Toward a Great Project for flood control in Bangladesh

by Laurent Rosenfeld

There was one shining exception to the abysmal performance at the Group of Seven's economic "Summit of the Arch" in Paris, France on July 15-16: French President François Mitterrand managed to maneuver the leaders of the world's seven industrial powers into adopting Resolution No. 50, which stated that "it is a matter of international concern that Bangladesh, one of the poorest and most densely populated countries in the world, is periodically devastated by catastrophic floods," and called for immediate action to remedy the problem with a great flood control project.

"We stress the urgent need for effective, coordinated action by the international community, in support of the government of Bangladesh," the resolution read, "in order to find solutions to this major problem which are technically, financially, economically, and environmentally sound. In that spirit, and taking account of help already given, we take note of the different studies concerning flood alleviation, initiated by France, Japan, the U.S., and the United Nations Development Program, which have been reviewed by experts from all our countries. We welcome the World Bank's agreement, following these studies, to coordinate the efforts of the international community so that a sound basis for achieving a real improvement in alleviating the effects of flood can be established. We also welcome the agreement of the World Bank to chair, by the end of the year, a meeting to be held in the United Kingdom by invitation of the Bangladesh government, of the countries willing to take an active part in such a program."

This initiative is the fruit of efforts launched by President Mitterrand less than one year ago, in the aftermath of the catastrophic floods which brought death, suffering, famine, desolation, and huge economic losses on more than 60% of Bangladesh territory in the summer of 1988. In early September 1988, the French First Lady, Danielle Mitterrand, chairman and founder of the Association France Liberté aimed at fostering freedom and development, traveled to Bangladesh to look into what could be done for this disaster-plagued country. Besides offering immediate relief in terms of shipments of food and medical supplies, she held discussions with with Gen. Hussain Mohammad Ershad, the Bangladeshi head of state, on ways to solve this recurrent problem (40% of Bangladesh territory had already been flooded the year before, in 1987).

On Sept. 28, 1988, President Mitterrand stated before the U.N. General Assembly, "Development is achieved via the launching of major projects of world interest, which are capable of mobilizing energy to help a nation wounded by nature—for example, stabilizing the rivers which flood Bangladesh. Such action would provide the right material for a project of this type. France, for its part, is ready to contribute."

Mitterrand's appeal received relatively favorable echo in the United Nations as well as in various multilateral institutions and potential donor countries. At the same time as France donated 25 million francs (about $4.5 million) for financing a preliminary feasibility study, which was carried out between December 1988 and April 1989, diplomatic efforts led to a preliminary agreement at the Madrid summit of the European Community nations in June, and finally to the above-cited resolution at the Paris summit.

The Bangladesh problem

With an abysmal average per capita annual income of about $160, Bangladesh is one of the five poorest countries in the world. It is also the most densely populated of the less developed countries (LDCs). Bangladesh is in fact one the the most thickly inhabited countries in the world: With a population of 110 million and a surface area of 144,000 square kilometers, its population density is 764 inhabitants per square kilometers, twice that of the Netherlands and 33 times that of the United States.

Not only its population density, but also its geographical situation is in some respect similar to that of the Netherlands. Bangladesh is entirely situated in an extremely flat alluvial plain, whose altitude is nowhere higher than 40 meters above sea level. It is situated at the mouth of three great rivers, the Ganges, the Brahmaputra (which is called Jamuna in Bangladesh), and the Meghna, the combined deltas of which form the largest river complex in the world after the Amazon Basin. The country is periodically inundated by monsoon floods (from July to September), which cover 20% of its territory every other year, and 37% of its territory about once every ten years. Records were broken in 1987 and again in 1988, with respectively 40%, and then more than 60% of its territory affected by floods.

In addition to the periodic floods (and also earthquakes and tidal waves, in this seismically very active region), there is another dramatic and paradoxical problem: Bangladesh suffers major droughts (from November through April). These two combined elements have kept Bangladesh's rice production at a low yield, since only very specific varieties of rice can withstand such varying water conditions. And low yields, of course, are a terrible problem in such a heavily populated country. Lack of water during the dry season has been the source of sharp differences with neighboring India, since Bangladeshi authorities, on occasion, have accused New Delhi of using too much water from the Ganges for its own irrigation purposes, leaving less than the required volume of water for use in Bangladesh.

Several great projects have been envisioned in the past to try to solve the flooding problem. Technically most promising seemed to be a series of dams situated on the spurs of the Himalayas, where these rivers and their most important tributaries originate. But disagreements with Bangladesh's neighbors—India, in particular—on technical and economic feasibilities make such a solution difficult, not to speak of the substantial cost, to the tune of at least $100 billion, to build such a series of dams. Another impediment is that such a large project would involve long delays and discussions with neighboring countries. An added problem is the seismic activity in the Himalayan foothills. Many experts have expressed doubts about whether large, stable dams can be built at all.

These considerations led the Bangladeshi authorities to request a solution be worked out within the country's own borders, while at the same time carrying out longer-term discussions with neighboring countries.

So, what was agreed between France and Bangladesh was "to find a development scheme which will eliminate the flood problem in Bangladesh, while allowing a fair development of irrigation and drainage, in order to increase food production without degrading the environment."

The flood control project

Experts from the French Ministry of Equipment were sent to Bangladesh to work together with Bangladeshi experts toward defining the best possible solution. A pre-feasibility study has been worked out, and aims at outlining a "vision" of what a comprehensive, overall development scheme could give rise to in the long term (20 years). Its guiding idea is to start with the most effective equipment, in order to obtain at least partial relief much earlier than the 20-year target date.

The basic hydraulic problem is easy to understand: Since the country is so flat, any dam would create a water reservoir that would cover a huge amount of land, a solution which would unacceptably displace too many people. Therefore, the basic principle consists of channeling the floodwaters along the existing waterways, doing so in such a way as to avoid flood diversion either upstream or downstream of these artificially constructed channels.

One further problem to be tackled is the sparse availability of construction materials, especially the scarcity of stones and boulders necessary for shielding the banks eroded by the water currents. One of the heads of the project has reported to this writer that for embankments, dikes, and seawalls presently under construction in various isolated parts of the country, the method used generally consists in first cooking clay blocks in ovens, and then breaking these bricks into stones which can be used for stabilizing the banks.

Given these parameters, the project plans to channel the waters between longitudinally compacted earthfill embankments. The height of these embankments is designed for a 100-year flood, i.e., with an average height of 4.5 meters (and a maximum of 7.4 meters). In the event of even higher flood levels, fuse-plug sills would enable "controlled flooding," i.e., spilling onto land only the excess water for a short period. This would allow most crops to be saved, since a flood 2 meters above the embankment level does only limited damage to rice, whereas a 3 meter flooding for three weeks has dramatic consequences.

The variability of water discharge in the rivers in question is very large. For example, while the average flow of the lower Meghna is approximately 32,000 cubic meters per second, the maximum flow has been known to reach 160,000 cubic meters, or five times the average. To give a comparison, in the Amazon Basin the maximum and average flows are respectively 370,000 and 150,000 (i.e., a ratio of less than 1:2.5), while for the Yangtze River, it is 93,000 and 30,000 (a ratio of 1:3.2), and for the Mississippi it is 67,000 and 18,000 (a ratio of 1:3.7). Therefore, the embankments have to be situated in such a way as to allow such significant amounts of excess water to flow off in times of flood. Excessive concentration of flow would also threaten the stability of both the river bed and of the embankments themselves. On the other hand, social pressures are great to protect the largest possible part of the population and land.

Given these conditions, two alternate solutions have been proposed:

Solution No. 1: Place the embankments relatively close to the river banks (about 1 kilometer away).

Solution No. 2: Locate the embankments further away from the river banks (2 to 5 kilometers away).

The first solution has one important drawback: It implies a very heavy and fast flow in times of flood, which would erode the embankments. It therefore requires the construction of numerous strengthened "river training works" or groynes, breakwaters that lie perpendicular to the direction of water flow. These would have to be very strong, and would be difficult to construct given the scarcity of hard and heavy construction materials. As we shall discuss further, these groynes would increase the overall price by a factor of 60%.

The second solution would leave the larger areas of land lying between the riverbed and the embankment subjected to floods. But the second option foresees minimizing that danger by constructing an additional series of lower, easily repairable secondary dikes close to the river banks, thereby providing protection against 10-year flood levels.

In both options, the protective embankments would be constructed not only on the three main rivers (Ganges, Jamuna-Brahmaputra, and Meghna), but also on a certain length of the tributaries above the confluence, in order to avoid "pushing the flood" upstream into the tributaries. Further, considering that the three main rivers form a complex delta system, there are also plans to embank some of the distributaries (the lower branches of the delta mouth of these rivers), such as Dhaleswari, Arial Khan, and possibly the Old Brahmaputra), in order to reduce the flow in the main rivers and lower the risks of erosion in the distributaries.

TABLE 1
Investment costs of alternative approaches to water control plan

	Investment (million $)
1. *Solution Nr. 1* (close embankments)	8,755
Mechanical construction	
Manual construction	10,202
2. *Solution Nr. 2* (distant embankments)	5,345
Mechanical construction	
Manual construction	5,922

TABLE 2
Investment costs for mechanical construction of distant embankments

	Investment (million $)
Flood warning	32
Embankments	2,633
Groynes	220
Protection of towns	1,038
Drainage	1,422
TOTAL	**5,922**

In total, Solution No. 1 version would include 3,350 kilometers of embankments, of which 30% already exist but needs strengthening. Solution No. 2 implies the construction of 4,000 kilometers of new dikes. Eighteen major cities and their associated industrial zones would be protected by special reinforced embankments, and it is planned to run main roads and railways along the tops of some of the dikes, so as to prevent isolation during flooding. The embankments also have to be connected to the coastal seawalls currently being studied with European Community funding.

Impact on agriculture and environment

The benefits for agriculture of flood control alone would be limited to the years of large flood. The project also includes the construction of free-draining or pumped drainage works so as to better control the level of water in rice plantations. These works would help irrigation, which is the only means to water crops during the dry season, thus allowing two to three crops per year. But irrigation is only possible with water protection, and flood control is therefore the main priority. The project proposes to develop 2.3 million hectares of new irrigation schemes using both surface water and underground aquifers. It is estimated that additional rice production of about 12 million tons could be attainable in 15 years.

A major issue is protecting and developing fishing activities, which currently provide 80% of animal proteins consumed in the country. The plan is to maintain 60% of the low flow discharge in the secondary rivers, and to install sluices through the embankments in order to allow continued fish migration and supply water to parts of low-lying areas currently permanently flooded.

The project also plans for environmental improvement. A total of 250 cubic meters of water per second will be diverted into the Gorai River in order to fight saline intrusions along the coast in the Khulna and Sundarbans regions, where the mangrove swamps and forests are being threatened. More generally, reduced flooding will preserve the habitats of certain dry-land species of animals.

Financial and economic implications

The investment cost of the project is estimated between $5.9 and $10.2 billion. Four alternatives have been studied, depending on: 1) which solution is retained in terms of the location of the embankments; and 2) the construction processes, using either advanced mechanical means or locally available low-skilled manual labor. (See **Table 1**.)

In the least expensive case, where distant embankments are constructed mechanically, the total investment cost breaks down as shown in **Table 2**.

These costs are more or less similar in the case of Solution No. 1, except for the groynes, which have to be much more numerous and more solidly constructed: They would cost about $4.8 billion if manually built, and $3.8 billion if mechanically constructed.

Manual construction is not only more expensive, but morally undesirable; however, it would cause less political resistance. One of the heads of the project described to this writer how some similar, small-scale embankments are currently being built by using laborers carrying earth in baskets on their heads and just dumping it where it is approximately mandated, with no way of tamping and compacting it adequately; such methods clearly must be avoided. The only "advantage" of manual construction is that it would lower very slightly (9% for Solution No. 2) the cost in foreign currency (by 9% for Solution No. 2), while more than doubling its cost in domestic currency.

The general idea in terms of funding is that the government of Bangladesh would support the local currency cost (about one-fourth of the cost in the case of mechanical construction of Solution No. 2), whereas the rest would be borne by the international community. Let us therefore hope that enough money will be allocated by international donors to allow this economically much more sensible solution to be adopted.

As for choosing between Solutions No. 1 and No. 2, the decision is left to the Bangladeshi political authorities. Given the sharing of the costs mentioned above and very low income of the Bangladeshi government, it would seem that Solution No. 2 has much better chances of winning, since it would cost them much less. Operation and maintenance would also be about 10% less costly in the case of Solution No. 2. It is technically a better solution in terms of flood control per se, but there are serious social problems that would have to be dealt with adequately.

Considering the benefits of the project in terms of flood damage reduction ($140 million per year), improvement of cropping patterns (estimated at $195 million), and an acceleration of activity in non-agricultural sectors, a micro-economic analysis shows that the internal rate of return to be between 11% and 13%—which is already a good economic performance.

To these immediate benefits, other advantages can be added in terms of "general public good," but are more difficult to quantify. The flood risk is certainly a continued impediment to industrial and infrastructure investments, preventing satisfactory growth of the economy. Building this project would be a strong incentive for better infrastructure as well as for foreign and internal industrial investments. This and other considerations associated with the reduced risks induce to think that, far from just paying for itself, such a project could open the way toward stronger economic growth and thus help this extremely poor country to get out of its present squalor.