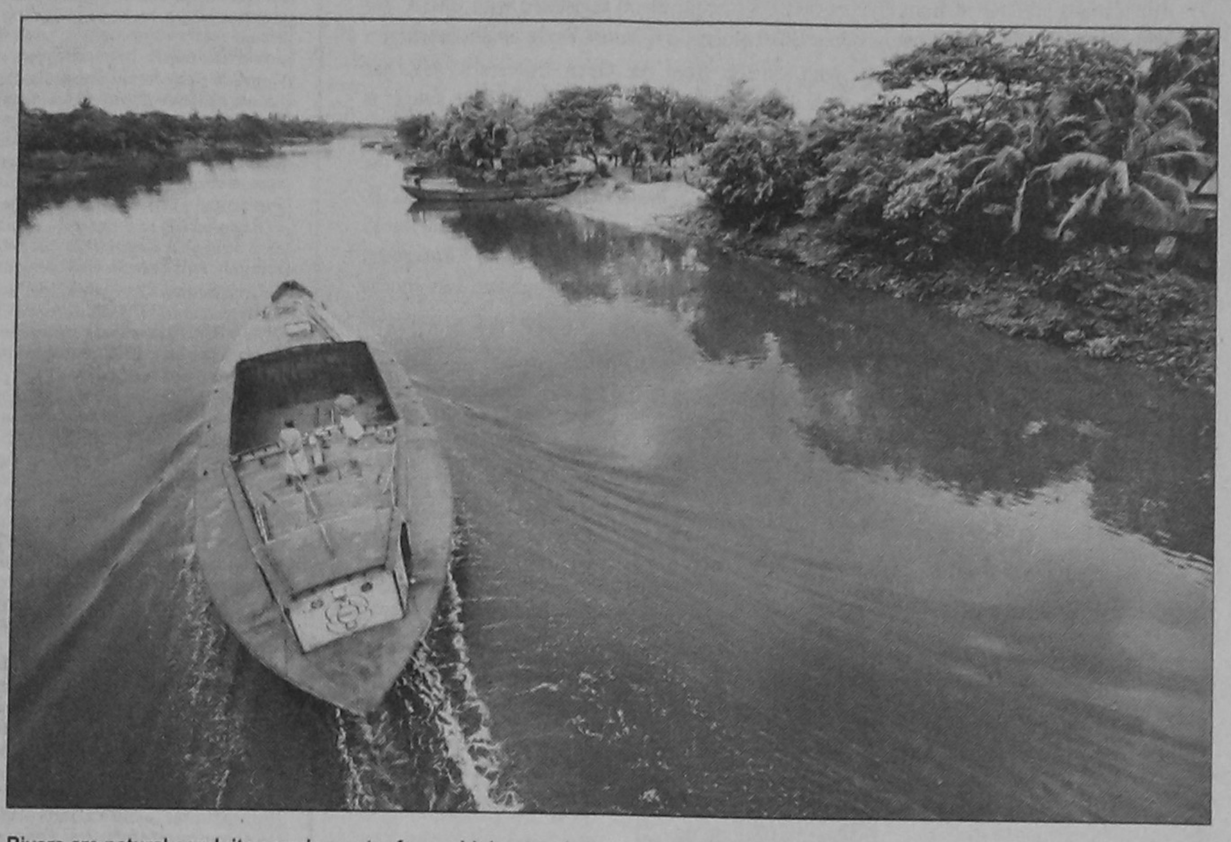
Can river training benefit us?

In Bangladesh, as well as other developing nations, the mindset needs to be one of living in harmony with rivers not one of complete control. In the United States, attempts are underway to return some rivers to their natural states by means of dam removal and re-meandering of straight- ended rivers. The unbiased perspectives of the international experts should help the policymakers of Bangladesh comprehend the "do's" and "don'ts" of river training.



Rivers are natural conduits carrying water from a higher to a lower elevation.

JASIM IMRAN

LAST month a section of press published a news report on a mega plan to dredge and train the river systems of Bangladesh, including three major rivers the Padma, the Meghna, and the Jamuna, to maintain navigation, recover land, and prevent flooding and bank erosion (The Daily Ittefaq, July 12). According to the report, the prime minister of Bangladesh announced this plan on July 9th during a meeting with food and disaster management ministry officials. As an academic working in the field of river mechanics and sediment transport, I am concerned about the viability and outcome of such a major undertaking.

While the objectives of the proposed river training activities are noble and worthy, implementation of such a project without in-depth studies and careful consideration of the natural balance of water and sediment would not only aggravate the existing problems but may also lead to many unforeseen consequences and irreversible damage.

Rivers are natural conduits that carry water from a higher to a lower elevation and are shaped continuously by their content, i.e., water and sediment. Interaction between the river geometry, the owing water, and sediment leads to a variety of rhythmic features that can form on the river bed. These include ripples, dunes, and bars, commonly known as chars in Bangladesh. Some of these bars become semi-permanent and get inhabited by people, while others appear, disappear, and migrate with seasonal flow variation.

A river can also deform significantly in plan. Erosion on one bank and deposition on the other, due to local variation of the flow velocity across a channel, can cause a river to migrate in time and space leading to a very beautiful sinuous or winding shape. Typically consisting of a single channel, these rivers are known as meandering rivers. The meandering pattern of rivers is most widely observed in the nature.

Common features of a meandering river include a crescent shaped bar known as a point bar that remains locked on the inside of a bend and a relatively deep pool located near the outer bank. The topographic variation of the bed at a meander bend is caused by a helical motion in the river flow. In Bangladesh, the majority of the smaller rivers display meandering patterns. The migration traces of these rivers are clearly visible in satellite images and aerial photos. Based on the analysis of aerial photos and some theoretical considerations, the migration path of a meandering river can be predicted with reasonable accuracy.

Although not as abundant as meandering rivers, braided rivers are also commonly observed in nature especially in Alaska, New Zealand, and the Himalaya region. Braided rivers are characterized by multiple bars within a river reach and a number of channels joining, dividing and rejoining.

Observed from the air, these rivers display the intertwining effect of a braid. The depth of braided rivers is quite small compared to their width. The banks or outer boundaries of braided rivers are relatively straight, and the channels may flow within an area defined by relatively stable banks or may occupy an entire valley floor. Conditions that promote braiding include an abundant supply of sediment, high stream gradient, and the lack of clay material that would otherwise provide a stable bank.

A large width to depth ratio of a river promotes an instability mechanism that can easily lead to the appearance of bars in a channel reach. These bars are known as free bars and are different from crescent shaped point bars found in a meandering river. If the width to depth ratio of a river is greater than about 20, the free bars become unstable, i.e. their shape, size, and position change considerably with time. When this value approaches 50, a river starts to braid. Amalgamation of a number of free bars can lead to the formation of relatively stable large mid channel bars or islands with elevation up to the oodplain level.

The Brahmaputra-Jamuna river system is one of the world's largest braided rivers. The braided characteristics of the river start at the Himalayan foothills and continue until the river meets the Ganges River in Bangladesh. The Teesta, a major tributary of the Brahmaputra in Bangladesh, also shows a braided pattern. Unlike meandering rivers, the rate and direction of bank erosion in a braided river are unpredictable since the sudden appearance of a large bar close to the bank can locally increase the flow velocity and detect the flow towards the bank.

Although a river tries to maintain a relatively constant width, the widening of a river stretch due to sudden changes in water and/or sediment supply, as well as tectonic activities, is not uncommon. In the Indian state of Assam, the average width of the Brahmaputra has increased by more than 25% in less than 50 years. This increase of width has been attributed to a sudden increase of sediment supply caused by massive landslides resulting from major earthquakes in the Himalaya region.

Now, let us look into some examples of river engineering projects of relatively small scales that led to unintended and adverse consequences. Charleston Harbour in the State of South Carolina is one of the busiest seaports in the eastern United States. Prior to 1942, the harbour received a modest freshwater supply of 20 cubic m/s from the combined flow of three tidally dominated rivers: the Cooper, the Wando, and the Ashley. During this period, the average annual maintenance dredging of the harbour's channel was 61,200 cubic m. In 1942, power generation began at the Pinopolis Dam on Lake Moultire which diverted the Santee River flow into the Cooper River at an average rate of 417 cubic m/s. In the twenty-eight years following the diversion, the average annual maintenance dredging was 2 million cubic m.

While the objective of diverting the water of the Santee River to the Charleston Harbor, as well as some capital dredging of the harbour in 1941, was to prevent siltation and reduce maintenance dredging, the consequence was devastating. The excess fresh water from the diversion changed the hydrodynamic characteristics of Charleston Harbour that encouraged a large influx of sediment from the adjacent continental shelf. During the 1980s, the US Army Corps of Engineers constructed a diversion canal to send some of the water back to the Santee River which partially mitigated the problem. However, the heavy siltation and expensive dredging of the harbor continues to date.

Severe siltation at the Port of Calcutta persists despite diversion of the Ganges to the Hugly River through a feeder canal from the Farakka Barrage. River straightening was popular in North America in the 1960's and 1970's. The goal was food protection: the steeper slope of the straightened reach allowed higher flow velocities and thus conveyance of the same flow at a lower depth. This short term benefit was often outweighed by the long-term pattern of aggradation, degradation, and bank failure induced by the straightening.

The common observation in Bangladesh is that the river systems are experiencing significant changes due to siltation. While the adverse effect of the Farakka Barrage on the distributaries of the Ganges cannot be disputed, the other two major river systems, the Brahmaputra-Jamuna and the Barak-Meghna, have so far remained relatively free of human intervention along their entire courses. When trying to determine whether or not a river is in peril, we need to look at the river in its entirety from its source to its mouth. Since Bangladesh is not the major contributor of water and sediment to these rivers, the country cannot simply dredge its way out of the problems occurring with siltation.

Of particular concern is the plan to convert the major rivers from multiple to single thread channels. Let us consider the Brahmaputra River. Based on some of the published data, the typical depth of the river in the main channels is in the range 8-10 m. Now, if the river is forced to a single channel with a width of 5 km and the depth of the river is increased to 20 m, the width to depth ratio will become 250, which is 5 times the threshold of braiding. This means that within a short period following the implementation of such a project, chars will appear and the channel will start to braid. Stabilizing the imposed bank on one side of the channel for 10s to 100s of kilometers will be extremely difficult and expensive, if not outright impossible.

In Bangladesh, as well as other developing nations, the mindset needs to be one of living in harmony with rivers not one of complete control. In the United States, attempts are underway to return some rivers to their natural states by means of dam removal and re-meandering of straight- ended rivers. The major population centers and infrastructures should be protected by constructing and maintaining well-designed flood walls, levees, and other hydraulic structures.

Every kilometre of river bank cannot be protected from erosion, and sometimes flooding is inevitable and should be tolerated outside of major population centers. Without controlling the source of sediment, dredging would have only limited and seasonal impact. Disposal and storage of dredged material is also an important issue that needs to be addressed properly.

A long-term strategy of monitoring, systematic study and actions that respect the natural balance and laws of physics are necessary in order to maintain and improve the health of the rivers in Bangladesh. Close collaboration with the neighbouring countries at all levels should be an essential part of this strategy.

The academic researchers, technical staffs, as well as NGOs from Bangladesh and its neighbours that share common rivers need to exchange data, conduct joint research projects, and establish land use practices that minimise soil erosion and sediment supply to the rivers. In order to start this process, an international conference should be organised in Dhaka in the near future. In addition to personnel involved in the study of the common major rivers in Bangladesh, Bhutan, China, India, and Nepal, leading international experts on river mechanics should be invited.

The unbiased perspectives of the international experts should help the policymakers of Bangladesh comprehend the "do's" and "don'ts" of river training. Organising regular workshops and short courses on river mechanics will also help develop the necessary skills and visions of water resources engineers, geologists, and physical geographers in Bangladesh. Cross-border organisations such as Friends of Brahmaputra-Jamuna, Friends of Ganges-Padma, and Friends of Barak-Meghna can be formed by the environmental activists in order to inuence the policy decisions of the countries that share these magnificent rivers.

Jasim Imran is a professor at the Department of Civil and Environmental Engineering, University of South Carolina, Columbia, USA (www.ce.sc.edu).

Protecting our water

Central treatment plants may be the way forward

Fortunately, economic zones provide a unique opportunity to government regulators who are trying to monitor and enforce international standards for environmental controls. Regulators can channel monitoring and enforcement efforts through a single entity -- the zone management.

Indiscriminate pollution of water bodies should not be allowed to continue unabated.

PETER NIEDERBERGER

THE Daily Star has done a commendable job in bringing to the public attention the terrible damage being done to our rivers -- the lifeblood of our city -- due to encroachment on river banks and untreated industrial discharges.

The dyeing and washing factories and tanneries, among others, often discharge toxic effluents without any treatment into the water, affecting the health and well being of thousands of people in the areas nearby. Many of these factories do not have effluent treatment plants, though they are required by law to have one. Those factories that have installed ETPs to comply with the law often bypass the treatment process as a cost saving measure.

Solutions are not easy to come by, however, time and again, more developed countries have demonstrated to us that green businesses (ones that don't pollute) are more sustainable and profitable in the long run.

Some good work has been done on this front. The Dhaka Export Processing Zone, operated by the Bangladesh Export Processing Zone Authority (BEPZA), has shown its commitment to better business practices.

The Dhaka EPZ holds nearly one hundred enterprises and employs nearly one hundred thousand workers. Of these factories, one- fourth of them generate wastewater in their process, mostly from the washing and dyeing of garments.

While many of these factories have their own effluent treatment plants, some of which function quite well, BEPZA has decided to build a central effluent treatment plant (CETP) to better manage the overall impact of wastewater in both the Dhaka zone and the Chittagong zone.

Two firms have been selected to design, construct and operate the central plants -- D-Water in DEPZ and the Chittagong Waste Treatment Plants Ltd. in the CEPZ. The CETPs are expected to be constructed and in operation by August 2010, and promise to provide treatment levels that are in accordance with our Department of Environment effluent standards.

To help assure that the projects are successful, BEPZA has partnered with the Bangladesh Investment Climate Fund (BICF), managed by IFC, in partnership with DFID and EC. BICF will provide technical assistance to BEPZA staff so they can assess and monitor the design, construction and initial start-up operations of the CETPs.

BEPZA's commitment to improving the environmental conditions of its EPZs is commendable, and if it is successful it may become a model for the rest of the country.

BEPZA has also initiated projects with BICF to establish strong environment management practices at their facilities. BICF is helping BEPZA develop an environmental monitoring program for inspectors to encourage the best management practices by their enterprises. They are also developing a comprehensive Environmental Management System for the organisation, again in line with best international practices.

Fortunately, economic zones provide a unique opportunity to government regulators who are trying to monitor and enforce international standards for environmental controls. Regulators can channel monitoring and enforcement efforts through a single entity -- the zone management.

The zone management typically maintains regular contact with its tenant companies for a range of issues. It also has at its disposal a variety of mechanisms that can be used as enforcement tools. For example, if a company within the zone is not complying with established standards, the zone management can, after following an established notification and warning procedure, deny that company an import or export license, or assume other tactics, which impede the operation of the company.

These are drastic measures that are only to be used as a last resort. Just the existence of such mechanisms is often enough to prevent companies from violating environmental standards.

Thus, a regulatory authority such as BEPZA is well-positioned with an established team and a variety of tools at its disposal to monitor and enforce environmental compliance.

Peter Niederberger is a consultant at the IFC and an environmental specialist.