

Jorrit K. de Groot and Pieter van Groen

The Gorai Re-Excavation Project

Abstract

In the last decades the Gorai River, a branch of the Ganges in Bangladesh, has been drying up, causing difficulties for the people that live along its banks. The decrease in water in the river during the dry season caused an increased salinity intrusion into the river, leading to harmful environmental conditions of a large mangrove forest situated at the rivers mouth. To get the river flowing again, a number of solutions were considered. Owing to the extreme morphological activity, the river response to an intervention is very hard to predict. Therefore investing in permanent structures was considered too high a risk. A better solution was found to be dredging a deeper channel at the bifurcation where the Gorai splits off from the Ganges.

After implementation of three dredging seasons, 1998, 1999 and 2000, this solution has increased the water flow in the river, restoring the fish population and allowing year-round shipping.

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Introduction

The Gorai is one of the most important river branches in Bangladesh. The river is a branch of the Ganges and is the most important sources of sweet water for the southwestern part of Bangladesh. It is also important for shipping, fishing and for the ecological environment of the mangrove forests, the Sundarbans, situated along the coast.

Not insignificant is also the household use of the river water for the people living along the river's banks.

During the last decades the flow of the river gradually began to slow down. In contrast to the decrease in the (low-water) discharge of the river, the annual sedimentation of sand in the river increased. The combination of too little water and too much sand led to the lengthening of the period in which the river was completely dry.

After receiving his master degree in civil engineering at the Technical University of Delft in 1999, Jorrit de Groot started working at Hydronic, the "in house" engineering company of Boskalis. Specialised in coastal and river engineering, he became a project engineer at the Gorai River Re-Excavation project soon afterwards. There he designed and evaluated the works and supervised the on-site survey department. During his stay in Bangladesh he also worked on a feasibility study of dredging the old Brahmaputra, a tributary of the Jamuna.



Jorrit K. de Groot

For the last 25 years Pieter van Groen has been involved in numerous river related projects in Asia. From 1991 onwards he participated in several large river projects in Bangladesh. He was design engineer for low cost river training works (FAP22) and project manager of the River Survey Project (FAP24) for Delft Hydraulics. Since 1998 he has worked as site engineer on the Gorai River (pilot dredging) for Boskalis.



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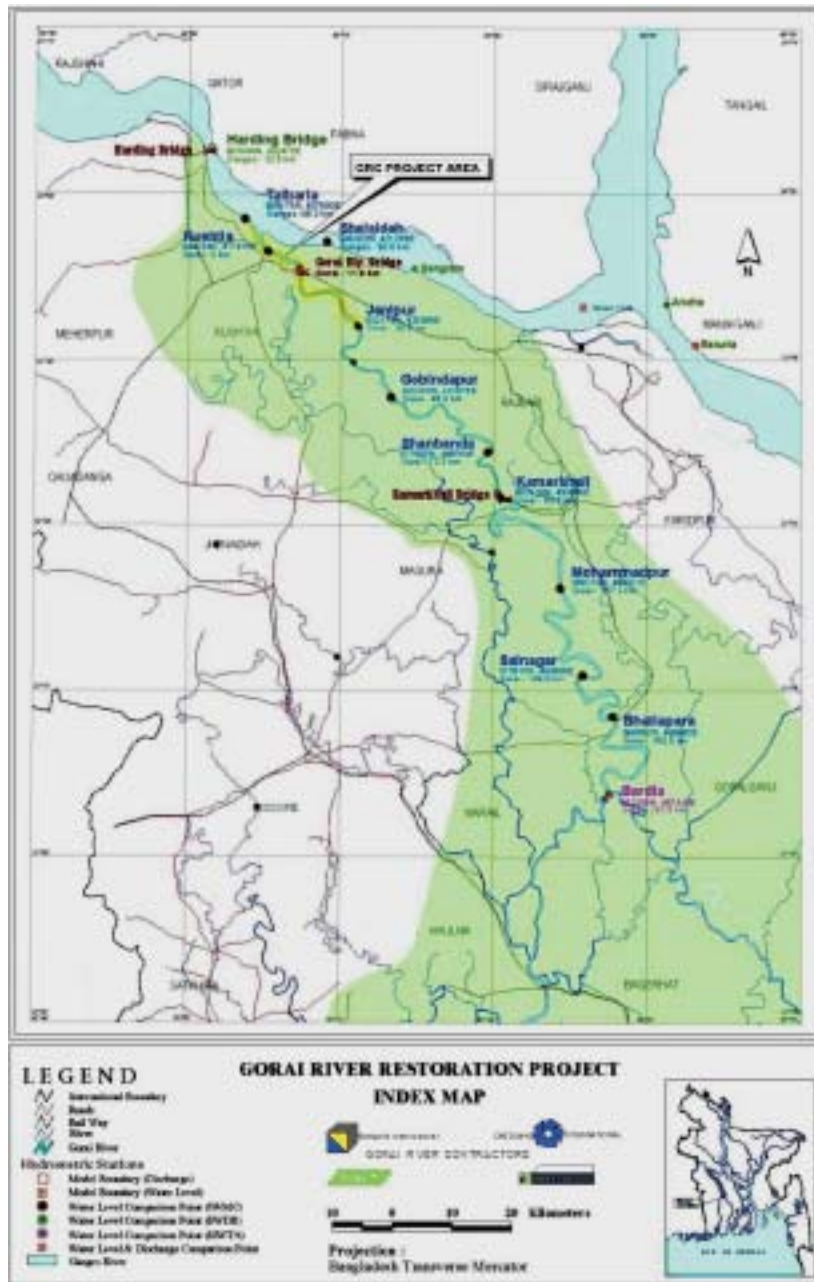


Figure 1. Map of the Gorai River. Project area marked in yellow.

This drought was catastrophic for all the functions of the river. In the last few years the Gorai was dry from January through April. Shipping was in this period no longer possible, and the related trade in goods was disrupted. The health of the inhabitants of the area around the river was threatened because there was no clean water available for household tasks. Because the river was dry, the salty sea water was able to push further upstream into the riverbed. As a result of the higher salinity, the river water could no longer be used for irrigation for agriculture. In addition, the increase in salinity resulted in a decrease in the biodiversity of the mangrove forest.

TREATY BETWEEN INDIA AND BANGLADESH

In order to solve these problems, the Bengali Government signed a treaty with India in which the distribution of the water from the Ganges between the two countries is regulated. The treaty establishes a certain minimum discharge and as a result of that a certain minimum water level for the Ganges. The treaty became effective in 1997 and established the circumstances for the restoration of the discharge of the Gorai. However, because the top part of the course of the Gorai was blocked with sediment, there was still no water flowing through from the main stream, the Ganges. In other words, the cork was still in the bottle.

To solve this problem a dredging project was begun in 1998 with the projected duration of two years. The dredging, performed by a joint venture of Boskalis, Dredging International, HAM and VOACZ, was meant to dig a low-water channel in order to restore the low-water discharge of the river. Because the Bengali Government attached great importance to these dredging works, the project was given the stamp of high priority (Figure 2).

PURPOSE OF THE DREDGING

Owing to insufficient and limited knowledge of the behaviour of river systems such as the Gorai-Ganges system, it was impossible to adequately predict the response of the river to the action of dredging.

A secondary aim of the project was therefore to gain insight into the role that dredging could play in the restoration of the Gorai river in the long run. By intensively measuring the behaviour of the river during and after the dredging a better idea of the response of the river to dredging was achieved, and the ability to predict the response in the long run was improved.

Because alluvial rivers — such as the Ganges and the Gorai — consist of beds composed of fine sand, they are heavily subject to morphological changes. It is thus difficult to plan a detailed design of the work far in advance. For this reason a so-called “design and construct” contract was chosen, in which both the design of the work as well as its implementation are left to the contractor. The design, the evaluation of the dredging works and the interpretation of the surveyed data were done by Hydronomic bv, the internal engineering group of Boskalis.

THE WORKS

At the end of the wet period in October 1998 the dredging work began at the bifurcation where the Gorai branches out of the Ganges (Figure 3). At that point a



Figure 2. At the request of the Bengali Government dredging of the Gorai took place; interested citizens line the river banks to watch the works.

large amount of sedimentary sand was blocking the stream of water into the Gorai. A new low-water channel was dredged at this fork in the river with help from two cutter suction dredgers, the *Gemini* and the *Wombat*.

The dredging of the channel took place in a downstream direction, until the low-water discharge of the river was restored. The final length of the dredged low-water channel reached a distance of about 20 km from the fork of the Gorai branch and the Ganges.

The dredged sand was placed within the high-water banks, so that the high-water bed was narrowed and the flow channel was deepened.

In Bangladesh the dry period is followed by the very wet monsoon season, during which the flowing water stream carries a great deal of sand along with it. This destroyed part of the dredging work so that another dredging intervention was necessary to prevent the river from drying up.

The second dredging season started in September 1999, just after the monsoon was finished. This time only one cutter was used. With less effort than the first time, the low-water discharge of the Gorai was restored for a second time. This provided evidence that by dredging the river, the conditions of the river stream could be restored and that a general improvement in



Figure 3. Bifurcation area of the Ganges and Gorai.



Figure 4. Aerial view of the cutter suction dredger at work.

Figure 5. The Gorai provides water for washing for the populations along its banks. In the background, the dredgers continue their work.



the condition of the river was possible. The results of the project were so promising that it was decided to extend the project another year.

After the third dredging season — going from October to mid-December 2000 — the low-water discharge restored itself again, while the dredging effort itself lessened. The condition of the river again demonstrated further general improvement.

CONTINUING IMPROVEMENT

Since the start of the dredging project, the volume of sand to be dredged in order to improve the river discharge during the dry season has steadily declined. In the first season, going from mid-October to mid-March two suction dredgers removed 9.2 million cubic metres of sand. In the second season going from mid-September to the end of January, one suction dredger removed 5.8 million cubic metres of sand. In the third dredging season, mid-October to mid-December, only 3.4 million cubic metres were dredged (Figure 4).

Despite the decreasing volumes of sand dredged, the results in terms of low-water discharge through the Gorai have remained the same. Soundings taken from the riverbed indicate that the river is slowly restoring itself in response to the dredging. The overall sedimentation which the river was experiencing in the years prior to the start of dredging has now been turned around into an increase in net erosion of the riverbed.

This has resulted in a steady deepening of the flow channel over the years, leading to an improvement in the flow of the river and a reduction in the volume of sand needing to be dredged.

THE FUTURE

Despite the present situation of increased river erosion, and thus a reduction in the annual volumes to be dredged, the future in terms of dredging is uncertain. The from year-to-year varying characteristics of the monsoon, the ever-changing configuration and heading of the Ganges main channel upstream, the bifurcation and the shape of the bifurcation area have great influences on the sedimentation pattern of the Gorai. These factors subsequently influence the volumes to be dredged. Because these factors are difficult to predict, so are the volumes to be dredged.

It is clear that for the near future it is necessary to continue to dredge in order to safeguard the low-water discharge of the river. From soundings of the riverbed it seems that during the monsoon the river is re-profiling itself. This means that the deep, narrow dredged channel is transformed by the monsoon into a broader,

shallower channel, which is (still) unable to guarantee that water will be discharged through the Gorai during extreme low-water levels in the Ganges.

Another morphological process, which occurs during the monsoon, is that shallow spots develop at bend crossings in the river, which again create obstacles during extreme low-water situations. After the monsoon it is then necessary to dredge the flow channel back to a geometry that is capable of low-water discharge.

Conclusion

The conclusion after three seasons of dredging the Gorai is that intervention by dredging should be included in any long-term solutions for the restoration of the river, and can be seen as an alternative for building any conventional hard (i.e., stone) constructions in the river. The dredging operation can be seen as a flexible long-term solution for river problems, which — in contrast to conventional options — can anticipate the extreme changes in the morphology of the river system.

As a direct result of the intervention by dredging, water is flowing once again through the Gorai even in the dry season. Villagers can use the water of the Gorai to wash clothes, to catch fish for a nutritious evening meal, and children can play in the river and on its banks (Figure 5). The river can be used the whole year through for shipping so that goods can easily be transported from one village to another. The fish have returned to the river and the intrusion of salinity has been strongly reduced.

The restoration of low-water discharge has established the prerequisites for an enduring development of the Sundarbans. The certainty of sweet surface water during the entire year also creates the basic conditions for further development of irrigation for agriculture. The availability of surface water during the whole year can, with the installation of water purification facilities, be used in the future as a source of drinking water. Because the groundwater in Bangladesh is contaminated with arsenic, while the surface water is not, the use of surface water can remove a serious threat to public health.

In general the conclusion may be drawn that the restoration of low-water discharge of the river, as a result of these dredging works, have created new chances for further development in southwestern Bangladesh.