International Workshop on Flood Risk Management
24-26 January 2006, Tsukuba, Japan

A Rational Approach to Flood Risk

A Background Paper Prepared by

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I. Introduction

The last decade brought particularly destructive natural disasters to many countries. Floods top the list among natural disasters for economic damage, and there is evidence that they are becoming more frequently extreme.[2] In the past, flood protection was mainly based on containment of rivers to prevent inundation of valuable property in a particularly vulnerable part of the floodplain—that is, a localized, predominantly engineering approach.

Recent research has led to a proliferation of excellent literature on new approaches to flood risk management. We now know that a more comprehensive and integrated approach is required. The concept of integrated flood management (IFM)[3] has been well described by the Associated Programme on Flood Management (APFM), a joint initiative of the World Meteorological Organization and the Global Water Partnership. IFM looks at land and water resources development in an integrated way within a river basin context, and considers trade-offs in arriving at an optimum level of development efficiency. Many other organizations have arrived at similar holistic approaches.

In spite of the much greater awareness among researchers of the need to balance available options,[4] development agencies continue to rely almost exclusively on engineering measures to respond to flood hazards. This paper looks at the disconnect between the present knowledge of IFM principles and the application of these in the real world. It argues that engineering measures have not delivered their intended benefits in many cases, and that the process of decision-making often precludes the adoption of more appropriate measures, some of which are simpler, cheaper, and more effective. It is postulated that it may now be appropriate to involve behavioral scientists to assist communities make better choices.

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[2] The International Center for Urban Safety Engineering at the University of Tokyo reported that the frequency of floods in Asia doubled during 1978–1999, and that the rate of increase has been more pronounced in the past 10 years. [Dutta, D. 2003. *Flood Disaster Trends in Asia in the Last 30 Years*. Tokyo: The University of Tokyo.]

[3] The Associated Programme on Flood Management. 2003. *Integrated Flood Management: Concept Paper* (edited by the Technical Support Group). Geneva.

[4] These include, for example, measures to (i) reduce flooding (reservoirs, flood embankments, catchment modification, river channel modifications); (ii) reduce susceptibility to damage (land use regulation, development policies, flood proofing, flood warning); and (iii) mitigate the impacts (education and awareness raising, disaster preparedness, post flood recovery).

II. Flawed Decision-Making

When major natural disasters happen, there is always a public outcry for a response—which normally means public investment to prevent negative impacts on lives and livelihoods of any such event in the future. Responsibility for action is assumed to rest with the larger community and in particular with the government. Politicians respond accordingly—out of fear of being seen as lacking in compassion—with grandiose engineering works or technical solutions.[5]

Decision-making at the level of organizations (and governments) rarely follows prescriptive theory or any of the other structured techniques for analyzing multiple conflicting objectives and trade-offs under conditions of uncertainty. It should always be remembered that it is an individual (or at most a small group of individuals) that makes decisions in an organization and not the organization itself. Nevertheless, the behavior of a person in an organization is constrained by the position he or she holds.[6] Hence, the choice of a decision-maker is strongly influenced by the norms of the organization and does not reflect all options that might be available. There may also be ideological or other cultural overlays that inhibit the range of choice.[7] Given such bounds and the political imperatives involved in allocating public funds, decision-makers do not always respond in a rational manner to logical technical arguments. They are more likely under these circumstances to make the wrong decisions in satisfying their immediate constituents and protecting themselves against public outcry. A few examples of bad decisions are:

(i) In December 2004, flash floods and landslides killed more than 1,500 people in Auora and Quezon provinces of the Philippines. The government blamed this on illegal logging of forests and immediately imposed a logging ban (as had been done in 1991 when more than 5,000 people were killed in similar flash floods).[8] Laws banning indiscriminate logging already exist in the Philippines, but they are not uniformly enforced. In addition, no rigorous analysis has ever been made to establish a direct link between floods and the (legal or illegal) clearing of forests. The area of forests has declined from about 30 million hectares (ha) 100 years ago to about 70,000 ha today. Hence, if the absence of trees has anything to do with the severity of flash floods in the Philippines, then the damage was done long ago, and the imposition of a ban on logging will not reduce flooding.

(ii) A 1987 fire in London's underground railway killed 31 people. The government then spent $450 million on fire-proofing doors and escalators in

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[5] Flood protection of New Orleans is based on flood embankments (levees) along the Mississippi River and its tributaries and lakes, together with large pumps to drain parts of the city below sea level. As far back as 1937 when a flood broke through the levees in more than 120 places, many questioned the viability of levees and proposed a return to more natural conditions. Katrina, a Category 3 hurricane, showed how vulnerable such works are to even moderately extreme climatic hazards. Reconstruction of New Orleans and its flood defenses is now being planned or is underway. Residents have stated that they will not move back until the federal government commits to rebuilding the levees whose failure led to the flooding of the city, the only argument now hinging on whether the standard of protection should be for Category 3, 4, or 5 hurricanes. Conditions will thus be ripe for an even greater disaster next time an unusually large flood occurs. In another strange twist, rebuilding will be permitted in even the most heavily damaged, low-lying areas—to do otherwise would be seen as racial discrimination because these areas are mainly inhabited by blacks. Thus, many black citizens will be living in the most hazardous areas when the next flood disaster hits New Orleans.

[6] Beach, L.R. The Psychology of Decision Making People in Organizations.

[7] An example would be the mandatory sentencing to prison of first-time drug offenders in the United States of America. This has overfilled the prisons, driven up prison costs to bankrupting levels, and had no impact on the use of drugs. Reversing this choice would now be difficult given the ideological positions taken by the decision makers at the urging of their main constituents.

[8] Flash floods are characteristic of the climate and the short, steep rivers found in the Philippines.

its stations. With the same amount, it would have been possible to put smoke detectors in every house in the United Kingdom with a potential reduction in loss of 500 lives annually.[9]

(iii) A 2000 rail crash in Britain killed 4 people, following which rail authorities imposed speed restrictions. The delays and disruptions in the service encouraged many passengers to use their cars instead of the trains, leading to many more deaths on the road. Meanwhile, the railways lost customers and almost went bankrupt.

(iv) When the Exxon Valdez ship which ran aground on Bligh Reef in Alaska on 24 March 1989, more than 41 million liters of oil was spilled into the sea. The punitive measures imposed on the owners of the ship were severe, and the cleanup effort cost the company the equivalent of $12,000 per barrel of oil spilt. There remains considerable controversy over the success of the cleanup operation. Many believe that it caused more harm than the original oil spill.

From these few examples, we can see that rapid, politically expedient responses to disasters may be ineffective at best and at worst can cause more damage than the disaster itself. The lesson is that a period of reflection is needed to analyze the causes, examine the merits of the possible responses, and decide coolly (preferably with the aid of structured decision-making techniques) how best to respond to the perceived problem. Only then should something be done. The challenge is how to bring this level of rational approach into the political decision-making process.

III. The Uniqueness of the Flood Problem

For humans, floods are natural hazards and their increasing frequency and severity a major impediment to economic development. However, in the grand scheme of nature, floods are environmentally benign and wholly good. They are a natural land-forming process. They sustain many aquatic life forms. They are a source of life and richness in the whole river environment. They come with the terrain. Floods and droughts simply mark the extremes of hydrological cycles that are as natural as the seasons.

Floods are only a hazard for people who choose to live within the floodplain of a river. They choose to live there because of the natural richness and livelihood opportunities presented by the land-river environment. This convenience comes at a cost, and that cost is the risk of losing one's property, livestock, and livelihood—even one's life. As much as 2/3 of the world's population lives in flood-affected areas.[10] The earliest records of civilization show that human settlements thrived in the fertile floodplains of major rivers. Obviously, the benefits of "living with floods," even in conditions of relatively high risk, outweigh the disadvantages associated with floods.

Earthquakes are also natural events. As hazards, they differ from floods in one particularly important way—they are amenable to engineering solutions. Why do earthquakes of the same magnitude kill fewer people in rich countries than they do in poor countries? Buildings

[9] Alternatively, the government could have obliged its citizens to pay for and install smoke detectors in their homes, thereby making people take greater responsibility for their own safety and heightening their awareness of the actual risk of fire.

[10] According to a United Nations Universtiy prediction, the number of people living in flood-affected areas will reach 10 billion by 2050.

in rich countries have generally been built to better standards.[11] Improve the quality of construction, adhere to building codes, reinforce major infrastructure, and the risk of serious injury and death from earthquakes will decrease dramatically.

Floods (and their river basins) do not respond in the same way. All engineering (structural) measures applied to a river result in the loss of some part of the natural environment, and all engineering solutions aimed at decreasing the risk of flooding for one part of a river basin increase the risk of flooding for other parts.[12] These counterintuitive outcomes encapsulate the uniqueness of the flood risk.

Low river embankments prevent frequently occurring (seasonal) floods from destroying crops and entering people's homes, and have relatively few negative impacts. Large-scale structures create a false sense of security (encouraging ever more development in unsafe areas) and provide the conditions for catastrophic failure when an unusually large flood occurs. For politicians and decision-makers, the allure of complete flood control is hard to resist because the economic benefits (or the potential losses)[13] are enormous. It is, however, an illusion.[14]

IV. Dealing with Floods: Back to Basics

Most of the technical aspects of floods are well understood, and the IFM approach is widely accepted by the scientific community as the appropriate way of reducing flood hazards. Ongoing research will continue to improve the techniques of analyzing probability, risk, and vulnerability.[15] The knowledge base is good and improving.

However, although it is seductive to look for highly sophisticated, technical solutions, and to attempt to apply these to river basins and even to whole regions, there is no substitute for getting out on the ground to see what is actually happening. Talk with the people affected by floods and you will learn what is important to them—you will not have to agonize over the definition of vulnerability nor how to measure it. You will also learn that people living in flood-affected areas derive benefits from floods. Their lives are in harmony with the flood cycle. Learning to appreciate the duality of floods—their benefits as well as their disadvantages—will help moderate the over-reliance on quick-fix, engineering solutions.

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[11] The earthquake that last year killed 73,000 people in Pakistan was of a similar magnitude to that which hit Los Angeles in 1994, killing only 60 people. Earthquakes don't kill people, poor quality structures kill people.

[12] The major deficiencies of the engineering approach are (i) insufficient provision for the passage of larger-than-design floods; (ii) insufficient consideration given to the risk of failure (nonetheless a frequent occurrence); (iii) insufficient consideration of the effects of climate change; (iv) low capacity of most river basin authorities to build and maintain flood control schemes in a condition of excellence; and (v) little if any consideration given to the beneficial impacts of floods.

[13] Japan has gone perhaps further than any other country in using engineering measures to control floods. Its special geographical, sociological, and economic characteristics, however, may warrant such an approach. All of its rivers are short and steep with little flood plain area. It is geologically active and experiences frequent earthquakes and landslides. Some 50% of its population and 75% of its infrastructure are located on only 10% of its land area. The option of giving space to rivers and allowing floods to inundate the lowlands is available only at extremely high cost. Hence, Japan is now "locked into" an engineered solution to flooding. Although flood deaths have been drastically reduced, Japan recorded a steady increase in flood damage to property from 1997-2001, reaching 47,000 ¥ billion by 2001 compared with an average of about 30,000 ¥ billion in the period 1970-1996.

[14] APFM states "Absolute protection from flooding is neither technically feasible nor economically viable. Thinking in terms of setting a design standard of protection is both a trap and a delusion: such a standard conflicts with the principle of managing all floods and not just some. It is also a delusion because estimates of the magnitude of extreme floods are very inaccurate and, due to climate change, likely to get modified over time."

[15] Probabilistic risk assessment has become a much more effective tool in terms of determining the likely severity of extreme events (based on scientific data concerning the climatic characteristics of the earth), but is nevertheless less accurate regarding frequency because of the relative paucity of historical data on catastrophic events.

Some of the most effective measures of reducing flood hazards are the simplest and least intrusive, and they are largely being overlooked. For example, the most effective emergency assistance is provided by local communities (friends and neighbors of the affected people) in the first few hours after disaster strikes. This was true in Kobe after the Great Hanshin-Awaji earthquake in 1995, it is true in the remote corners of the Mekong River floodplain during each seasonal flood.[16] Put effort into building their capacity to be self-reliant.

To improve the relevance of flood management and to ensure that the trade-offs are well understood by the affected populations, make space for participation in project planning. It is not enough to inform the public after the main characteristics of a flood management project have been decided. Participation is a fundamental element of good governance[17] and people have a right to participate in decisions that affect their lives. This means that technicians will have to learn how to communicate complex concepts to people who have no scientific background. Bear in mind that the people most severely affected by flood disasters are poor, and yet the poor are rarely allowed to participate in the decision-making process. Those who decide on major projects are rarely those living in the flood-affected areas.

Enlist the aid of the media to communicate the concepts of flood management to the public so that more informed choices may be made.[18] Be honest about failures, uncertainty, risk, costs, and negative impacts. Get rid of language that makes flood management sound like a battle against evil (e.g., fighting floods, vicious cycle, environmental damage caused by floods). Help explode the myths that proliferate in the field of flood hydrology. For example, the widespread belief that forests prevent or reduce floods, and that clearing forests leads inevitably to worsening of floods.[19]

Transfer risk decisions to individuals where possible. For example, use flood hazard maps to set property insurance premiums, and use insurance premiums to cover investments in flood protection. For areas at risk of flooding, make flood insurance for property damage compulsory. This creates an awareness of risk in the general public and builds appropriate incentives to restrict development in high-risk areas.

There remains a large area of unfinished business and that is the improvement of decision-making at the policy and investment levels. We have seen repeatedly that politicians rarely make the right choices in responding to disasters, and flood protection designers have been far too complacent about providing engineering measures when these are not the most appropriate solutions. Politicians need to learn that there are no quick technical fixes that can resolve flood problems once and for all—the only effective approach is one that (i) examines the complexity of the environmental factors in an integrated manner over the whole river basin; and (ii) balances the trade-offs to achieve the greatest benefit for the majority of people.

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[16] CARE Cambodia implemented the Disaster Preparedness Action Planning Project in response to the severe Mekong River flooding of 2000. Major findings of the project included the following: (i) rural communities work together to reduce their vulnerability to disasters and their traditional coping mechanisms are highly effective; (ii) immediately after disasters, villagers initiate rescue and relief activities long before officials and other sources of aid arrive on site; and (iii) women are affected more directly and in more ways than men by disasters, due largely to the need for women to continue to meet all of their work obligations under extremely difficult circumstances, while men leave disaster areas in search of employment. These are not observations that can be made by satellite, but they highlight the effectiveness of simple measures implemented at community level.

[17] Good governance includes participation, transparency, accountability, rule of law, effectiveness, and equity.

[18] Make the message lively and entertaining or the audience will switch channels (MTV does not hold its audience by showing regression curves).

[19] Food and Agriculture Organization of the United Nations and the Center for International Forestry Research. 2005. *Forests and Floods: Drowning in Fiction or Thriving on Facts?* Rome.

This may mean accepting heavy losses due to floods if that is consistent with better use of the floodplain and the river basin in general. We need therefore to find a way to work within an irrational system to bring more reason into our (communal) response to disaster. It may now be appropriate for engineers and scientists to work closely with behavioral scientists to improve the quality of decisions on flood management and disaster response.

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6 February 2006