The myth of flood control

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Floods: an increasing menace

Floods are a serious problem in many river basins throughout the world, particularly in the monsoon and typhoon areas of South East Asia. In the ESCAP region, for example, the damage caused by floods today has been estimated at some $3,000 million per year. [1] In Asia as a whole, floods are said to destroy about 4 million hectares of crops every year and the lives of some 17 million people are affected. [2]

In recent years, floods seem to have been very much more destructive than usual. In 1978, India was struck by some of the worst floods in its history. Thousands of villages were flooded. Crops were damaged on millions off acres of farmland. Hundreds of people were drowned, millions were made homeless while damage to property and livestock is said to have run into billions of dollars.

In 1981, China was also devastated by record floods. In July and August of that year, 53 cities, 580 towns, 2,600 factories and vast areas of agricultural land were submerged in Sichuan Province. Houses containing 1.6 million rooms were destroyed; 1,000 people were killed and nearly 30,000 injured; and the cost of the damage to property was estimated at over a billion dollars. That very same year, floods ravaged neighbouring Shaanzi Province - causing the death of 764 people, injuring 5,000 people, destroying 160,000 houses, washing away 230 villages and leaving 200,000 people homeless. [3]

Similar tales could be told of the devastation caused by floods in many other parts of the world. Moreover, all the evidence suggests that such floods are becoming ever more frequent and destructive. Thus, in India, the National Commission on Flood Control estimates that the area ravaged by floods has almost doubled in the last 30 years. [4]

In the USA, according to Dr. Maurice Arnold of Philadelphia's Bureau of Outdoor Recreation, floods cost the country some $300 million in 1937. By 1976, the annual damage caused by floods amounted to $3.5 billion. At the time, Arnold calculated that - if the current trends continued - then the annual bill due to floods could reach $12 billion by 2000. [5]

More recently, Dr. Stanley Changnon, Chief of the Illinois State Water Survey, told the 1983 conference of the American Association for the Advancement of Science, that flood damage was costing $4 billion - and that the cost of such damage was rising at a steady 4.7 percent a year. [6] Although Changnon did not give an estimate of the likely future cost of floods in the US, his figures suggest that by the turn of the century the

cost of floods will have reached $9 billion a year - slightly less, that is, than the sum calculated by Arnold, but staggering all the same.

What, then, has gone wrong? Why - despite massive expenditure worldwide on flood control measures - does the damage done by floods continue to rise?

The failure of a strategy

The main methods used today for 'controlling' floods are, first and foremost, the building of embankments so as to contain flood waters within rivers; and, secondly, the construction of reservoirs in which flood waters can be impounded before being released at a rate which is sufficiently slow to prevent any destructive flooding downstream. Embankments, dams and other similar devices are referred to as 'structural controls'.

The historical experience with such controls has repeatedly shown just how ineffective they are. The inhabitants of China's Yellow River Basin, for instance, have built barriers to control the course of the Yellow River and its tributaries since time immemorial. Those barriers, however, have not prevented the Yellow River from flooding surrounding villages and agricultural land at least 1,500 times in the last 3,000 years - nor from changing its course on at least 26 occasions, 9 times very violently.

Despite the record, the Chinese Government - like other governments throughout the world - continues to rely on embankments to control floods. Yet the floods continue to occur. Indeed, there is now a growing body of evidence which makes it increasingly clear that structural controls do little or nothing to reduce the ravages of floods. On the contrary, they would appear to exacerbate the problem - not least by increasing the severity of those floods which occur. Thus:

In India, a National Flood Control programme was launched in 1953. By 1979, 9.75 billion rupees (nearly $1 billion) had been spent on embankments and other structural controls. Yet, as we have seen, flood damage is increasing year by year. Significantly, Mr. B.B. Vohra, who is President of the Environmental Planning Commission of the Indian Government, warns: *"The building of spurs and embankments - which, incidentally, have to be rebuilt or raised every year - is no answer at all to the problems of floods"*. [7] Rather than offer a solution to the problem of floods, says Vohra, the building of embankments *"merely creates the illusion of doing so"*.

In the USA, the situation is very similar. Thus, both Arnold and Changnon emphasise that the devastation caused by floods has increased in spite of the vast amount of money which has been Spent on flood controls. [8] Since 1937 - the year that the structural flood control programme was launched - the Federal Government has spent over $12 billion on structural controls and further massive sums on flood relief. Yet since then, as we have seen, the average annual cost of flood damage has risen from $350 million to between $3.5 and $4 billion in l976. [9]

Indeed, it even seems that much of the devastation can be blamed on the structural controls themselves. Thus, when hurricane Agnes hit the middle and North Atlantic drainage basins of the Upper Ohio River, it caused $3 billion worth of damage - more than any other single 'natural' disaster in the history of the US. It so happens that those areas were precisely where the most elaborate structural controls had been put up. [10]

So, too, Professor Arthur E. Morgan argues that the run-off which caused the l967 floods in the Lower Mississippi was no greater than usual - and that it was only because of the levees which had been built to contain the flow of the river that the floods were so destructive. [11] In a similar vein, Professor Charles Belt of St. Louis University, points out that the floods which ravaged the Mississippi basin in 1973 contained less water than a previous and less destructive flood: if they caused so much damage, it was largely because of the levees and navigation structures which had been built along the river. [12]

The idea that flood control embankments actually increase the severity of floods must seem paradoxical. It is, however, a paradox which is easily explained. By containing a river within concrete embankments, one does not reduce the total volume of flood waters. One does, however, dramatically increase the river's rate of flow - not least because the building of embankments tends to eliminate the oxbow bends which previously slowed down the river's waters on their way to the sea.

When a flood occurs therefore, the floodwaters are literally propelled downstream and, inevitably, the damage done in the flood plains below is correspondingly increased. It is for that reason that Arnold argues that channels or canals - also used as structural flood controls - should not be regarded as flood control mechanisms but rather as 'flood threat transfer devices'. [13] The same can indeed be said for embankments.

Deforestation, erosion and floods

The problem of controlling floods by structural means has undoubtedly been compounded by the widespread deforestation which has taken place in almost every part of the Third World since the Second World War. Such deforestation appears to be an inevitable concomitant of 'development' - not least because it is by cutting down forests and exporting timber (especially tropical hardwoods) that Third World countries earn the foreign exchange to develop. But cutting down forests does more than simply earn cash: it also increases dramatically the risk of flooding. Let us see how.

When the catchment area of a river is heavily forested, the elaborate root system of the trees acts as a vast sponge which soaks up rainfall, releasing it only very slowly to the river below. Once a catchment area has been deforested however, the runoff (as a proportion of rainfall) is vastly increased.

Thus a recent UNESCO study found that, when forested, the watershed of one selected river only released between 1 and 3 percent of the total rainfall: by contrast, once the area was deforested, between 97 and 99 percent was released to the river. During

periods of heavy rainfall, therefore, the volume of water carried by rivers in deforested areas can be massive. Inevitably, the pressure put on existing embankments is tremendous - thus increasing both the need for repairs and maintenance after each rainy season and the possibility that the embankments might simply collapse.

Deforestation has still another serious consequence. In a heavily forested area, the soil's organic content - and hence its structure - is maintained by the decomposition of the forest litter. At the same time, the soil is held together by the elaborate network of roots which underlies the forest floor and is thus subject to minimum erosion. Once the forest cover has been removed however, the roots rot away and there is no longer anything to hold the soil together. In addition, the soil - deprived of the forest litter - rapidly loses its structure, becoming very vulnerable to erosion by wind and water.

A study, quoted by Alan Grainger of Oxford University's Oxford Forestry Institute, shows that a natural rainforest lost only one tonne of soil per hectare to soil erosion; but soil losses increased to between 20 and 30 tonnes once the trees had been removed and the land put to cultivation.

Another study, conducted in the Ivory Coast, found that soil erosion in a secondary forest with a 7 percent slope was no more than 0.03 tonne per hectare per year. Again, once the tree cover had been removed and the area brought under cultivation, soil losses increased - in this instance to 90 tonne per hectare. When the land was left bare, erosion increased still further - with 138 tonnes of soil being lost per hectare. [14]

Under such conditions, during periods of heavy rainfall, the soil is carried down the denuded mountain slopes into the rivers below, correspondingly increasing their silt load (which, in the tropics, is already likely to be high). In normal circumstances, that silt would be deposited on the flood plains downstream when the rivers flooded their banks during the rainy season.

Where a river is channelled between embankments, however, such flooding is no longer possible: thus, the silt simply accumulates, raising the height of the river bed until - eventually - it becomes higher than the surrounding land. Indeed, where China's Yellow River crosses the Yellow plains, the river's bed is now five to ten metres above ground level.

Inevitably, such silting up further increases the pressure on embankments, whose height must continually be raised in order to prevent flooding. Raising the height of embankments, however, does not solve the problem indefinitely: in fact, in the long run, it is a measure which can only increase the severity of future floods.

The point is well made by *The Economist* in an article on the problems of flood control in India: *"High embankments have served to raise the level of several rivers above that of the surrounding countryside; and when a breach occurs, the result is disaster"*. [15] Sooner or later, *The Economist* concludes, erosion inevitably *"offsets the protective*

value of embankments". Indeed, the building of such embankments *"has proved to be no more than a temporary palliative"*.

As in India, the terrible floods that have ravaged China in the last few years have also to be no more than a tepporary palliative.

As in India, the terrible floods that have ravaged China in the last few years have also been attributed to increased run-off and erosion in the catchment area of the large rivers. Thus, Dr. Li Jinchang, Deputy Representative of the Permanent Mission of the People's Republic of China to UNEP in Nairobi, points out that, every year, the three major rivers in the Province of Sichuan now carry an estimated 250 million tonne of silt - the equivalent of 50 mm of topsoil over an area of 166,000 hectares of cultivated land.

Much of that silt, says Li Jinchang, has been washed away from land in the upper reaches of the Yangtze and Yellow Rivers which has been deforested in recent years. Indeed, an expert committee from China's National Science Association points out that it is no coincidence that, of the 193 countries in Sichuan Province,

"only 12 had forest cover exceeding 30 percent of their land area, while of the 53 counties in Central Sichuan, almost half had forest cover that was less than 3 percent of land area, in some cases, less than one percent." [16]

Much of that deforestation has occurred in the last thirty years. Thus, Wuzeng County - one of the areas worst hit by floods - possessed more than 10,000 hectares of forest in the early 1950s: by 1975, it had a negligible 56 hectares. Significantly, even the provincial authorities have blamed the recent spate of floods on deforestation. [17]

Building on the flood plains

During periods of heavy rainfall, free-flowing rivers regularly burst their banks and inundate their flood plains. In many countries, those floods are extensive. Thus, according to Arnold, seven percent of the total land area of the United States is subject to some flood risk. Five percent is classified as having one chance in a hundred of being flooded in any given year - such areas being known as 'hundred years plains'. [18] Flood plains occupy anything between one and 20 percent of most other countries - the figure being particularly high in Bangladesh, where something like 66 percent of the country lies in the flood plains of the Ganges and Brahmaputra Rivers.

In times gone by, people very sensibly avoided building permanent settlements on flood plains. Today, however, we live in an age of technological euphoria, in which man's ability to control the forces of nature is taken for granted. People have, thus, become accustomed to the idea that - so long as enough money is spent on embankments, dams and other structural controls - it is comparatively safe to build all the houses, factories and shops they want on the flood plains of the wildest rivers. Sadly, it is a belief that has been actively encouraged by both developers and governments alike -

governments in particular being attracted by the prospect of increasing their tax income from new developments.

Yet, it is significant that the 1969 United Nations Conference on Floods singled out the intensified use of flood plains as a major cause of the increased costs of floods in North America and Western Europe. The conference also argued that building on flood plains had greatly increased the potential for flood damage in Japan, Eastern Europe, South and South-East Asia, South America and Africa. So, too, Professor D.I. Sikka of the Department of Major Multi-purpose Projects, Madhya Pradesh, blames the terrible destruction caused in India by the floods of 1971 - and, indeed, by those of more recent years - on the intensified use of flood plains. [19]

Other Reasons why Structural Controls Cannot Work

From the above, it should be clear that - on theoretical grounds alone - structural controls are unlikely to solve the problem of floods. Those theoretical deficiencies aside, however, structural controls have other drawbacks, which make them still more inappropriate to the task in hand.

To begin with, they are too expensive - especially for those poor countries of the Third World (such as India, Bangladesh and China) where floods cause the most serious damage. Thus, in India, $900 million are expected to be spent in the next few years on flood control measures. Yet, even that vast sum is regarded by many experts as woefully inadequate. Indeed, it is argued, $1.3 billion needs to be spent in the Ganges Basin alone. [20]

Moreover, as Third World countries sink further into debt, the money required for structural controls is less and less likely to be available. That squeeze on funds will undoubtedly be compounded by the low priority which politicians give to flood control in general. Thus, even today, very few dams are built specifically in order to combat floods: indeed, out of the 1,554 dams listed in *The International Registry of Large Dams*, only 17 have been built for that sole purpose. More often than not, funds are only allocated for flood control when a disaster looms - a point well made by an editorial in *The Statesman*, one of India's leading newspapers.

"Parliamentary indignation is roused only when the waters are at their highest: demands and pledges alike being quietly shelved once the deluge has disappeared." [21]

Put bluntly: few politicians see any political capital to be gained from spending money on projects which bring neither visible nor immediate economic benefits. Cynics might even argue that the only political advantages to be derived from floods is when they actually occur when, in fact, politicians themselves can be seen to be 'doing something'.

Even where the money is available to build structural controls, there is the additional problem of their management. Indeed, Carl Widstrand argues that structural controls have little chance of success unless there is *"a highly committed administrative staff, as*

well as a sound organisational structure" to ensure that they are properly run and maintained. [22] In the Third World in particular, those conditions are rarely met - this despite the high-sounding titles of those departments responsible for administrating flood control programmes. Indeed, in many instances, those departments exist in little more than name.

Thus, according to the *Indian Express*, India's National Commission on Flood Control - set up in the wake of the disastrous 1975 floods - has remained *"in a state of suspended animation after the first chairman named for it was moved to a political office"*. Significantly, no-one has been appointed to take his place. Indeed, the newspaper goes on to brand the Commission as *"an alibi for evading positive action"*. [23]

The 'trade-off' between flood control, hydropower and irrigation

Where dams are used to 'control' floods, the problems of management are exacerbated by the desire of politicians to make the maximum use of the waters in the dam's reservoir. For flood-control purposes, the water level in the reservoir must be kept as low as possible: for the purposes of generating hydro-electricity or of irrigation, the opposite is the case. There is, therefore, a trade-off between, on the one hand, the containment of floods and, on the other, the provision of electricity and irrigation water. More often than not, the latter uses have priority. As Widstrand puts it,

"the high short-term value of water for irrigation or hydropower would be too strong an argument not to sacrifice some flood-mitigation benefits in favour of increased supply benefits." [24]

That trade-off frequently proves disastrous. Dr. A. L. Mukherjee describes how operations at a dam in West Bengal led directly to widespread flooding in 1978. [25] In their eagerness to generate the maximum amount of hydro-electricity, the dam's authorities maintained the reservoir practically full even during the rains of May and June. Those rains were particularly heavy and, as a result, the flow of the river was greatly increased. With the reservoir full, the river's floodwaters could not be contained behind the dam. Inevitably, vast areas of West Bengal were flooded.

More recently, we have the example of the 1983 floods which ravaged California. [26] Heavy snowfall - said to be three times the annual average - in the winter of 1983 resulted in greatly increased runoff from the Rocky Mountains during the following spring. The waters of the Colorado River swelled to almost unprecedented heights, quickly filling the reservoirs behind those dams which have been built along the river - and, incidentally, placing considerable stress on the dams themselves. Although it soon became clear that the water-level in the reservoirs would have to be lowered to avoid large-scale floods downstream, the decision to do so was put off time and again.

It is now clear that those delays were prompted by purely short-term political and economic motives. Worried about its massive budgetary deficit, the US government was

anxious that government agencies throughout the state should increase their incomes as far as possible. Thus, Bob Gottlieb of the Metropolitan Water District (MWD) later revealed to William Scobie of *The Observer* that the MWD was under strong pressure from Washington *"to squeeze every kilowatt from the river's hydro-electric stations"*.

So, too, says Gottlieb, there was pressure from California's powerful farming lobby to keep the reservoirs as full as possible in order that the maximum amount of water could be provided for irrigation. Meanwhile, the tourist industry - which, in California, has an annual turnover of billions of dollars - was also lobbying to keep water levels high so that the reservoirs could still be used for recreation.

When, in the first week of July 1983, a decision was eventually taken to release water from the reservoirs, it was far too late. Officials openly admitted that they were unleashing *"a controlled disaster"* on the south-west. Fifty-five thousand acres of farmland were flooded: thousands of people made homeless; an estimated $100 million worth of property destroyed; and at least five people drowned.

Nonetheless, the US government refused to admit that the floods were man-made - or, more precisely, politician-made. For its part, the Bureau of Reclamation attributed the error to faulty computer models - its own and those of the national Weather Service. Local hydrologists, however, were less sanguine: they told Scobie, *"the gates were opened ten weeks too late for basically politico-economic reasons"*.

Dealing with floods: the ecological approach

Serious floods are not simply acts of God. As Arnold points out,

"Too often, flood policies and programmes are based on the assumption that flood disasters result from nature's actions, not man's, whereas in actual fact the misery and damage are mostly caused by human error - especially by poor land management and myopic flood-control strategies." [27]

Those *"myopic"* flood-control strategies undoubtedly have their roots in the atmosphere of panic that reigns when a serious flood occurs. At such times, writes Arnold, *"rationality is difficult to achieve"*. He goes on to explain why:

"People in a trauma want immediate action which means dealing with the effects rather than the cause - in other words, building structural controls rather than adopting real long-term solutions." [28]

How then should the problem be tackled? Quite obviously, our first task is to prevent any further deforestation in the catchment areas of the world's greatest rivers. The importance of such an anti-deforestation programme is eloquently stated by B.B. Vohra, President of India's Environment Planning Council, in a recent speech on the subject of land and water management.

"The only way to tackle the growing menace of floods, is to control deforestation, denudation and soil erosion in the watersheds of rivers." [29]

Such a task

"must be undertaken on the most urgent basis, particularly in the case of the Himalayan rivers, if certain disaster is to be avoided. If this problem is not tackled in time, it is not difficult to imagine a situation in which, thanks to increasingly frequent and intense floods, and the consequent rise in the level of river beds, large portions of the rich flat lands of the Ganga basin may be turned into undrainable swamps. Perhaps it is already too late to save the situation because, while the denudation and erosion of the Himalayas is already far advanced and is growing rapidly, it will be years - even with the best will in the world - before we will be able to control it effectively."

In India - as in many other countries - flood control is the responsibility of the Irrigation Department, whose officials are mostly engineers or people with an engineering mentality. Unfortunately, that Department is totally committed to building structural flood controls and is apparently unwilling even to entertain the notion that the solution to the problem of floods is of a non-technical character.

For that reason, Vohra very sensibly suggests that the responsibility for controlling floods should immediately be *"handed over to organisations which can control soil erosion in the catchments"*. The trouble, of course, is that such organisations do not exist: moreover, were they to be created, it is questionable whether they could survive for long in the present politico-economic climate.

Any long-term solution to the problem of floods must undoubtedly go further than simply halting deforestation. Indeed, deforestation is now so far advanced in many areas of the Third World that a massive and systematic programme of reafforestation is of the utmost urgency. That reafforestation is required - and for many reasons other than just flood control - is generally accepted by both governments and international agencies.

The World Bank in particular has, on occasions, made the reafforestation of watersheds a condition for the financing of water-development schemes. But reafforestation for the World Bank (and most other aid agencies) still means the planting of row upon row of fast-growing pines or other exotic trees which often have a very shallow root system and, therefore, a minimal capacity either to retain water or to bind soils within their roots.

If, moreover, those trees have been chosen for planting, it is largely because there is a ready market for their timber: it is thus taken for granted that, one day, they will be cut down. Such trees are, therefore, of little use in combating erosion or run-off. If those functions are to be fulfilled, then it is of vital importance that reafforestation programmes ensure that a mix of native trees be planted so that the new forests resemble as closely as possible those that previously grew in the area. Only then can we be confident that the trees will be adapted to local geological, biotic and climatic conditions.

Finally, it is essential to prevent the further development of the flood plains of the great rivers. Again this is not only necessary for flood-control purposes. Flood plains, as Arnold points out,

"provide key links in many food chains. They are the habitat of numerous birds and other wildlife. They support a vast diversity of plant-life, they also provide some of the most fertile land and best-watered land for growing crops for a society that has mastered the technique of doing so." [30]

The last thing one should do with such land is cover it with housing estates and factories.

In a country like Bangladesh, where flood plains make up 66 percent of the land area, it will of course not be possible to prevent all building on the flood plains. But, where floods are of a common occurrence, people eventually learn to live with them. Among other things, houses can be designed and built that are able to withstand flooding or that can easily be rebuilt after inundation.

Above all, what is required is a completely new attitude towards the problem of flood control. We must abandon the illusion that floods can actually be eliminated. Regardless of the brilliance of our scientists, the ingenuity of our engineers and the generosity of the World Bank, floods will continue to occur. But they need not necessarily cause disasters. On the contrary, throughout history, floods have been made use of by populations inhabiting river basins to irrigate and fertilise their fields in a perfectly sustainable manner. If floods could be brought once more under the joint control of the forests and the flood plains, we too might learn to live with floods and derive from them still more sophisticated benefits.

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