FORUM

Birth of a Megaproject: Political Economy of Flood Control in Bangladesh

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ABSTRACT / A major flood control initiative has been launched in Bangladesh under the coordination of the World Bank. The bank's five-year Action Plan is intended to initiate a long-term investment program, the specifics of which remain to be determined. Long-term proposals under consideration include the construction of massive embankments along the great rivers of the Bangladesh delta. The wisdom of such a "structural solution" to Bangladesh's flood problems can be questioned on economic, environmental, and technical grounds. Regrettably, the decision-making process has not encouraged wide debate on these questions.

A massive flood control plan for Bangladesh, being launched under the coordination of the World Bank, could drastically change that nation's environment. The plan, which emerged largely in response to unusually severe floods in 1987 and 1988, has the stated aim of "higher economic returns from land, property and infrastructure" (World Bank 1989b, p. 4). Critics fear, however, that the resulting environmental modifications will threaten, not improve, the livelihoods of millions of poor farmers and fishermen.

The World Bank plan sets forth an agenda of flood control actions for the next five years, leaving the specifics of the longer-term agenda for later decision. The most dramatic long-term proposal, prepared last year by a team of French engineers, calls for the construction of hundreds of kilometers of tall embankments along the great rivers of the Bangladesh delta, including the Ganges and the Brahmaputra (French Engineering Consortium and Bangladesh Water Development Board 1989). Costed initially at $5.2–10.1 billion for construction, the French scheme would be the biggest development project in Bangladesh's history.

The French plan has powerful political backing. It was the centerpiece of the Third World development effort proposed by French President Francois Mitterand at the Group of Seven's Paris summit meeting in July 1989 (Summit of the Arch 1989, Item 50). The Bangladesh government of General H. M. Ershad also is vigorously urging a major flood control initiative upon international funding agencies, with an enthusiasm attributable in no small measure to the prospect of lucrative construction and middleman contracts for Bangladeshi firms.

The G-7 leaders and the Ershad government asked the World Bank to coordinate flood control plans for Bangladesh. At a meeting held in London in December 1989, the bank presented its Action Plan for Flood Control to representatives of the US, Japanese, and European governments, who are being asked to provide financial support. Despite grave and well-founded reservations as to the wisdom of massive embankments, the long-term strategy envisioned in the bank's action plan incorporates central elements of the French scheme.

KEY WORDS: Bangladesh; Development economics; Floods; Flood control; Natural hazards

The Setting

Annual floods created the vast Bengal delta over the millennia, depositing sediments washed by the monsoon rains from the slopes of the Himalayan mountains (Figure 1). The floodplains of the Brahmaputra, Ganges, Meghna, and some 250 smaller perennial rivers account for 80% of the area of Bangladesh. Ninety per cent of the water discharge (1,360,000 million cubic meters per annum) originates outside the country in India, Tibet, Nepal, and Bhutan (Alexander 1990). Within Bangladesh, 83% of the floodplain area is normally flooded in the summer monsoon season (Brammer 1990).

The floods also have shaped the lives and livelihoods of the delta's inhabitants. Rice, some of it grown in water so deep that the grain is harvested by boat, is the staple food of the people of Bangladesh. Fish caught in the rivers and flooded rice paddies are their main source of animal protein.

The Bengali language distinguishes between the normal beneficial floods of the rainy season, which are termed *barsha,* and harmful floods of abnormal depth and timing, which are termed *bonna.* The English word flood conflates these two very different phenomena. "The *barsha,* which occurs more frequently than *bonna,* is not considered [by Bangladeshi villagers]

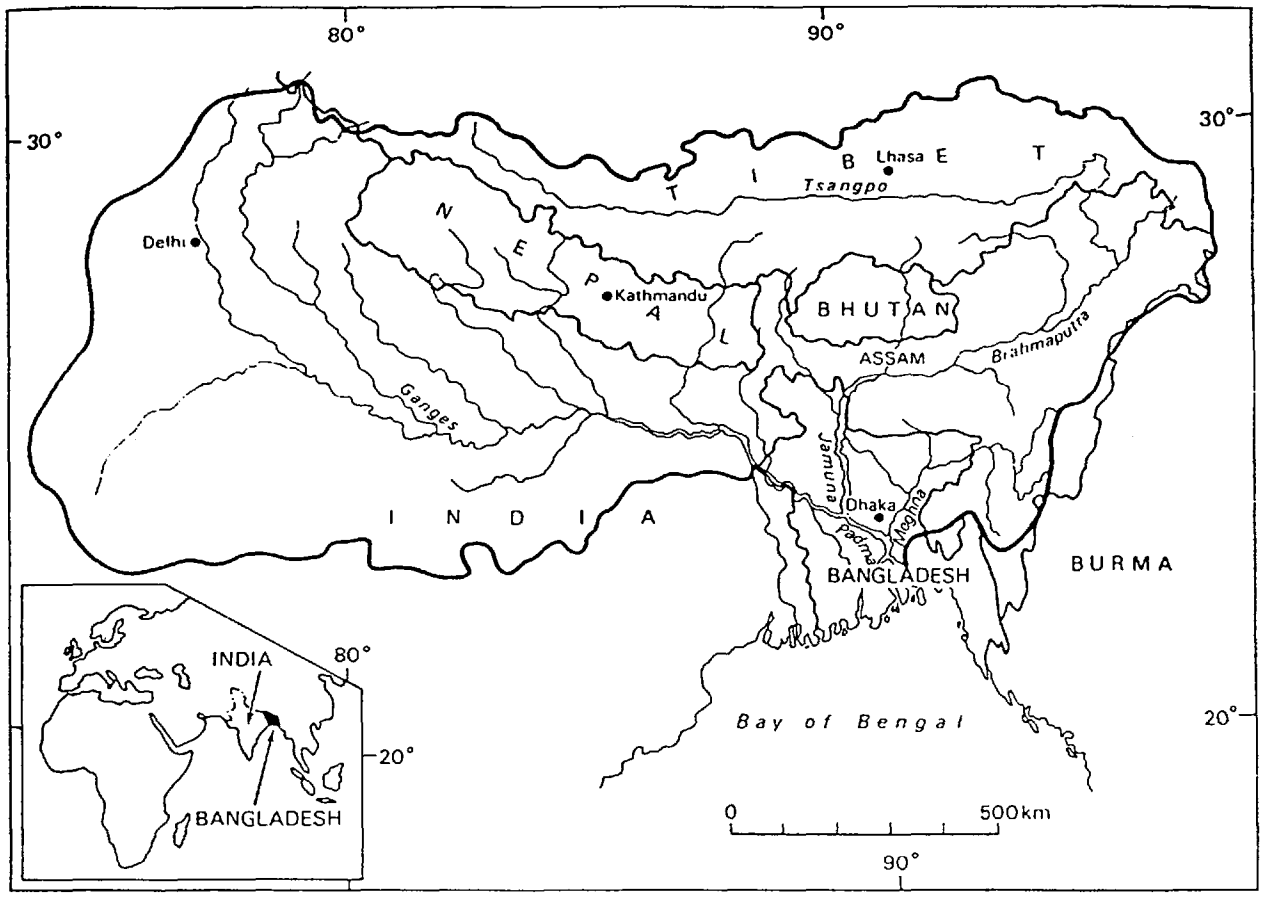

Figure 1. The Brahmaputra–Ganges–Meghna basin. Source: Brammer (1990, p. 13).

to be a hazard at all, but rather a necessity for survival" (Paul 1984, p. 10, see also Islam 1980).

During the summer months in which much of the countryside normally lies under water, wooden boats serve as the principal means of transport. In many places individual houses, which are built on raised land, become tiny islands in a shallow sea of rice and fish.

The boat was the election symbol of the party of Sheikh Mujibur Rahman, whose sweeping 1970 electoral victory precipitated civil war in East Pakistan and the birth of an independent Bangladesh. Independence brought in its wake a flood of a different sort: a huge influx of development assistance from foreign governments and multilateral institutions. Within two years more than $2 billion in external resources had flowed into the country, more than it had received in its previous 24 years as East Pakistan. Since then the influx has continued at over $1 billion per year. With the embankment project, this aid now threatens to sink the boat or, more precisely, to ground it.

Bangladesh has been governed by a succession of military-based regimes since Sheikh Mujib's assassination in 1975. The current regime of General H. M. Ershad, who seized power in a 1982 coup, has been described by *The Economist* (1986) as among the most corrupt in the world. A recent Unicef-sponsored study found that diarrhea-related illnesses kill 300,000 children each year in Bangladesh (*Wall Street Journal* 1990). The Ershad government's priorities are reflected in the fact that between 1980–1981 and 1987–1988 expenditures on "defense" rose in real terms by 73%, while in the same period government expenditures on health declined by 15% (calculated from data in World Bank 1989a, pp. 106, 138).

The 1988 Floods: Enter the French

The annual floods, which created the delta and which give life to its people, are fickle benefactors. Too little water can mean drought (Brammer 1987), threatening serious crop failures. Too much water can also create hardship. In 1988, floods described by hydrologists as a once-in-a-century event (United Nations

Development Programme 1988, p. 7, Rogers and others 1989, p. 35) forced millions of peasants to abandon their homes, seeking temporary shelter on higher ground. The disruption extended to the capital, Dhaka, where two-thirds of the city was flooded.

Among those who witnessed the 1988 flood was Danielle Mitterand, wife of the French president, who was visiting Dhaka as a guest of General Ershad (Powell and Shahriar 1989, Lydon 1989). Deeply moved by the experience, Madame Mitterand described the floods to her husband upon her return to France. The French president, in search of projects to implement his vision of greatly expanded aid to the Third World, responded by sending a team of 30 French engineers to Bangladesh to study the flood problem together with Bangladesh government engineers and to draw up a plan for its solution.

The French engineers' scheme, prepared in five months, would dramatically change the environment of Bangladesh. The country's great rivers would no longer meander across the countryside, spilling their waters and sediment onto the land. Rather they would be channeled to the sea between massive embankments. Rainwater accumulating on the lands behind the embankments would be discharged into the canalized rivers through gravity drainage and pumps, providing "total flood protection."

Initial estimated construction costs for the French scheme range from $5.2 billion (for embankments with a long setback distance of 2–5 km constructed by mechanical methods) to $10.1 billion (for embankments with a short setback distance of up to 1 km constructed by manual methods). Subsequent operation and maintenance costs are estimated at $160–180 million per annum in perpetuity (French Engineering Consortium and Bangladesh Water Development Board 1989). These estimates are likely to err on the low side, according to experts familiar with the plan.

Flood Prevention versus Flood Management

The primary economic rationale advanced for the project is that it will improve agricultural performance. There is undoubtedly much scope for increasing food production in Bangladesh. Despite some of the world's most fertile soils, it has the lowest per hectare rice yield of any major rice-producing country. Despite abundant water supplies, only one quarter of the cropland receives irrigation in the dry winter season. At the same time, rainy-season yields are constrained by inadequate drainage and unpredictable floods.

Improved water control—including drainage and dry-season irrigation as well as flood management—is widely recognized as the key to fulfillment of Bangladesh's rich agricultural potential (Boyce 1986, 1987, Hossain 1986). However, flood management does not necessarily mean flood prevention. Between the extremes of zero control and zero floods lies a wide range of alternatives, which seek to maximize the beneficial effects of floods while minimizing their damages. These include the construction of ponds for surface water storage and fish culture, local improvements in drainage, submersible embankments that would check flooding only during the crucial early weeks of the rice crop, and better preparedness for emergencies caused by unusually high and rapid flooding. These soft measures would be far less expensive and environmentally disruptive than the high levees proposed by the French engineering team. They also would require active participation by the local population in project planning and execution.

The danger of excessive reliance upon structural solutions to flood problems is illustrated by the United States' experience of increasing flood losses despite expenditures of billions of dollars on dams, embankments, and river channel modifications. The dominant structural approach itself contributed to larger flood damages, as large investments occurred in areas protected from moderate floods but not from less frequent floods of exceptional magnitude (Goddard 1976). This experience ultimately led to a shift towards nonstructural measures, including zoning, regulation, and flood insurance. Since the success of the latter depends greatly upon community acceptance, this requires an associated shift in the locus of policy making from federal to local governments (Costa 1978).

Economic Issues

In a recent article in this journal, Fearnside (1989, p. 401) compares Brazil's Balbina Dam to the pyramids of ancient Egypt: "Even if the structures are simply built and abandoned, they serve the short-term interests of all concerned—from firms that receive construction contracts to politicians wanting the employment and commerce the projects provide to their districts during the construction phase." In Brazil such projects are called pharaonic works.

Unlike the monuments of ancient history, today's pharaonic works are subjected to economic analyses: the present value of the benefits must exceed the present value of the costs. Flood control in Bangladesh has pushed economics to such creative heights that the results might be termed *pharaonomics.*

The French study enumerates three types of benefits to be derived from a multibillion-dollar embank-

ment scheme in Bangladesh: the avoidance of flood damage in abnormal years, agricultural benefits arising from changed cropping patterns in normal years, and indirect benefits to nonagricultural sectors (French Engineering Consortium 1989).

The agricultural losses caused by floods in abnormal years do not justify the massive expenditures needed for total flood protection. Indeed, a review of rice output trends in the past two decades indicates that years of abnormally high floods have produced normal or above-average harvests, whereas drought years have led to serious production shortfalls (Montgomery 1985). For Bangladesh's rice farmers, too little water is a greater threat than too much.

In years of above-average rainfall, positive effects in nonflooded areas typically compensate for flood losses. Thus 1988 saw bumper rice harvests in much of Bangladesh, despite the once-a-century floods, partly thanks to increased residual moisture and soil fertility in the dry winter season (Rogers and others 1989, Brammer 1990). Rice output surpassed 15 million tons, close to the all-time record set the year before. The World Bank (1989a, p. 15) reports that better-than-expected *aman* (monsoon season) and record *boro* (winter season) rice harvests, coupled with large-scale government imports in response to the floods, led to a foodgrain glut in Bangladesh in early 1989: "Boro procurement had to be suspended because of the lack of storage capacity; and market prices fell by as much as 25% below the procurement price, adversely affecting incentives to farmers."

Aggregate production data mask the flood losses borne by particular regions, since "there is no social transfer mechanism to compensate the losers" (Montgomery 1985, p. 169). In other words, the flood damage problem is not overall production losses but rather a lack of redistributive mechanisms.

Hence, while the impetus for a major new flood control initiative in Bangladesh arose from the abnormal floods of 1987 and 1988, the supporting economic calculations have placed greater weight upon benefits from changes in normal-year cropping patterns. The World Bank Action Plan, for example, declares that "economic justification of flood control rests more on the enhancement of land use than on the reduction of flood damage" (World Bank 1989b, p. 4). In some areas flood management (as opposed to flood prevention) would permit a shift from broadcast sowing of rice to seedling transplantation, which gives higher yields with current technology. On other lands, measures to delay the onset of the floods could expand possibilities for growing more than one crop per year.

Past World Bank experience in this respect is not encouraging, however. A highly critical internal audit of a recently completed World Bank-financed flood control project in Bangladesh, the major component of which was the rehabilitation of a 225-km embankment along the right bank of the Brahmaputra constructed under an earlier bank scheme, concludes that project was "not economic" as means to raise wet-season agricultural production and that dry-season gains arose from irrigation investments in which the embankment played no role (World Bank 1990b, p. 17).

The Brahmaputra project included polder schemes for the controlled flooding of compartmentalized areas, also a feature of the World Bank's Action Plan. Here the project encountered "operational surprises" arising from the lack of institutional mechanisms for cooperation in land use among cultivators: "Farmers on relatively high land within the polders had a different view from farmers on the low lands as to what constituted a flood. Gate settings that were just right for the former would be disastrous for the latter. Similarly, farmers growing jute may need flooding at times when rice growers in the same polder do not." In practice, the gates that regulated water inflow and outflow were "under the control of the most influential farmers." The audit points to the social constraints upon technological change: "The need for organizing farmers numbering in the tens of thousands to set up equitable polder operations is one of the great drawbacks of the polder technology for wet season agriculture" (World Bank 1990b, p. 17).

While the intended agricultural rewards of the Brahmaputra embankment largely failed to materialize, the project did yield one unintended benefit: About 100,000 landless people built shelters above the high-water mark along virtually the entire length of the embankment. "The construction of an artificial island for strip development of housing for the rural poor is an intriguing concept," the audit remarks wryly. Since housing construction involved excavation of the embankment, it was seen by the embankment designers as a threat to the hydraulic integrity of the structure. The World Bank initially put "considerable pressure" on the government to eject the squatters, but in the end it accepted the unplanned settlement as a *fait accompli* (World Bank 1990b, p. 17).

In the French prefeasibility study, avoided flood damages and projected agricultural benefits from changed cropping patterns account for only half of the projected annual benefit stream. The other half comes from an anticipated "acceleration of activity in the non-agricultural sectors," which is assumed to add

0.1% to the annual growth rate of these sectors (French Engineering Consortium 1989). Commenting upon this assumption, the World Bank auditor remarks: "Precisely what those indirect benefits are and how they are to be measured, if at all, is an open question of considerable importance" (World Bank 1990b, p. 11). Incorporating these benefits, the French study manages to project an internal rate of return of 10.9%–13.0% per year on the proposed investment.

The art of pharaonomics is not a monopoly of the French flood control team. At the World Bank, according to the audit: "Micro economic or project analysis for flood control projects [in Bangladesh] has increasingly become a formality that has little to do with reality. The imaginative search for acceptable rates of return, retroactive to the decision to transfer resources, has become the job of the project economist. The last time the Bank allowed the economic analysis to influence the design of a flood control project was in the early 1970s." The audit remarks upon "the extraordinary absence of formal evaluations of flood control investments in Bangladesh after twenty six years of experience" (World Bank 1990b, p. 19).

The World Bank's Operations and Evaluation Department, which produced the Bangladesh flood control audit, is not responsible for project implementation. This detachment enabled the auditor, in his own words, "to present this information in a manner that runs counter to the culture of an institution that attempts to be a lender of funds for economically justified projects." At the same time, however, the audit recognizes "the continuing pressure for large scale capital intensive 'solutions' to the flood control problem when all available evidence indicates that such schemes have not been cost effective in the past and are unlikely to be in the future" (World Bank 1990b, p. 21).

Environmental Risks

The environmental impact of embankments on inland fishing in Bangladesh is a cause for grave concern. As a recent United Nations Development Program study remarks, "Perhaps more than people in any country, Bangladesh's citizens depend on natural wild fisheries resources for their food and livelihood" (Minkin 1989, p. 2). Approximately 80% of the animal protein in the Bangladeshi diet comes from fish. Data for 1983–1984 indicate that inland freshwater fisheries accounted for 77% of the country's total fish harvest, and marine fisheries for the remaining 23%. Open-water capture is by far the most important source of fish, accounting for 80% of the freshwater catch. Closed-water culture, mostly in ponds, accounted for 20% of the freshwater catch and 16% of the total (Minkin 1989).

Half of Bangladesh's open-water inland fish catch comes from flooded lands, and the other half from inland rivers, estuaries, and *beels* (shallow depressions). Many species captured in the rivers, estuaries, and beels use the flooded fields as spawning grounds. Minkin (1989) reports that 60% of 251 identified fish species in Bangladesh are floodplain dependent.

These open-water fisheries are particularly important to the rural poor, whose income and subsistence rely heavily upon free public access to surface waters and their aquatic life. It has been estimated that 73% of rural families engage in part-time open-water fish capture (Minkin 1989, p. 7).

There is much uncertainty about the potential impact of large-scale embankments upon the ecological balance that underpins this industry, but past experience with smaller embankments in Bangladesh provides alarming precedents. An independent group of Bangladeshi scholars convened in November by the Bangladesh Agricultural Research Council (1989, p. 4), noted that the traditional diversity of Bangladesh's aquaculture resources "has already been drastically reduced" by embankments and that past projects have "left scores of fishing villages in decay." Minkin (1989, p. 8) reports, "Nearly total loss of open water fisheries has been documented in some flood control projects." The World Bank (1990b, p. 7) mentions that polder enclosures had a negative impact upon the fishing industry in its earlier Chandpur irrigation and flood control project.

There is enormous potential for expanded closed-water fish culture in Bangladesh, but growth in this sector does not offer a satisfactory substitute for open-water capture for three reasons. First, the sheer magnitude of open-water capture means that a 25% decline in the open-water harvest would necessitate a doubling of the closed-water harvest merely to maintain production at existing levels. Second, closed-water culture, particularly if based upon hatchery stocking, entails a reduction of species diversity and increased susceptibility to disease outbreaks. Third, and perhaps most important, the substitution of closed-water culture for open-water capture is also a substitution of private property for common property. In a socioeconomic context marked by stark inequalities of wealth and power, this can result in a dramatic curtailment in the access of the poor to aquatic food resources. Past experience in the rehabilitation of derelict ponds demonstrates this danger (Minkin 1982). The rapid spread of shrimp culture in semisaline areas in southwestern

Bangladesh similarly has reduced access of the poor to common property resources, including grazing land and drinking water (Guimarães 1989).

The role of flooding in the maintenance of soil fertility in Bangladesh remains poorly understood. An important benefit of the annual floods, only recently recognized by soil scientists, is that the blue–green algae that thrive in the floodwater play a key role in the fertility of the rice fields (Brammer 1988, Ladha and others 1985). The algae capture atmospheric nitrogen and then release this crucial nutrient in the soil for uptake by the roots of the rice plants. If this nitrogen source were eliminated by flood prevention, very large quantities of chemical fertilizers would be required to offset the loss. Less drastic interventions, involving changes in the timing, duration, and volume of flooding, could also affect algal growth.

The silt carried by riverine floodwater has long been thought to be important in maintaining soil fertility. Brammer (1988) questions this belief on the grounds that most floodplain areas are flooded predominantly by rainwater rather than by the rivers and that raw alluvium is "relatively infertile in the short term." Instead he emphasizes the short-term fertility benefits of flooding due to algae, the decomposition of weeds and rice leaves killed by submergence, and the alteration between reducing and oxidizing conditions of intermittently flooded soils. In the long term, however, the weathering of minerals in river alluvium also contributes to soil fertility.

"Very little factual information is available at present," Brammer (1988, p. 15) concludes, "on the relative contributions of biological and alluvial materials to short-term and long-term fertility." This underscores the need for much more scientific research before drastic interventions are contemplated.

Embankments: Some Technical Problems

The Bangladesh embankment scheme presents extraordinary risks and technical problems. The peak flow of the Ganges–Brahmaputra confluence in the Bengal delta is more than double that of the lower Mississippi. The rivers carry average suspended sediment loads of 2.4 billion tons each year, seven times the volume carried by the Mississippi (Schumm 1987). Deforestation in the Himalayas has added to the sediment loads, although the magnitude of this effect is a matter of debate (Alexander 1990, Ives and Messerli 1989, Rogers and others 1989).

If sediment were to accumulate in the confined river beds, this would necessitate massive annual dredging operations or else the construction of higher and higher embankments. Sediment accumulation plays a major role in the constant lateral migration of the rivers today. When the Brahmaputra River is at maximum flood, for example, bedforms up to 15 m high migrate downstream as much as 600 m/day. The greatest bankline shifts occur during the falling-river stage, when sediment bars change local flow direction. Lateral channel movements as high as 800 m/yr are common (Coleman 1969). Many experts consider the confinement of such rivers to be impossible.

The French plan envisages embankments with an average height of 4.5 m and a maximum of 7.4 m. The French feasibility study notes that maintenance of existing embankments in Bangladesh has been "badly neglected." Repairs are typically delayed until "the situation has already become critical." This policy would not "be viable any more" under the proposed project, the French study continues, since an "unexpected failure" of embankments would expose people living in protected areas to sudden floods of catastrophic proportions. Yet the study concedes that the capacity of the Bangladesh government to finance regular levee maintenance "remains an important question" (French Engineering Consortium and Bangladesh Water Development Board 1989, p. I-49).

The Bangladesh embankments would be constructed in one of the world's most earthquake-prone locations. An active fault line lies along the northern edge of the delta, at the foothills of the Himalayas. The largest earthquake on land known to seismologists, registering 8.7 on the Richter scale, occurred in this region in 1897 (Bolt and others 1977, p. 306). Witnesses reported that the quake caused plumes of water to gush from the ground. A century earlier, an earthquake caused major shifts in the courses of the Brahmaputra and Teesta rivers in northwestern Bangladesh.

In areas of recent sand and silt deposition with high water tables, such as the Bengal delta, earthquakes lead to liquefaction, the temporary loss of strength of sands and silts, which behave like viscous fluids rather than soils. Potentially serious consequences include the loss of bearing strength, lateral spreads, and flow failures (National Academy of Sciences 1985). The feasibility study drawn up by the French team addresses this risk simply by recommending that "special steps" be taken to compact the embankment foundations in the upstream reaches of the project (French Engineering Consortium and Bangladesh Water Development Board 1989, p. I-21). The glossy summary version of the study (French Engineering Consortium 1989), distributed to political leaders and the public, does not mention earthquakes.

The World Bank's Action Plan

The World Bank's Action Plan, unveiled at the December meeting, calls in the short term for pilot programs, flood protection for Dhaka, and further studies. It also emphasizes possibilities for controlled flooding, that is, engineering works to reduce flood damages without eliminating beneficial effects of flooding. The bank's plan represents a compromise among different proposals advanced in four recent reports commissioned respectively by the French, United States, and Japanese governments and the United Nations Development Programme (UNDP). At one end of the spectrum is the French proposal discussed above. At the other is the US-commissioned Eastern Waters Study (Rogers and others 1989), which advocates actions to help people "live with the floods" coupled with continued emphasis upon dry-season irrigation. The Japanese, whose potential financial role gives them considerable influence, are also reportedly skeptical about the French plan. The UNDP report occupies the middle ground (see Powell and Shahriar 1989, and Bingham 1989, for brief comparisons of the plans).

The Bangladesh government of General H. M. Ershad was reportedly "infuriated" by the "defeatist tone" of the US report; as *Newsweek* put it, the government "naturally prefers the bold French approach" (Powell and Shahriar 1989). The title of the US report also made it an easy target for the exploitation of nationalist resentment: The waters of the Ganges and Brahmaputra are not "eastern" from the standpoint of Bangladesh, but rather from the standpoint of neighboring India, with which Bangladesh has long been engaged in disputes over water sharing and the augmentation of dry-season flows (Crow 1981, Kaye 1989, Crow and Lindquist 1990). In the face of the Bangladesh government's hostility, the US ambassador in Dhaka and other US officials have sought to distance themselves from the report.

The UNDP report, prepared jointly with the government of Bangladesh, proposes large-scale flood control works but is more cautious than the French plan: "Although for the long term the strategy 'Flooding prevented' is probably the guiding model for flood protection, for the medium term, the strategy 'Flooding controlled' may offer the most feasible framework for a workable flood protection programme" (UNDP 1988, p. 19). The UNDP report notes that controlled flooding offers several advantages over total flood prevention: It would allow replenishment of surface and underground water reserves, improved conditions for fisheries, and continued internal navigation. Given these advantages, it is curious that the report nevertheless endorses a long-term model of "flooding prevented."

Figure 2. Proposed major embankments depicted in the World Bank's Action Plan. Source: World Bank (1989b, p. 93).

The World Bank's Action Plan adopts a similar stance. For the long term, it "envisages that the Brahmaputra and the Ganges may eventually be embanked on both sides, possibly followed by the Padma and Meghna rivers," an apparent (albeit not unambiguous) endorsement of the central element of the French plan (World Bank 1989b, p. 93). The plan includes a crude map depicting the proposed major embankments (Figure 2). According to the bank's flood control audit, the French and UNDP studies "were major inputs into the [Action Plan] document as controlling the major rivers is the underlying assumption" (World Bank 1990b, p. 13).

Individuals involved in the formulation of the bank's plan stress its research component. "At this point in time we feel that insufficient is known either to rubbish the idea of a major structural solution to the flood problem (e.g., the French and UNDP reports) or of concentrating primarily on a non-structural strategy (the Eastern Waters Study)," explained two experts who contributed to the plan (personal communication, anonymity requested). "The Action Plan is designed to

get the extra information that is needed to come to a decision about the potential and scope of future flood control works."

Few question the need for further research on the technical, environmental, and economic questions involved in flood control in Bangladesh. Critics fear, however, that the Action Plan advances an agenda in which certain answers are favored over others. The bank plan attempts to be "all things to all people," according to a consultant involved in its formulation (personal communication, anonymity requested). The inclusion of a number of soft options wins favor from critics of the hard approach proposed by the French team, but at the same time the action plan can be interpreted as a first step towards large-scale embankments. This possibility is deliberately left open in order to placate proponents of the hard approach within the Bangladesh and French governments. "No one wants to say that the emperor has no clothes," explains the consultant.

On the eve of the December 1989 meeting, one of the authors of the Eastern Waters Study offered this analysis: "Some donor-country representatives attending the London meeting will try to restrain the Bangladeshi engineers' response to floods, but the diplomats will not oppose embankments so strongly as to compromise their countries' future participation in this decision-making or to complicate relations with Bangladesh" (Lydon 1989).

Hence the World Bank (1989b, p. 91) states, "Future development of the floodplains of Bangladesh demands that, eventually, the river courses should be stabilized rather than be left free to change their geometry." Although perhaps motivated simply by the diplomatic exigencies of the moment, such declarations may open the door to large-scale engineering adventurism in coming years.

In a policy brief issued by the Bangladesh Agricultural Research Council (1989) on the eve of the London meeting, a group of senior Bangladeshi scientists charges that the concept of "staged developments" espoused in the World Bank Action Plan is "inadequate for coping with potential flaws in embankment-centered schemes."

The World Bank's Action Plan specifically allocates only $200,000 for environmental impact assessments. In addition, proposed regional and project feasibility studies will include unspecified environmental components. Peter Rogers, a Harvard University professor of environmental engineering who coauthored the Eastern Waters Study and has been involved in water planning in the region since the mid-1960s, charges that the aim is "to moderate embankment effects, rather than to affect the decision to construct or not to construct an embankment." In this respect, he maintains, environmental considerations have been "marginalized from the outset" (personal communication).

Concluding Remarks: Flood Control and Democracy in Bangladesh

Over the centuries, the cultivators and fisherfolk of the Bengal delta have learned to survive in a setting in which the boundary between land and water is elusive and ever-changing. Their accomplishment should not be romanticized: Millions of Bangladeshis today live near the edge of subsistence, while agricultural potential remains unfulfilled. Neither should their accomplishment be underestimated.

Indigenous adjustments to floods include the building of homes on natural levees, sand bars, and raised platforms; the planting of different rice varieties at different levels of the floodplain; the development of "floating" rice varieties that can grow by more than 15 cm in a 24-h period with rising flood levels; the use of bamboo stakes and fences to support and protect rice crops; and a continuous process of selection by which traditional and modern rice varieties are adapted to localized agroecological conditions (Brammer 1980, 1981, Rashid and Paul 1984).

This resourcefulness stands in marked contrast to the local populace's response to top-down initiatives of the Bangladesh government and its international patrons. Remarking upon the endemic problem of substandard maintenance of embankments built under past government schemes, the UNDP (1988, pp. 25–26) decries "the total disinterest often demonstrated by the population to maintain the structures and works that are to protect their life and property. Unless this situation is changed fundamentally," the report continues, "to the extent that people respect flood protection infrastructure and are willing to contribute to proper maintenance, the very purpose of building embankments and structures will be defeated."

Analogous problems have plagued past irrigation development efforts in Bangladesh. Marked inequalities in the country's land ownership pattern have not only biased the distributional outcomes of government interventions in favor the rural rich, but also have posed a formidable barrier to the local cooperation essential for water control development (Boyce 1987). In response, the government and international agencies pursued a strategy of subsidized private irrigation development, channeling pumps, and wells to large farmers.

There are indications, however, that this strategy is reaching its limits, as the opportunities for noncooperative irrigation are depleted. The World Bank (1990a, pp. 96–98) reports that the beneficiaries of the government's minor irrigation program "were essentially the large farmers." The bank cites "difficulties in group formation of small farmers" as a reason for declining sales of minor irrigation equipment since 1985 and observes that fragmentation of landholdings will "put a major management constraint on further expansion of minor irrigation."

Engineering can and must play an crucial role in addressing the water-control constraint upon Bangladesh's agriculture, but while necessary, engineering alone is not sufficient. First, there is a need for much more scientific research into the ecological complexities of the delta. Second, there is a need for the mobilization of the cultivators and fisherfolk who best know the terrain, and upon whose active involvement the success or failure of water-control initiatives will ultimately hinge.

Foreign engineers and their Westernized Bangladeshi counterparts often bring to this environment a very different ideal landscape, one in which land is dry and rivers are tame. Confronted by the delta, their impulse is not to learn from nature but to transform it.

French President Mitterand expressed this vision of progress in his September 1988 address to the United Nations General Assembly: "Development is achieved via the launching of major projects of world interest, which are capable of mobilizing energy to help such and such a region wounded by Nature, for example, stabilizing the rivers which flood Bangladesh. France, for its part, is ready to contribute" (quoted in French Engineering Consortium 1989, p. 3).

So far, the supposed beneficiaries of flood control in Bangladesh—the country's poor majority—have been virtually excluded from the decision-making process. The World Bank (1989b, pp. 7–8) concedes that past embankment projects have been undermined by deliberate cutting of embankments by disgruntled farmers and fishermen, and hence calls for "closer involvement of the beneficiaries" and "more cooperation among farmers." It provides no inkling, however, of how these are to be achieved in a context of military-based rule and a highly inequitable land ownership pattern.

Declaring that "democratic accountability requires public opinion first of all to be educated," M. M. Rahman, executive vice chairman of the Bangladesh Agricultural Research Council, stated in November 1989 that the Bangladeshi public "has the incontrovertible right to know" about the costs and benefits of proposed flood control investments (Bangladesh Agricultural Research Council 1989, p. 1). However, democratic accountability has not been a prominent feature of development planning in Bangladesh. As if to underscore this reality, Rahman was dismissed from his government post after making this statement.

In coming months and years, officials of the international agencies and the Bangladesh government will further consider how to treat the "wounds of nature" in the delta, erecting a long-term strategy upon the foundation of the current five-year plan. In the end, the good intentions, technological hubris, and political opportunism driving the embankment scheme may be tempered by economic and environmental objections. The cultivators and fisherfolk who have lived with the rivers for generations are likely, however, to remain notably unrepresented in the deliberations.

Literature Cited

Alexander, D. 1990. The case of Bangladesh. University of Massachusetts, Department of Geology and Geography, Amherst, Massachusetts. Mimeo.

Bangladesh Agricultural Research Council. 1989. Highlights of the discussion on floodplain agriculture, 30 November 1989. BARC, Dhaka. Mimeo.

Bingham, A. 1989. Floods of aid for Bangladesh. *New Scientist* 124(1693):December 2:42–46.

Bolt, B. A., W. L. Horn, G. A. Macdonald, and R. F. Scott. 1977. Geological hazards, 2nd ed. Springer-Verlag, New York.

Boyce, J. K. 1986. Water control and agricultural performance in Bangladesh. *The Bangladesh Development Studies* 14(4):1–35.

Boyce, J. K. 1987. Agrarian impasse in Bengal: institutional constraints to technological change. Oxford University Press, Oxford.

Brammer, H. 1980. Some innovations do not wait for experts: a report on applied research by Bangladesh peasants. *Ceres* 13(2):24–28.

Brammer, H. 1981. Traditional and modern methods of intensifying crop production in Bangladesh. Government of Bangladesh, Ministry of Agriculture and Forests, Dhaka.

Brammer, H. 1987. Drought in Bangladesh: lessons for planners and administrators. *Disasters* 11(1):21–29.

Brammer, H. 1988. Floods in the agroecology of Bangladesh. Relief and Development Institute, London. Mimeo.

Brammer, H. 1990. Floods in Bangladesh: I. geographical background to the 1987 and 1988 floods. *The Geographical Journal* 156(1):12–22.

Coleman, J. M. 1969. Brahmaputra River: channel processes and sedimentation. *Sedimentary Geology* 3(2/3):129–239.

Costa, J. E. 1978. The dilemma of flood control in the United States. *Environmental Management* 2(4):313–322.

Crow, B. 1981. Why are the Ganges and the Brahmaputra

underdeveloped? *Bulletin of Concerned Asian Scholars* 13(4):35–48.

Crow, B., and A. Lindquist. 1990. Development of the rivers Ganges and Brahmaputra: the difficulty of negotiating a new line. Milton Keynes: The Open University, Development Policy and Practice Research Group, Working Paper No. 19. February.

Economist, The. 1986. Where the right policies get no credit. 301(7468):October 18:23–26.

Fearnside, P. M. 1989. Brazil's Balbina dam: environment versus the legacy of the pharaohs in Amazonia. *Environmental Management* 13(4):401–423.

French Engineering Consortium. 1989. Prefeasibility study of 31 May 1989 for flood control in Bangladesh (7-page summary version).

French Engineering Consortium and Bangladesh Water Development Board. 1989. Prefeasibility study for flood control in Bangladesh. Draft final report. Vol 1: executive summary. Government of Bangladesh and Republic of France. May.

Goddard, J. E. 1976. The nation's increasing vulnerability to flood catastrophe. *Journal of Soil and Water Conservation* 31(2):48–52.

Guimarães, J. P. C. 1989. Shrimp culture and market incorporation: a study of shrimp culture in paddy fields in southwest Bangladesh. *Development and Change* 20(4):653–682.

Hossain, M. 1986. Irrigation and agricultural performance in Bangladesh: some further results. *The Bangladesh Development Studies* 14(4):39–56.

Islam, M. A. 1980. Agricultural adjustments to flooding in Bangladesh: a preliminary report. *National Geographical Journal of India* 26:50–59.

Ives, J. D., and B. Messerli. 1989. The Himalayan dilemma: reconciling development and conservation. Routledge, London.

Kaye, L. 1989. Resources and rights: rivalries hamper Indo-Bangladesh water sharing. *Far Eastern Economic Review* 143(5):February 2:19–21.

Ladha, J. K., I. Watanbe, and P. A. Roger. 1985. Biological nitrogen fixation in wetland rice. Pages 481–487 *in* Women in rice farming. International Rice Research Institute. Gower, Aldershot, UK.

Lydon, P. 1989. A dramatic "rescue" portends new calamity. *Los Angeles Times,* December 12, p. B7.

Minkin, S. F. 1982. Fishpond development and the landless. Danish International Development Agency, Norwegian Agency for International Development, and Swedish International Development Authority, Dhaka. Mimeo.

Minkin, S. F. 1989. Steps for conserving and developing Bangladesh fish resources. United Nations Development Programme, Agricultural Sector Review, Dhaka. Mimeo.

Montgomery, R. 1985. The Bangladesh floods of 1984 in historical context. *Disasters* 9(3):163–172.

National Academy of Sciences. 1985. Liquefaction of soils during earthquakes. National Academy Press, Washington, DC.

Paul, B. K. 1984. Perception of and agricultural adjustment to floods in Jamuna floodplain, Bangladesh. *Human Ecology* 12(1):3–19.

Powell, B., and H. Shahriar. 1989. Bailing out Bangladesh: will the world's wealthy nations stem the floods? *Newsweek* August 28, p. 42.

Rashid, H., and B. K. Paul. 1987. Flood problems in Bangladesh: is there an indigenous solution? *Environmental Management* 11(2):155–173.

Rogers, P., P. Lydon, and D. Seckler. 1989. Eastern waters study: strategies to manage flood and drought in the Ganges-Brahmaputra basin. Prepared for the Office of Technical Resources, Agriculture and Rural Development Division, Bureau for Asia and Near East, US Agency for International Development by the Irrigation Support Project for Asia and the Near East, Washington, DC. April.

Schumm, S. A. 1987. Rivers: streamflow and sediment yield. *The New Encyclopedia Britannica* 26:902–908.

Summit of the Arch. 1989. Economic declaration. Paris. July 16.

UNDP (United Nations Development Programme). 1988. Flood policy study. Draft inception report of the joint Government of Bangladesh and United Nations Development Programme teams. November.

Wall Street Journal, The. 1990. Death in Bangladesh. May 11, p. A10.

World Bank. 1989a. Bangladesh: recent economic developments and short-term prospects. Report No. 7596-BD. Asia Country Department I, Washington, DC. March 13.

World Bank. 1989b. Bangladesh: action plan for flood control. Asia Region, Country Department I, Washington, DC. December 11.

World Bank. 1990a. Bangladesh: poverty and public expenditures: an evaluation of the impact of selected government programs. Report No. 7946-BD. Asia Country Department I, Washington, DC. January 16.

World Bank. 1990b. Project performance audit report: Bangladesh: drainage and flood control project (credit 864-BD). Operations Evaluation Department, Washington, DC. January. Draft.