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# ABUNDANCE AND SCARCITY OF WATER IN BANGLADESH : ISSUES REVISITED*

## Introduction

One paradox of the water resources in Bangladesh is that there is excess water, at times in devastating magnitude, when the country does not need that much and there is too little, when it needs much more than is available. Both problems are pervasive affecting almost all the vital aspects of national life. The monsoon brings excess waters to cause flood which destroys whatever the country develops with its limited resources. Flood also destroys whatever infrastructure is built to contain the elemental force itself. The 1987 flood and the recent 1988 devastating flood sent alarm signals throughout the country that lives, properties, physical infrastructures and well-built urban areas – all are equally vulnerable to this particular menace.

In the dry season, acute shortage of surface water threatens crops, human and animal lives, navigation, commerce and industry, fisheries and ecology alike. Reduced flow of surface waters induces salinity intrusion affecting agriculture, industry and ecological balance. The trend is alarming in irrigation sector. For example,

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surface water irrigation by LLPs experienced a decline in the early 1970s because of limited availability of surface water. Dependence increased on tapping ground waters. But in the coming decades, limits of ground water may threaten the present boom in STWs before irrigation coverage reaches any significant proportion of total cropped area.

The problematic aspects apart, water is also a precious resource, perhaps it constitutes the largest single natural bounty of Bangladesh. Its importance in national life can hardly be overemphasized. The productivity of agriculture which as a sector employs 58 percent of the civilian labour force and contributes more than 50 percent of GDP is constrained by floods during monsoon when 70 percent of the foodgrain is produced, and by drought and consequent moisture deficiency when irrigation is needed.[1] Most decisive factors for agricultural productivity are water supply for irrigation, maintaining desired water level (drainage control) and conserving water quality (salinity and also pollution control). Besides, inland water fisheries currently produce 70 to 80 percent of total animal protein consumed in the country, while inland navigation accounts for 65 percent of cargo transport and 38 percent of passenger movement. In the dry season, 85 percent of the population depend on ground water for drinking and other domestic purposes.[2]

The combination of enormous problematics with tremendous resource value of water poses three-fold dilemmas for Bangladesh. First, there is a compelling element in its harnessing through well-planned measures, for if it is left to itself, both its scarcity and abundance would create havoc for life, property, economy and ecology of the country. On the other hand, development of some of the vital aspects of our national life and economy is contingent

1. See Master Plan Organization (MPO), *National Water Plan*, Summary Report, Dhaka, December 1986, p. 1
2. *Ibid.*

on controlling water, making it available in time and managing it properly. Thus, harnessing of water resource, which means control, availability and management of water, is key to our existence and hence, central to our development strategy.

Second, the problems are two sides of the same coin, they cannot be viewed in isolation. Segmented approaches focusing on one neglecting the other has cost the nation a lot. More important perhaps is the interlinkage among manifold dimensions of problems associated with water development. At one level, the problems have seasonal, spatial as well as magnitudinal aspects. At another they have domestic and international dimensions. At the international (bilateral and regional) level in turn, there are technical, political and legal aspects. A proper understanding of the interlinkage of these dimensions is required in order to attempt a comprehensive solution.

But a third dilemma complicates the scenario. Because the problems are two separate sides of the same coin, solutions to the problems often end up in contradiction. Water sector needs and priorities are not always consistent, even water sector scheme for one objective is counter-productive for other sub-sector needs and priorities.

Understandably, water-related issues have evoked a lot of public discussions in Bangladesh. Specially in the wake of the 1987 floods and more so after the 1988 devastating floods, profuse writings have come out in the press and a good number of seminars/discussions have been held in which concerned citizens, observers and experts have tried to find out the causes and suggest possible solutions of these complex water-related problems. But perhaps we are caught in an 'intensity trap'. On the onset of lean season, we are concerned about scarcity of surface water flow, depletion of ground water table and salinity intrusion. But when the flood comes in the monsoon, the concentration is on how to get rid of the unwanted water forgetting that this very water is so dear and

scarce a commodity in the lean season. What are the implications of these partial approaches to water development? Is there any scope of looking at the problems in their totality? Keeping these questions in view, the persent paper attempts at raising some pertinent issues concerning harnessing of water resources in Bangladesh. The focus of the paper is on two broad but most critical problems—floods during monsoon and shortage of surface water in the lean season from which all other problems follow. An attempt is also made to indicate some broad policy guidelines.

**Issues of Abundance—Flood**

*Concept and Classification* : Floods of different frequency, intensity, coverage and depth has been a recurrent phenomenon in the country from the time immemorial. Floods are usually classified in many categories : normal flood, moderate flood, severe flood, devastating flood and/or catastrophic flood.[3] Then there are general floods and flash floods depending on nature of catchment and rate of increase of water.[4] By sources of flood waters also floods are divided into rain-fall induced flood and tidal upsurge.[5] The question is : which floods we are talking about? This question is pertinent because certain amount of flood as such is not unwelcome to the people of this riverine and agrarian society. And people can, if with some difficulties, adjust to certain level of floods. It is severe and devastating/catastrophic floods that cause concern, increase extent of damage and at times, threaten our lives. But how to draw the borderline between these categories? Moreover, which aspects of the

3. P. C. Mahalanabis, *Report on Rainfall and Floods in North Bengal 1870-1922*, Calcutta, 1922, quoted in M. Maniruzzaman Miah, *The 1987 Flood in Bangladesh : A Hydromorphological Study* (unpublished), report prepared for the Bangladesh-Canada Agriculture Sector Team, CIDA, Dhaka, 1988.
4. Nurul Islam Nazem, "Management of Environmental Disaster in South Asia : A Regional Approach", *BIISS Journal*, Vol. 9, No. 3, July, 1988.
5. *Ibid.*

flood—frequency, area coverage, depth or rate of increase of water, duration and extent of damage—are of critical importance need to be determined. Shallow flooding spread over larger area and longer time may pose significant problem. Again, severe damage in short time and in relatively smaller area may stir the whole nation.[6] Quick rise in water level submerging the crops is a critical problem for the farmers. When all or most of these dimensions of flood combine, the outcome is devastating or catastrophic, as with the 1987, and more so with the 1988 floods which brought into sharp focus not only coverage, depth and damage aspects but also the time factor and the rate of increase of flood water (available chronological records of floods are given in Annexure 1).

Available earlier studies[7] emphasized on the frequency and aspects on the basis of which it had been forecast that in Bangladesh normal floods would occur every 2 years, moderate or moderately severe floods in 4 years, severe floods in 7 years and catastrophic floods in 33 to 50 years. When 1987 floods came in about 32 years since 1954, when a major flood with record level damage took place, the forecast was thought to be approximately valid. The 1988 flood, however, raised serious questions about the validity of such a forecast. In the country presently, available landsat data provide information on flood coverage, the Flood Forecasting Cell of the Hydrology Department generates data on rate of increase of major river levels at different points of time. Data on depths of flooding are available with the Mastar Plan Organization (MPO). Perhaps it is time that with the help of these data, regional flood behaviours be monitored and evaluated in order to update the existing flood probability map. A second point that is intended to be made here is that a combined index of all possible dimensions of flood should be followed to define various categories of floods. Following this combined index the 1954, 1974, 1987 and 1988 floods could be considered as devastating.

6. 1970 tidal bore in Bhola and other southern areas and 1985 tidal bore in Urir Char are examples.

7. P. C. Mahalanabis, *op. cit.*

Among these again 1987 and 1988 floods surpassed all past records in terms of area, depth, rate of increase, duration as well as damage. It is this type of flood that stirred our very existence and in people's minds, all and sundry, a countdown that perhaps in another 8-9 months we might be heading for another more devastating flood had already started. It is this type of flood that we shall be dealing with in what follows.

*Issues Relating to Causes of Flood*: Experts, analysts and concerned citizens—all have come forward with different explanations of the floods including the recent devastating one. There is a consensus that among the factors contributing to recurrent floods in Bangladesh the major ones are (a) the huge catchment area which is about 15 times bigger than the country itself; (b) geographical location; (c) relief and topography including the flat terrain; (d) low gradient of the rivers which averages at 3 inches per mile[8]; (e) sedimentation of channel with about 2.4 blllion tons of silts that come down from upstream every year; (f) pondage effects, created by tidal and monsoon winds pressure that reduce slope and discharge flow of water into the Bay of Bengal; (g) frequent meanders in channels; and finally, (h) ill-planned man-made infrastructures.

However, recurrence of flood as such is not the main problem. The problem lies in its intensity and its devastating magnitude. In explaining the increased intensity of flood in recent years a number of factors operating at three levels—domestic, regional and global—are said to be combined with the above causes. The domestic factors are : (a) criss-crossing network of roads and embankments that are constructed in unplanned and haphazard manner; (b) poldering of low lying areas that results in flooding of relatively higher but unprotected lands[9]; (c ) increased sedimentation and

8. Morgan and McIntre, "Quarternary Geology of the Bengal Basin, East Pakistan and India", *Journal of the Geological Society of America*, quoted in Maniruzzaman Miah, *op. cit.*,

9. The impact of roads, embankments and similar infrastructures may be explained by the fact that while flood levels of the Meghna at Bhairab bazar

choking-off in channels resulting from reduced flow of river waters, specially in the Ganges basin. The regional factors consist in mainly extensive deforestation in the Himalayan region. It is believed that over the past three decades there has been a 50 percent reduction in forest areas.

The recent earthquake, artificial melting of snow in the Himalayas for enhancing availability of water in the upstream in the lean season and opening of the barrage gates to relieve pressures on the barrage itself are also mentioned as contributing factors for sudden increase of waters in the rivers.[10]

Among the global factors mention is made of the substantive atmospheric and climatic changes including the so called 'greenhouse' or 'El-Nino' effects that also result in increased melting of snow and climatic disturbances. To what extent these factors are responsible for increased intensity of floods needs to be closely observed and studied through exchange of scientific data among regional and other countries.

Question is : what causes floods to assume devastating magnitudes ? Experts seem to emphasize the '*damming effect*', that is, simultaneity of reaching peak flows in all the three major rivers of Bangladesh—the Ganges, the Brahmaputra and the Meghna. Experts also emphasize the height of the peaks of the rivers. The relatively longer duration of flood water is also notable. Again a question can be begged : Why did the peaks occur simultaneously and at so much height and why did the waters take so long to recede ? The general agreement is on the presumption that there was intense rainfall in the catchment areas in very short period of time and this

and Chandpur in 1954 was higher than those in 1974 at those points, area flooded in 1974 was much more than in 1954 because of the fact that poldering of lower areas resulted in flooding of much more unprotected higher areas. See Mohammad Maniruzzaman, "Flood Problem in Bangladesh and Its Remedies" unpublished paper in Bengali, Dhaka, October 1988.

10. These have, however, been denied to be true by the country concerned. See *Holiday*, 23 September 1988, p. 3

caused the three rivers systems to swell within a span of three days compared to 30 days during 1954 flood, 27 days during 1974 flood and 34 days during 1987 flood.[11] It remains curious that unlike in the past, rainfall and snow-melting occurred this year at such times and in such intensities that given the meandering paths and choke points on the way, the three rivers reached peak flows simultaneously. At best, we ascribe this unprecedented phenomenon to probability factors.

An alternative explanation could be cumulation of all or most of the factors responsible for normal and severe floods as well as of the simultaneity factor. This means that significantly reduced discharge capability of channels, cumulative blockade with intensive rainfall in short period of time, combined with snow melting in the Himalayas—all add up to create floods of the magnitude that we experienced *for the first time* recently.

The coincidence or the probabilistic theory leaves a question : Will the coincidence or the probability factor operate again ? The cumulative impact theory would raise an even more awesome question : What if the devastating floods repeat on a continued basis and with bigger magnitudes owing to further cumulation? Does the occurrence of two consecutive floods in 1987 and 1988 signal the beginning of such an ominous trend? The questions need immediate answers based on careful analysis of facts and figures.

The substantive part of the section may be summarized in this manner : the problem of devastating flood boils down to two major issues having territorial and political implications : (a) flow of an extraordinarily huge quantum of water in very short and quick span of time entering Bangladesh from upstream and (b) passage of the same waters through channels and overland with such velocity and volume that inflict major harm on the people, ecology and the economy. The two issues may be presented in further simplified form:

11. Bangladesh Water Development Board, quoted in *Engineering News*, Engineers Institution, Bangladesh, Dhaka, August 1988.

*flow volume* and *passage*, both having a common and critical element, that is *time factor* : how quick or how delayed is the flow volume to enter Bangladesh and how quick or how delayed is it to pass through Bangladesh. Shall we address only one or both time elements? The policy makers and planners of the country will perhaps address this question. We, in the meantime, may try to identify the issue-areas related to the solution of the problem.

*Issues Relating to Solution of Flood Problem* : Proposal for solution of flood problem are perhaps much more numerous than the causes observed in the trend of on-going deliberations. And the frequency of divergences is also more than is the case with causes of flooding. However, the suggestions fall into two broad categories :

—*Controlling* floods
—*Living* with floods or *adjusting* to floods.

These lines of suggestions roughly correspond to the structuralist vs. non-structuralist schools, as they are sometimes called. All these schools, however, agree on two points : emphasis on lasting solution of floods on the one hand and regional approach without which, it is felt, permanent solution cannot be achieved, on the other. The consensus on regional approach stresses on the time element involved in the external flow volume that enters Bangladesh.

On the domestic front, the non-structuralist school has two sub-groups: one advocates leaving flood to itself, no control, allowing it to flash the country and adjusting life style, cropping pattern, settlement pattern to flood water; the second advocates for controlled flood through strengtheing of flood containing and discharge capability of the channels.

Since controlling flood through constructing structures has so long been the strategy of the country, some issues pertaining to this approach may be raised, to begin with. Firstly, it is argued that haphazard empoldering of flood affected areas on small and medium scale intensifies flood and delays recession of flood water. If so,

what should be our future strategy of water development? Secondly, what types of flood have we tried to control—external or internal —with respect to a particular polder area ? Existing flood control schemes, except perhaps few, do not provide for controlling internal accumulation of waters during monsoon when the level of outside water is higher than the level of internal water. This brings in the concept of on-farm management of water resource, a concept usually applied in case of irrigation during the dry season. Thirdly, the flood control projects might have provided crop security but in most cases, have not been able to raise agricultural productivity, one important objective of the flood control projects.[12] Finally and most importantly, can the existing flood control projects withstand the devastating floods? Apparently not. Then while addressing the devastating floods how would one take into consideration these flood control infrastructures in which crores of taka have already been invested ?

Then comes the question of living with floods. First, we take on the improvement of discharge and flood containing capacity of the channels. The question of improvement of navigability of the channels is also linked with this proposition. A debate is going on in the country regarding the feasibility of extensive dredging of river channels for improving channel capacity. It is not the cost factor alone that is the issue, the feasibility of dredging from geomorphological point of view is also questioned. Of course, those who advocate dredging are also emphasizing selective dredging. Some selective dredging on very limited scale is in fact being carried out from time to time. The cost of dredging would be quite high in absolute sense, no doubt. But the question to be addressed first is to what extent dredging is desired and feasible from technical and geomorphological points of view. Then the benefit-cost ratio calculation should include

12. See M. Moslehuddin and Abdur Rob Khan, *Study on Impact of Ten Early Implementation Projects in Bangladesh*, Vol. I, (unpublished) study report prepared for the Early Implementation Projects ( EIP ), BWDB, 1983—84

a number of factors on the benefit side: (a) average annual potential loss due to flooding, (b) investment on structural flood control schemes that can be spared because of channel improvement, (c) benefit to navigational sector and (d) benefits, limited though, to irrigation and fishing. To the extent dredging is not possible, the possibility of involving vast human resources of the country could be explored.

While discussing channel improvement issue, the strategic aspect of flood problem, the possibility of addressing the simultaneity of peak flows may be touched. Is there any way in which the "simultaneity trap" could be diluted not by attacking the time factor but the peak factor itself? The techno-economic feasibility of diverting part of Ganges flow into the Arial Khan and the Gorai and the Brahmaputra flow into the old Brahmaputra and the Dhaleswari may be explored in this context.

The second component of living with floods is adjustment of cropping pattern and life style with floods. Adjustments of cropping pattern with floods means making genetic transformation/adjustment of the main crops, namely, Aus and Aman crops, so that the crops become flood resistant. The possibility of innovating long stem HYV paddy by the Bangladesh Rice Research Institute (BRRI) has been heard since the 1970s. But todate the variety has not been replicated commercially. Probably, the necessity was not felt that urgently so long. Can we now hope that necessity would be the mother of invention ? Even then the question begs : Will the crop variety, so invented be resilient and luxuriant enough to grow at a rate in which the recent flood waters increased ?

The question of adjustment of cropping pattern in terms of timing, that is, shifting bulk crop production to the lean season is no less radical. About 70 percent of the food-grain (Aus and Aman) is produced in the monsoon and of this, 80 percent is contributed by Aman crop which commands 61 percent of the net cropped acreage.[13]

13. See Bangladesh Bureau of Statistics, *Statistical Tearbook of Bangladesh* (Dhaka, 1986), Table 4.

We compare this with the fact that only about 25 percent of the total cropped area has come under irrigation but surface water irrigation has substantially shrank and we are dealing with an unknown quantity with respect to ground water. It may also be mentioned that winter is the most competitive crop season. But then we have also to take into consideration the Aman plantation timing when the devastating floods occur. Should crop diversification be the beginning of an answer? And how about trying for a drought resistant variety to relieve pressure on Aman ? These agronomic questions need to be answered.

Question of adjusting life style is both romantic and realistic a proposition. Why it is romantic needs no explanation because for many in the urban areas, 1988 floods provided the first opportunity to witness flood waters. It is realistic in the sense that the bulk of the people in the rural areas have in fact been surviving floods for centuries.

A good number of proposals have been offered here. These include linear resettlement along roads, highways and embankments, raising homesteads and plinth level or even houses on raised platform. Which of these propositions are feasible legally, administratively and which are not, and to what extent they are consistent culturally need closer scrutiny.

We are left with the regional approach about which there is a general consensus, a rare occasion in Bangladesh, and with this the first stage of homework is over. Second and critical stage of homework lies in the political, diplomatic and legal arena. The stage has partly been set through bilateral understanding that have been reached with India, Nepal, Bhutan and China recently. But how is the regional parlance going to take place actually on the stage that has only preliminarily been set ? How are we going to relate this regional approach with the much-sought-after multi-lateral approach with regard to augmenting the lean season flow ? In the meantime, let us see what the lean season problem is.

**Issues of Scarcity of Water**

The single most parametric constraint that affects development of water resources during the dry season is the scarcity of surface water, specially in the Ganges Basin. There is no doubt that upstream withdrawal of water at Farakka contributes to this phenomenon. The question of water diplomacy between the co-riparian states is important here. Bilateral negotiations over the last one and a half decades between India and Bangladesh made little headway excepting a short term water sharing agreement. The proposal of inclusion of Nepal has merely been agreed upon, but no substantive progress has been achieved in implementing this agreement. Any success on this front would depend on several critical factors : technical preparedness backed by adequate legal arguments on the one hand and applying all possible leverages of diplomacy at our disposal on the other. The critical question at this point is how we are going to link the scarcity problem with the excess water, that is the flood problem. It is also important that we have our contingency plan at the domestic level.

The debate on the domestic front has again many facets, e.g., large scale vs. medium and small scale; surface vs. ground water; mechanized vs. gravity flow irrigation ; infrastructural facilities for irrigation vs. on-farm water management ; public ownership vs. privatisation of means of irrigation and the like.[14]

The debate between large scale vs. small scale irrigation projects is relevant in view of the fact that some of the ambitious large scale projects in Bangladesh did not materialize. But the small scale projects are early implementable and quick yielding. But should the large option be altogether given up? Projects may operationally be medium or small for successful implementation. But they have to be coherent, consistent and parts of a bigger project.

14. See Akbar Ali Khan, "Economic Considerations and Alternatives in Water Policy Formulation in Bangladesh", paper presented at a Regional Symposium on *Water Resources Policy in Agro-socio-economic Development*, Organized by the Government of Bangladesh, Dhaka, 4-5 August 1985.

In the context of surface water vs. ground water irrigation, LLPs are almost an extinct specie now. But should we give up the option altogether? How justified are we in reckless expansion of ground water-based irrigation system without knowing the ground water condition? Have we explored all possible avenues of exploiting the surface waters? This question is pertinent on three counts. First, we have to keep in the forefront the issue of strengthening the drainage capability of the channels for tackling the flood problem. To what extent we can combine the drainage improvement option with surface water irrigation option needs to be explored. Secondly, a number of rivers in the country are perennial. Now taking an incremental approach, can we explore the possibility of inter-river or inter-channel transfer of waters for facilitating surface water irrigation? We have raised the same question in connection with controlling devastating floods. Thirdly, the country has at the moment 1.8 million ponds spread over an approximate area of 6,60,000 acres.[15] Then there are almost equal number of *beels*, *khals*, *haors*, ditches and other water bodies owned by government in most cases but as they are getting dried up, these are being usurped by private individuals. On a macro plane of discussion where we are dealing with basin wise development of major rivers, these water bodies may not add up to anything significant. But taking an incremental approach, these water bodies may be renovated and re-excavated to increase their storage capacity. The possibilities of engaging human resources come again.

A final point on scarcity of water and for that matter, flood control is the consistencies and contradictions in needs and prioities. Flood control or cotaining floods may be broken into a set of specific objectives which in turn may be contradictory to needs and priorities in scarcity of water. Even within one broad category, the alternative solutions are not consistent (Annexures 2-5). But the fact remains that these objectives are not *alternatives* but parts of the broader goal of water sector development, Taking this in view, the feasible answer to

15. See Bangladesh Bureau of Statistics, *op. cit.*

water problem is the one that helps achieve all or most of the objetcives with minimum contradiction.

**In Lieu of a Conclusion**

This section provides a set of broad policy outlines in order to provoke discussions. The outlines are discussed in their international and domestic dimensions.

*International Dimension*: So far international dimension of harnessing water resources in Bangladesh is concerned, some basic propositions have to be accepted:

(a) the problem of flooding, that is, excess waters in the monsoon and the problem of scarcity of surface water in the lean season are interlinked and they can not be viewed in isolation;

(b) a lasting solution of the problem of controlling floods and augmenting water flow in the lean season has to be evolved on a regional basis involving the concerned countries. Now, in the regional approach, the centrality of India, because of her share in the total length and catchment area of the common rivers, has to be accepted.

The question arises: how to approach the problems on a regional basis? One good thing about the last devastating flood is that the water related problems as an international issue has gained wide recognition and sympathy from the international community. The need for regional approach to solving the problem has also been underscored by the international community. A second positive aspect of the flood is that it helped to widen the perspective of the international dimension. It should be mentioned that the initial clauses of the 1974 agreement between Bangladesh and India on water issue contained provisions for controlling floods as an integral part of harnessing water resources of the common rivers. However, later on the focus shifted to sharing and augmenting lean season flow only. The time is propitious to reactivate the issue of flood control also within the bilateral framework of cooperation.

The question is, how to arrive at a regional solution. The authors humbly submit that the answer lies in astute and vigorous diplomacy of Bangladesh to convince India for a political commitment to solve the problem for mutual benefits. The international sympathy and support that has been rather spontaneously offered, should be capitalized in two ways: convincing India and other regional countries about the seriousness of the problem and about the need for regional approach to the problem on the one hand and exploring the possibilities of mobilizing international assistance, on the other.

The starting point for the regional diplomacy could be Rajiv's agreement on including Nepal in the process of augmenting waters of the Ganges. The point that the authors intend to make is that the substance of any regional approach would be based on Indo-Bangladesh agreement. If India and Bangladesh agree about the need for any regional cooperation on this particular issue and if India and Bangladesh together approach the other concerned countries, there is a fair chance that regional cooperation in water issue would get off the ground. The hopeful sign is that all the concerned countries have agreed to cooperate with Bangladesh.

As we narrow down to the substantive part, we have to grapple with the problem of obtaining commitment of India. The role of political leadership in vigorous diplomacy, the role of technocrats and bureaucrats in sound homework and the role of the legal experts in providing a sound legal basis of the homework are critical. At this point the authors would like to make another humble submission. And that is we probably differ too much on any issue. Difference of opinion and existence of many schools of thought are healthy signs, no doubt. But, before floating a proposal to co-riparian countries, let the debate be held, let the people simultaneously become enlightened and then let us arrive at a particular set of proposals, against which we put our whole weight—technical, legal, political and diplomatic.

*Domestic Dimension* : Regional approach to harnessing of water resources is no substitute for domestic development. In the first

place, a sound and integrated development strategy for water resources itself provides strength to the bilateral or regional water diplomacy. Secondly, and most importantly, regional approach to solution of water related problems is not only capital intensive, it is time-consuming as well. Can we wait for that long time only to be plunged in another devastating flood ? Something has to be done immediately.

We have indicated the need for widening and deepening the major rivers and channels through selective dredging, if decided upon. For other channels massive excavation and re-excavation works involving manual labour should be our strategy. There are several thousand miles of seasonal and erstwhile perennial rivers and canals that get completely dried up during the lean season. Several thousand miles remain under shallow water with the outfalls and mouths choked up. Utilization of the manual labour is the answer. Even the *chars* (islets) in the major rivers can be lowered by removing earth through employing labour and country boats. Where such employment of human labour is not possible and where the river channel has to be deepened, dredging has to be applied. In any case, deepening and widening river channel will serve the tripple purposes of containing flood, improving navigational facilities and expanding surface water irrigation.

In point of providing passage for flood water, the question of overland drainage is important at least when flood waters reach a critical stage. This is where the question of haphazard and unplanned construction of roads and embankment comes in. As a general principle, the roads and embankments should not be antithetical to the natural slope and general direction of the rivers, that is North-South. A second guiding principle should be to ensure as minimum obstruction to passage of water-ways as possible. When roads are constructed, culverts and pipe sluices should also be provided for, closures should be avoided unless technical considerations unavoidably dictate so. Another technical point may be raised here. In

most cases, guided by technical and cost considerations, bridges, culverts and sluices are constructed over a diversion canal with narrower cross-section than the original channel. Because of soft soil composition which cannot resist water pressure and because the narrower cross section can not discharge volume along the channel, such structures were completely washed away by this year's floods.

To the extent possible, our attempt should be to adjust to the floods. Perhaps, there is hardly any alternative option if the 1987 or 1988 floods recur in future. The question of flood preparedness, minimising losses and relief operations naturally is of great importance here. During the last flood it was observed that the poorest section of the society, specially those who depended on selling of physical labour, were the most vulnerable to the ravages of flood. It is thus evident that strengthing the economic base of the poorest would contribute to flood preparation and minimization of the loss. Such a step would itself contribute to the development process of the country. This reinforces our earlier plea for combining human and water resources. Where does this argument lead us to? It leads us to the conclusion that given the prevailing circumstances, the national development strategy should be in fact *water-cum-human resources oriented development strategy.*

**Annexure 1**

**Available Records of Floods in Bangladesh**

| Year | Coverage (%of Area) | Extent of Loss (Tk) | Year | Coverage (%of Area) | Extent of Loss (Tk) |
|---|---|---|---|---|---|
| 1784 | — | — | 1971 | 25.3 | — |
| 1787 | — | — | 1972 | 14.4 | — |
| 1788 | — | — | 1973 | 20.8 | — |
| 1794 | — | — | 1974 | 36.6 | 10,000m |
| 1842 | — | — | 1975 | 11.5 | — |
| 1855 | — | — | 1976 | 19.7 | — |
| 1871 | — | — | 1977 | 8.7 | — |
| 1875 | — | — | 1978 | 7.5 | — |
| 1885 | — | — | 1980 | 22.9 | — |
| 1892 | — | — | 1982 | 2.2 | — |
| 1900 | — | — | 1983 | 7.7 | — |
| 1902 | — | — | 1984 | 19.7 | 2,500m |
| 1907 | — | — | 1985 | 7.9 | — |
| 1918 | — | — | 1986 | 3.2 | — |
| 1922 | — | — | 1987 | 39.9 | 15,000m |
| 1954 | 25.6 | 1200m | 1988 | 67.0 | 25,000m |
| 1955 | 35.2 | 1240m | | | |
| 1956 | 24.7 | 2180m | | | |
| 1960 | 19.7 | — | | | |
| 1961 | 20.0 | — | | | |
| 1962 | 26.0 | 1020m | | | |
| 1963 | 30.0 | 83m | | | |
| 1964 | 21.7 | 246m | | | |
| 1965 | 20.0 | 45m | | | |
| 1966 | 24.3 | 544m | | | |
| 1967 | 18.9 | 90m | | | |
| 1968 | 26.0 | 1645m | | | |
| 1969 | 20.9 | 330m | | | |
| 1970 | 29.6 | 1380m | | | |

(—): Not Available

Source : Figures for the period 1954-1983 from A.M. Chowdhury, SPARSO Data on 1984. 1987 and 1988 data from Newspaper Reports.

**Consistency and Contradictions in Water Development Needs** **Annexure 2**

| Sector / Development Scheme | Domestic Water Needs | Agriculture | Navigation | Fisheries | Industry |
|---|---|---|---|---|---|
| Domestic Water Supply | Municipal DTW dry up adjacent suction-lift pump | Some impact on urban fringe agril land dependent on suction-lift pump | Siltation around intake points may obstruct navigation | Negligible | Negligible unless industrial water supply system based on DTW is separate |
| Irrigation | —DTW/STW irrigation may dry suction-lift pump; lean season surface water irrigation may dry up source<br>—Intensive surface water use may induce salinity intrusion in South | -DTW owners capture water rights when STW and MOSTI dry up<br>-Intensive surface water use in South induces salinity crop damage<br>-Large scale irrigation may cause waterlogging specially in lowlying plots unless efficient water managent provided | Surface water irrigation reduces base flow in minor channels<br>-Embankment, closures and structures disrupt navigation | -Depletion of pond water level in permeable said condition<br>-Shift to salt water fisheries in Southern region<br>-Water control structures reduce free floating fisheries | -Depletion of surface and ground water<br>-Depletion intrusion following large-scale withdrawal |

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**Annexture 2 Contd.**

| | | | | | |
|---|---|---|---|---|---|
| Flood Control & Drainage by Structure | Decreased recharge of Ground water storage reduce overall availability | Same as domestic water supply | -Incrcased siltation in minor channels<br>-Closure of feeder network<br>-But increased flow in trained channels | -Disrupts free floating fish population in flood plains<br>-May encourage or discourage salt water fishing | Negligible |
| Channel & Navigation Improvement | Conductive | Conductive | Coaductive | Conductive | Conductive |
| Fisheries | Brackish water shrimp production may pollute ground water | Brackish water shrimp fisheries impair soil properties and soil moisture | None | — | None |
| Industry and Urbanization | Pollution of surface and ground water sources | Surface water demand may constrain irrigation availability | Surface water intake may increase silta tion | Pollution may impair fish culture | None |

Source: Adapted from W. Choudhury and M.H. Siddiqui "Towards a National Water Plan in Bangladesh" paper presented at a Regional Symposium on *Water Resources Policy in Agro-socio-economic Development*, Dhaka, 4-8 August 1985.

Annexure 3

**Consistency and Contradiction between Objectives and Options in FCD Project**

| Objective | Option (1) Accept current levels of flooding | (2) Introduce controlled flooding | (3) Full flood control and drainage |
|---|---|---|---|
| (a) Safety of life and Property | Not consistent | Not consistent but risks marginally reduced | Feasible policy |
| (b) Maintain present navigation routes | Feasible | Not consistent, disruption to navigation | Not consistent severe disruption |
| (c) Maintain present levels of fish production | Feasible policy | Feasible policy | Not consistent, —severe disruption of floodplain fisheries ; however intensive culture fisheries more feasible |
| (d) Increased crop production | Not consistent | Feasible for protection of late Boro and early Aus planting. Additional protection for Aman for late floods. Less risk may promote change to transplanted varieties. | Feasible policy but disruption to nevigation and reduced ground-water recharge |
| (e) Increased land and water under cultiva tion and higher crop yields | Not consistent | Not consistent | Feasible policy but disruption to navigation and reduced groundwater recharge |

Source : MPO quoted in W. Choudhuri and M. H. Siddiqui, "Towards a National Water Plan in Bangladesh", paper presented at a Regional Symposium on *Water Resources Policy in Agro-socio-economic Development*, held in Dhaka, 4-8 August, 1985

Annexure 4

**Consistency and Contradiction between Objectives and Option for Development of Major Rivers**

| Objectives | Option 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| | No further development | Develop short to medium term tech nologies floationg pumps, pumped offtakes | Limited development with major barrages | Full development with major barrages |
| (a) Increase food production in medium term | Not consistent | Feasible policy, limited results | Not necessary, too late | Not consistent |
| (b) In long term develop to limit of salinity at Ilsaghat | Not consistent | Feasible during period preceding barrages | May be feasible | May be feasible |
| (c) Maximize irrigated area and accepting yield reductions in salinity affected areas. | Not consistent | Feasible during period preceding barrages | Feasible policy | Feasible policy if salinity damages to yields can be mitigated |

Source : MPO, quoted in W. Choudhury and M. H. Siddiqui, "Towards a National Water Plan in Bangladesh", paper presented at a Regional Symposium on *Water Resources Policy in Agro-socio-economic Development* held in Dhaka, 4-8 August, 1985

Annexure 5

**Consistency and Contradiction between Objectives and Option for Development of Regional Rivers**

| Objectives | Options | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| | Prohibit additional withdrawals | Reserve a fraction of flow for fisheries and navigation | Allocate entire flow to irrigation |
| (a) Preserve existing fisheries and navigation | Feasible policy, Assumes protected fishery and navigation benefits exceed foregone agricultural benefits. | May be feasible in selected rivers. | Not consistent |
| (b) Accept reduction fisheries and navigation | Not required | Feasible policy, Attempts to balance combination of fishery, navigation, and irrigation benefits. | Not consistent |
| (c) Accept elimination of fisheries and navigatson during dry season | Not required | Not required | Assumes fishery will recover after day season and alternative transport is available |

Source : MPO, quoted in W. Choudhury and M. H. Siddiqui, "Towards a National Water Plan in Bangladesh", paper presented at a Regional Symposium of *Water Resource Policy in Agro-socio-economic Development* held in Dhaka, 4-8 August, 1985.