains from mixing in main rivers because this will deprive the larger rivers of significant inflows of water.

In the field of agriculture itself, work is being done on several levels to control and reduce whatever negative effects chemical fertilizers and pesticides otherwise have, e.g., on crop health and on soil fertility. Research is in progress to find ways to increase the yield of high-quality crops while reducing the use of chemical fertilizers in agriculture. Chemical-free methods like organic farming and natural farming are also being adopted. On the other hand, work is also in progress on advanced agricultural techniques such as hydroponics. Niti Ayog has constituted a task force recently to encourage production, popularization and use of bio-fertilizers and organic fertilizers. Efforts in this direction are also being made under the Namami Gange mission. We hope that these efforts will progress in the direction of better results.

PREVENTING EUTROPHICATION IN RIVERS IS EASY

Conservation of wetlands is the key to stop eutrophication in rivers. Wetlands are like kidneys for rivers as they filter out toxins from the waters entering rivers. Nitrogen and phosphorus, along with several heavy metals, are reduced or eliminated by the aquatic plants and weeds of wetlands outside the main river flows.

It is said that if it is difficult to conquer enemies, then they should be befriended. The solution of the aforementioned problem is possible in such a way that instead of making the herculean effort to artificially remove nutrients from waters flowing into the rivers, attention should be turned to the enhanced growth of aquatic vegetation and making use of them. In West Bengal and Assam, people have found creative ways to use water hyacinths. In West Bengal, biodegradable paper is made out of the stems of water hyacinths, which is used to make paper cups, plates and boxes. People are showing interest in using these products in community feasts, and they are proving to be a good alternative to plastic utensils. On one hand this is providing employment to local people, and on the other hand the general public gets a better alternative to plastics along with the control of water hyacinths in rivers. And after making the paper, the leftover parts of water hyacinths are used to make organic manure, whereby the nutrients absorbed by the plants are returned or added to the earth.

In a similar vein as above, in rural Assam yoga mats are being manufactured from water hyacinth. This eco-friendly mat is receiving good response from customers from the country and abroad. Dried water hyacinths are also being used to make several decorative and handicraft items. And, besides using the stems of water hyacinth in handicrafts, other parts of the plant are used to make organic manure to enrich soil fertility. Such industries are providing employment and business opportunities to rural people without discharging any harmful wastes or consuming any valuable natural resource.

In conclusion, we have seen that chemical inputs in modern agriculture are hardly an important cause of nutrient pollution in Indian rivers. But high amounts of nutrients from other sources – domestic and industrial – do enter many rivers disrupting their biochemical balance. How can the influx of excess nutrients, particularly of nitrogen and phosphorus, into rivers be controlled? And, if these nutrients do reach the rivers in spite of controls, then how can their impact be minimized? Can this management lead us towards fulfilling the national goal of environment conservation? Further discussion on this subject will continue in the next issue of *Pragyambu*.

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