Working Paper Series No. 90

RURAL PEOPLE, VULNERABILITY, AND FLOOD DISASTERS IN THE THIRD WORLD

Terry Cannon
August 1990

A version of this Working Paper will be published in:
P. Blaikie, T. Cannon, I. Davis and B. Wisner, At Risk: Hazards, vulnerability and the causes of Third World disasters, Unwin Hyman (forthcoming 1991 - provisional title).

Contents

Please note: this draft paper must not be quoted without permission. The final version will appear in P Blaikie, T Cannon, I Davis & B Wisner At Risk: hazards, vulnerability and the causes of Third World disasters London: Unwin Hyman 1991 (provisional title). The book is aimed at students, government officials, activists, NGOs and others in the North and South who are interested in the realisation that disasters are not natural, and that planning for them must take account of peoples' vulnerability as well as the necessary technical measures. Comments and criticisms that can assist in this function are especially welcome.

'Rural people, vulnerability, and flood disasters in the Third World'

Terry Cannon

Introduction

The environmental hazard which annually affects more people than all others (excluding epidemic disease), especially in the Third World, is flooding (Ward 1978; UNDRO 1978: p.1).[1] Floods are the most widespread of all hazards, and may even affect places which at other times are prone to drought.[2] They are destructive of life not only through drowning and direct injury, but also associated diseases and famine. But their impact is also disastrous because of the disruption and destruction they cause to livelihoods. The loss of assets or ability to work, of land and animals or of injury and illness, may be felt for many months or even years after the inundation has subsided. Any deaths which occur after such a time-lag are unlikely to be linked to the flood.

Some flood hazards are entirely a product of the natural environment. But this is not the same thing as saying that disasters which appear to be caused by floods are natural disasters. Disasters occur when people and their livelihood systems are vulnerable to such hazards; a disastrous outcome should not be regarded as automatic. Vulnerability is a product of human-created environments which locate people and their livelihood systems in hazard-prone places, and human-created economic and social systems which allocate societies' resources to the detriment of some groups and in preference for others.

Flooding may be associated with famine (as for example in Bangladesh in 1974), and this may be more significant as the cause of death. Even where flood disaster does not extend into famine, the impact of the deluge on many people's livelihoods is at least medium-term disruption and probably hunger for some groups of people. Usually long-term vulnerability is increased, so that starvation is a more likely outcome from the next hazard-strike. Land and other assets may be lost or have to be sold. If the next flood reduces wage-earning opportunities (for instance for agricultural labourers when there is no harvest to be weeded or gathered), the associated higher food prices in the markets may lead to starvation for some even when there are adequate food supplies around (Crow 1984).

A lot of what is discussed in this paper concerning patterns of vulnerability to floods may also be relevant to cyclone-prone areas. But the more detailed discussion of tropical cyclones will be left out, despite the fact that they are often a proximate cause of major flooding. This is mainly because there are other distinct forms of wind damage involved, and also the precautionary measures needed to reduce risks are different.

Floods and known risks

There are few flood hazards which are not known about as a result of prior occurrences of similar events, although this is complicated by the different return periods. As with other natural hazards, there are trade-offs in some economic systems between the livelihood benefits from inhabiting a risk zone, and the potential disastrous consequences of the hazard itself. The most common gains are in farming on flood-plain alluvium, the cost advantages of industrial and urban locations on flood-plain sites, and enhanced fishing opportunities derived from the nutrient-rich waters brought to ponds, lakes and rivers by fresh-water inundation. In this sense, human action through settlement patterns has created the flood risks, though there are many variations in the degree of vulnerability of different sections of a population.

But there are also floods which might almost entirely be attributed to human action. With these, people's vulnerability may arise not from the site itself, but because of the supposed benefits to livelihoods from economic activity in other places, sometimes far distant from the flood-zone itself. The most prominent examples of such problems are those produced by flood-control measures which shift the surplus water problem elsewhere, or of dams built (whether or not to control floods) to inadequate standards or on unsafe sites which collapse and cause flash floods.

There is also the issue of human intervention through deforestation, which results in the change of rate of flow of water into river systems, and generally increases the risk of flooding downstream. This results from both the increased discharge of water itself, and its potential for overtopping of river banks, and the augmented load of silt and debris carried into rivers from the less-protected soil. The eroded material carried by the water reduces the river channels' capacity to transport water away. In upland areas themselves, sudden landslips and soil movements, some of which may be associated with deforestation, can lead to stream-damming and floods of farmland and villages. The mechanisms some people use for dealing with their 'normal' poverty and vulnerability can induce them to follow practices like deforestation which may increase flood risk for themselves and for millions of others in distant downstream areas.

A typology of flood hazards

A pragmatic definition of a flood hazard might be the existence of more water than is wanted by a given population in a particular place at a particular time. Unfortunately this situation is brought about by a wide range of natural phenomena, and also by some aspects of human action. The disastrous outcome of floods are examined shortly, for just as it is possible to design a typology of the hazards themselves, various forms of vulnerability can also be distinguished. Part of the purpose of this paper is to argue that analysis of such vulnerability leads to much better explanations of why floods can be disastrous. First though, we see what sort of natural and human-induced events can act as the trigger.

Riverine Floods

The key to understanding most floods is that as a matter of course many rivers rise above their banks and inundate the adjacent flood plains. The plain itself is formed by the action of bank overflow, with the deposition of silt on low-lying ground near the channel. As a result of deposition, the adjacent land is flattened, irregularities in topography filled, and the ground-level gradually raised.[3] This process is affected by the volume of water precipitated onto the catchment area (and perhaps melt-water from snow and ice), the ability of the catchment to absorb and retain water rather than let it run-off, and the nature of the erodible material in the upstream area and how much of it is carried away by the water as sediment and debris load.

If there is more precipitation or snow-melt than can be carried by the stream system, if the water reaches the streams without sufficient retention by soil and vegetation, or if the capacity of the channels is reduced by sediment, then there is an increased risk of a flood. Depending on the speed with which these factors operate, the flood itself is regarded as a flash flood (often with high velocity and led by a high wave whose impact force can be very damaging, and normally affecting hilly areas), or a slow-onset flood, the arrival of which may be signalled in advance, and which affects flood plains.

Such flooding may be made worse by the fact that rain which raises the rivers' flow is often also falling in the area around the sections of the river which may overflow, so that land is already waterlogged, lakes and ponds filled. In catchments which have snow and ice melt begun in the spring, there may be an unhappy coincidence with the rainy season, as in the Ganges and Brahmaputra basins.

The problem of sediment load is shown up in two ways. When silt is deposited it restricts the size of the stream and river beds, so reducing the effectiveness of the river system in transporting water down to the sea. Secondly, the sheer volume of material carried by the water increases the amount of fluid which has to be contained within the river banks, hence increasing the risk of overflowing.[4] Particular topographies can produce magnifications of this effect, for instance when a river emerges from an upland area (with relatively steep gradients) to a plain (with shallower gradient). The resultant slowing in the river's velocity means that sediment load is deposited, restricting channel carrying capacity. Usually the plain itself is a product of the flood process inherent in this change, and often combines the hazard with good quality arable land.

Such is the situation in the North China Plain as the Yellow River emerges near Kaifeng from the mountainous middle reaches. Here, it is likely that this river's floods 'have claimed more lives and caused more human suffering than any other single natural feature on the earth's face'. (Clark 1982 p.37). The lower reaches of the river, as it snakes across the North China Plain, are retained within high embankments, and the river bed itself is raised above the level of the surrounding land. Because of this, breaches in the dikes lead to virtual flash floods, rather than slow-onset river plain floods. Despite massive disasters (and floods which on average cover more than 7,000 square kilometers) it is one of the most densely settled areas of the country on account of the agricultural potential of the land.

It is widely recognised that the reduction of vegetation on the slopes of river catchment areas increases the rate and volume of water run-off, by reducing the absorptive capacity of vegetation and the soil it retains, and the decreased effectiveness of a denuded slope in retarding water-flow. The loss of stabilizing vegetation cover increases the erodibility of slope material and can lead to the scouring of the surface down to bare rock, which has little water-retention capacity. Conversely, there is ample evidence that increasing the vegetation cover on catchment slopes changes runoff considerably. Data from the USA on the reduction of runoff as a result of afforestation shows peak discharges reduced by an average of about 60 per cent over a 25 year period (UNDRO 1978).

But despite the widely accepted view that deforestation is the major cause of siltation and increased run-off, this is a matter of deep controversy in current analysis of the Himalayas and flooding in north India and Bangladesh, as is illustrated later. To this deforestation factor should be added the evidence that high silt loads and debris which disturb river flow are being generated by the rapid growth (in geological terms) of some mountain systems. The orogenic uplift of mountains increases the instability of slopes which contribute stream debris through erosion and landslips, and this is a natural process. But is this factor additional to devegetation, or is it sufficiently intense in itself that it makes human action proportionately much less relevant? Some research indicates that we have to remain much more uncertain about answering this question than is often thought (Thompson & Warburton 1988; Ives & Messerli 1989). They argue that the run-off is not necessarily greater in recent decades (as a result of deforestation) than it has been in centuries past.

Coastal flooding

In some cases, flood plains and other low-lying land near the coast are subjected to floods triggered by more than the river system itself, and this can initiate some of the most devastating disasters. Tropical cyclones are the major culprit here, though it is other coastal hazards that are dealt with in this chapter. Many rivers disperse their water to the sea by means of the dense and complex network of distributaries of a delta. In effect, this is the seaward extension of the floodplain itself, the many channels which distribute the water being a product of the river depositing its load as it encounters the still waters of the sea, unable to carry it further. Deltas are therefore inherently low-lying and waterlogged, with a slowly extending seaward edge.

They are prone not only to flooding similar to that affecting rivers, but also storm surges and the earthquake-induced tsunami. Both of these types of event produce higher than normal water levels and clearly have serious implications for other low-lying coastal areas and mid-ocean islands as well as the deltas mentioned.

Storm surges. These are often linked with tropical cyclones, but can occur otherwise in association with the low atmospheric-pressure systems of less extreme but deep depressions (cyclones). The effect of storm-localised low atmospheric pressure is to 'suck-up' sea water to above-average levels. The increased height may be 125 cm or more in the case of the more severe tropical cyclones. Such a body of water can have a devastating impact on unprotected coast or islands, especially if it coincides with high Spring Tides, the action of the wind in both piling up water against the coast and raising waves (which increase the height and damage potential). The surge-induced flooding in Bangladesh in November 1970 may have killed as many as 300,000 people and directly affected 2 millions (Ward, 1978).

Tsunami ('Tidal waves') are waves produced by volcanic eruption, under-sea earthquake or landslumps into or under the water. They radiate at high speed from the epicentre (700 to 800 km per hour is not unusual). Their wavelength is exceptional - often more than 150 km and sometimes as much as 1000 km between peaks of successive waves, which may be several in number (Ward, 1978). Tsunami are most common in the Pacific, on other Asian coasts generally, and in the Mediterranean and Caribbean. The name is taken from the Japanese, and is preferable to the misnomer 'tidal wave', since the phenomenon has nothing to do with tides.

In May 1960, southern Chile was affected by a severe earthquake which set up a tsunami which caused loss of live and damage on Pacific coastlands up to 16,000 kilometers away. The impact in Japan was unexpectedly bad, with wave heights up to 10 metres causing many deaths. Part of the problem is that the particular characteristics of tsunami wave structure means that the shape of coasts and the slope of the seabed near the shore can concentrate the impact and reduce its speed while increasing its height. Normally having a very shallow amplitude (height) in open water where they may pass unnoticed by shipping, it is not unknown for tsunami to generate onshore waves of 10 metres and as much as 30 metres, depending on the slope of the shore. Such massive strikes of water can be devastating, especially for low-lying coastlands, though the mortality is rarely as bad as that of the event in the Bay of Bengal in 1876 which killed 200,000 people (Ward, 1978).

While storm surges have a medium-term onset, making forecast and warning possible, tsunami are much less predictable, as they are usually a result of earthquakes with an under-sea epicentre. In situations like the Pacific fringe countries, the distances from epicentre to the potential target coasts is sufficient to allow tsunami warnings of several hours. Some tsunami warning systems have been developed, and are useful given the huge distances that still-damaging waves can travel after they are first detected. Elsewhere, in seas like the Caribbean or Mediterranean there is not enough distance/time.

Climate shifts

One distinct flood hazard, not easily included in the others though in some ways sharing various of their consequences, is the phenomena of sudden climatic changes. The best known example of such phenomena which brings much increased rainfall is El Nino, which periodically affects the west coast of South America. The change usually occurs in December, so the local people's name, El Nino, signifies 'God's child' in relation to Christmas. It is a warm-water current brought against the coast by an end-of year reversal of the trade winds. It disturbs the normal upwelling of cold-water from deeper levels, which are nutrient-rich and provide the basis for successful fishing.

Occasionally, the event can be extreme, particularly when the increase in water temperature may be 10 degrees Centigrade higher. This means that the onshore winds are saturated with water vapour and release torrential rain over the coasts, mountains and deserts of south America. Other places, including south Peru and Bolivia, and more distantly Australia and Indonesia appear to experience a concurrent drought which seems to be related to the severe El Nino event.

In 1982-83 El Nino struck badly, principally affecting Peru and Ecuador. In parts of Peru a state of emergency was declared: rainfall in the first six months of 1983 was many times more than the total rainfall of the previous ten years (Gueri et al, 1986). Flash flooding and landslides destroyed many roads, irrigation facilities, dams and bridges. Mortality directly caused by floods does not seem to have been high, but disease and health problems were made much worse, and people's livelihoods suffered enormously as will be seen later.

Human action and floods

Most of this paper is concerned with floods related to natural hazards and looks at the way in which social and economic systems can lead to them becoming disasters. But there are floods which are the direct result of human agency as well. The profit-seeking priorities of businesses and the inadequate building supervision by the relevant authorities can lead to dams which are sited inappropriately, or where the dam's construction is to inadequate standards. All dams ought to have precautionary and warning systems (for dam failure, overtopping and emergency release) and the lack or inadequate nature of these can lead to disaster when the dam fails or is overtopped in a flood.[5]

There are also a number of cases in this century of deliberate flooding being caused in military actions during warfare. In China in 1938, a disaster of immense scale was caused across a huge area of the North China Plain when a General of the retreating Nationalist Army ordered the dikes of the Yellow River to be blown up near Kaifeng. The intention was to impede the advance of the Japanese invaders with the inundation. The scale of the resulting flood over 23,000 square kilometers ought to have been predictable given the history of the river; it is estimated that half a million people died and that six million were left homeless (Clark 1982).

On a much smaller scale, in 1944 British and German forces bombed sea-dikes in The Netherlands to inundate low-lying land in aid of their respective advance and retreat. And in the Vietnam war, United States bombers supporting the government of the South tried with little success to demolish the retention dikes on the Red River, with the intention of destroying crop-land and disrupting the economy.

Other flood hazards

One last category deserves mention, though it affects many fewer people than those dealt with so far. In mountainous areas of extreme relief and unstable slopes, rainfall may generate landslips or mudflows which block rivers. Such events can in themselves be disastrous especially if they strike settlements. But they can also lead to a double-flood risk: firstly water backing-up behind what is in effect a natural dam may inundate villages and agricultural land. Then, if the dam becomes unstable due to being saturated or unstable because of the sheer force of water behind it, a flash flood of considerable size and velocity can be released down the valley to strike settlements and livelihoods often many kilometers away. In 1841 on the upper Indus river in today's Pakistan, a huge dam formed after the side of a mountain fell into the valley, creating a lake 60 km long and 100 metres deep; its bursting led to a massive flood down the Indus, affecting areas 500 km distant (Ward, 1978).

A typology of disastrous outcomes

The existence of a flood hazard is not a sufficient reason for there to be a disastrous outcome, an argument crucial to the approach used here. To understand how disasters happen in the context of floods, we need to analyse the various patterns of vulnerability generated by different economic and political circumstances.[6] It will also help to see what types of disasters occur, and indeed why it is that in some situations seemingly similar flood hazards do not have disastrous consequences.

We shall also see that it is often difficult to separate the problems generated by one sort of hazard from those ostensibly derived from another. In other words, though it is the type of hazard event which dominates most peoples' perceptions of disasters, many people are vulnerable whether struck by an earthquake or a flood. But this is not so straightforward. It is necessary also to be clear that we are not equating vulnerability with poverty. So for example in some floods there is a pattern of consequent famine, and the groups affected may not be identical at all to those affected by a drought striking the same area. Of course in precautions and prevention, it is vital to address the particular characteristics of various hazards; but this is not enough - the best precautions and preventions are those which end or reduce the vulnerability of people, and this is rarely achieved through technical means.

Mortality, morbidity and injury

Floods are not only the most widespread of natural hazards, likely to affect more people in more parts of the world than any other. They also lead to the greatest loss of life, immediately through drowning and fatal injury and through illness and famine.[7] Others may die later, never to be counted as victims of the deluge, in the deepened vulnerability of those whose livelihoods suffer a further downward twist of the spiral.

In a wide range of Third World countries, floods frequently lead to large numbers of deaths. Flash floods are particularly hazardous, because of the combination in many regions of people in vulnerable locations where this risk is not offset by precautions or warning systems. Combination floods in which there is a coincidence of riverine inundations with heavy rainfall and/or coastal storms are also much more disastrous than ordinary slow-onset floods.

From China in August 1988 there were reports of the worst floods for centuries in the coastal province of Zhejiang, where flash floods took at least 256 lives, with over 300 missing.[8] Extreme events of such rarity are understandably difficult to anticipate. But other parts of that country share, with many other upland regions of the world, the risk of flash-floods which have much shorter return periods, and for which precautions ought to be possible.

Compared with other countries, in China both the scale of the hazard and the history of attempts to deal with it seem extraordinary. Massive inundations still occur, though events in which hundreds of thousands would die, especially in the valley of the Huanghe (Yellow River), seem to be in the past.[9] In recent decades, effective flood evacuation and follow-up organisation has reduced mortality considerably. Sichuan (Szechwan) province in south-central China experienced a deluge of gigantic proportions in July and again in August 1981, affecting nearly 12 million people and over 800,000 hectares of farmland, about 7 per cent of the sown area. The number killed was put at 920.[10]

Aside from the many casualties which can be caused by flooding brought by the impact of tropical cyclones on low-lying coasts, the highest direct mortality figures appear to result from rapid-onset deluges brought by flash floods (including dam bursts) and tsunami. Slow-onset riverine inundations of flood plains seem to bring lower direct casualties (and these more from building collapse, other injuries and snake bites than from drowning), but to enhance the risks of disease and malnutrition in the months or even years following.

This pattern is recognizable in the 1988 Sudan disaster, which affected worst of all the millions of people already refugees from civil war and famine in the south of the country. Many were not prevented by the authorities from settling in low-lying, flood-prone land around the city of Khartoum. Bangladesh experienced immense slow-onset floods for two years running in 1987 and 1988, on top of the devastation of 1984 and 1974. These had in any case increased many peoples' vulnerability, as have the occasional tropical cyclones which have struck some areas as well.

Increased risk of disease such as cholera and dysentery arises from sewage-spread and the contamination of drinking water, while the incidence of malaria and yellow fever grows from the multiplication of insect vectors in the stagnant water which may remain lying about for months after an inundation, often held back by raised structures like roads and railways which have inadequate or unmaintained ducting for the return flow of water back to river channels. In addition, respiratory illnesses often become more prevalent, and take a toll especially among very young children and babies, and the elderly. Disease itself when not fatal, or injuries caused in the flood (e.g. by building collapse) are important factors in the perpetuation of vulnerability and its extension to new groups of people. The sick and injured usually cannot work, and the family's loss of their labour, especially during attempts to recover after a hazard strike, can be an element of the disaster.

There are insufficient surveys to know much about what actually happened to people after floods strike. An idea of the pervasiveness of morbidity and disablement problems is given by a 1980 sample survey in Pakistan of rural settlements in the Ravi valley. The people interviewed were asked about their experiences in three years in the previous decade in which floods were particularly bad. Of the families questioned, between 43 and 57 per cent of members fell ill after floods, and 'at least one member of every family is bed-ridden throughout the coming season' (Sikander, 1983, p.102). Pakistan regularly experiences flooding affecting around 700,000 people a year, though in bad years like 1971, 1975 and 1979 investigated in the survey, between three and six million were affected.

The health problems are particularly highlighted in studies of El Nino's 1982-83 impact, not because they were especially bad compared with other regions of the world, but because again there are valuable survey results. In Ecuador, many rural people fled to towns and cities, optimistic of conditions there when the waters failed to subside in the countryside. They took with them malaria, leading to the infection of urban areas previously cleared of the disease. The floods greatly increased the number of cases of malaria anyway. Despite massively increased insecticide sprayings, the number of cases rose in 1983, and even more in 1984, to levels ten to twenty times those of previous years (depending on location) (Cedeno 1986).

To the south, in neighbouring north Peru, a study of government health centres showed morbidity rates up by 75 per cent for respiratory and 150 per cent for gastro-intestinal illnesses in the first six months of 1983 (compared with the same period the previous year when El Nino had not been extreme) (Gueri et al, 1986). These illnesses led to a large increase in death rates.[11] The centres surveyed covered a population of only 630,000; the number of deaths in the first half of 1983 was 6,327 compared with 3,226 in the same period in 1982. This 'unseen' aspect of the flood hazard, which may be repeated in many other inundations where such detailed figures are not available, give deeper significance to the notion of flood disaster.

None of the illnesses were unknown; they were endemic in the region. Their much-increased incidence was a predictable result of the deluge, and ought not to have produced such high mortality. But they struck a population many of whom were already very vulnerable owing to existing economic and social conditions.

The 1983 El Nino was of intensity unknown for over fifty years. As with other hazards that have a long return period we have to ask how fair it is to consider human factors in the causing of the associated disaster. There is a strong argument here that the 'collective memory' needed for hazards with a long return period ought to reside with government at local and national level, if it is unreasonable for it to be held by the community. However, the conditions that make this successful are likely to be similar to those which determine the value of government action/inaction in other respects. Certainly, in one town in north Peru, the role of government had not included the guardianship of collective memory. While some inhabitants of the town of Sullana recalled rain of similar severity to the 1983 El Nino some seventy years previously, a dangerous site was built on in the interim. Housing and the market built in an old water course were all destroyed or flooded.

Livelihood disruption

While death, illness and disablement lead to a reduced capacity for work in affected families, there are other impacts on peoples' livelihoods which make some vulnerable and others possibly enriched. Not all groups in flood areas are necessarily disaster victims. The flood may have its impact on different social and economic groups in a more or less severe manner. Famine associated with flooding may be generated by the coalescence of several disruptions in some peoples' means of existence.

Each group's 'bundle' of property and assets (including land and animals for farmers, or boats and nets for fishers) and economic connections with others in or beyond the group, may be lost, enhanced, disrupted or reinforced in a number of permutations.

The sort of livelihood disruption just alluded to are not necessarily bad for everyone in a hazard area. In floods it is of course true that much property is damaged, destroyed or swept away. But even flooded land can be sold by a destitute farming family to buy food, despite its likely low prices arising from many others making such 'distress sales' at the same time. The same applies to other goods, and so there are beneficiaries of the disaster who can accumulate land or other assets at depressed prices. Others may benefit from their possession of food stocks, selling at higher prices in the aftermath. Still others may have saleable goods or services on which they can thrive, perhaps trading in drinking water by virtue of owning a boat to carry it around.

This sort of disaggregating approach to the impact of hazards is a vital element of the analysis, because it enables us to see that although possibly a large majority of people are made worse off, floods may not be a disaster for everyone. They operate under the influence of rules and structures derived from the existing social and economic system, but modified by the distinct characteristics of particular flood strikes and patterns of vulnerability.

House and domestic losses

The poor in most third World countries are rarely insured. The loss of the home is a major livelihood setback, not because it is necessary for earning a living (though it often is), but because of the burden on limited finances in providing some replacement. This cost may not be in terms of cash outlay, but instead the loss of time which would otherwise be used in livelihood/earning activities.

Many simple household items may need replacing, such as cooking pots and water vessels. This also diverts time and labour from livelihood activities, or consumes limited reserves. There is no need to provide a list here; the point is evident, that recovery is not just about the hardship of loss, but also the disruption of normal livelihoods. In a sense then, uninsured people with no reserves of cash lose twice in a flood disaster: they lose the goods many of which are essential to life, and they lose the time which they have to spend in work to replace them, which is therefore not so available for survival (in food-growing or wage-earning). Having reserves or insurance means being able to return more immediately to normal livelihood activities.

Crop and animal losses

Other losses may be directly disruptive of a person, family or larger group's livelihood. Standing crops are a property-loss to the farmers who own them (and for the poorer families this is perhaps the most serious aspect of flooding). In many areas of the world, there is an unhappy coincidence of the season in which floods may be more likely and the crops ripening for harvest. However, crops in some parts of the world are well-adapted to expected levels of flood. Many thousands of varieties of rice have been developed indigenously in south and south-east Asia, and they include types which grow with rising water, and the floating varieties planted in many areas.[12] But even these will succumb to inundation under some circumstances, along with non-adapted crops.

For larger land owners, there would normally be a need for labourers in flooded fields whom they no longer need to employ. That there is perhaps a massive loss in wage-earning employment on the flooded fields may be disastrous for the poor families which rely for a large part of their livelihood on such income-earning opportunities as ploughing, weeding, irrigating and harvesting. The impact of crop loss on better-off land owners is likely to be much less disastrous, depending on the amount of the families' reserves.

The length of time that water remains on the land may also affect the prospects of the subsequent normal planting, or of a 'catch crop' aimed at recovering some of the losses. The difficulties which follow crop-loss vary, depending on the existing level of vulnerability of the affected people, from an immediate deepening of hunger through to a reduction of cash or material reserves. Whether the loss is of food crops for subsistence or sale, or of other cash crops, the flood-affected people are very likely to have a reduced resistance to the impact of the next hazard.

Animals may be swept away and drowned or injured, and their loss to those families which used their produce for subsistence or sale suffer in a manner similar to that of crop loss. But animals are often the main source of draught power and/or transport for significant sectors of the rural population in many parts of the Third World. In Sikander's study of Pakistan, the surveyed villagers reported 35 per cent losses of their animals. So the risk of their death or injury in floods adds a further measure of vulnerability. Recovery is often not to the same level of well-being as before the hazard struck.

Loss of land

The necessity to give up land through distress sales during times of hardship associated with floods has been mentioned already. It is a part of the process by which productive resources are redistributed in the Third World countryside from the vulnerable to better-off groups. But in floods there is also the physical process by which land is destroyed by the erosive capacity of the flood streams, and recreated in the areas where silt is deposited as sediment-laden waters are slowed down.

Flooded rivers are by definition flowing beyond their usual banks. Their route across the countryside, if unconstrained by human constructions, will be through the lowest-lying land, which provides new routes as gravity pulls the deluge down the gradients. Rivers carve new channels in this way, often miles away from their previous course. The distances of such channel migrations can be large even for relatively small rivers like the Kosi in Bihar, north India. There the highly braided (split) channel has moved westward across a hundred kilometer-wide tract of country for the past 250 years at least (Ives and Messerli 1989). In the Yellow River floods of the last century, its main channel has migrated hundreds of miles from the north to the south and back again. At times it has joined up with the Yangzi and discharged near Shanghai; at others its mouth has been near Tianjin (Clark 1982). The two cities are a thousand kilometres apart.

Those who lose land is lost in part or in total in this process are unlikely to have access to the compensation of land to replace it, even should they get other forms of aid. Yet others may find that fortuitously the river has abandoned a channel near them, making it possible in time to colonise the waterlogged land. However, the more powerful and already better-off classes are more likely to gain control of such new land, as happens in Bangladesh (Elahi 1989).

But land is 'lost' in other ways too. Depending on the speed of the flood waters at a given place, the soil itself may have been carried away. Generally though, as flood waters spread out across the landscape, they slow to a pace at which they can no longer carry their suspended load of silt and sand. They then deposit the sediment on top of the earth, and the characteristics of it can vary tremendously. In some regions it is usually beneficial in replenishing minerals which are useful to plant growth and otherwise improving fertility; the nature of the silt deposited is benign. But this is not always the case. The size of deposited particles may be much larger, covering extensive areas with infertile sand or gravel. The mineral content of the sediment may be too saline or alkaline, rendering the ground toxic to plants.

Depending on the combination of these different factors (water speed and consequent erosion or deposition, the size of deposited particles and their chemical characteristics), the land left behind can be enriched and newly fertilized by the layer of deposited silt, or more barren and less productive, with a crust of inferior sand or minerals which inhibit plant growth. Flash floods in Rajasthan (west India) are likely to produce the latter situation (Seth et al 1981), in a region which is more normally facing up to problems of drought rather than inundation. The Kosi's floods in north Bihar also normally deposit a layer of sand over agricultural land, rendering it useless for fifty years (Lyngdoh 1988).

In Bangladesh it is more likely that flooded land is enriched by the new layer of silt cast on it by the floods. Further downstream in that country, the waters of the Ganges and Brahmaputra arrive at the Bay of Bengal laden with silt, are stilled by the sea and add new material for the expansion of the delta. This new land, often in the form of islands called chars in the middle of the many channels of this complex river system, is quickly squatted by poor and landless peasants from elsewhere who otherwise have no means of subsistence. Their precarious existence on the edge of this watery boundary-zone is being aided by NGOs in some places by the building of protected high-points which offer some security during cyclones and storm surges.

Poor and landless peasants in Bangladesh and other countries often become victims of floods through loss of their livelihood rather than life or home. Farmers with sufficient land to require the use of wage-labour will not need to employ others if the harvest is destroyed by flood. If those who normally would be employed have no alternative, then their normal 'entitlements' to a means of subsistence suffers disruption. They may end up in towns or cities seeking relief, and may even be forced to resettle on the chars or dikes.

River-based livelihoods

Water itself is an important part of the resource or livelihood rights of many people likely to be affected by floods. Rivers are crucial for livelihoods based not just in agriculture but also on transport, trading and fishing. Channel migration may disrupt these livelihoods too, creating havoc among whole sections of a population.

In some circumstances (as in Bangladesh), the normal flood regime of a river is used beneficially by farmers. On some rivers 'flood-retreat' agriculture is practiced where the receding waters reveal moist soil primed for planting with food crops. Such a system has emerged on the River Senegal on its route through Mauritania and Senegal in west Africa. Ironically, in an area where floods are welcome and beneficial, human intervention is going to restrict the flood. Livelihoods based on farming and fishing (in the ponds which remain as the flood goes down) are likely to be severely undermined. A dam has been constructed at Manantali on the upper Senegal, mainly for the generation of hydro-electric power and to regulate the river's flow to permit year-round barge traffic up to Kayes in Mali. It will also irrigate farmland, but in large-scale projects which will not compensate those who lose out in the valley. One of the costs of this is that the planned regulated river flow will not allow the traditional flood-retreat agriculture to take place (Horowitz 1989).

The people at risk: floods and vulnerability

There is a variable impact on people of flood hazards according to vulnerability patterns generated by the socio-economic system they live in. Those who are vulnerable to a hazard are unlikely to be able to move against the process which has generated their vulnerability, so that after a hazard's impact they are yet more vulnerable to similar and other hazards. In general terms, the three types of division between peoples generated by social and economic systems are of gender, class and ethnicity. These may act as determinants of vulnerability to flooding, as in other hazards, and we now need to examine instances of flood disasters to identify the variable impacts they have had according to gender, class and ethnic origin on different groups of people. This will need to be done in relation to studies which identify particular 'risk groups' - such as agricultural labourers, farmers, urban dwellers, fishing people, refugees, people in shanty towns - from which can be teased out the differential types and levels of vulnerability.

Class position is a crucial aspect in explaining several aspects of vulnerability to floods. The dominant factors in this are existing levels of ownership and/or control over means of production (or lack of it), together with the resultant livelihood opportunities (which may be already inadequate to provide basic needs). It is largely responsible for determining income level. From this derive a range of other characteristics, including the command over resources which influence where someone lives (and its proneness to inundation), the structure and type of housing and workplace (and its resistivity to floods), and the daily and yearly pattern of work and other activities which affects the time and place patterns in relation to hazard impacts.

These variables not only relate to risks of death and injury, but also destruction of assets and livelihood opportunities. In turn, income level affects nutritional status, and this factor combined with place and time patterns for work and habitation affect the vulnerability of someone to disease caused by water-borne pathogens or water-related disease vectors. Illness in turn affecting livelihood operations. There is a need to recognise distinctions between different components of vulnerability: physical (death and injury), morbidity (illnesses associated with hygiene or water-borne disease vectors), material (loss of means of production), or livelihood disruption.

In general, those who possess means of production or have control of hard assets which are robust in the face of flooding are likely to be economically much less vulnerable to flood hazards. Some who may have little or no means of production may have a livelihood opportunity (for example fishing) which is not seriously disrupted by flooding, and these too are less economically vulnerable, but may be vulnerable in health terms. Those who have neither means of production, nor assured access to use of some, and lack a livelihood of a secure nature are likely to be most vulnerable both in health and economically.

There are several reasons why we do not want simply to equate vulnerability with poverty. Firstly, poverty is a consequence largely of class and ethnic position, and in itself is not an explanation of the differential impact of hazards. Also, although it may be true that most of the suffering in disasters is experienced by poor people, it may not be the case that all the poor suffer. Nor is it only the poor who suffer. More sophisticated analysis is needed. One crucial point is that the impact of hazards may well be a factor in creating newly impoverished people (in the sense of loss of assets or access to a livelihood) from those who previously had employment or were endowed with at least some resources (including perhaps land, animals and other means of production).

Also, although it is likely that those who own more means of production are likely also to be less vulnerable physically (they are likely to have a more substantial house, less likely to collapse and lead to drowning and injury), this is not always the case. It would be wrong to deal with disaster vulnerability by simply using poverty (including low level of assets) as the main factor explaining a disastrous outcome of a hazard. It has to be recognised that floods redistribute assets according to pre-existing patterns of vulnerability and opportunities, so creating poverty in new sections of the population and not just striking those who are already poor.

Class is only one manner in which access to resources and livelihoods is socially differentiated. In many parts of the world there is 'ethnic discrimination' which is often superimposed on class patterns or even in some situations the predominant form of exploitation. It involves differential access to or possession of resources, or of the right to participate in different livelihoods, depending on supposed racial distinctions between peoples.

In these respects, it produces vulnerability in ways which may be broadly similar to those of class position. But it also involves a very different component: the subordination of entire ethnically-defined groups of people, often of all classes (where it is possible for the ethnic group to include its own classes of dominant and resource-rich people).

It is also crucial to understand differential vulnerability dependant on gender. Many of the material differences between classes mentioned in the section above are relevant also as factors in the inequitable possession of and access to resources by men and women. In general terms, economic and cultural systems are male-dominated, and allocate power and resources in favour of men. In relation to flood hazards, this may mean that the efforts put into disaster recovery is disproportionately carried by women, who are in most 'normal' situations having to work harder in rural agricultural and domestic activities (though there seems to be little specific empirical evidence to support this view at present).

In addition, there is the possibility that women are likely to be more prone to post-flood disease, largely as a result of their poorer nutritional condition and physical susceptibility. Another aspect which there may be differences in the impact of floods on men and women is in relation to the time and place patterns of daily and seasonal activities (to the extent that young children are more likely to be with women than men, this also affects their relative vulnerability too). Again, there is an apparent lack of data to support these views (concerning nutrition and time/place). In spite of the rapid increase in awareness of gender issues in development and underdevelopment, there seems to have been little investigation of the differences in the impact of flood disasters on women.

Wider-scale processes and the generation of vulnerability

Vulnerability of people to flood, whether in rural or urban areas, can also be interpreted in terms of a range of wider physical, social and economic processes. These are related to those which generate different levels of vulnerability according to class, gender and ethnicity, but are of such significance in that they warrant separate treatment. They include socio-economic ones like deforestation, the debt crisis, global warming, and population growth, and natural ones such as geologically-rapid orogenic uplift of mountainous regions (leading to high rates of debris load in rivers and increased soil erosion).

Firstly, in many parts of the Third World, pressure for access to land is pushing people to farm more and more in flood-risk areas. Such pressure can arise through population growth, or because of land being expropriated for cash crops (sometimes a result of pressure to pay external debt). This is often linked to a lack of economic opportunities other than farming and consequent dependence of some sections of the population on balancing the costs of floods and benefits of a livelihood option which is possibly the only one available.

Land-shortage also has the effect in upland areas of increasing the rate of deforestation, as people clear more land for agriculture, or damage it for fuel and fodder. They may be new arrivals, or local people who have to reduce the fallow period in upland swidden (slash and burn) agriculture. As will be discussed shortly, many researchers associate such deforestation with the increase of flooding downstream.

In upland areas of many parts of the world, a range of factors produces landslips and soil erosion. These generate local flooding (through stream-damming) and increase the sediment load of rivers, contributing to the rise in level of river-beds downstream and increased flood hazard. There are disputes among scientists about the significance of different factors in this process. One conflict is about whether or not there has been an increased incidence of flooding during recent decades when, it is supposed, rapid deforestation has occurred.

Some argue that the evidence for a strong connection between deforestation and increased flooding is uncertain, and that hydrological data does not demonstrate that good vegetative cover in large river basins is necessarily a factor in preventing rapid run-off of storm water (see Ross 1984 pp.224-5 and his summary of a debate about evidence from the USA). Others suggest that flooding of equivalent severity and frequency is apparent in river basins for centuries, long before recent increases in deforestation. For example, discussing the situation in Sichuan province, Ross (1984) presents arguments by one Chinese engineer that 'historical records show a high incidence of flooding even before modern increases in population and logging' (p.223). Ives and Messerli (1989) argue likewise for the Himalayas that there is no convincing evidence of an increase in runoff during the last forty years, despite the apparent increased incidence of flood disasters. The rivers of the Ganges-Brahmaputra basin have been contributing immense amounts of sediment to the Ganges plain and Bengal delta for thousands of years, owing to climatic and tectonic factors in the mass wasting of Himalayan slopes, rather than recent human action. Ives and Messerli ascribe the common perception of an increase in flood disasters not to greater amounts of water in the drainage system, but to human systems having put more people in more vulnerable places.

In analysing vulnerability in terms of both social differentiation and these broad socio-economic processes, the approach here is to focus not on the natural hazard so much as the way in which the structure of societies and the conflicts within them and between them determine the manner in which floods will take their toll.

Policy responses: from precautions to vulnerability reduction

Precautionary measures and policies for dealing with floods are commonly much more related to the hazard factors involved in the triggering of flood disasters rather than with vulnerability and its causes. They include hazard avoidance strategies, different forms of precautionary intervention, mitigation, and impact alleviation. The need is for policies that go beyond this to look at the implications of vulnerability analysis in the development of different ways of disaster avoidance. The conventional methods of precautionary behaviour are normally restricted by the dominant economic and political systems and often fail to (or are unable to) take account of vulnerability.

Local level and indigenous responses include peoples' own strategies for dealing with flood risks. These have been developed by people in many places, often over hundreds of years because of the need for increasing the area of land used for agriculture. In some circumstances, even those floods which seem to outsiders to have brought disaster may in many respects be beneficial. This is the situation in Bangladesh, for example, where the usual shortage of water for crop growth in the winter may be resolved by the increased soil moisture following on summer flooding. Also, the increased rainfall over higher ground, even while lower areas are inundated, may increase yields considerably, resulting in a net increase in grain output compared with non-flood years. These two factors resulted in Bangladesh having bumper harvests in both 1987 and 1988, despite these being the worst floods on record (Rogers et al 1989: 37). But it is not simply a matter of population growth in or movement to flood plains. The vulnerability of many people is class-related or arises out of ethnic, internal or external conflicts. All of these, singly or in combination, may render local initiatives much less effective, or for some groups actually impossible. For instance in the Gangetic plain of north India, villages in flood-prone areas (which includes much of the plain) often demonstrate a clear pattern of differential class vulnerability. The more substantially-built houses of the wealthier groups are often near the centre, where the land is usually slightly higher. Poorer classes including lower castes and untouchables are mainly to be found round the edges of the settlement in low-lying sites.

Although there is an advantage for livelihoods in people settling in flood plains, where the people are well aware of the risks, most of the world's worst disasters have involved floods in such areas. But it should not be assumed that because economic pressures have led people to occupy hazardous tracts of land that flood disasters are inevitable, the price to be paid for the advantages gained in non-flood years. Reducing the risk of flood disaster involves reducing the vulnerability of people by removing the factors which generate them. Without this, precautionary measures are likely to be enjoyed much more by those whose class, gender or ethnic position puts them in a situation where they can afford precautions.

People often deal with flooding by adapting to it, indicating an orderly and not an anarchic response to inundation. This is especially the case in areas affected by regular flooding (such as Bangladesh) where the majority of people have adopted a 'living with floods' strategy. In such situations, floods are not necessarily disastrous, and jeopardize lives and livelihoods only when floods exceed certain levels or velocities.

But there are complex constraints which limit people in their ability to use their knowledge of flood hazards to overcome their vulnerability and avoid disaster. They include the economic necessity of their livelihood, itself determined by their class, gender, and ethnic position. This in turn determines the location of their resources (both livelihood and domestic) and their proximity in place and time to the hazard. In addition, there is the relationship of State interventions (or lack of them) in respect of flooding, and the ways in which these connect with the different livelihood systems, and with people in their various class/gender/ethnic positions. Overlying these are the effects of foreign states and other external agencies which directly influence flood hazards and affect the nature and level of vulnerability of different sections of the people by their actions or inactions.

Preventive measures

One common response to riverine flood hazards is attempts at prevention of their disastrous impact by modifications of the stream flow. These can be classified as controls of either the speed of discharge of run-off water at different points in the river basin, or of the direction and location of the water channels or overflow.

Discharge controls include a narrow range of measures which nearly always involve a high level of technical (and therefore capital) investment. This is largely a result of the dominance of views both in national and international elites which favour a 'technical fix' approach to problems, rather than a mobilization of peoples knowledge and local solutions. Large-scale dams and barrages are sometimes used in this context (though they are normally also used to provide irrigation and hydro-electric power (HEP) as well). In many cases they have been very successful in flood mitigation and prevention, as for example with the dams on the Damodar River in Bihar and West Bengal, which are claimed to have greatly reduced damage in West Bengal in 1978 (Government of India 1978: p.3). On the Yellow River in China, dams in the upland tributaries have been credited with preventing serious flooding in 1981, despite an unprecedented peak discharge.[13]

The reservoir capacity must be sufficient to hold and store the run-off upstream of the dam during periods of peak rainfall. This can then be released in non-destructive quantities over subsequent weeks, provided of course that there are no more rainstorms soon afterwards. The problem they present is that such large-scale investments make it possible to believe that everything has been done that can be done. There is little scope for alternative policies which might reduce runoff or the sediment load which is sometimes responsible (as with the Yellow River or the Ganges–Brahmaputra system) for the downstream impact of flooding. Such alternatives include small–scale check dams in upland gullies (which also have the virtue of reducing sedimentation in the reservoirs of large dams) and reforestation of upland watersheds. Large dams are also unlikely ever to be enough; they are not technically possible on all tributary rivers, even if they could be afforded. One estimate suggested that 'Even if all the possible dams were built in India and Nepal, only about 8 to 10 percent of total flows could be stored'.[14]

Another problem of large–scale investment projects is that they can induce a false sense of security. This may be misplaced if the design capacity of the dam is inadequate, or siltation is greater than expected. In such circumstances there may be settlement downstream which is in the path of dam overflows which have to be released when the incoming water reaches capacity. The dam itself may fail (collapse) because of design faults, construction inadequacies, incorrect location on inappropriate rock base, or earthquakes (which may sometimes be locally–induced by the mass of the reservoir water itself). In such circumstances the resultant flood is truly man–made, and may arise in situations where the dam was not originally in place as a flood prevention measure.[15]

Channel control methods tend to be less capital intensive, and usually the construction materials used are local and involve much more labour input, often employing thousands of workers along lengthy stretches of river. The most common approach is to constrain river channels within artificial embankments or dikes (river training), or to use dikes to protect particularly vulnerable areas along the riverside. In addition, embankments may be used to encircle areas or places (e.g. ring bunds around towns or cities) which are deemed to need special protection. Such methods have a long history in some parts of the world. In China the channel of the Yellow River has been repeatedly enclosed within dikes for much of its lower course across the North China Plain for thousands of years. In that particular situation, it has not been all that successful, and there have been massive floods in many years as a result of the river breaching the embankments. The main problem in using dikes in this way is that rivers carrying heavy sediment loads continuously build up their river beds in the lower reaches where the gradient is slight. Consequently, the embankments have to be repeatedly raised higher and higher, so that the river is actually flowing at some considerable height above the surrounding countryside. The impact of any flood is therefore likely to be greatly enhanced should there be any breach of the dikes; breaches are likely if the dikes are not well maintained and upgraded.

Such a model of flood control is being contemplated for Bangladesh at the present, promoted largely by the French government with support from the World Bank (Boyce 1990). The difficulty is that one it is begun, it is very difficult to change to any other method, and the country is committed to a policy which is expensive and difficult to maintain and fraught with risks if it is not (Rogers et al 1989; Boyce 1990). This approach also seems to be rooted in a faith in the efficacy of large-scale civil engineering projects, in this case based on foreign expertise that does not suit the economic or social conditions of the country.

Large-scale river training schemes like this can also generate a false sense of security, as with dams. An added factor is the likelihood that many people who lack land and other resources actually squat and settle on the land left between the channel and the bunds, which is extremely prone to flooding. This is already the case in parts of Bangladesh where river training projects have been used.

There are other channel control methods which are used (often in conjunction with river training) to provide emergency storage for flood water. These may be existing lakes which adjoin the river channel. At crucial moments in the control of the downstream movement of a peak flow, the embankment leading to the lake can be deliberately breached. Water from the peak is then stored to prevent the river reaching danger levels further downstream. Such a system has been in use for centuries on the Yangzi in its lower reaches. This method can also be used to store water on low-lying land if necessary; less productive places can be sacrificed as flood-ponds, in order to protect more densely populated and more productive areas. This can be a valuable adjunct to systems of embankments, especially to protect the bunds downstream, or to reduce inundation should there already be breaches in them.

Knowledge of the flood risk is no guarantee that the state will commit itself to the necessary preventive measures. On the other hand, some state interventions may alter the pattern of the hazard's impact rather than removing it completely. Policies involving dikes and bunds to protect some areas can enhance the impact of floods and create risks in entirely new locations, sometimes many kilometers distant, as with canalization projects which increase downstream risks. Similarly, strategies which displace flood risk, such as the building of ring-bunds around towns and cities, concentrate water onto surrounding lands so that the victims are farming people instead of urban dwellers.

Normal development interventions can also create flood problems. These include roads and rail lines which are elevated on embankments to avoid floods. These then act as barriers to the return of water into river channels. They are considered to be major factors in flooding in a number of reports, in effect a case of 'development' causing floods.[16] Such linear constructions (ironically including flood-protection dikes) can create inundations even when the rivers themselves have not flooded. It is also apparent that some flood disasters have arisen out of the failure of what ought to be quite adequate systems for flood prevention, avoidance or mitigation, or of inappropriate actions which fail to take account of the flood hazard.

Flood avoidance measures

Where there are known river flood hazards, land-zoning measures can be effective in preventing disaster. These are generally operational only in urban areas. Unfortunately, it is common in developing countries for there to be a large number of people who avoid the restrictions on settlement inherent in zoning plans. Squatting on unstable hillslopes which can slip in heavy rain, or in low-lying flood-prone areas, is often the only way for the poor to obtain any land for housing. A rare example of rural flood plain 'zoning' is the state's intervention in Mozambique in the mid-1970s. Part of the peasants' response to independence there was to occupy and farm land in valleys which was abandoned by Portuguese companies and settlers. This increased their vulnerability to floods, which was to some extent resolved during the governments' settlement scheme by transferring villages from flood plains to higher ground (Wisner 1979: p.302). Although this protected people, because of the need to use the land, it did not necessarily protect food production.

In some rural situations, people have needed to rescue themselves from flooding by seeking higher land. These unofficial coping mechanisms have led to more or less permanent squatter settlements on raised embankments and old railway lines by many thousands of Bangladeshis. They have generally lost assets (especially land) in floods, either through damage, distress sales, or the erosion of their land or village by flooded rivers. Elahi (1989) reports on estimates (probably too low) of 70,000 households living on the embankments of the Jamuna river (the present channel of the Brahmaputra) in Bangladesh.

Flood alleviation and preparedness measures

Although very often inundations may damage crops, kill and injure animals, destroy houses and other infrastructure, it is possible to develop alleviation policies which save peoples' lives even though the flood itself cannot be prevented or contained. The most conventional of such preparatory methods is flood warning systems, the effectiveness of which has been shown in a range of countries. The value of warnings depends greatly on their accuracy (this affects their credibility), the lead-time available for preparedness and evacuation, and the effectiveness of the message delivery system.

In valleys prone to flash flooding, the distance from the catchment area to the endangered settlement may make warnings worthless, and there would need to be other preventive measures. But in the slow-onset type of flood which affects many longer stretches of river, there may be hours or even a day or so for cautions to be made effective. The warning systems need a linked network of hydrographic stations at well-chosen points on the hazardous river's catchment area. In some countries, these stations are automated, and relay their information by radio to central control points from which warnings can be issued, in others, they are linked by telegraph or telephone. They may be in less than perfect order, especially in the stormy weather of flood times, and so proper organisation and maintenance is another vital factor in their success.

The delivery and receipt of the warning messages cannot be taken for granted. There have been cases where warnings may be issued only for the most vulnerable sections of the rural people to become victims for want of possession of a transistor radio on which to hear the broadcast. In a report of the impact of the exceptional flooding around Alice Springs in central Australia in 1985, it was clear that ethnic bias was responsible for the lack of delivery of warnings to the Aboriginal people, many of whom were living in flimsy accommodation in low-lying land.[17] The radio broadcasts that alerted the white people were not on channels which were customarily used by the Aborigines.

New flood precautionary methods

In some regions where temperatures permit year-round farming with more than one harvest, especially parts of Asia where the rainfall is seasonally concentrated in the monsoon months, there is the possibility of both floods and water shortage for agriculture. It has been proposed by some scientists that the dry-season shortage could be resolved by pumping out groundwater in a systematic manner in particular places, and that this be replenished by pumping back the peak flows of the flood season. In this way it is proposed to deal with both the flood hazard and increase agricultural output in the dry season. This strategy has been proposed especially for Bangladesh and parts of north India (see for instance Chaturvedi 1981; Rogers 1989). It involves considerable investment (though less than major civil engineering proposals), but has benefits of possible increased output in the dry season. In Bangladesh, this method would involve HEP dam development in tributaries, and the sale of electricity across international boundaries to enable the pumping it would require. In all, the proposal seems attractive but restrained by severe political difficulties.

Conclusion

In understanding disasters and their inequitable impact, it has been suggested that vulnerability analysis is not equivalent to simply discussing who is rich and who is poor, even though this might seem a crude approximation of hazard-proneness. In the context of different hazards, different groups of people possessing or having access to varying 'bundles' of resources or entitlements, may be vulnerable to one type of hazard more than another. It is such a focus which makes this approach different, and which means that the new emphasis in disaster analysis need not be the particular type of hazard itself. Many existing precautions used in the mitigation of flood risk operate within the existing systems of differential vulnerability generated through class, ethnic and gender factors. It seems essential to go beyond this situation if there is to be more success in flood disaster avoidance.

References

Bommer, Julian (1985)
'The politics of disaster - Nicaragua' Disasters vol.9 no.4 pp 270-278

Boyce, James K (1990)
'Environmental concerns submerged in Bangladesh flood plan' Unpublished paper

Brush, Lucien M, M Gordon Wolman, & Huang Bing-Wei (1989)
Taming the Yellow River: Silt and Floods Dordrecht: Kluwer

Cedeno, Jorge E Moreira (1986)
'Rainfall and flooding in the Guayas river basin and its effects on the incidence of Malaria 1982-1985' Disasters vol.10,2 pp.107-111

Chaturvedi, M C (1981) 'Flood management - New Concepts, Technology and Planning Approach'; paper presented at International Conference on Flood Disaster, New Delhi.

Clark, Champ (1982)
Flood Alexandria, Virginia: Time-Life Books

Clarke, John I (ed) (1989)
Population and disaster Oxford: Blackwell

Crow, Ben (1984)
'Warnings of Famine in Bangladesh' Economic and Political Weekly vol.19,40 (6 October 1984) pp.1754-1758

Curson, Peter (1989)
'Introduction' in: Clarke (1989) pp.1-23

Elahi, K Maudood (1989)
'Riverbank erosion of the Jamuna in Bangladesh' in: Clarke, John I (ed) Population and disaster Oxford: Basil Blackwell

Gueri, M, C Gonzalez & V Morin (1986)
'The effect of the floods caused by "El Nino" on health' Disasters vol.10,2 pp.118-124

Horowitz, M & Muneera Salem-Murdock (1989)
'Management of an African floodplain: a contribution to the anthropology of public policy' forthcoming in M Marchand (ed) The peoples' role in wetland management Leiden

Hossain, Mosharaff et al (1987)
Floods in Bangladesh: recurrent disaster and people's survival Dhaka: Universities Research Centre

Ives, J & B Messerli (1989)
The Himalayan Dilemma: reconciling development and conservation London: Routledge

Ives, J & D C Pitt (1988)
Deforestation: Social Dynamics in Watersheds and Mountain Ecosystems London: Routledge

Le Moigne, G, S Barghouti & H Plusquellec (eds) (1990)
Dam safety and the Environment Washington: The World Bank

Lyngdoh, J M (1988)
'Disaster Management: a case study of Kosi security system in north-east Bihar' Journal of Rural Development (Hyderabad) vol.7,5 pp.519-540

Rashtriya Barh Ayog (National Commission on Floods) (1980)
Report 2 volumes New Delhi: Ministry of Energy & Irrigation

Rogers, Peter, P Lydon & D Seckler (1989)
Eastern Waters Study: Strategies to Manage Flood and Drought in the Ganges-Brahmaputra Basin U.S. Agency for International Development

Ross, Lester (1984)
'Flood control policy in China: the Policy Consequences of Natural Disasters' Journal of Public Policy vol.3,2 pp.209-232

Seth, S L, D C Das & G P Gupta (1981)
'Floods in arid and semi-arid areas - Rajasthan' Mimeo New Delhi: Ministry of Agriculture

Sikander, A Sattar (1983)
'Floods and families in Pakistan - a survey' Disasters vol.7,2 pp.101-106

Thompson, M & M Warburton (1988)
'Uncertainty on a Himalayan Scale' in: Ives, J & D C Pitt (1988)
Deforestation: Social Dynamics in Watersheds and Mountain Ecosystems London: Routledge

UNDRO (1978)
Disaster Prevention and Mitigation: a compendium of current knowledge. Volume 2 - Hydrological Aspects New York: United Nations

Ward, Roy (1978)
Floods: a Geographical Perspective London: Macmillan

Wisner, Ben (1979)
'Flood Prevention and Mitigation in the People's Republic of Mozambique' Disasters vol.3,3 pp.293-306

Zhao, Songqiao (1986)
Physical Geography of China New York & Chichester: John Wiley

Notes

1. This dominance of floods as an environmental hazard would be overridden by a factor of ten if epidemic disease were included. See the table of Curson (1989 p.6), for example. Curson includes war and famine in his list, which also dominate floods in mortality. We do not share his definition of disaster to include war: war is a factor in creating disasters, and is entirely human in origin. Famine is also not a natural hazard, but a potential outcome of the impact of hazards (as well as human-caused events like war). Although we include disease in this book, perhaps they should not be all lumped together; there are many differences between them, in some ways as much as there are differences between flood and drought.

2. It is sometimes argued that deforestation is a factor in the causation of both. Later there will be some discussion of the increasing contention around the way that deforestation has been seen as a major cause of flooding in some parts of the world.

3. If the river has filled the underlying topography so that few or no hills protrude from the deposited plain (as is the case in much of the Ganges basin and the entire North China Plain, then the river is unhampered in its oscillations across the landscape, and there are no refuges of higher land for the people.

4. This is well-illustrated by the contrast between the Yellow and Yangzi rivers in China. Despite its great length, the Yellow River (Huanghe) carries relatively little water: it is fourth longest in the world and about 13 per cent shorter than the Yangzi, but has an average discharge of less than 6 per cent of the Yangzi (Zhao Songqiao 1986 p.42). The problem is that so little water is carrying immense quantities of silt (three times more than the Yangzi), eroded from the bare loess hills of north China. Attempts to contain the river in its lower reaches within its banks has led to the need to continually raise those banks because the silt deposited on its bed raises the level of the river. It is flowing at about 5 metres above the level of the surrounding countryside for much of its journey across the North China Plain.

5. A study of dams around the world found that up to 1965 out of a total of 9,000 there had been 202 total failures (i.e. collapse). In India, out of 433 registered dams, there have been 20 failures up to 1989 (Le Moigne et al 1990 p.62).

6. It is also important to recognise that a disaster is often only recognised when defined by outsiders as such. Much of the content of what is called a disaster may affect smaller numbers of people and occur in relatively small floods, and are no less disastrous for those who suffer them than the larger recognised events.

7. This statement would incorporate the mortality involved in all types of flooding, including that from tropical cyclones.

8. The Guardian 3 August 1988.

9. In 1931, it is estimated that more than 3 million died in a Yellow River flood.

10. The information is taken from the official weekly Beijing Review (28 September 1981). This is probably too soon after the event for the mortality to be completely assessed, but the figure is low given the scale of the event. In the debate about the flood's causes, a lot of stress was put on what was considered a rapid increase in deforestation in the hills and mountains which surround the fertile Sichuan basin, blamed on the commercial outlook on timber-cutting generated by the then recently-introduced economic reforms. Others disagree and argue that there is no evidence for a recent increase in Sichuan flooding; this is referred to later.

11. By contrast, malaria was not reported and much of the area had previously been extremely arid.

12. 'It is estimated that over 20,000 varieties of rice have been developed by farmers to suit the different cropping conditions in Bangladesh.' Anon. 1989 'The role of Non-Government Agencies in Disaster Mitigation' Oxford: Oxfam

13. Beijing Review, various issues in October and November 1981.

14. K L Rao (1975) India's Water Wealth Orient Longman, India; quoted in Chaturvedi (1981) p.2.

15. There is anxiety about a dam project in the north of Uttar Pradesh (India), on a site which is considered tectonically dangerous by some scientists.

16. See e.g. Rashtriya Barh Ayog (1980) p.132

17. Hazards Panel Newsletter November 1985 p.24.