Volume: 1 Issue: 3 July 2021

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.

Conservation of Small Rivers and Streams: Necessity and Selection

In the first issue of *Pragyambu*, the approach for initiating river restoration efforts with small rivers was introduced. Considering the importance of this topic and its contribution to river conservation, it is being discussed in more detail in *Pragyambu*'s 3rd and 4th issues. To begin with, if the efforts being made in the country and abroad on river conservation are critically assessed then, except for the last few years, these efforts have been mostly focused on large rivers as whole units, which is probably not very effective and successful due to a variety of reasons. From the example of River Ganga's restoration, it is apparent that the efforts needed to preserve the main stem of the river can only fructify if adequate resources and funds are continuously pored in by the central government. Moreover, to carry out the needed works as suggested by GRBMP and other agencies, the integration and understanding of the work in all its dimensions in a short time is a very complex task.

In addition to the above, anthropogenic factors affecting a river are often very diverse and unevenly distributed, which complicates the task of comprehensive monitoring of a large river and its basin. Hence, to simplify the task of river monitoring and conservation, current efforts will need to be focused on small urban and semi-urban streams/ tributaries and natural drains, especially those streams/ drains that are perennial or can easily become perennial. The latter type of channels are mainly those drains which are natural drains during monsoons, but which have now been converted to or seen as "dirty drains" due to urban wastewater flows in them. They can be converted to perennial freshwater streams by feeding treated wastewater into them. Such rejuvenation has many immediate benefits in the economic, environmental, aesthetic and cultural spheres, and they affect large population groups, which can have a cascading

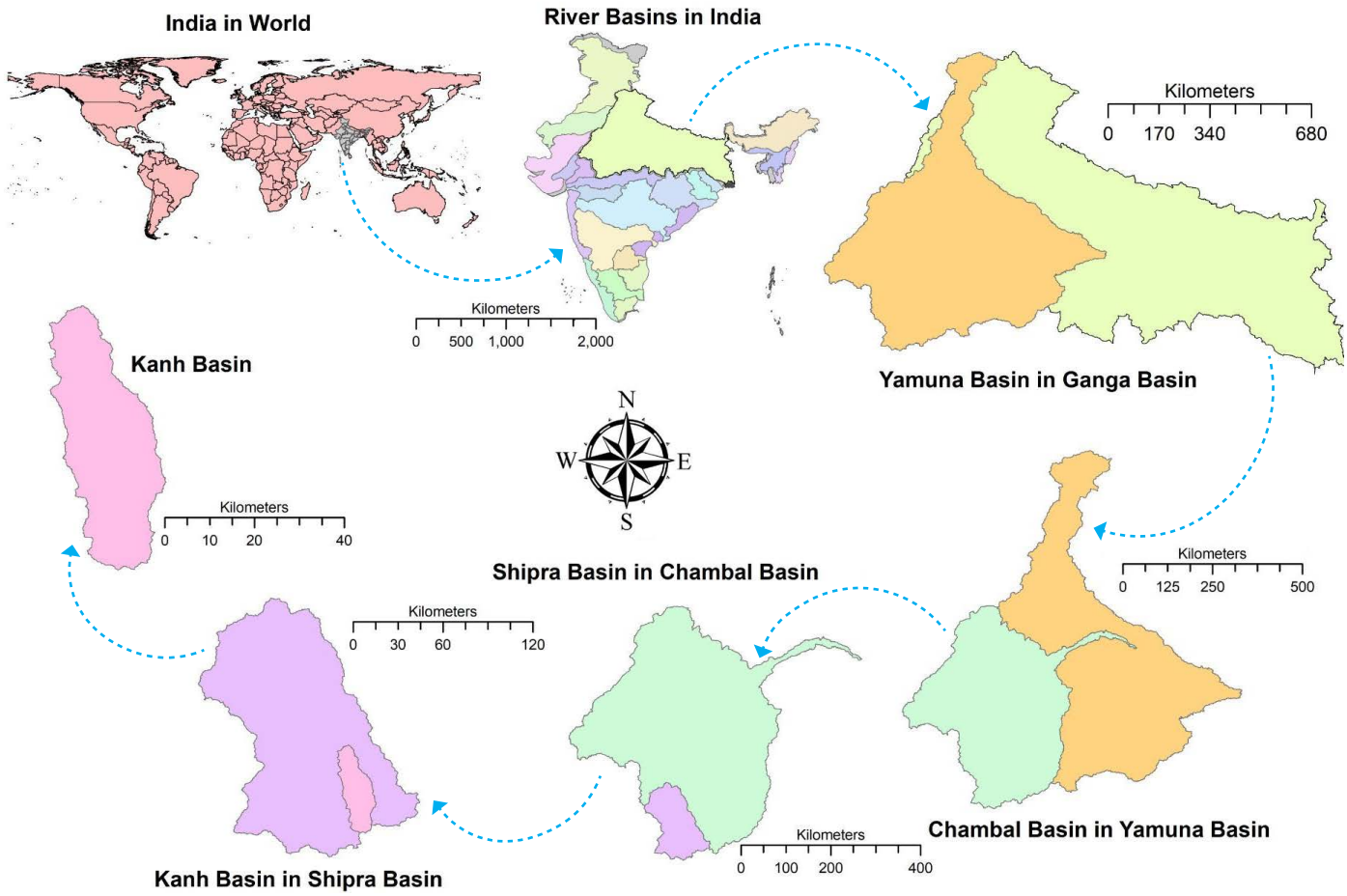

Figure 1: Contribution of small river basins in the constitution of large rivers

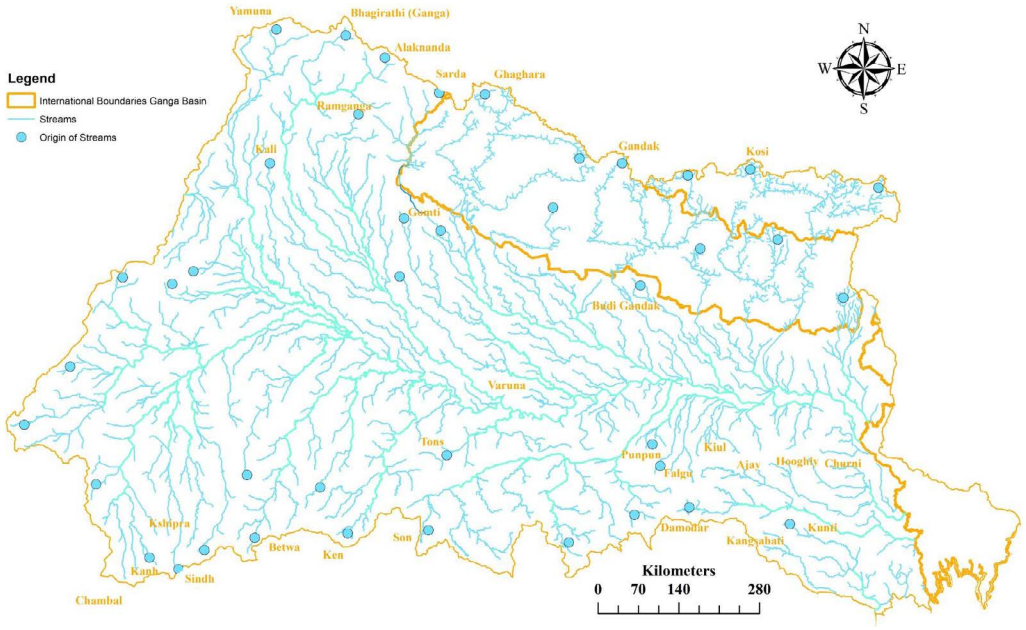

Figure 2: Thousands of source streams originating from different locations in Ganga Basin

Figure 1 shows the natural boundaries of major river basins and some of their sub-basins in India. In Figure 2, an attempt has been made to show the many source streams of River Ganga originating at different locations all over the international Ganga River Basin. This dendritic form of Ganga River is often referred to in India as "Sahastra Dhara" (i.e. A Thousand Source Streams). Through these two figures an attempt has been made to explain how there are many small source streams and rivers that contribute to the benefits of large rivers and their basins. Hence if big rivers are to be conserved, then it is very important to conserve their source streams.

effect on river rejuvenation initiatives in the rest of the basin.

As discussed in the earlier issues of *Pragyambu*, the top-down process can be suitable to some extent for the study of any river basin, providing some limited information on various aspects of the river. But, just as it is said that, to keep a country clean one should begin the cleanliness drive from one's own home, then clean up small localities, and then cities, etc., to achieve cleanliness in the whole country, so it is that the revival of big rivers is only possible when small rivers and streams connected to a big river are revived first. For this task to be executed it is necessary to understand the bottom-up approach and adopt this method for the restoration of rivers.

Similarities and Diversities of Rivers: Basis for Selecting Rivers for Restoration

Rivers carry out their natural ecosystem functions for the region in which they flow in a continuous and uninterrupted manner unless there is any natural or man-made interference in the region. However, before grasping the importance of river conservation, river scientists and engineers had viewed rivers as only a source of water supply and other apparent benefits. Thus all these rivers, regardless of in which region they flow, were seen identically: as sources of profit and resources. In reality, rivers have many variations on the basis of their place of origin, catchment area geomorphic character, hydrology, aquatic, riparian and terrestrial biodiversity, etc. To explain these variations, the importance of different rivers has been expressed in ancient scriptures as follows:

त्रिभिः सारस्वतं तोयं सप्ताहेन तु यामुनम्।
सद्यः पुनाति गांगेय दर्शनादेव नार्मदम्

(मत्स्य पुराण १८५/१०-११)

[Bathing for three days in River Saraswati, seven days in River Yamuna, and only one day in River Ganga bestows sacredness, but humans become sacred merely by the sight of River Narmada.

Matsya Purana, 185/10-11]

The above verse conveys the message that, though all rivers may be important and sacred to human beings, our behavior towards different rivers should be different depending on behavior of humans their varied topographies, catchment properties, geomorphology, hydrology, water quality and ecology. Similarly, the restoration and conservation measures of River Ganga should be undertaken with equal differentiation for the different river constituents.

Since small low-order streams are not affected much by their tributaries/ source streams, the low-order streams of large rivers should be selected on a priority basis for river restoration in large river basins. At the same time, the flow and drainage areas of the selected rivers should not be very small and insignificant, and as far as possible it should be historically a perennial stream – or at least a stream that can be converted into a perennial one given the present situation. Only perennial rivers can meet the objectives of minimum water availability throughout the year. If the selected streams are located in or near urban centres, municipal wastewater, industrial wastewater and/ or agricultural return flows, after necessary treatment, may be fed into the river to augment its flow. Thus, the selection of low-order urban streams or natural drains for restoration not only conserves the selected river, but also enables the recycling of urban wastewaters in a clean and aesthetic manner.

Suitable criteria for selection of stream/ river can be as per the following points:-

- The selected stream should be a low order stream.
- The selected stream must be historically perennial (flowing throughout the year) – or at least one that can be converted into a perennial stream by water coming from other regions (e.g. from other river basins, through water supply, through agriculture).
- It should be located in or near urban areas as far as possible.
- It should be relatively big or having a relatively large basin among rivers in the area.

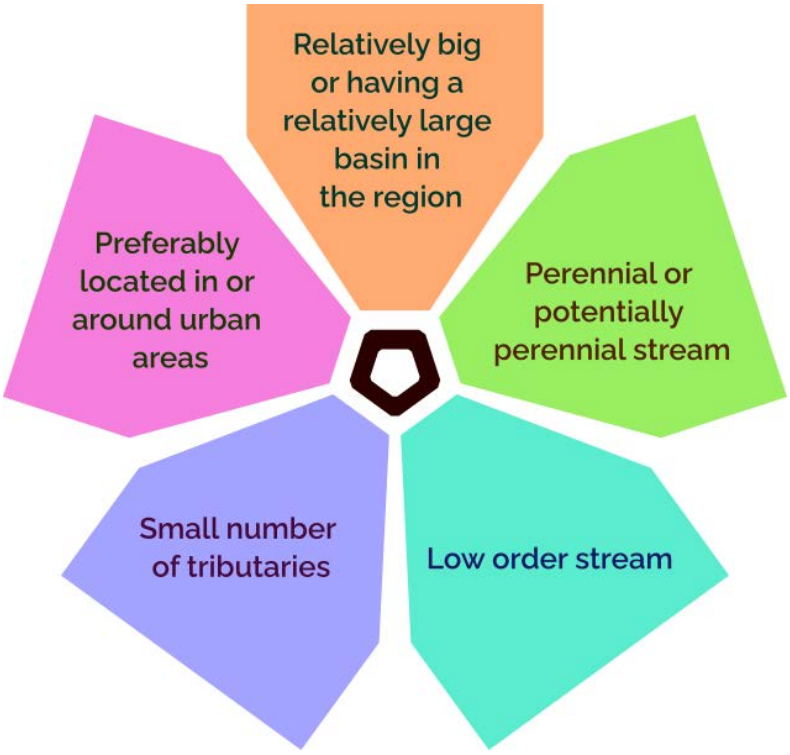

Figure 3: Criterion for selection of a river as an independent entity in a bottom up approach

As stated earlier human behavior towards each river should be unique on the basis of local situation and other criteria; perhaps it may be also desirable to critically assess whether it is justified to convert a non-perennial stream to a perennial one in the process of its restoration. Will this conversion have any adverse effect on its ecosystem? Will the stream's conversion to a perennial stream have a long-term adverse effect on its flow and basin? After getting proper answers to all such questions and taking appropriate decisions on them, perhaps the work of river conservation and restoration can be made sustainable.

Different Stages and Goals of Restoration of Rivers and Waterbodies

Regarding river conservation and revival it is important to ensure that the efforts extend over the entire basin and that all benefits are derived. Thus, these efforts should have a positive impact on all small and large water bodies, forest areas and other ecosystems in the basin. Rehabilitation and conservation efforts need to include comprehensive measures not only for the river, but also for the floodplain, and the entire catchment area. In this endeavor, all the following aspects should be taken into account:

Quality of Incoming Water

cGanga proposes a Four-Stage Water Quality Improvement Cycle to ensure that that water loop should be closed at the appropriate geographic scale to avoid long distance conveyance of water/ wastewater and the freshwater source is not only ecologically and aesthetically satisfactory, but also a reliable source of water for human use which can prove useful in the management of municipal, industrial, commercial and agricultural wastewaters/runoff (figure 5). Thus, while primary treatment (and, where possible, secondary treatment) of municipal sewage ensures the removal of organic and inorganic wastes, the leftover organic, nutrients and other contaminants of the wastewater are removed through phyto-remediation in wetlands, after which this water does not harm the waterbody and its ecosystem to deliver its natural functions and also fulfills the human needs of freshwater.

Goals and Stages of Restoration

The restoration goals may not be achieved immediately in completeness. The restoration targets and milestones may be set out in stages as follows:

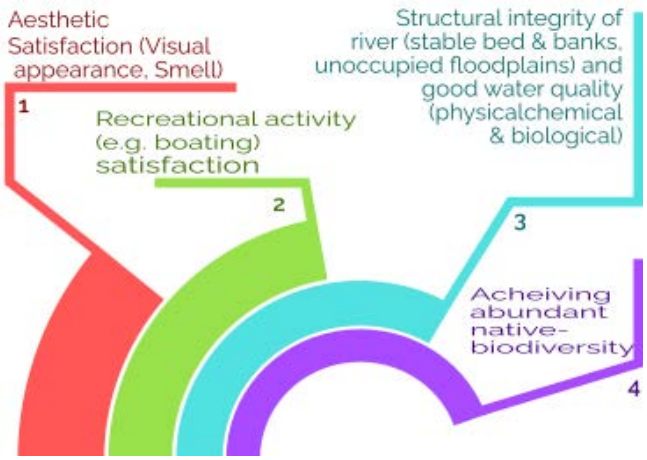

Figure 4: Stage-wise goals in river restoration

Unification (Integrity) of River System

The river bed and banks need to be fully protected against harmful anthropogenic activities such as sand mining, constructions and other interventions. Simultaneously, the floodplains, tributaries (natural drains) and, indeed, the entire catchment or watershed need safeguards against encroachment, structural damage, and degradation and blockage of drainage paths.

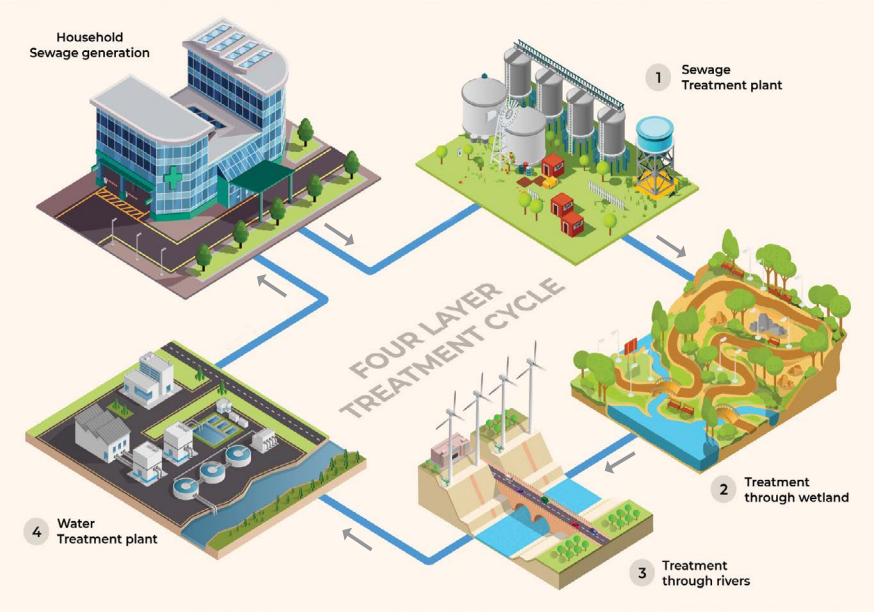

Figure 5: Four layer treatment cycle to improve water quality

Water Resources Integration

Rivers are the main focus of attention as a primary source of freshwater, but drains and waterbodies, that sometimes appear to be functionally isolated, are hydraulically and hydrologically connected to other waterbodies in their vicinity. Therefore, it is necessary that waterbodies are interconnected (including with groundwater) and remain in continuous use.

Continuous Record-Keeping

A complete inventory of all changes made and/ or observed in the river and its basin (including key monitoring indicators) during the restoration-conservation period should be maintained. These records will not only help in assessing the progress and success of the efforts, but can help in overcoming unforeseen obstacles in the progress as well as in implementing similar programs in other river basins.

River-related Infrastructure

Some structural interventions may be necessary to ensure river functioning as a secure perennial river without disrupting terrestrial activities. Thus, for example, one may need to construct weirs (or check dams or small dams) to maintain the required water depth and flow (speed) suitable for river fauna, or to make embankments in flood-prone areas, or construction of bridges for terrestrial animals and humans to cross the river.

Restoring/ Developing Aquatic and Terrestrial Biota

Both aquatic and terrestrial flora and fauna are essential for healthy rivers and their drainage basins. Natural vegetation in particular helps recharge water in both soil and groundwater, as well as in purification of runoff. It is therefore necessary to make desirable efforts to generate and maintain adequate cover of natural vegetation in the basin. Likewise, the population of aquatic organisms and plants can be maintained and increased only by preventing over-exploitation of aquatic biological resources and by increasing the number of suitable biological species.

Status of Conservation of Small Rivers in India

Special importance is attached to rivers and their special contribution to culture in India. In various religious texts, rivers are classified on the basis of their characteristics. On the basis of the size of the catchment area, K. L. Rao (1977) classified rivers as large/ major rivers (whose catchment area is 20000 sq. km. or more), medium rivers (whose catchment area is 2000 to 20000 sq. km.), and small rivers (whose catchment area is 2000 sq. km. or less). The quantity of water coming in big rivers has decreased over time. In some major rivers of the country like Kaveri, Krishna and Narmada, the flow regime has been substantially modified in the last century. Behind all this, manmade changes in the basin and in small rivers that bring water to the large rivers can be considered as the main reason. Even during the initial efforts of river conservation, more importance was given to the main stem of big rivers rather than small rivers. As a result, the condition of small rivers deteriorated and neither could large rivers improve in any significant manner. Some of the minor rivers which were perennial in nature have now become seasonal, and those which were seasonal rivers have mostly disappeared. The Shahibi/ Sahibi river flowing through the states of Rajasthan, Haryana and Delhi, Dhela river in Ramganga Basin, etc. are some such examples. On the contrary, some seasonal rivers have also been converted into perennial ones in some stretches or over their entire lengths; but the untreated wastewater flowing in them not only affects their ecosystems but also harms groundwater and surface waterbodies. The Kanh river of Indore and the Jojri river flowing in Jodhpur are examples of these. Apart from this problem, other local water-related problems have also arisen in these areas. In the work of conservation and rejuvenation of such small rivers, the first need is to identify these rivers so that appropriate steps can be taken by estimating the number of such rivers and the affected areas.

CONTACT US
Centre for Ganga River Basin Management and Studies (cGanga)
Indian Institute of Technology Kanpur, Kanpur 208 016, Uttar Pradesh, India
Email: info@cganga.org, Website: www.cganga.org, Contact No.: +91 512 259 7792