Flood Mitigation Strategies for the Red River Delta

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Abstract

The increase of natural disasters and especially floods are causing economical losses to escalate. One of the reasons for this phenomenon is the global problem of climate change. Governments of both developed and developing countries are therefore concerned with increasing post-disaster liabilities in aiding recovery, repairing infrastructure damage and compensation of victims. In particular, governments of developing countries are ill prepared to cover the financial losses of disasters. Moreover, they often experience difficulties of raising funds for the recovery process. In this article, we identify possible policy strategies for coping with complex environmental and social decisions with flood risk involved; using the Red River delta in Vietnam as a case for investigating various mitigation strategies. The delta is densely populated and many people are at risk of flood. The paper is concluded by an outline of a model used for policy scenario simulations and decision support.

Introduction

Recovery from disasters are hard to cope with, especially for developing countries. Natural catastrophes cause substantial economic damage in these countries every year. The economic damage, from, e.g., flood disasters, are rising, mainly as a result of increasing concentration of populations and assets in high-risk zones, as well as detrimental land-use practices [Los99]. Co-operation across boundaries that enhance the management of natural resources for the benefit of all stakeholders has quite recently come into the limelight, because of increased competition over natural resources by users of various levels, e.g., community, national, regional and international.

The concept of vulnerability has a very specific meaning to hazard specialists; it encompasses not only the physical effects of natural hazard, but also the status of people and property in the region. A large number of factors can increase vulnerability to hazardous events. These factors are population density, scientific understanding of the area, public education and awareness of hazards, existence of an early warning system, effective lines of communication, the availability and readiness of emergency personnel, construction styles and building codes and, finally, cultural factors that influence public response [MSP97]. Many of these factors can explain the fact that less developed countries are much more

vulnerable to natural hazards than industrialised countries. Whereas the actual dollar value of property damage from an event, such as a flood, may be higher in an industrialised country, the relative monetary loss is on average much greater in developing countries. Poverty itself is a contributor to increased vulnerability. Furthermore, inadequate housing and high population densities on sensitive land contribute too much higher losses from natural disasters.

During 2001, around 73.80 per cent of fatalities from disasters came from earthquakes. About 13.70 per cent came from flooding, 4.17 per cent from land/mudslides (excluding deaths resulting from the El Salvador earthquake in January), and 5.48 per cent from storms, avalanches, extreme weather, wildfires and volcanic activity. From a geographical point of view, around 88.66 per cent of known fatalities have occurred in Asia/Pacific region (including Russia). Latin America/Caribbean bears 6.97 per cent of the fatalities and the balance being recorded in Africa is 2.96 per cent, in Europe 0.71 per cent and in North America 0.70 per cent [Fer01].

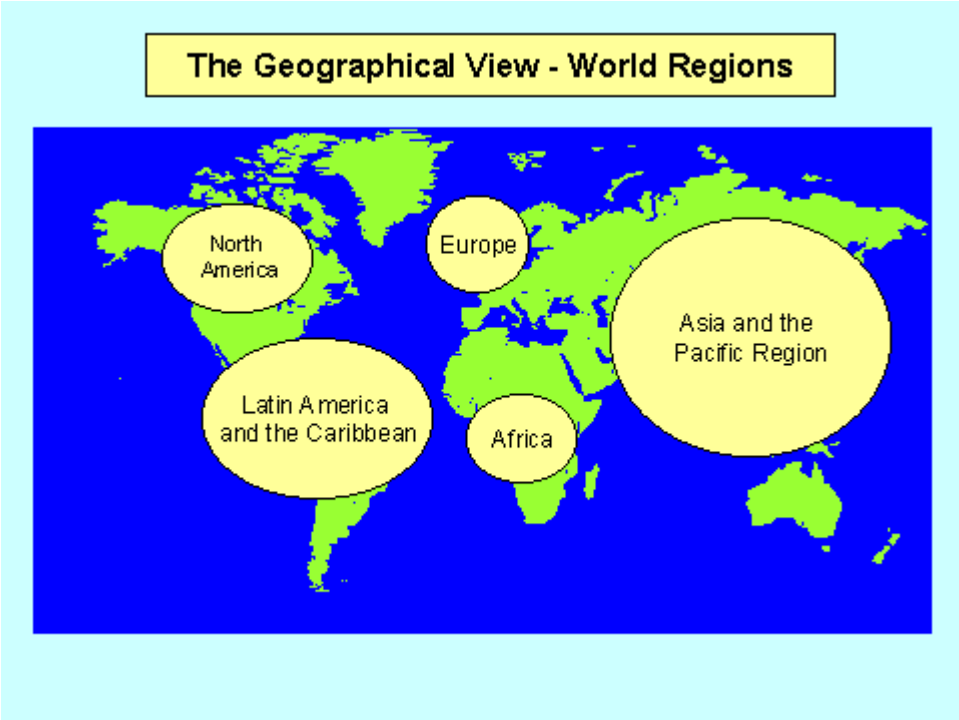

Figure 1. Spread of fatalities from disasters. Figure from [Fer01.]

As the figures above indicate, the losses are highest in the Pacific Region and in Asia, see figure 1.

Floods are the worst of all hazards facing Vietnam [Ngh00]. As an example, in July 2001 a flood occurred in northern Vietnam where more than 60 fatalities were estimated. One of the largest deltas in Vietnam, seriously threatened by floods, is the Red River Delta. Loss of life and property are threatened by annual disastrous events, which impose a substantial burden on the community. The reason for the seriousness of the floods is that the majority of the Vietnamese people have exploited the low coastal land for wet-rice agriculture, and these areas are prone to flooding. Although the people have adapted their culture to these events over the centuries, the problem has been compounded in recent years by a number of changes, such as environmental degradation during and after the recent war, rapid population increase, and degradation of the existing extensive system of dykes.

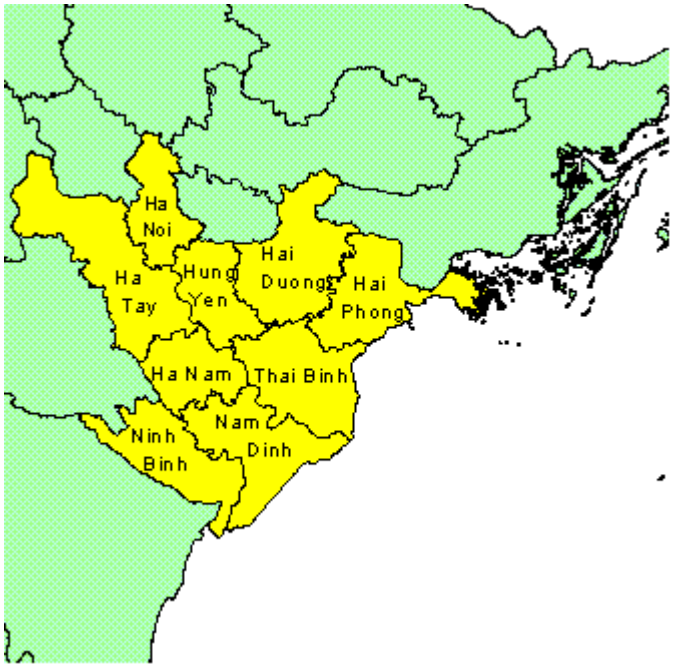

Figure 2. Provinces in the Reed River Delta. Figure from [MAD00].

Currently, the costs of catastrophes in the developing world are borne by the victims and governments, but considering the increasing numbers of disasters the financial cost will be unbearable.

This work focuses on finding new methodologies for coping with complex environmental and social decisions with risk involved. In particular, it focuses on how computer-based modelling and simulation techniques can be used for developing reasonable policy strategies for coping with floods.

We are using the Red River delta as a case for our research, since the area exposes all the characteristics of a region in distress, i.e., increasing numbers of floods, dense and increasing population, and a low land location.

The Case

While catastrophic risk insurance has expanded dramatically in developed countries, such instruments have been slow to expand to the Third World. The result is that, when catastrophe strikes, as recently in Mozambique and Honduras, damaged capital goes unreplaced, development projects are disrupted, and poverty is worsened. This is also the case in Vietnam. The main conceptual barrier to expanding insurance against catastrophic risk, as well as to encouraging mitigation, is the difficulty of estimating the benefits of such programs.

The Red River Delta

The Red River Delta in northern Vietnam is a low-lying area with a dense population and intensive agriculture. Vietnam consists of 61 provinces and centrally administered cities grouped into regions. The Red River delta consists of 9 provinces namely: Ha Noi, Hai

Phong, Ha Tat, Hai Duong, Hung Yen, Ha Nam, Nam Dinh, Thai Binh and Ninh Binh. See figure 2.

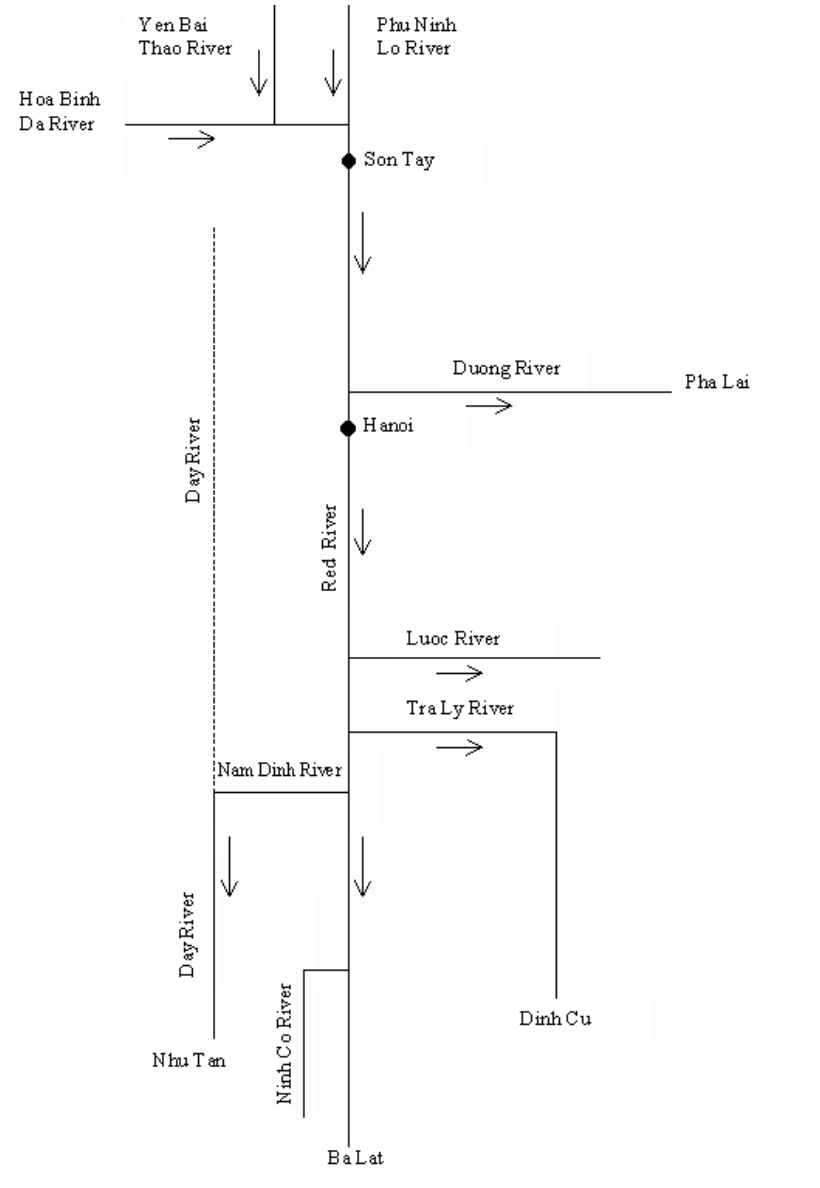

Figure 3. River system in the Red River Delta. Figure from [VP00].

The river system, shown in figure 3, is one of the largest river basins located in the north-eastern and northern part of Vietnam. Being an international river, it has the upstream part and large tributaries in China and one part in Laos. The Red River has an important role in the development of the social-economy of the northern delta of Vietnam.

Floods in the Red River Delta often occur in July and August. In the basin, a combination of climatic conditions and a large space cause floods. A result of this is that large floods rarely are occurring at the same time in the entire basin. Losses from floods are a serious annual event in North Vietnam. In studies by the United Nations Development Program (UNDP), it was estimated that the average annual loss in the Red River Delta and along the Central coast could substantially reach more than 130 million USD [Pro02]. In a subsequent, more rigorous, Asian Development Bank study, it was found that the average annual damage

from floods in the area protected by dykes, amounted to well over 50 million USD per year around Hanoi alone [Pro02]. Figure 4 shows an estimation of the increase of losses.

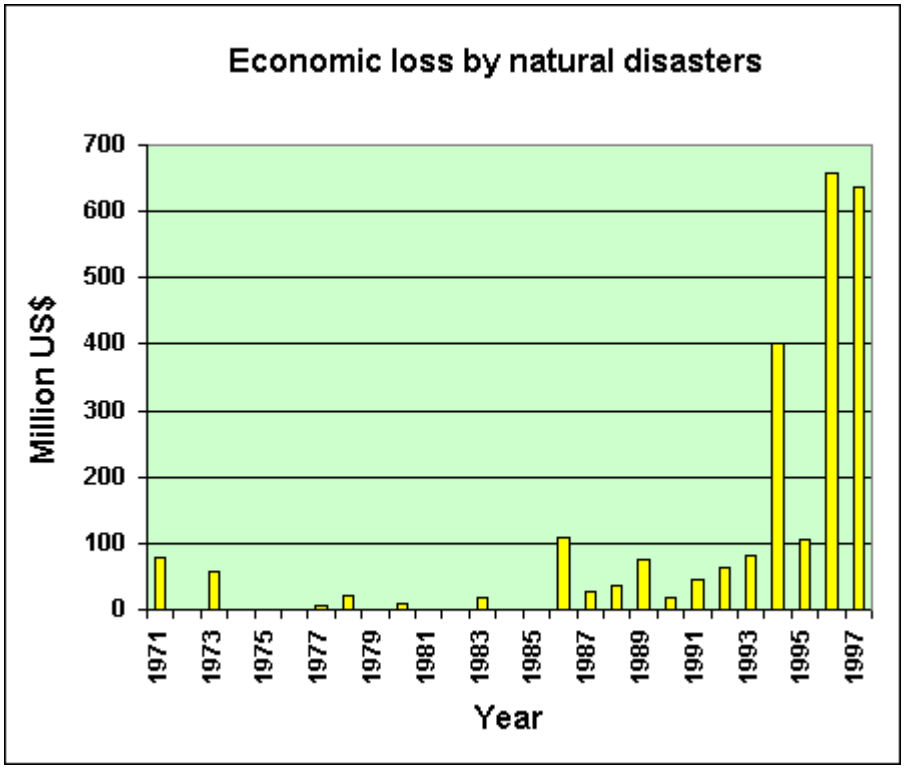

Figure 4. Increase of losses in Vietnam. Figure form [Pro02].

The significant rivers, the Da, Thao and Lo Rivers, combine from the Red River at the head of the Red River delta, near Hanoi. See figure 5. The total catchment area of the Red River is 169,000 km^2, of which 82,400 km^2 lies in China. The part of the delta that lies in Vietnam covers the natural area of 86,660 km^2, accounting for 51 per cent of the total area. The delta itself covers 16,444 km^2 and is very flat; more than 50 per cent is less than 2 meters above sea level [Ban95a].

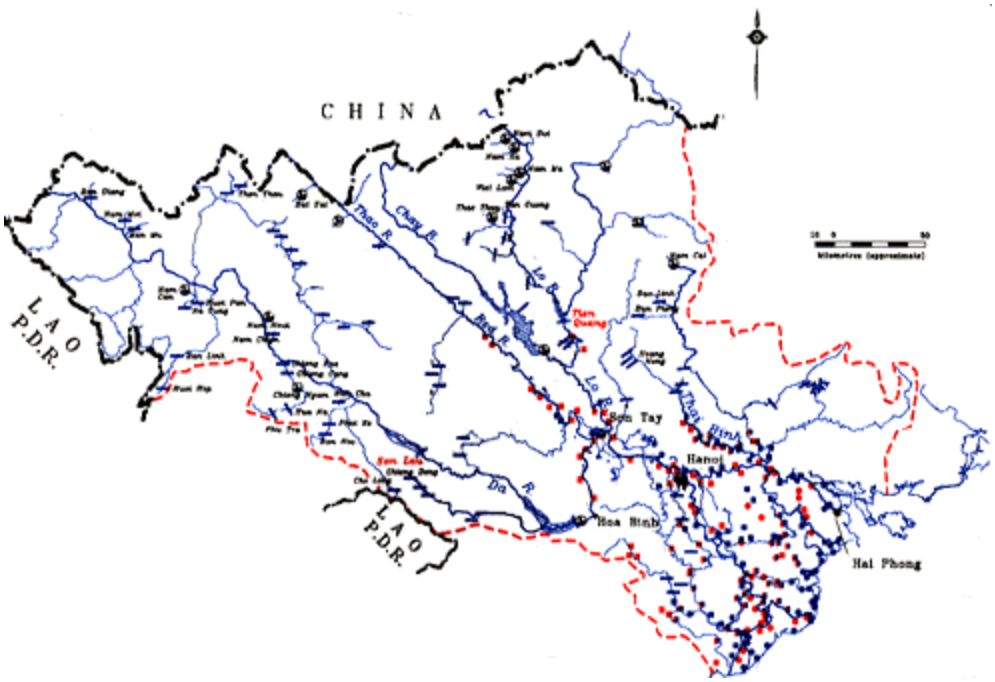

Figure 5. Map of the Red River Basin. Figure from [MAD00].

The land area is protected by two series of dykes, preventing the area from floods from the river system. The dyke system has a total length of 2,700-km. The height of the dykes is 6-8 meters in average. The system of dykes was built through a period of many years, and at many locations the material and building technology were not reliable. Therefore, the quality of dykes is insufficient. Many sections of the system are poorly repaired, and during the wet season, sand erodes and leaks appear. Maintenance cost for the dykes is high in the region. From 1886 to 1990, the total volume of earth-fill for the dyke system was 285 million m^3. Many sections are also too low, since they lie below normal flood level, requiring large efforts in the flood season to protect against collapse [Ngh00].

There are two dams in the Basin. A smaller scheme, Thac Ba Dam on the Chay River, with an active storage capacity of 1.2 billion cubic metre and an installed hydro-electric generating capacity of 120 MW, annually producing about 400 Twh. The Hoa Binh dam on the Da tributary is expected to reduce the peak flood level of the 1971 magnitude by 1.5 m in Hanoi (from 14.8 to 13.3 m). The dam is the major multipurpose scheme in the country with a storage capacity of 9.5 billion cubic metre, a live storage of 5.6 billion cubic meter, and energy production at 7,8000 Twh (providing 40 percent of Vietnam's electricity) [Pro00].

Approximately 54 per cent of the Red River Delta surface is cropland. About 82 per cent of this is rice-paddy and 75 per cent of the regions labour force is working in the agricultural sector [Ban95a]. About 78 per cent of the cultivated land is equipped with drainage facilities. The delta depends heavily on pumping for drainage (60 percent).

The average population density for the entire basin is about 280-persons/km^2. However, with almost 17 million people living in the Delta, the Red River Delta is one of the most densely populated rural areas in the world, with about 1,000-persons/km^2. This provides a large (and mostly literate) labour pool, available at low cost. By comparison, the Mekong Delta has 400-persons/km^2. The national average is 200-persons/km^2.

A total GDP of 2.8 billion USD in the Delta corresponds to more than 80 per cent of the whole Basin and 20 percent of the national total. However, because of the large population, average income was only 165 USD in 1993 in the Delta (141 USD in the basin).

Strategies to Deal with Natural Catastrophes

To choose a suitable and fair policy strategy in order to cope with losses from disasters is a difficult task. Several stakeholders are affected by the strategy, such as the inhabitants in the region, the insurers, the non-governmental organisations (NG0's) and the government. Numerous dependencies between different variables also have an effect on the outcome of the strategy. For instance, land use changes might affect the amount of compensation to be paid by the government -- if the land is cultivated, loss is greater than for an afforested area.

Risk transfer for natural disasters in the developed world is primarily directed at transferring the risk of damage to private real property to the insurance industry. However, in the developing world, where there is a high concentration of public owned infrastructure, the vulnerability of impact from natural catastrophes is high. Risk transfers provide a safety net for economic property loss (mainly rebuilding). As a safety net, it reinforces original investment decisions [Fre99].

Natural catastrophes destroy essential rural infrastructure. In Asia, which accounts for approximately half the number of the natural catastrophes in the world, and 70 per cent of all floods, the average annual costs of floods over the past decade is approximately 15 billion USD [Com98]. To reduce rural poverty, effective infrastructure projects related to agricultural have proven to be an essential policy tool. In particular, infrastructure development for transportation, irrigation, and electricity plays an essential role. For instance, [Com08] estimates that damage of infrastructure accounts for 65 per cent of all flood losses. For Asia, this means an average annual infrastructure loss of approximately 12 billion USD for the past decade. Rural infrastructure loss in the developing world has severely affected the activities of the world's international lending institutions. For instance, the World Bank loans to developing countries in the last 20 years, for damages from natural disasters, has been estimated to 14 billion USD [RK99].

Swiss Re, [Com97], estimates the direct costs of natural catastrophes. However, long-term development impacts of catastrophes depend on how direct loss lead to indirect and secondary costs depending on a country’s financial capacity to absorb losses. In general, losses from natural catastrophes can be grouped in three categories: direct, indirect and secondary effects. Direct losses represent the financial value of damage to, and loss of, capital assets. In financial terms, direct losses like these can be equated to stock losses. Indirect losses arise from interrupted production and services and can be measured by loss of output and earnings. These losses can be equated to flow losses in economic terms. Secondary impacts are the short- and long-term impacts upon aggregate economic performance. Secondary impacts could include disruption of development plans, increased balance of payment deficits, and increased public sector deficits and debt [Fre99].

Furthermore, the issue of fairness, or equity, should be taken into account. This means that flood protection should be extended to all members of the society. Yet, difference in vulnerability to floods even between neighbouring households can be enormous, especially in less developed countries. Wealthier households can receive flood warning on the radio or TV and can escape by their vehicle, whereas poorer families, deprived of such warning, may remain on site and suffer destruction of their houses and belongings and even death. Consensus implies that involved and affected parties should agree as to the program of flood protection and management. Yet, striving for absolute consensus can make the process of decision-making more difficult.

Strategies in the area today

On a macro scale, disaster management in the Red River Delta reflects the overall nation mitigation strategy. The framework for management of natural hazards at governmental level is strongly influenced by flood hazards and traditional structural methods for flood control. It also reflects the typical structure of centralised decision-making and shared responsibility between line ministers, passed down provisionally, to district and ultimately to commune levels through a system of people committees.

Since the new Water Resources Law was adopted in 1998, the responsibility for management of surface water lies on the Ministry for Agriculture and Rural Development (MARD). The responsibility for ground water is under the control of the former Ministry of Industry. The Ministry of Fishery is responsible for water surface issues for areas were the surface is used for fishery development. And finally the river channels are the responsibility of the Ministry of Transport and Communication. Earlier the responsibility overlapped between agencies. By law, MARD, on behalf of the government, is responsible for the water resources all over Vietnam. Every ministry has its own disaster preparedness unit, which must co-operate at the national level [Ben98]. Means of reducing vulnerability include:

- water management infrastructure to reduce the impact of floods and drought;
- diversification of production to reduce the impact on the household economy, if one line of production fails;
- community savings and credit schemes to reduce dependence on private moneylenders;
- insurance services for production losses;
- improved health insurance;
- improved veterinary services to reduce the occurrence of diseases in animal husbandry;
- improved market information systems for a broader understanding of how markets might develop;

The government is active in all these areas. At the same time, insurance services are the least developed. When natural disasters occur, the government is very active in providing support for people to rehabilitate their production and livelihoods. This is mainly provided in terms of seed for the next crop, production credits and food aid during the immediate crisis. Special credit was channelled through the Bank for Agriculture to enable people to reinvest in production, mainly rice, after the 1999 floods. The mass organisations mobilised the mutual support and informal safety net structures in the communes. The extension services are active both in immediate rehabilitation after a disaster and in the long-term work to reduce vulnerability. They focus on short-term varieties of rice and other crops, and diversification to a broader range of crops, vegetables and spices. The veterinary organisation mobilises massive vaccination campaigns to try to avoid the spread of animal husbandry diseases. Nevertheless there were large losses of animals due to diseases after the floods in 1999 and 2000 [Bec01].

When a crisis is community-wide, there is action on the part of the government, local organisations and people all over the country to mobilise resources to handle the immediate coping strategies. For individual household crises, there is less support available. Safety nets are not yet sufficiently developed. Also after a community-wide crisis, some people experience more difficulty in recovering. Households, which were already indebted before the crisis and which have health problems in the family, are among the most vulnerable. Household coping strategies often include:

- borrowing from family and friends; social capital networks are often strong;

- borrowing money privately at 2.3 per cent interest per month;
- borrowing rice at a set interest rent, per season, to be paid after the next harvest;
- collecting minor forest products, such as leaves for hat-making and firewood;
- seasonal migration to work as farm labourers;
- working locally as day labourers;

Even though people in the hilly areas often are poorer than those in the paddy-growing areas, the poor in the hilly areas tend to be less vulnerable to seasonal crises because of their more diversified sources of income, many of which become vital for coping strategies in relation to seasonal crises such as floods.

According to [Bec01], a special type of advisory service is needed to support indebted households rebuilding their economies and livelihoods. If such advice on how to restructure loans and avoid high-interest private debts could be provided in co-operation with the World Bank for Agriculture and Rural Development, it would have a significant impact on poverty reduction. A common reason why poor people are excluded from services like credit and extension is that they often use the resources for other purposes than intended, for example for housing, medical costs, or repaying old debts, and not for the production purpose intended. Pure production-oriented services are therefore often not feasible for the poor and more integrated forms of services need to be developed. Policies aiming at reaching the poor need to take this into account

Policy strategies can mean reduction of risk prior to an event occurring. These tools are generally classified as mitigation activity such as land use planning. Other types of strategies can involve measures to be taken after an event has occurred, such as borrowing money. Below we will present several possible strategies.

Structural defence as mitigation

In the Red River Delta the dykes form the primary defence against flood disasters. The condition of these dykes, and the ability to maintain them in the social and economic climate is of concern. In the last few years the system of dykes in the delta, has been strengthened, and reservoirs constructed as a mean of flood control. Behind the dykes people have reclaimed the land. For the inhabitants in the region the dykes serve as a protection and a more secure environment for investment. This may also be of negative effect, since a false sense of security actually will contribute to the flood impact. Erosion and sediment are also a factor that has to be considered. Sedimentation raises the riverbeds, from this follows further elevation of the dykes. A strategy using only structural measures is not a realistic option since the cost for maintenance is constantly rising and losses increasing due to more dense population in land areas protected by the dykes. However, it seems that many consider further measures of dyke rehabilitation to be economically and socially justifiable [Ben98].

A large part of the population in the delta is dependent of drainage systems. The irrigation and drainage channels handle runoff from the river to avoid flood downstream. Constraints on further development are primarily financial and institutional. Operation and maintenance costs are high. There are also areas where existing drainage schemes suffer from physical limitations, for instance, design constraints, insufficient maintenance and inadequate infrastructure [Ban95b].

International aid as mitigation

Direct donations from the developed world are small in comparison to the large burdens imposed by natural disasters on the developing countries. Most official bilateral aid is given by the members of the Organisation of Economic Development (OECD) [EDO02], through the Developments Aid Committee (OCD). Global loss sharing, where the developed countries subsidies poor countries as a way of coping with losses, might also be an option. This issue is discussed in Bayer [LB00]. One of the reasons for this is that the responsibility for emissions and global warming lies most at the developed countries.

The issue of increased foreign borrowing to finance post disaster reconstruction raises important policy issues. Around 56 countries have since 1980 borrowed 7.5 billion USD from the World Bank for post disaster reconstruction, mainly for infrastructure projects [RK99].

Borrowing to fund reconstruction after a catastrophe increases the debt of a country, but does not increase its ability to repay relative to pre-catastrophe conditions, because post-disaster reconstruction focuses on repairing lost infrastructure. An important issue for developing countries is their reliance on external debt as the primary means to finance post disaster reconstruction, which may exacerbate existing budgetary constraints.

Insurance as mitigation

Transferring risk to the taxpayers by introducing more private insurance in the region is one way of coping with loss. In Vietnam, insurance is not yet custom, and disaster insurance is virtually non-existent.

Since floods occur more frequently, the cost for the government becomes unbearable. Consequently, in several countries there is an increasing recognition that programs have to be developed for creatively and effectively linking private and public responsibility. Insurance is one possible option, transferring responsibility to the public. Insurance as mitigation might help the country to finance the cost of natural disasters and also provide a relief to poor farmers. Private insurance transfers the risk of large loss to a third party.

By using an insurance based policy strategy, the financial risks could be transferred and spread internationally through reinsurance companies -- providing an alternative to relying on relief agencies. One of the benefits with this strategy is that private insurances, with clear contractual obligations, have the potential to deliver cash to affected people and organisations very quickly after the occurrence of a disaster.

If a strategy like this is introduced, thorough research on risk exposure must be performed in order to aid the insurance companies in their decision-making process, e.g., for setting adequate premium and claim levels. Further investigation needs to be performed on whether inhabitants in the region are interested in the concept of insurance and, if so, the premiums they are willing to pay. Here we might expect that additional funding would be needed to cover insurance premiums for large groups. Finally, a survey on the insurance companies in the Red River delta, as well as the re-insurers, should be performed -- will they be willing to bare the risk? An assumption is that this is not the case, since flood is a frequent event and the consequent losses are severe.

Using a pool of money as mitigation

A possible solution to the problem, in the above section, might be to create a public-private insurance scheme. In this scheme a catastrophe fund or insurance pool might be established, with a possibly involvement of the government. This would minimise the risk for the reinsures. Other contributors to the pool can also be investigated; possible participatory partners might be, for instance, local commercial banks and NGO´s. However an important aspect to take into account is that when developing countries try to pool their resources together, sometimes there is not much to pool.

Renaturalisation

In flood-risk contexts, risk is often understood as a product of low probability of failure and high consequences. The concept of risk can be illustrated in the context of structural flood defences such as dykes [KBB *et al* 01]. Dykes may provide good protection against more frequent small to medium floods, yet their existence creates a false feeling of security and may trigger intensive development of low-lying areas. If a dyke breaks, this defence does not act as a protection, but rather as an amplifier of destruction; flood losses without a dyke would be lower.

One of the major goals of a future-orientated water policy must be to give priority to the protection of water, e.g., conservation of flowing waters and wetlands. Dams are now viewed more critically; they devastate river ecosystems and undermine the rights and livelihoods of affected communities. Increased international recognition of the high environmental and social costs of dams, along with numerous river restoration successes, are inspiring dam removal campaigns worldwide.

Renaturalisation improves the porosity and absorption of soil, provided that the existing ground water level allows for this. An investigation on this matter must be performed. The renaturalisation and re-wetting of formerly drained areas in Vietnam can only be achieved based on detailed knowledge of the occurring organic and mineral soil substrates, the terrain characteristics and the available surface and groundwater resources. However, since the necessary field measurements are costly and time consuming, this is a difficult task for most developing countries.

Projects, such as the renaturalisation of brooks, the creation and restoration of meanders, the restoration of vegetation and afforestation, aiming at retaining an optimal amount of water, are key issues to reduce the peak discharge. In order to renaturalise and afforest an area, land might have to be purchased. However, if land has to be purchased, numerous inhabitants in the area must be re-located. This solution might have long-term benefits, but is costly for the government to bear.

Every cubic meter of water held back by the restoration of flood plains, the renaturalisation of water bodies, the reopening of soil, leakage and site-adapted agricultural and forest management and by maintaining and promoting small-scale water retention structures in agriculture, represents a bonus for the natural balance and reduces the threat of flooding. Forests on the Red River basin play a very important role: protecting land from erosion and increasing the humidity of the basin. After decades without protection of forest, the forest is degrading not only in coverage level but also quality and bio-diversity. So to recover the forest on the Red River basin is a very substantial task.

Evaluating Policy Strategies

The past two decades have witnessed technological improvements and the increased use of computer applications (GIS, Remote Sensing, Internet and satellite imaging) designed to support the capture, management, manipulation, and analysis of spatially referenced data for solving resource management problems, among others. The relative infrequency of catastrophe events and the resulting scarcity of historical loss data make it nearly impossible to reliably estimate catastrophe losses, using standard actuarial techniques only. However, by combining mathematical representations of the flood occurrence with information on property values and other variables, simulation models that generate loss estimations, may guide insurers and other policy makers. For this reason, a model to extend understanding of stakeholder decision and land use changes, both local and regional, has been developed. For thorough description of the model, please consult Hansson and Ekenberg [HE01], Brouwers [Bro02] and Brouwers and Hansson [BHVB01]. The executable and geographically explicit model will be used in the next step of our research, for simulation flood events and estimating loss for a specific region. The model is integrated and links hydrological, geographical, financial, and social data together. The outcome of the simulations can be investigated at different levels, both the micro level and the macro level. By using the model we combine loss data, uncertainty, probability with financial data and make it possible to estimate different strategies and the outcome both on the micro and the macro level. We can chose to aggregate data for all inhabitants in the region or look at individual cases. We also combine different types of policy analyses by using a decision tool linked to the simulation tool, see [Eke00] and [DE98].

Conclusion

Poverty is linked to vulnerability. Production increase and income generation is not enough if there is a constant vulnerability to floods, drought, diseases and falling market prices, which are common factors in hazardous areas, why people stay poor or become poor. The extension services need to develop their capacity to support people in order to reduce vulnerability [Bec01]. Floods not only deepen poverty levels but also may widen the income gap between rich and poor countries. Who loses and who gains due to floods in the long run is thus a pertinent research question. The distribution effects of flood impacts are important because these are associated with sustainability of development. Many problems of sustainable development and environment arise from inequalities in access to resources, and presumably existing poverty and the skewed distribution of resources in the area escalate these problems. Flood losses have cumulative effects to particularly those that are most vulnerable. Any flood research and floodplain management policy must therefore address these problems in order to confront the problems relating to the sustainability of development, especially in the context of developing countries socio-economic situation and flood conditions.

According to [KBB *et al* 01], the prevailing situation in Asia and the Pacific region, considering the economic crisis (2001-2002) as well as the prevailing issues of poverty, unemployment and environmental stress, there is a danger that sustainable management of flood and drought disasters could take a back seat and its priority is at risk being reduced as each country seeks to regain economic momentum. Support in capacity building from international, regional and national external support agencies is thus urgently needed. Mitigation measures have to be affordable. Cost effectiveness should be encouraged, but not

to the extent of scarifying the disaster mitigation effect of an investment. Poor communities should be provided with a safety net. Furthermore, the full implications of the relationship between natural disasters and economic and social development are rarely fully understood. There is a need for further research into the long-term development impact of natural disasters.

In this article, we have identified a set of possible policy strategies for coping with complex environmental and social decisions with flood risk involved; using the Red River delta in Vietnam as a case. One of the major problems faced by Vietnam's flood victims, like many of the poor in the developing world, who are vulnerable to natural disasters, is that the various stakeholders often lack the means of adequately managing the risks they face, and in particular to recoup their losses. More attention is needed to the possibilities of the poor in handling risk, which includes both increased knowledge to avoid diseases as well as insurance systems to make people less vulnerable to production failures and loss of income.

As a step towards highlighting the economic consequences of disasters and different mitigation strategies, this work has suggested a set of strategies that could be introduced in the Red River region. For the next step, we will evaluate the strategies using a model for flood simulation and evaluation of the financial outcome of each strategy on the micro as well as the macro level.

Acknowledgement

This work was supported by a grant from Sida/Sarek. We would like to thank staff at CRD in Hanoi, specifically Director Phan Huy Chi and Project Officer Tran Tru Dung for their support, time and information. Finally we would like to thank Dr Harko Verhagen for his valuable comments and support.

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