



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.

## STREAMS WILL GRADUALLY BECOME NIRMAL

In the previous issue, we discussed the concept of cleanliness of rivers and tried to understand its importance. In addition, we had discussed the ill-effects of industrial pollution, of increasing urbanization and urban waste management, and of chemical fertilizers and pesticides used in agriculture on rivers. In this issue let us try to understand how rivers can be cleaned. What are the criteria based on which it is decided whether a river is clean or not? What is the relationship of biological agents on the cleanliness of rivers? Can we identify the cleanliness of rivers by simple visual inspection, and can we play any role in ensuring that the river flow becomes clean and remains clean? Let us try to clear up these questions in this issue of Pragyambu.

Rivers are like a credit card that nature has given to humans. Humans have extracted innumerable benefits from it, but instead of responsibly returning the gifts taken from rivers they have become defaulters. Consequently, a day arrives when the river has degenerated like a bank gone bankrupt with all its resources exhausted. Several of our rivers have reached such a limit and some are about to reach it. There is a close connection between a river's resources and the cleanliness of the river. If the cleanliness of a river is compromised, then its resources also come under threat. Likewise, if the resources of a river are over-extracted, then its cleanliness is affected.

The cleanliness of rivers is a complex subject, which requires consideration of numerous factors and processes for understanding. We can clean any place by removing the garbage and wastes lying

there. We can uproot weeds and remove garbage from unclean and unhealthy gardens and parks to make them clean. However, the cleanliness of rivers is much more complicated than the examples stated above. It is a continuously changing biological system, in which it is necessary to maintain the balance of vegetation similar to gardens, biological balance similar to the earth, balance of micro-organisms similar to the body of living beings, and like the harmony that prevails in a community — all that and also adequate flow of water. For that to happen, a balance in the relationship among the mainstream of a river, its tributaries and the basin is necessary.

There are several factors which affect the cleanliness of rivers directly or indirectly. Among these factors, most discussions centre on industrial pollution, sewage, and pesticides and chemical fertilizers used in agriculture. The law and administration are continuously trying to check the pollution and filth caused in rivers by these factors.

### OCCURRENCE OF WATER HYACINTH IN RIVERS

If Water Hyacinths (Biological Name: *Eichhornia crassipes*) occur in rivers, then it could be a danger signal, which requires monitoring, and cutting and trimming the hyacinths from time to time. It is noteworthy that while the presence of water hyacinths in rivers signal danger, their growth is common outside the river and near its banks, where there is occasional ponding of water.

### BIODIVERSITY OF RIVERS

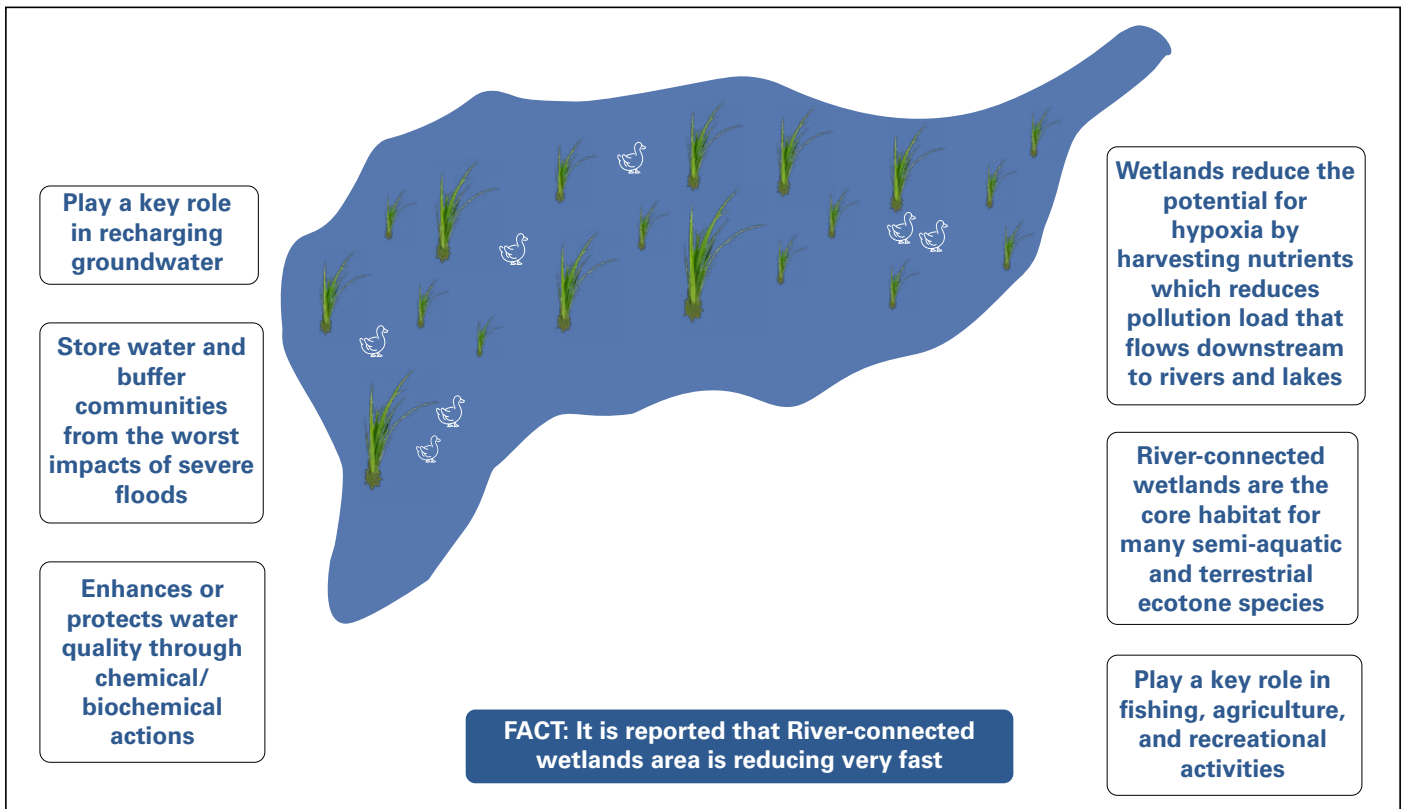
If indigenous species of aquatic life are present in a river, and their food, habitation

### CLEAN BASIN, CLEAN RIVER

Just as we can guess the cleanliness of a house by glancing at its courtyard, likewise we can assess the cleanliness of a river by looking at its basin and catchment area. Large rivers flow through several cities and states. If these cities have proper solid waste management, wastewater management and industrial effluent management, then it can be assumed prima facie that the river is clean. The same holds for rural areas as well. But these aspects alone are not sufficient for the cleanliness of rivers; there are several other factors which affect a river's cleanliness, such as:

### WATER DISCHARGE MANAGEMENT

What is the arrangement of drainage in urban areas during monsoon? Usually drains in urban and rural areas convey stormwater runoff to a nearby river. These drains are an important member of the river system provided they remain stormwater drains as such and are not converted to wastewater drains. When the sewerage system in a city is not proper, then sewage water mixes with rainwater in the drains, leading to the drains becoming polluted. At some places, they bring sewage, at other places industrial effluents, and at yet other places some other type of polluted water into the river.



**Figure 1: How wetlands work**

and reproduction are going on properly, then it can be generally said that the river is clean.

But there are additional factors which hinder the cleanliness of rivers. Reduction of wetlands, imbalance of the aquatic systems of rivers due to human interference, over-abstraction of river waters, hindrance to the river's *aviralta* ("continuous flow"), and pollution of tributaries — all these factors hamper the cleanliness of rivers.

First of all, let us talk about wetlands. Wetlands of rivers work like sponges which absorb water when the water is in excess,

and slowly discharge this water into rivers during the dry season.

In this process, wetlands also play the role of a filter as they prevent several pollutants from mixing in rivers. The area of wetlands of our rivers is continuously decreasing. In India, a reduction in the area of wetlands of rivers is noted all over, from north to south and east to west. The role of wetlands in any area is similar to that of kidneys. They are also known as the 'kidneys of landscape' because they prevent harmful elements of human and natural origin from entering the water system. According to one report,

the worldwide diminishing and degradation of wetlands exceeds even that of forests, which is a major cause of environmental change occurring all over the world.

## HOW DO WETLANDS WORK

When rainwater runoff flowing through a river catchment reaches wetlands, then the plants, shrubs and other vegetation of wetlands reduce its flow. Whatever mud, soil, solid waste or chemicals were moving towards river after getting suspended and dissolved in river water, their speed reduces after reaching wetlands, and mud and soil settle at the bottom of wetlands. Phosphorus and nitrogen present in chemical fertilizers as phosphates and nitrates are absorbed by plants and shrubs of wetlands (Figure 1).

## WHEN THE FILTER IS NOT THERE

When the river does not have the filter in the form of wetlands then mud reaches rivers in greater amounts, soil erosion takes place, and due to the higher amounts of nitrogen and phosphorus reaching the river, the population of algae and other aquatic plants in the river increases. With

## WHAT ARE WETLANDS

Wetlands are commonly known as bogs, marshes, swamps or mires (or quagmires). It is the area of land near rivers or seas where grasses, shrubs and trees are found. In such places, there could be an accumulation of water; at a few places small lakes and seasonal ponds are also occasionally found in wetlands. The rate at which wetlands have diminished can be guessed by an example: 20 wetlands in the basin of the river Jhelum in Kashmir have disappeared due to urbanization. Many reports are available in open domain. For many rivers before the identification and documentation of their wetlands could be done, these wetlands were converted to agricultural, residential or industrial land.

# RELATIONSHIP BETWEEN RIVER BIOTA AND CLEANLINESS OF RIVERS

The presence of living organisms in a river and its cleanliness go hand in hand. If river is clean, only then will aquatic creatures be able to live easily in the river. By the same token, the presence of aquatic life in a river enables the river to remain clean. According to environmental scientists, the cleanliness and health of a river can be ascertained by looking at the condition of tertiary consumers of its food chain. Crocodiles are tertiary consumers in the food chain of most large rivers where they have no natural predators.

In fact, the presence of crocodiles in a river establishes a balance in the ecology of the river. Crocodiles keep the population of fishes and other secondary consumers under control. It not only hunts fishes, but also consumes dead creatures which have died by natural causes, and thus plays a role in maintaining the cleanliness of the river. In a way, this creature is a natural waste management mechanism for the river. Crocodiles also consume catfish which hunts several fishes important for the fishery industry. In this way,

crocodiles play a crucial role in maintaining the balance between different species of fishes.

Similarly, turtles are an important component of the ecological balance of rivers. Turtles do not pose any threat to humans, though humans have definitely put turtles at risk. Turtles were hunted because of high price of the biological products that are obtained from them. In addition, several other factors have contributed to the destruction of their habitat. Decrease in the population of Gangetic dolphins found in the river Ganga is one such example.

In India, the inclusion of Golden Mahseer in the list of near-extinct species is one example of this imbalance. Golden Mahseer is considered as the lion of rivers. Similar to the lion of forests, this lion of rivers is also among the near-extinct species. Earlier Golden Mahseer was primarily found in Ganga and other rivers of Uttarakhand. In fact, this beautiful fish migrates from a large river to a small river once a year. It used to make several rivers its home. Today these fishes are nearing extinction.

increase in nitrogen supply, their growth also accelerates, which eventually proves to be harmful for the river. There are examples where water hyacinth, algae and other types of vegetation spread over the whole surface of the river and created a situation of black-out for the lower surface. Complete or substantial covering of the surface of the river reduces or eliminates light reaching lower layers, hence the river's aquatic life comes under risk and the water level of the river also reduces. In such a situation, the amount of oxygen dissolved in river water also decreases. The environmental and chemical balance of the river is disturbed. Accumulation of water hyacinth in rivers is the most common example of this phenomenon. Several rivers of moderate length dry up due to the accumulation of water hyacinth. In the 1990s, several stretches of the river Kshipra in Madhya Pradesh dried up due to the accumulation of water hyacinth,

which completely destroyed the aquatic biodiversity of the river.

## WHY DID THE WETLANDS VANISH?

Fresh water wetlands were converted to agricultural land at several places, whereas several wetlands were affected by dams. The biggest cause of decrease in wetland areas was agricultural cultivation and construction of residential facilities on wetlands. Now that the role of wetlands in the river system is clear, artificial wetlands are being developed at several places in India. These work as filters and stop the urban wastes of cities from mixing with small and large rivers. Water-sensitive urban programmes are now giving more importance to wetlands. However, this is just a beginning as more work remains to be done in this direction. The identification and documentation work of the wetlands of several rivers is still pending.

## PREYING ON AQUATIC LIFE

Just as in the case of wild animals, large aquatic animals also have succumbed to human greed. Just to demonstrate their valour, humans killed the king of forest – the lion – on the one hand and destroyed the protector of rivers – the crocodile – on the other. Lions and crocodiles are both deadly enemies for humans, but are important for their own ecosystems. As humans wanted to establish their monopoly over both water as well as forests, they tried to establish their supremacy by removing the tertiary consumers (i.e. the apex or highest level predators) of those systems.

Hunting of crocodiles in India was done for two reasons — first, for the possible threat to human life from crocodiles, and second, for commercial benefit. The belief that the body of crocodiles can be used for certain type of medicines only encouraged the hunting of this creature. However, its hunting is prohibited at present. Due to these reasons, the number

## RELIGION ALSO SAYS THE SAME THING

In Hindu religious texts, the crocodile is depicted as the vehicle or carrier of rivers. In idols and images of rivers Ganga and Narmada, they are depicted as goddesses seated on crocodiles. Behind such depiction, there is a message for the importance and protection of this creature. Not only that, in the 10th chapter of the Bhagvad Gita (Vibhuti Yoga), God described the crocodile as His own form. In the 31st verse of the 10th chapter, Lord Krishna says:

पवनः पवतामस्मि रामः शस्त्रभतामहम्।  
झषाणां मकरश्चास्मि स्रोतसामस्मि जाह्ववी।।

I am the wind among all the purifiers, Ram among the warriors, crocodile among fishes, and Ganga among the rivers. Here the word 'fishes' probably is used for aquatic creatures.

Among several hill tribes of Himachal Pradesh and Uttarakhand, the Golden Mahseer is considered as a divine incarnation.

of crocodiles in Ganga during the decade of 1970 was reduced significantly. But after much effort, an increase in the number of crocodiles in Ganga and its tributaries is noted. Though Ganga and its crocodiles both have survived, in the rivers which are near extinction, first and foremost their crocodiles were eliminated.

There are evidences of the previous existence of these animals in the said rivers in folklore and history. Not just that, even today there are people of the old generation living in our villages and cities who had seen crocodiles in those small rivers. It is those same rivers which have been converted to dirty drains, stagnant lakes, small ponds or seasonal rivers. Several places like Magarkhedi and Magarmua in central India got their peculiar names because of presence of crocodiles ("*magarmachh*" in Hindi) in those areas. However, today there are neither rivers in those areas nor crocodiles.

### HOW WOULD BALANCE COME

In order to clean rivers the natural way, we have to work at several levels. The administration must take a strong stance so that pollutants do not enter rivers from outside. Implementation of rules and regulations made for the conversation of rivers must be ensured. In order to establish internal balance of rivers, regular inspection,

training, activity and awareness of stakeholders must be accelerated. Developing citizens' awareness levels about rivers and the whole water resource system is the first step in this direction. We have to pay special attention towards positive development in the relationship of humans with dangerous and amphibian animals such as crocodiles, less dangerous but commercially valuable animals such as turtles and gharials, and aquatic animals such as Mahseer and other fishes. Although no technique or formula has yet been developed to improve the interrelation of humans and aquatic creatures, several small attempts are being made. According to environmental scientists and life scientists, animals becomes hostile towards humans only when their natural habitat and food sources are affected. A combination of science, popular science and religious knowledge could be helpful in establishing this balance.

### CLEANLINESS OF RIVERS AND CITIZENS RESPONSIBILITY

What role can citizens play in increasing and maintaining the cleanliness of rivers?

In the context of cleanliness of rivers, first and foremost it is essential to increase the awareness of citizens. Usually we connect cleanliness of rivers to drinking water and

form an imaginary notion that when water of a river is fit for drinking, it would imply that the river is clean. It is improper to have such expectation in the context of every river. In addition, it is necessary to understand that the chemical composition of river water can be different for different rivers. It depends on the geological conditions of the area and the chemical characteristics of the land through which the river is flowing. If we try to directly convert the water of every river to drinking water, then it is possible that we end up making mistakes for which the whole ecology of that area is harmed.

Rivers are the centre of our collective faith and a public resource, on which everyone has equal right. Cleanliness of rivers is a scientific subject, which has to be understood by making certain laboratory tests.

Not all citizens can conduct scientific tests, though they can certainly monitor their rivers. Citizens can perform their duty towards river conservation by helping the administration in monitoring rivers, noting any changes occurring in them, and inspection of creatures living in rivers and their circumstances. This particularly holds for people settled near riverbanks.

### HOW TO MONITOR RIVERS

Unlike the monitoring or protection of any treasure, for which regular guarding is required, the monitoring of rivers is much complicated, risky or an individual responsibility. Just a little alertness and the initiative to inform concerned stakeholder will enable everyone to fulfil the collective responsibility. While going near a river, if one notices oily layer on the water, or foam in river, or dead fish or large number of dead insects and flies on the surface or the banks, or any odour from the water, then these can be a sign of some change. Any such change must be communicated to the administration.

The urban or rural administration of cities and villages through which the rivers flow must ensure that the inhabitants, sailors and fishermen living near the rivers have a communication or connection point from where they can send any information whenever required.

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