World Meteorological Organization

RISK SHARING IN FLOOD MANAGEMENT

A Tool for Integrated Flood Management

ASSOCIATED PROGRAMME ON FLOOD MANAGEMENT

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The Associated Programme on Flood Management (APFM) is a joint initiative of the World Meteorological Organization (WMO) and the Global Water Partnership (GWP). It promotes the concept of Integrated Flood Management (IFM) as a new approach to flood management. The programme is financially supported by the governments of Japan and the Netherlands.

The World Meteorological Organization (WMO) is a specialized agency of the United Nations. It coordinates the activities of the meteorological and hydrological services of 188 countries and territories and such is the centre of knowledge about weather, climate and water.

The Global Water Partnership is an international network open to all organizations involved in water resources management. It was created in 1996 to foster Integrated Water Resources Management (IWRM).

Note for the reader

This publication is part of the "*Flood Management Tools Series*" being compiled by the Associated Programme on Flood Management. The contained Tool for "Urban Flood Management" is based on available literature, and draws findings from relevant works wherever possible. This Tool addresses the needs of practitioners and allows them to easily access relevant guidance materials. The Tool is considered as a resource guide/material for practitioners and not an academic paper. References used are mostly available on the Internet and hyperlinks are provided in the "References" section.

This Tool is a *"living document"* and will be updated based on sharing of experiences with its readers. The Associated Programme on Flood Management encourages flood managers and related experts engaged in environmental assessment around the globe to participate in the enrichment of the Tool. *For the purpose comments and other inputs are cordially invited.* Authorship and contributions would be appropriately acknowledged. Please kindly submit your inputs to the following Email address: apfm@wmo.int under Subject: "Urban Flood Management Tool".

Acknowledgements

This Tool has exploited the works of many organizations and experts, as listed in the references. Acknowledgement is due to the members of the Climate and Water Department in WMO and the members of the Technical Support Unit of the APFM for their competent technical guidance and frank discussions on the issues and for bringing various perspectives into focus.

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Executive Summary

1. Integrated Flood management (IFM) aims at minimizing loss of life from flooding while maximizing the net benefits derived from floodplains. As part of the approach, the management of flood risks is based on a judicious combination of measures that address risk reduction, risk retention and risk transfer through a strategic mix of structural and non-structural measures for preparedness, response and recovery. The decision have to be made on how to share the cost of taking risk placed on society among governments (central, regional and local governments), interested parties (such as private companies), communities and individuals. The tool is primarily aimed at flood managers and in particular those that are involved in formulating flood management strateges and policies. It attempts to provide rapid access to information on risk sharing mechanisms as part of the overall flood management strategy.

2. Flood risks are essentially the costs of taking risk: the sum total of the cost of risk reduction, costs of managing the residual risks and the flood losses that finally materialize. There are three strategies for risk management: risk reduction, risk retention and as a last resort risk transfer. Risk reduction includes activities that contribute towards diminishing the probability of potential losses. In case of floods, risks due to events greater in magnitude than the design floods of mitigation measures, the efforts required to reduce the residual risks is also included. An efficient solution requires a combination of all the three.

3. Risk reduction is the first step in risk management process. Within the IFM approach, flood risks can be reduced either through decrease of flood magnitudes; or the exposure of the economic activities; through structural or non-structural measures. At the same time risk reduction can be achieved by reducing the vulnerability of those exposed to floods. Generally a judicious combination is the answer. An equitable mechanism for sharing the costs of risk mitigation is based on providing the basic protection against a minimum level of flood that addresses the vulnerability and accelerates wealth generation. The federal government, in a welfare state, as the chief development agent should generally be able to bear this cost. The costs of protection against higher floods can be distributed between the state and municipal authorities as they benefit direct revenue from economic activities. For any protection above basic minimum, they should share the cost of risk reduction through various financial instruments.

4. As protection against all flood is neither financially viable nor environmentally sustainable, residual risks are always present. Emergency preparedness plans, early warnings and disaster response actions are undertaken to keep the materialized risk to a minimum. Individuals also take the responsibility by reducing their own vulnerability and implementing proofing measures through retro-fitting etc. Transferring of flood risks physically by diversions of flood waters to less vulnerable areas is an important option for flood risk management.

5. With all the efforts in place, flooding results in losses due to damage to properties and interruption of economic activities. Some of the losses that are materialized are absorbed by the element at risk, as retained risks. Depending on the capacity and vulnerability of the elements at risk,

such retained risk may impact the recovery from flood and may turn into a disaster. In order to share the cost of recovery, some of the materialised risk is transferred through insurance as the last step in a systematic risk management process. It protects capital, enhance solvency and allows recovery, and if designed carefully, has the potential to encourage risk reduction behavior. Small scale floods are predictable so risk reduction methods are most suitable for dealing with such risks while low-probability high consequence events easily destroy the insurance market. As such, insurance instruments are most suitable for middle levels of risk. Reinsurers play crucial role in low frequency high impact events.

6. Recently, non-traditional financial mechanisms have been developed for the facilitation and support of recovery from flood events. Index based insurance, catastrophe bonds, micro-insurance are some of such financing instruments. Some of those mechanisms have almost exclusively been employed in developed countries and a developing country perspective needs to be brought into the financial risk sharing debate. The discussion on these financial mechanisms can contribute to relieving pressure on public finances, particularly in developing countries, for other development activities and governmental services.

RISK SHARING IN FLOOD MANAGEMENT

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1. INTRODUCTION

7. Floodplains provide excellent livelihood opportunities, for habitat, agriculture and commerce. Where these floodplains have been protected from frequent flooding, they have developed into throbbing economic centres. The Integrated Flood Management approach aims to maximize the net benefits from floodplains and at the same time reduce loss of life because of flooding, flood vulnerability, and risks. The concept recognizes the importance of flood plains and the increasing development demands they face, while at the same time recognizing the disruptive nature of floods. IFM aims at a fundamental re-orientation of social perception of floods from the "need to control" to the "need to manage". It integrates structural and non-structural measures; land and water management; ecosystem preservation and development needs; and short- and long-term mitigation measures.

8. Agriculture continues to be an important source of livelihood in most of the developing countries. The poor and marginal farmers that occupy the flood plains, being exposed to frequent flooding, tend to adopt low-risk strategies, for instance, devoting most of their land to crop varieties that promise more reliable yet lower yields. The "uncertainty" posed by flooding prevents poor farmers from taking higher risk, higher return investments, resulting in economically inefficient use of natural resources, increasing their vulnerability. In the event of a low frequency high impact flood event, they often lose their productive assets and are therefore pushed into a downward spiral of poverty.

9. Living harmoniously with floods is an important strategic option in IFM which provides a suitable framework for flood risk management. Integrated flood management is based on the proactive strategy of risk management through a three pronged attack on reduction of risks by reducing magnitudes, vulnerability and the exposure of the economic activities, and addressing issues at all the three phases of the risk management cycle: preparedness, response, recovery and recondition. IFM seeks to set up a transparent mechanism for sharing the cost the society has to pay for taking risks due to flooding. Under such a mechanism, the interplay between floods, the development process and poverty should be understood. A population might be poor because it is exposed to flooding regularly ot it moght be exposed to flooding because it is poor and occupies the most vulnerable land[1].

10. Accordingly, IFM is based on the following principles:

- Adopting a basin approach to flood management;
- Bringing a multi-disciplinary approach to flood management;
- Addressing climate variability and change; and
- Enabling community participation in decision-making.

11. Traditionally, in the larger public interest, governments ultimately provide the finances required to manage the risks from the public funds. Flood defences are built to pre-defined "design flood" to reduce the risk. The society has to deal with the residual risks of flooding that exceed the design flood. For decades, the financing of relief and recovery efforts after flood disasters in developing countries has relied on the diversion of funds from domestic budgets and financing from

[1] APFM 2004, p.7

international donors. Such reactive approaches are often poorly targeted, inefficient and insufficient. Moreover, they provide no incentives for proactive risk reduction measures such as improved urban planning, higher construction standards, etc.

* [ ] indicate the reference listed at the end of the article

12. Under the growing population that puts extra pressure on the limited natural resources, particularly in the flood plains; the increasing frequency and intensity of flooding due to climate change; and the adverse impacts of flooding and flood losses, that are growing, on the development process; flood management practitioners and policy makers have to judiciously allocate their limited resources, particularly in the developing countries. They have to pay special attention to distribute the cost of flood risk management measures across society.

13. The question that is of prime importance is to devise an approach to risk sharing that is economically efficient, corresponds to the shared principles of equitable treatment of and fairness towards various groups in society, and the one that encourages and strengthens the solidarity principle. It is therefore necessary to take a comprehensive approach to distributing risks posed by flooding across the stakeholder spectrum, which includes various layers of the government, private sector including insurance industry, individual users and residents of areas liable to flooding. It has to be apportioned according to the capacity and capability of the stakeholders and at the same time be able to meet the societal goals of well-being and sustainable development. The transparent mechanism should be able to allocate the costs of taking risk between different stakeholders, especially in societies which are regularly affected by floods.

14. Sharing of financial cost[2] of taking risk can be addressed through a number of measures such as appropriate allocation of cost of risk reduction measures; sharing the financial cost of disaster relief and risks transfer mechanism. This tool for "Risk Sharing in Flood Management" discusses various mechanisms for sharing risks. Some of the approaches, such as traditional claims based insurance solutions, have been deployed for a long time with varying degrees of success, others have only recently been developed or adapted into flood management from the realms of managing risks due to other natural hazards and are at various stages of product development. As such there remains doubt about their acceptability in the market. Further, some of those mechanisms have almost exclusively been employed in developed countries.

15. The tool is primarily written for flood managers and in particular those that are involved in formulating flood management strategies and policies. It is presumed that the flood managers primarily have engineering backgrounds and are not fully conversant with financial jargon. This tool is an attempt to provide rapid access to information on risk sharing mechanisms as part of the overall flood management strategy.

16. The tool defines risk sharing as allocation of costs of taking risks that encompasses bearing the financial and other costs for flood risk management and explains the shared responsibility of each stakeholder within the physical, technical, economic and political contexts. It highlights the mechanisms for spreading the financial burden for flood management in terms of efficiency and

[2] Generally, the term "financial" can be used in connection with individuals while the term "economy" is connected to the wealth system as a whole. This document uses "financial" mostly when individual or multiplied individual risk or mechanism is emphasized.

fairness, focused on incorporating equity in flood risk management with economic effectiveness. It provides an overview on flood insurance and other forms of transferring risks of flooding and deals with the inter-relationship between flood insurance, building resilience in the effected communities and reducing risks and takes a brief look at the alternative forms of sharing financial risks from flood, like calamity and reconstructions bonds by government, internal and external solidarity funds.

2. INTEGRATED FLOOD MANAGEMENT AND FLOOD RISKS

17. Risk is both scientific and social concept. It is a physical phenomenon that is concieved as a danger that society defines troublesome[3]. It has to be studied and understood in a societal context. The physical event by itself does not creat a risk of loss. It is the human activity that generates risk. At the same time it is not only the hydrological uncertainty that generates risk but also the political, economic and social uncertianity that add to the risk. Risk have the potential to be accentuated with the engineering modification of the physical environment. Under these circumstances it is important flood risks are appropraitely understood for their effective management.

2.1 UNDERSTANDING FLOOD RISKS

18. The dictionary defines risk in many ways, but some elements, of chance, loss etc, are common. Mathematically, it is expressed[4] as the product of probability multiplied by consequences.

Risk = Probability * Consequence

19. Flood risks are defined as the expected losses from given flood events, in a given area, over a specified period.

20. Consequences of exposure to flood hazard are commonly explained through Source-Pathway-Receptor-Consequence (SPRC) model[5], which account for:

- The nature and probability of the hazard (i.e., the source);
- The degree of exposure of the receptor to the hazard (the pathway);
- The susceptibility of the receptor to the hazard; and
- The value of receptor, or the element at risk. (the consequence)

21. The susceptibility of the receptor depends on its sensitivity - the damage caused by an event of a given magnitude; and adaptive capacity - the ability of a system to moderate potential damages, to take advantage of opportunities, or to cope with the consequences. The value and suceptibility of the receptor is combined to represent the vulnerability.

22. Often, the exposure is also included as a factor that determines the vulnerability. In this publication, however, while defining flood risks, a clear distinction between the exposure and the vulnerability is maintained. It helps to analyze the flood risks, enabling clear distinction between strategies that can be adopted to modify the pathways through engineering means from those that require consideration of social issues that address the vulnerability[6]. To follow an integrated approach to flood management, it is beneficial to define and understand the construct of flood risks that consists of:

- The magnitude of the flood hazard expressed in terms of frequency and severity (depths of inundation and related velocities and duration);

[3] Judith Rees, 2002, p.11
[4] UK Defra/Environment Agency, 2003, p.8.
[5] Floodsite, 2005, pp.3-15
[6] WMO, 2006, p.9

- The exposure of the elements to flooding; and
- The vulnerability of the elements at risk. (See Figure 1).

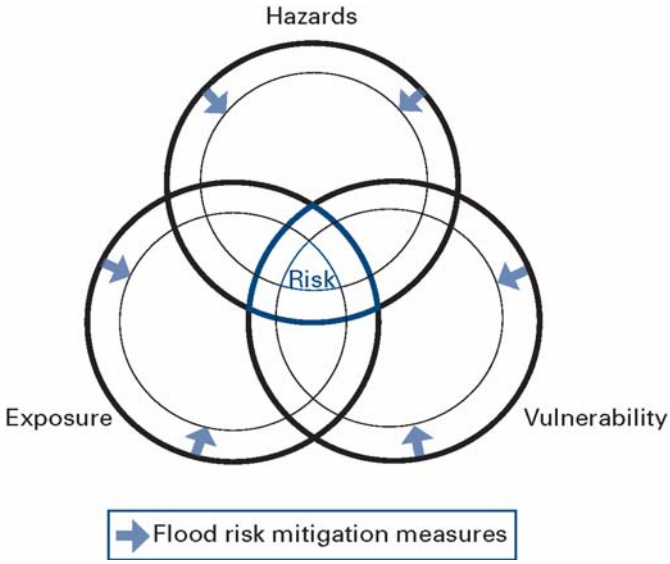

Figure 1. Construct of flood risk and its reduction

23. Under natural conditions, mathematically flood risk is defined as follows.

Flood risk = Probability of potential loss due to flooding = p[H] x v[D] x s[H]
Where
p [H] = probability of hazard;
v [D] = value of the elements at risk, which is a function of the development in the exposed areas and the land use; and
s [D|H] = the vulnerability of the elements at risk, which is a function of the magnitude of the hazard as well as the socio-economic construct of the exposed population.

24. For benefit-cost analysis of any flood management measure, estimation of potential losses have to be made for the lifetime of a particular measure. To calculate this, one needs to convert flood loss data into "potential average annual losses"[7].

25. Engineering of flood protection measures is based on the acceptable threshold for which the structures are designed to provide protection and reduce risks. Linked to it is the uncertainty of reliability of hydraulic structures designed for such events. Safety of exposed population and assets remain dependent on a protection that can fail. Even if flood probability and risk are reduced to extremely low levels with high levels of protection, residual flood risks always remain. Efforts are always made to reduce these residual risks. Eventually, in case these residual risks materialise the flood loss occurs.

[7] WMO, 2007, p.12.

26. In practical terms, under situations where flood management measures have been taken, flood risks should be treated as the 'costs of taking risk'. These costs include the cost of risk reduction, costs of managing the residual risks and the flood losses that finally materialize.

Cost of Risk Taking = Cost of Risk Reduction + Cost of Residual Risk Reduction + Actual flood loss incurred

27. It may however be recognized that there are indirect costs of taking risks in terms of losses or damage to the environment (degradation, loss of environmental services etc.) as well as psychological and cultural costs, which cannot be quantified. Cost of risk taking is illustrated in Figure 2.

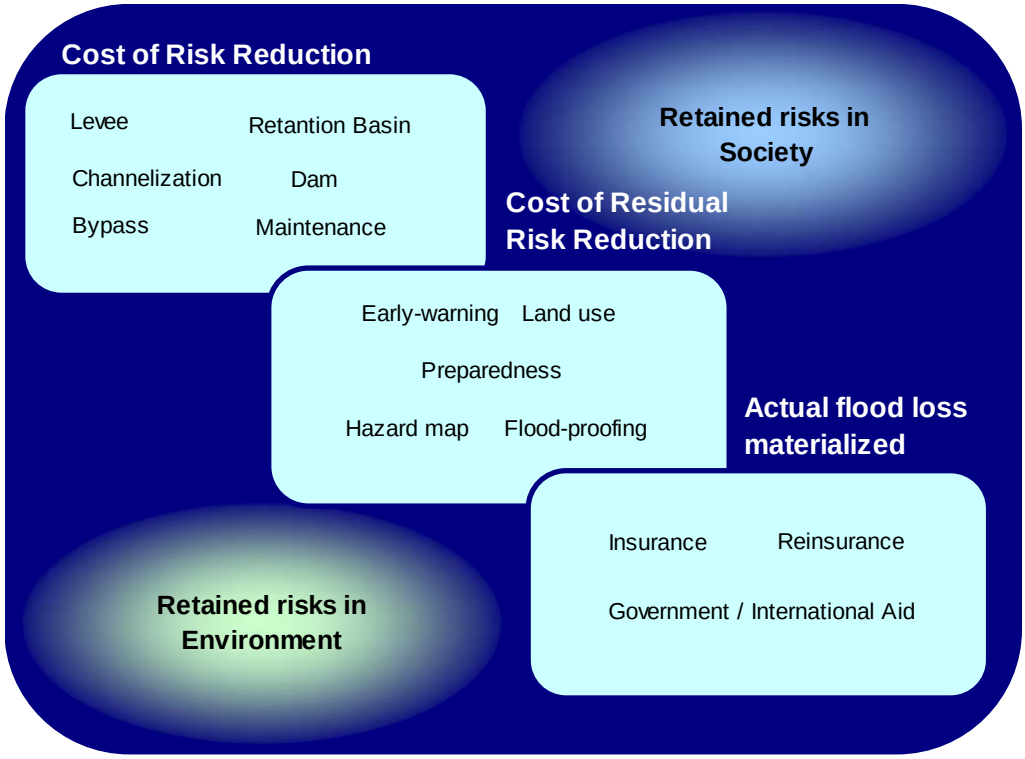

Figure 2. Cost of taking flood risks

2.2 MANAGING FLOOD RISKS

28. Flood plains provide tremendous benefit to the socio-econimc development of a society, and for that reason they have been the preffered place for human settlements. At the same time the flood plains are also subjected to the risks posed by intermitent flooding, thereby extracting the price of deriving the benefits. Wherever the percieved benefits from living in an endangered area exceed the disadvantages associated with the risk, society has continued to make use of such flood prone areas. Such benefits have to outnumber the costs exerted by the flood risks. In order to maximize the benefits from the flood plains, the flood risks to the economic and social activities have to be reduced to a minimum, while the residual risks are managed.

29. Integrated flood management manages these risks through risk management principles such as:Adopting a best mix of strategies:

- reducing vulnerability, exposure and risks;

- Managing complete water cycle by considering all floods, including both extremes;
- Integrating land and water management, as both have impacts on flood magnitudes and flood risks; and
- Adopting integrated hazard management approaches (including risks due to all related hazards such as landslides, mudflows, avalanches, storm surges), creating synergies.

30. Risk management calls for identification, analysis, assessment, control, avoidance, minimization, or elimination of unacceptable risks through policies, procedures, and practices. There are three strategies for risk management: risk reduction, risk retention and as a last resort risk transfer. Some ways of managing risk fall into multiple categories. Figure 3 illustrates the concept.

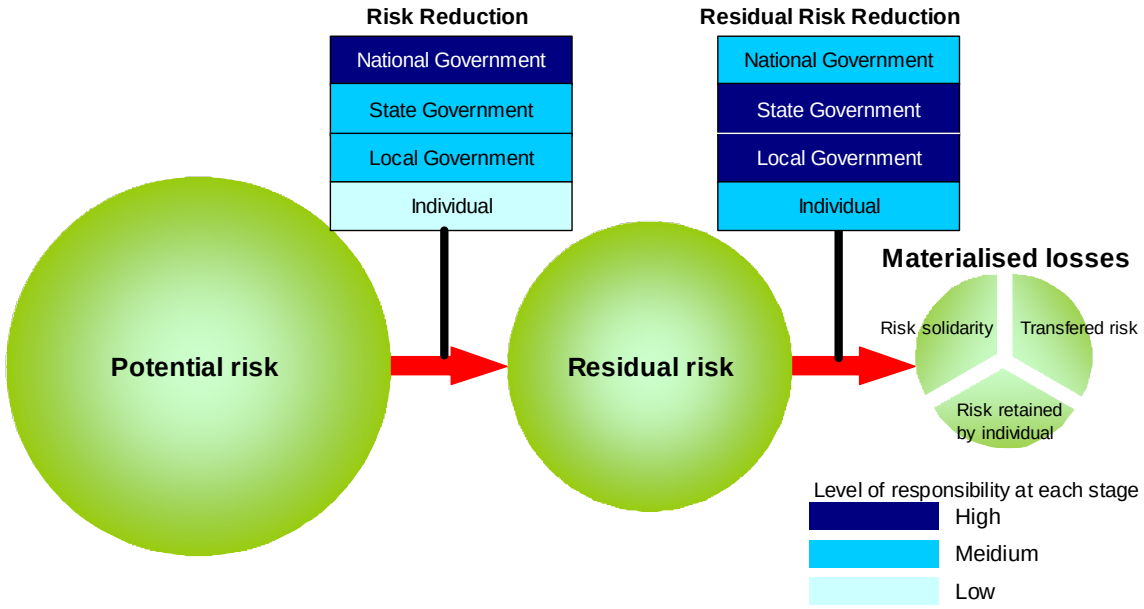

Figure 3. Managing Flood Risks

31. Risk reduction, also known as loss prevention, includes activities that contribute towards diminishing the probability of potential losses. However, it is recognised that no degree of protection is unsurmountable. There is always the possibility of a flood event impinging on the protected area by a flood greater in magnitude than the design flood of the protection works, called residual risks.

32. Risk management, therefore, includes the efforts that are made to reduce the residual risks that involves flood sensitive land use and spatial planning, early warning, evacuation and preparation for disaster relief and flood proofing. Some of these measures are also used directly in the first level of strategies. Finally, with all the efforts in place, flooding results in losses due to damage to properties and interruption of economic activities. Such losses have the potential to increase the vulnerability of the population that is affected directly or indirectly. Some of the losses that are materialised are absorbed by the element at risk, also called retained risks. In order to help recovery of the affected, some of the materialised risk is transferred, which entails passing a part of the materialised risk to the public at large through national exchequer or spread internationally through the aid agencies. Another financial mechanism for risk transfer is to transfer it to another economic agent for an exchange price, called the premium.

33. Typically, an efficient solution requires a combination of all the three. Each of the startegy deployed has a cost and corresponding benefits, and based on cost–benefit analysis[8], it is possible to determine an optimal combination.

[8] WMO, 2007, pp.11-26

3. SHARING THE COSTS OF RISK TAKING

34. The decisions to manage risks depend on how the risks are shared among various administrative entities and whether transferring of risks in time or in space is a viable option. Broadly, there are five sets of competing principles[9] that are followed in sharing the cost of risk taking in the water sector: precautionary vs reactive; uniform vs subsidiary; individual choice (market) vs maternalism; professionally determined vs political bargaining; and risk generator vs risk bearer vs taxpayer.

35. Paradigm shift from an engineering centred flood control to integrated flood management practices in many countries across the globe is effecting various shifts in the governance arrangements for flood management, most notably decentralization of the responsibility, increased participation of stakeholders in decision-making and the increasing influence of the private sector. Climate change, as a driving force in increasing flood risks and the call for "polluter pays principle"[10], adds another angle to the debate. This change has led to searching questions concerning the appropriate division of responsibility between the state and its citizens and the 'fitness for purpose' of the current appraisal, prioritization and decision-making processes. Integrated flood management through stakeholders' involvement in decision-making process calls for new cooperative arrangements between state (and among various tiers of government therein, market) , civil society and individuals.

36. All those within a basin, region or a country have a stake in the flood risk management system either directly by their exposure to flood risk or indirectly. Those within the basin, through various economic activities contribute to the flood risks in the flood prone areas. The infrastructure (roads and railways), and economic activities within the flood plains facilitate economic development even beyond the basin. By virtue of their status as tax payers they have a stake in how expenditure decisions on flood loss mitigation and relief expenditure are taken. In an urban context, with the construction of storm drainage system, not only those that are located in the downstream low lying areas but also those that are located in the upstream, derive the benefit of timely evacuation of rain waters. Basin solidarity can be one of the ways to account for and compensate downstream residents for upstream watershed changes that alter flood characteristics.

37. The principles of cost allocation needs to be set up. Based on above considerations, the costs of taking flood risk have to be distributed not only among those occupying the flood plains and drawing direct benefits but also among those who derive indirect benefits. For equity and fairness the costs of taking flood risks have to be appropriately shared in a transparent manner. Risk sharing is one

[9] Judith Rees, 2002, p.20

[10] According to the recommendation of Organization of Economic Cooperation and Development (OECD) in 1972, the "Polluter-Pays Principle" is a principle to be used for allocating costs of pollution prevention and control measures to encourage rational use of scarce environmental resources and to avoid distortions in international trade and investment. This principle means that the polluter should bear the expense of carrying out the above mentioned measures decided by public authorities to ensure that the environment is in an acceptable state. (OECD 1972 Recommendation of the council on guiding principles concerning international economic aspects of environmental policies, May 1972 Council Document no. C(72)128) http://www.ciesin.org/docs/008-574/008-574.html

of the risk management aspects which deals with the way the cost of risk taking are distributed among several stakeholders: the federal, state and local governments and the flood effected individuals[11].

38. Risk sharing includes:

- Sharing the costs for risk reduction;
- Sharing the costs of residual risk reduction; and
- Sharing the materialised risk, i.e. the losses or consequences

3.1 SHARING COSTS OF FLOOD RISK REDUCTION

39. Risk management calls for risk reduction as the first step. Within the integrated flood management approach, potential flood risk can be reduced either through decrease of flood magnitudes, or the exposure of the economic activities, or the vulnerability or a judicious combination. It entails a variety of measures that require financial resources, the availability or otherwise of which determines the execution of possible options.

> *Building a culture of prevention is not easy. While the costs of prevention have to be paid in the present, its benefits lie in a distant future. Moreover, the benefits are not tangible; they are the disasters that did NOT happen.* (Kofi Annan 1999)

40. Flood risks being the construct of both the physical and social aspects viz., flood hazards, exposure of economic activities and the vulnerability of the society affected by floods, it is crucial that options to reduce each of the components are fully explored to reduce flood risks.

41. The exposure is the measure of the population and the assets that would be directly exposed by a flood *in absence of flood protection*. As such the exposure does not necessarily translate into impact. The linkage between exposure and the residual risk of impact depends upon flood protection measures. Exposed population and assets should thus be distinguished from at-risk population and assets in presence of protection. Exposure, however, is a useful metrics as it provides the basic information needed to assess the need for flood protections.

42. Another approach would be increasing resilience of the society to withstand the adverse impacts. Reducing vulnerability plays key role in dealing with residual risks and the strategy to live with floods. Vulnerability to flood hazards can be reduced to a certain extent by measures to promote resilience, adaptation and flood risk reduction. A detailed discussion on the vulnerability characteristics and measures that may be useful in dealing with them is given in WMO[12]. Reducing vulnerability also requires the analysis of the disaster in order to learn lessons and integrate corrective measures into prevention and preparedness plans.

43. This still leaves residual risks caused by extreme flood events that are beyond the design flood events or to that which societies would have experienced from natural climate variability. Little efforts have been made to prevent further adverse impacts, reconditioning of important infrastructure and documenting events. The reduction of vulnerability through preparedness, such as early warning systems, is essential to achieving development goals.

[11] G.E. Galloway, 1994, pp.82-83
[12] WMO 2006

44. Below is a list of options for reducing each constituent of flood risks. This is not an exhaustive list but pointers to the possible means. These actions are taken depending on the conditions of risk and social, economic and physical setting.

45. Many view the government as responsible for protecting the public, and thus the government should bear the cost of flood risks. Traditionally, governments take the primary responsibility for protecting the public from floods in all their aspects. As the resources come from the public funds and are in competition with other needs of the society, many a times the governments are concerned about the fiscal implications of taking full responsibility of bearing the entire cost of flood risks. They are seeking measures to share the costs of risks between various tiers of governments (federal, state and local) and households and businesses.

Table 1. Options for reducing flood risks

Reduce hazard	Reduce Exposure	Reduce Vulnerability
• Retaining water where it falls (increasing infiltration, rooftop storing) • Retention basins (natural wet lands or depressions, man made e.g., school play grounds, household underground tanks • Dams and reservoirs • Diversion channel • Land use management (e.g., house building codes in urban areas, infrastructure building practices, appropriate spatial planning)	• Structural measures on the river (Dykes, river training work such as flood walls, raised infrastructures such as roads and railways) • Structural and non-structural measures/actions by individual (flood proofing) • Land use regulations • Flood emergency measures (flood warning and evacuation)	• Physical: by improving the infrastructure, well-being, occupational opportunities and living environment • Constitutional: by facilitating equal participation opportunities, education and awareness, providing adequate skills and social support system • Motivational: by building awareness and facilitating self organisation

46. It is arguable as to what extent the risk can be shared by the poor who are generally occupying these risk prone areas, particularly in the developing countries. A transfer of burden to an already vulnerable population cannot be justified by argument of efficiency and loss reduction. It also invokes the fundamental question of equity and social solidarity in responding to relief to the victims of catastrophic floods. How much those in non-risk areas and the general tax-payers contribute to preventing losses and compensating victims in vulnerable communities, and to what extent should those who are located in high-risk areas bear the burden. Such issues are deeply rooted in the societal values and the socio-economic and political environment in the given case. As such these issues need decisions based on democratic process.

47. A mechanism for sharing the costs of risk reduction could be developed by providing the basic protection level against a minimum level by the federal government, while the costs of protection against higher floods be distributed between the state and muncipal authorities. Funding of projects by

the federal government puts the responsibility on all taxpayers—this is appropriate where there are countrywide benefits in terms of national security, infrastructure protection and livelihood generation. According to Ingram[13], crises creates consent and they should be used creatively and effectively to alter the contemporary allocation of responsibilities among federal, state and local entities.

48. State and municipal authorities benefit from activities that provide direct revenue to them and as such, for any protection above the basic minimum, they should bear the cost of risk reduction in principle. They can also use various financial instruments such as market bonds, which can increases the state's ability to fund large projects in the near term. Bonds are an appropriate tool when the asset produced will provide long-term benefits. Bonds could be backed by the General Fund and/or another funding source such as user fees.

49. Galloway Report (U.S. Interagency Flood Plain Management Review Committee) [14] established after the Upper Missisipi floods of 1993 recommended introducing cost sharing provisions for the State, Local, and triabl participation in recovery, response and mitigation activities. The report claimed all of those who support the risk, either directly or indirectly, must share in the management and the costs of reducing the risk[15]. The federal-state cost-share originally 75/25 was adjusted for major disasters (Hurricane Andrew, the Midwest flooding, and Northridge earthquake) to 90/10 basis. These cost-share changes has two potential significant consequences; raising expectation of similar treatment for future disasters, and losing the fundamental purpose behind cost sharing which is to increase the amount of local involvement, responsibility, and accountability[16]. Flood losses actually incurred to indivisuals and communities can be shared by putting in place a flood insurance program that obtains its support from those who are protected. Disaster support for those in the floodplain is contingent on participation in these self-help mitigation programs.

50. In Japan, the River Law (1896, totally revised in 1964, last amended in 1997) has played an important role in forming policy for flood management.[17]. The River Law established the cost allocation for river administration among the central government for class A rivers and prefectural government for class B rivers. Upon a government ordinance, a prefecture government undertakes half of the administration cost for major part of the class A river within the prefecture in principle while central government can provide subsidy up to half of the cost for designated major works in class B rivers[18]. At times of flooding, the responsibility of flood response lies mainly with the municipality to take action for mitigating the impact of floods[19]. It is the responsibility of the State to take emergency measures in the event of a large-scale disaster. In case of extreme floods, national government provides special financial supports to the local governments[20]. The overall management of all natural disasters is based on the law that clarifies the responsibility of the State, local governments and the public.

[13] Ingram, 1988
[14] G.E. Galloway, 1994, pp.83-84
[15] Ibid, p.187
[16] Ibid, p.82
[17] MLIT, Rivers in Japan (in Japanese), http://www.mlit.go.jp/river/index.html (23 January 2009)
[18] River Law in Japan, Article59-62
[19] Flood Fighting Law in Japan, Article 41-44
[20] Cabinet Office, Scheme for disaster management (in Japanese), http://www.bousai.go.jp/hou/index.html (23 January 2009)

51. In Switzerland, the role of the federal government is largely limited to the provision of financial, scientific and technical support, with cantons and communes taking on the principal duties of emergency management[21]. The federal government is responsible only for tasks that are explicitly in the Constitution. The Federal Law assigns the responsibility for flood control to the cantons, which in turn can assign this task to the municipalities or even to the riparian landowners. This means that the role of the Federal Government is to provide financial support and, as required, technical and scientific support. Financial support can be provided only if projects fulfill the objectives as given in chapter 1 of the Law. The subsidies cover on average 30 per cent of total costs and are dependent on the financial power of the canton and the municipality. The maximum is 45 per cent, which may exceptionally be raised to 65 per cent for restitution after flood disasters. The remaining costs are distributed between the canton (frequently 30 per cent) and the municipalities. The cantons are the executing agencies. Even if the municipalities are responsible, the technical knowledge will be supplied by the canton. The initiative for protection projects must come from the municipalities.

52. Some of the costs could be transferred to individuals by dircet taxes. For example, the Netherlands Water Boards fully fund all operations including flood protection from a levy and tax based on the size of the stakeholders' property. The house bank approach of Dutch Water Bank is another example[22]. Individual initiative for reducing flood risks should be encouraged even with economic incentives. The state could rely on increased—but not exclusive—reliance on user fees and/or assessments, applying the "beneficiary pays" principle. Additional fees or assessments could be used for operations and maintenance, for direct capital outlay, or to pay off bonds. In such cases it is important to transparently assess the proprtionate benefits to each section of the stakeholders. Although, the incentive issue is somewhat irrelevent in very poor areas, particularly in developing countries in informal settlements composed of environment or economic migrants.

3.2 SHARING THE COST OF RESIDUAL RISK REDUCTION

53. The residual risks are always present, as there is no way to provide protection against all flood magnitudes,. The residual risks tend to increase with time after construction of structural measures as the economic activities in the protected areas increase with time. This is one of the reasons why the flood damages continue to rise despite substantial investments in flood control measures. Climate change will also increase residual risks.

54. To mitigate the adverse impacts of residual risks due to overtopping the hydraulic flood protection structures, necessary emergency preparedness plans, early warnings and disaster response actions are undertaken in order to keep the materialised risk to a minimum. Information is needed to evaluate the flood risk in each area, the reliability of structural flood protection measures and assess the residual risk. Land-use planning and zoing regulations such as building codes can help the local authorities to limit development in vulnerable area. Safety of life becomes the top most priority in emergency preparedness. The consequences of materialised risks in terms of time and location of overtopping/breach, likely flooded areas, the population and properties at risk need to be assessed in advance and incorporated into disaster preparedness plans. Early warning of the impending

[21] WMO, 2006b, pp.87-97
[22] GWP 2008, p.18

failure/overtopping would require a close monitoring of the conditions that are likely to generate such a situation. Many of these monitoring parameters, particularly hydro-climatic, are undertaken at the basin level and beyond. Federal authorities have the responsibility to provide these at the national level.

55. Rescuing victims and providing assistance in case of need can be best addressed by the local community based authorities as community is the first to respond to the emergency situations. Local authorities have to share this responsibility by investing in preparedness, executing regular evacuation drills and organising rescue and relief operations. Local authorities along with the State authorities are responsible for promulgating and implementing land use plans within the protected areas, including the building codes and flood proofing measures.

56. Individuals take the responsibility by reducing their own vulnerability and implementing flood proofing meaures through retro-fitting etc. Community has the potential to handle response planning, and emergency management and as such should be effectively mobilised for the purpose, with appropriate institutional backing.

3.3 PHYSICAL TRANSFER OF RESIDUAL FLOOD RISKS

57. Transferring of flood risks, physically, where feasible, is an important option for flood risk management. It is based on the premise that protection objectives are set differently depending on the kind of land use in the protected areas. Where human lives or high material damage value may be at stake, the protection level is higher than it may be in areas used for farming or forestry. Thus some areas may be flooded often, others seldom and few others, as far as possible, never. Therefore, protection objectives should be defined in relation to land use.

58. Traditionally, the level of protection was set without regard to the vulnerability of the land to be protected. The risk based approach[23] seeks to define optimal flood protection through an economic evaluation of damages including consideration of different uncertainities. In this approach various alternative solutions are evaluated to determine the expected ecomonic net benefit (benefit minus the cost). Risk based approach is factored, in certain cases, say by fixing different design threshold for embankments providing protection to urban and rural areas. Further, cities in richer countries have higher protection levels than those in the developing world. Physically transferring risk, say through diversion of flood waters to less vulnerable areas, can also help manage the overall flood risks. It is, however, not only the monetary value of assetts that should shape that choice: equity issues between unban, rural / rich and poor neighbours, appropriate compensation through negotiations need to be added as well.

59. Figure 4 illustrates a hypothetical situation where an agricultural/rural area in the upstream can be used to divert and store the flood waters temporarily to prevent overtopping/ breaching of the embankments in the downstream, protecting the urban areas with dense population and economic activities. By diverting water into agricultural area, very high potential urban losses can be avoided. This may entail higher actual agricultural damages as compared to the potential agricultural damages. Such an arrangement would require additional compensation in agricultural/rural areas over and above the actual agricultural damages materialised. Such a compensation has to be agreed upon in advance at

[23] USACE, 1996

the disaster preparedness planning stage through a transparent process involving all affected and the insurance companies. The real-time operation of such a mechanism would require a close monitoring and clearly laid down decision-process supported by early warnings. The feasibility of such an arrangement would depend on the geo-physical charateristic. Some other similar arrangements could be retention of rain water in the natural or man-made depressions.

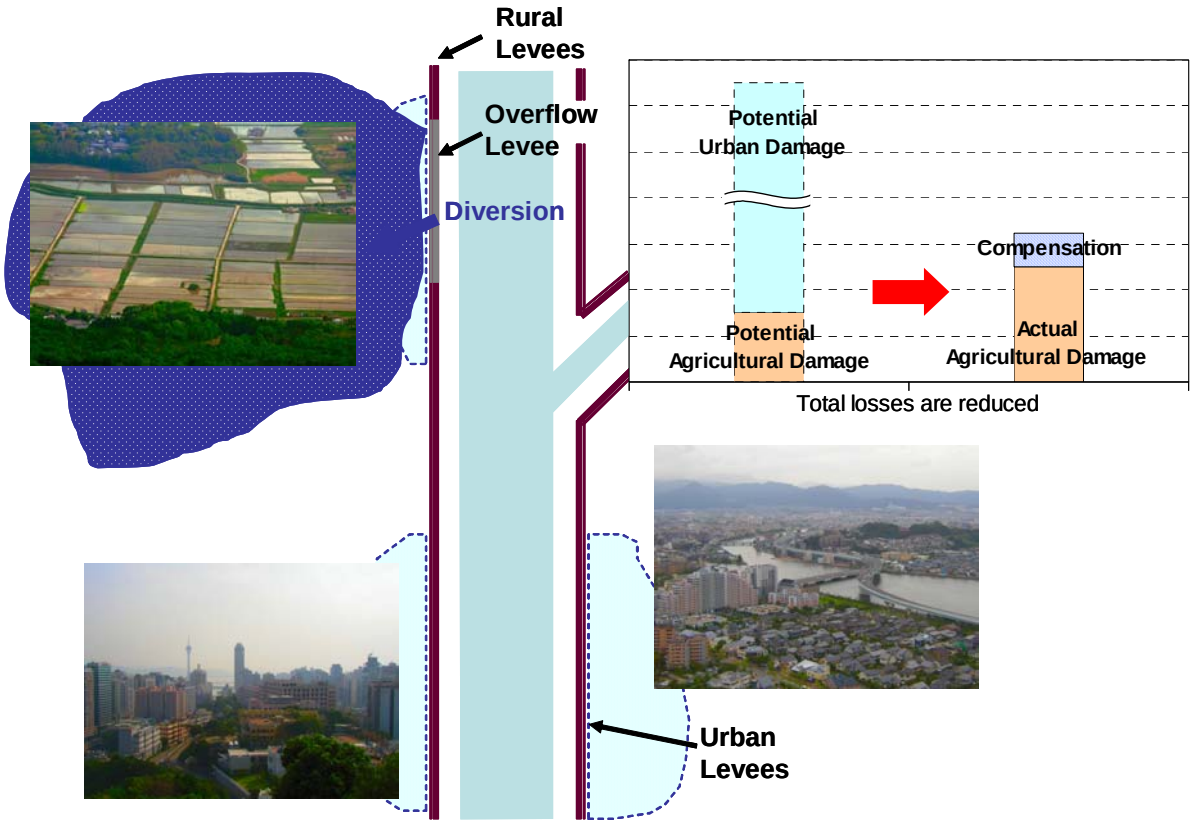

Figure 4. Physical Risk Transfer by diversion of flood water to agricultural lands

60. However, such a mechanism requires extensive consultations and negotiations with the communities effected. All such measures should be based on understandable, transparent, and comprehensive weighing of interests. This means a compromise satisfactory for all involved must be found through communication and discussions which are realized by participatory approach. Landowners and farmers directly affected by such diversion should be closely involved in the planning of the measures as well as the financial compensation (risk transfer) mechanism that should closely be linked with the physical risk transfer. A spirit of give and take should be promoted to the extent that individual interests are compatible with general welfare. Appropriate legal frameworks should exist to facilitate such transfers.

4. FINANCIAL RISK SHARING INSTRUMENTS

4.1 MATERIALISED RISK AND DISASTER RELIEF

61. Flooding changes into disasters if the people at risk are unable to cope with the consequences of retaining the materialised risks. The poor in developing countries are the most exposed to and affected by natural hazards. Most of the times due to their vulnerability and consequent limited political power they are the ones who occupy the most suceptible areas and face the risk of flooding. In case of poor and vulnerable people, more often the materialised risk adds to their vulnerability. If allowed to fend for themselves, they resort to sale of personal assets and loans that are likely to push them into a downward spiral of vulnerability and poverty. This is often seen as a primary cause for what has been called the "poverty trap". There are different views with regard to who should bear the losses.

62. They have limited or no access to insurance and financial services, and in most cases have to manage flood losses on their own. The lack of financial compensation can slow recovery. Sometimes state assistance for the survivors of a disaster may be dependent on the whim of a politician who could be influenced by many other issues, not always entirely objective.

63. Sharing the materialised risk includes formal and informal responses to expected losses such as self-insurance, precautionary savings in financial or other assets, social networks and formal insurance. Public disaster relief systems (for example emergency subsistence and soft loans) are often set up to cater for victims of natural disasters. Transferring the materialised risk in time through insurance, which is a post event compensatory mechanism at a given cost, is also resorted to. Adverse impacts of retaining the risks can be avoided through falling back on savings, borrowing from friends and family members, or selling of assets. In order not to allow the flood events to turn into disasters governments provide disaster aid, often by diverting their development budgets.

64. Such disaster aid is rooted in the concept of social solidarity with the flood victims, which is a valued public virtue that promotes a huminatarian and equitable society. Taxpayers solidarity with flood victims has not typical of socialistic political setups but also in market driven economies[24]. It has a strong appeal to those who see assistance to disaster victims, even if it encourages risk-taking behaviour, as promoting a humanitarian and stable society. However, under resource constrains when the development budgets are diverted for relief and rehabilitation, particularly in developing countries, the development programs are heavily impacted and often result in loss of GDP growth.

4.2 SHARING THE MATERIALISED RISK THROUGH RISK TRANSFER

65. Transferring risk through insurance is the last step in a systematic risk management process. It protects capital, enhances solvency and allows recovery, and, if designed carefully has the potential to encourage risk reduction. At the same time, while risk transfer can be very beneficial, it does not reduce the total risk because it just moves the risk either in time or transferred to other entities. However, problems to setting up risk-transfer schemes remain, where:

[24] In Hungary, where experienced the transition from socialist countries to market economy, floods and loss sharing was discussed in terms of public-private insurance system changed from 100% full compensation by the government (Linnerooth-Bayer and Vari 2003).

- *There is a large concentration of risk*: this is where many policies are at risk from the same event;
- *Ownership is difficult to establish*: where establishing ownership of assets lost is non-trivial, concerning, for example, fisheries, ecosystems or water supply; and
- *Damages are difficult to quantify*: it is difficult to assess the financial value of damage to livelihoods and cultural capital, which makes risk-transfer mechanisms problematic.

66. Before reaching a decision about which risks can be cost effectively transferred, it is essential that activities are thoroughly organized to reduce risks as far as economically possible through planning to eliminate avoidable risks, and by designing resilience into systems and assets.

67. Small scale floods happen fairly often. Without an appropriate management, these flood risks inhibit the optimal utilisation of the flood plain resources. If losses occur frequently, then the rationale for an insurance system is questionable. Moreover, small events are predictable and as such risk reduction methods are most suitable for dealing with such risks. Frequent risks require other strategies for mitigation and management[25]. As the magnitudes of flood events increase, the cost of mitigation increases dramatically making it economicaly unviable.

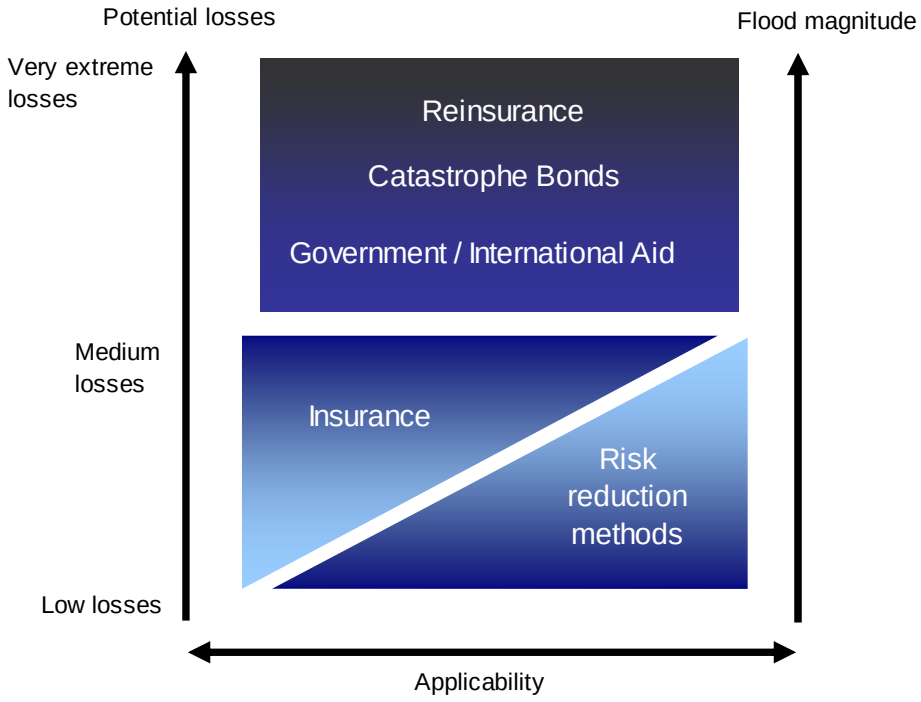

Figure 5. Applicability of insurance[26]

68. Insurance instruments are most suitable for middle layers risks. In case of low-probabilty high consequence events, the insurance market often fails. In such events, particularly in situations where the risk is concentrated in relatively small areas (such as densely populated cities, protected with levees), requires government, donors and other international institutions to provide re-insurance. This

[25] USAID, 2006, Index insurance for weather risk in lower-income countries, (27 January 2009) p.24
[26] MCII, 2008, pp.7-8

is known as catastrophe insurance. Here the cover is often based on individual private insurance policies and the state involvement is only for reinsurance and/or catastrophe situations. Figure 5 depicts the potential applicability of each of the instruments depending on the losses or magnitude of floods or losses from the floods.

69. Various levels of insurance that exist range from informal arrangements for assistance with family, friends and neighbours, to community schemes like Micro insurance and mutual insurance based on affinity groups such as communities and trades, to formal insurance where funds are collected by a profit-making third party, to reinsurance, which accepts risks that are too severe for smaller schemes or operators to retain. These are briefly discussed below.

4.3 TRADITIONAL FLOOD INSURANCE[27]

70. Insurance can work only for risks that are insurable. The main principles of insurability are: risks have to be quantifiable, occur randomly and be many in number, so that variations in claims are smoothed out. From the client's side, the premiums have to be affordable and the contract has to perform reliably. These issues sometimes prevent insurers covering losses due to flooding, pollution, farming and gradual deterioration of assets. Key insurance principles that determine the insurability of a risk and how they measure in case of flood risks are given in Box 1[28].

BOX 1. Insurance Principles and Floods

Key insurance principles that decide the insurability of a particular hazard in a given situation are mutuality; need, assessability, randomness, economic viability and similarity of threat:

Mutuality: A large number of people who are at risk must combine to form a risk community.
In case of flooding mutuality requirement is not met when frequently affected risks are the only ones insured. This is one of the major reasons why insurance cover against flooding is not widespread.

Need: When the particular event occurs, it must place the insured in a condition of financial need.

Assessibility: The expected loss burden must be assessable.
While it is feasible to assess losses due to small scale floods that occur fairly often, the statistics for catastropic flood losses since their probability of occurrence is small. The assumptions in risk assessment in such cases is laden with high uncertainty.

Randomness: The time at which the insured event occurs must not be predictable and the occurrence itself must be independent of the will of the insured.

Economic Viability: The community organised by the insured persons must be able to cover its future, loss related financial needs on a planned basis.
Economic viability is threatened when flood protection measures fail. Econimc viability of the region is threatened. Once in a centuary event may overtax the local risk-carrier financially. Re-insurance is generally resorted to in such cases.

Similarity of threat: The insured community must be exposed to the same threat, and the occurrence of anticipated event must give rise to the need for funds in the same way for all concerned.
Similarity of threat is present only to a limited degree as flooding comprises various types of occurences, such as storm surge, flash floods and dike failure.

[27] Swiss Re, 1998
[28] SwissRe, p.7

71. Many countries have some form of flood insurance cover (Table 2)[29]. These insurance systems differ widely between countries in their treatment of risks. Different approaches categorized[30] as the ‘‘option’’ system and the ‘‘bundle’’ system are used. Under the “Option” system, insurers extend their policy to include flood on payment of an additional premium; as in the case of Belgium, Germany, Australia, and Italy, for example, with a very low take up. In “bundle” system, cover for flood is ‘‘bundled’’ with other hazards, such as fire, storm, theft, earthquake, etc. This system is in use in Britain, Japan, Israel, Portugal, and Spain, for example. With the bundle system, insurers charge differential rates based on intensity of risk.

72.

Table 2. Various scheme of flood insurance

	Flood insurance
China	The flood insurance systems of other countries are being studied.
France	There is a nationally legalized natural disaster insurance system called "Cat Nat." Insurance rates: - Uniform rates relative to original insurance rates, regardless of such factors as the objects insured and locality. - Insurance rates rose from the initial rate of 5.5% to 9.0% as disasters increased. The current rate is 12.0%.
Germany	- Floods are considered a natural hazard which is not covered by ordinary insurance contracts. In the earstwhile German Democratic Republic household insurances covers flood damages. There are still a number of these old contracts in place which provide insurance protection. The same applies for old contracts in Baden-Württemberg. - There are a number of insureres that offer flood insurance. The risks, however, are assessed on a single case basis by the insurer.
Japan	Private comprehensive insurance: - Insurance against natural disasters exists in the form of comprehensive insurance offered by private insurance companies and the basic contract of special fire insurance. - The national government is not involved in the administration of the insurance. Insurance rates: - Insurance rates for flood damage are uniform throughout the country, regardless of flood risk levels.
Nether-lands	At present, there is no flood insurance system under which flood coverage is provided by insurance companies. The government and insurance companies, however, are discussing the introduction of a flood insurance system.
United Kingdom	There is no flood insurance system in which the national government is involved. Some insurance companies studied the feasibility of a flood insurance system, but such a system did not become a reality because the government was not necessarily positive about getting involved in insurance service.
United States	Flood insurance system: - There is a national government-run flood insurance system. - The flood insurance system is closely linked with land use regulation, and settlement in floodplain areas is strictly restricted. - In the case that a community participates in the flood insurance system, it is mandatory for flood hazard areas without levee protection to be insured, whereas it is not for areas with levee protection (either 1/100 or 1/200). Areas surrounded by levees must also be insured as it can be flooded both from landside and riverside. - CBO estimates that multiple year discretionary outlays for National Flood Insurance Program and the appropriation of authorized amount is appropriated to state and local comunities.

[29] Paper dealing with examples of insurance schemes in different countries, contribution from Japanese Institute of Construction Engineering including JICE, 2003 and Yoshioka et al. 2002.
[30] David Chricton 2008

	Insurance rates: - As per the flood insurance rate table prepared by the Federal Insurance Administration (FIA) Rates depend on the size of the family living in the building, the size of the building, whether the building has a basement, etc.

73. Evidence suggests that those at risk tend to conceptualy ignore the probability of the most extreme and infrequent loss events, but insurers need to load their premiums considerably to allow for them happening. This creates a gap between what buyers are willing to pay and what sellers are willing to accept for protection against very infrequent but catastrophic losses. In case the cost of the premium is relatively high, consumers will not insure. The high cost may be a signal from the private market that the risk is very high (unsustainable), or that there is great uncertainty, or that the scale of operations is too small, or that alternative risk management options exist.

74. Traditionally, insurance against floods have been limited to urban properties. Due to high price of the policies, they have not been very popular more so in the developing countries and have never played a significant role in developing countries. The private market will seek to segment customers, eliminating cross-subsidies. However, this may be contrary to public policy in terms of ensuring solidarity. This situation can be improved by raising risk awareness and promoting solidarity between those who are seriously at risk and those who are barely at risk, through a cooperative approach. The readiness for solidarity also depends on a public understanding of whether less risky alternatives are available or not.

75. Where primary interest is in reducing the vulnerability and poverty reduction and agriculture is the key, there is a need to expand applications of flood insurance from property to agriculture. The experience of managing agricultural risk shows the insurance in developed countries is not always a good model for developing countries[31]. Mandatory insurance policies are viewed as a tax. However, it can be acceptable if made conditional on assistance to low income groups.

Reinsurance

76. Natural catastrophes tend to be rare but very large events that have the capacity to adversly impact the yearly profitability of the insurance company. Investors prefer a lower volatility to permit steady payments of dividends as erratic profits depress their share values. For that reason, insurance companies often resort to reinsurance. Through participation of International Institutions, such as World Bank[32] or reinsurers, some of the risk is transferred outside the country.

77. Reinsurance is the insurance of the insurance companies. Whenever the insurer cannot or does not want to take the entire risk, and reduce the likelihood of having to pay a large obligation resulting from an insurance claim, he resorts to re-insurance, thereby protecting itself from the losses incurred by catastrophe. It is mechanism of insurer's transferring portion of risk portfolios to other parties. The reinsurance company recieves pieces of a larger potential obligation in exchange for some of the money the orginal insurers receives to accept the obligation.

78. The functions of re-insurace are to reduce volatility, minimize taxes, underinvestment incentive, costs of insolvency and real service advantages as the traditional hedge for primary

[31] World Bank 2005
[32] TCIP, Turkish Catastrophe Insurance Pool

insurer[33].. Reinsurers specialize in low frequency high impact events. Because capital reserves are limited, the reinsurer has to levy a significant uncertainty margin to cope with short-term fluctuations in occurrence and severity of catastrophes; this can be a multiple of the long-term risk premium.

79. Very extreme events may exceed the funds available, particularly in the early years when a surplus has not accumulated or a sufficient volume of business been established. The excess amount may need to be guaranteed, perhaps through contingent loans from government and/or donors. The Mongolian Index-based Livestock Insurance Pilot has such an arrangement with the World Bank[34]. A possible role for government, donors or other sources of financing is to provide resources for addressing low-probability, high-consequence events.

80. Risk based premiums are generally opposed in poor regions. Insurance may be an option, but only by circumventing the commercial insurers with non-profit mutual arrangements. If insurers are limited in their ability to introduce appropriate risk-related variations in, for example, deductibles or premium loadings, insurance can lead to a less risk-averse culture. It is therefore vital that insurance is complemented with a risk management framework (land development, building design, construction standards, etc.) to avoid such moral hazard. The private sector can be a partner in this: the insurance industry of the United Kingdom actively engages with policymakers on flood defence funding, land zoning and construction standards; in the United States, insurers help to fund the technical training of publicly paid building inspectors; and Australian insurers assisted Fiji in setting standards for cyclone-resistant buildings[35].

81. Involving the insurers in the development and execution of strategies like Integrated Flood Management that enhance flood resilience, reduce the magnitude of losses, and thus help increase insurers' willingness to establish, maintain and expand a presence in developing countries.

4.4 NON-TRADITIONAL FINANCIAL MECHANISMS

82. Non-traditional financial mechanisms, together with insurance mechanisms, belong in a portfolio of financial mechanisms for the facilitation and support of recovery from flood events. Such non-insurance mechanisms can:

- Provide direct financing for reducing the flood risks, such as flood proofing;
- Serve communities that do not have insurance institutions in place, or an insurance culture;
- In some contexts offer a lower-cost alternative to insurance for providing post-disaster capital, especially for low-level risks; and
- Share the materialised flood risks from the poor with national and international solidarity.

4.4.1 Index Based Insurance

83. One of the interesting developments in recent years has been the emergence of alternative indexed insurance risk-transfer products to handle risks which the conventional insurance industry has failed to achieve approparite market penetration or has avoided; for example, captive or mutual

[33] Lewis 1996, The Role of Government Contracts in Discretionary Reinsurance Markets for Natural Disasters, *the Journal of Risk and Insurance*
[34] World Bank, 2005, para 248
[35] Dlugolecki A, 2001

insurance companies for corporate risks; weather derivatives for non-catastrophic climatic variability; and catastrophe bonds (Cat Bonds) (Box 3).

84. Typical insurance schemes are indeminity based i.e., they are based on payment after the real verification of losses by an expert, subject to acceptance by the parties. An index-based risk transfer approaches use a proxy measurement to pay for significant economic loss. For example, if it is known that extreme rainfall or temperatures is highly correlated with agricultural production losses, then these measures can be used to proxy loss and make payments in case of loss of production. A variety of mechanisms used for payment of index-based insurance are described in Box 2. One noteworthy advantage of indexed insurance contracts is that claims management is greatly reduced, since there is no need to validate losses; they are determined by a simple objective measurement.

85. Such an approach helps solve a variety of problems associated with the usual public-sector response to catastrophic risk and to credit constraints in developed countries, namely traditional forms of agricultural insurance and *ad hoc* disaster aid. However, experience with index based insurance is largely limited to drought risk. There are only a couple of examples of their use in flood risk insurance.

Box 2 . Index-based insurance contracts

Five mechanisms can be used to determine a payment from an insurance contract:

(a) *Parametric*, a scheme based on physical parameters that determine if the risk materialized. For hurricanes, the parameter is wind speed. If the parameter reaches the established threshold, this triggers a loss;

(b) *Modelled losses* operate like the parametric scheme. In this scheme, a mathematical model is used with a set of parameters. The parameters are the inputs of the model. If the output of the model reaches a predetermined threshold, the financial scheme pays out;

(c) *Parametric index* is mid-way between the parametric and modelled losses mechanisms. It uses a number of observations of, for example, wind speed, at different locations, weighted to reflect the amount of business at risk in the vicinity of each location;

(d) *Industry index*, an index built using sources from the insurance industry to predict the losses in the industry. Once the industry index reaches a certain threshold, it triggers a payment.

4.4.2 Catastrophe Bonds[36]

86. An insurer faces a large cost after a catastrophic event. To reduce the expected costs of financial distress, the insurer hedges the risk. The insurer can obtain indemnity-based reinsurance or, it can issue a cat bond with a parametric trigger such as the actual magnitude and location of the earthquake or hurricane.

87. Cat Bonds are capital market-based alternative to reinsurance. A reinsurance contract's payoff is usually based on the realized loss (indemnity payment). In contrast, cat bonds usually have an index or a parametric trigger. In the first case, the payoff after the catastrophic event is based on an index of industry-wide losses; in the second, the payoff is determined by certain parameters. Thus, the payoff is largely, and in the case of a parametric trigger, completely, independent of the sponsor's realized loss.

88. Cat Bonds are high-yield debt instruments that are usually insurance linked and are meant to raise money in case of a catastrophe. They have special condition that states that if the issuer

[36] Neil A. Doherty, 1997

(insurance or re-insurance company) suffers a loss from a particular pre-defined catastrophe, then the issurers' obligation to pay interest and/or re-pay the principle is either deffered or completely foregiven.

89. Catastrophe bonds can be considered as another form of asset, which is acquired by the investor, for a fixed period of three to five years, who bears the default risk in return for a regular intrest payment, generally at rates higher than the market intrest rates to cover the possibility of default or loss of capital invested. Cat Bonds act like reinsurance to remove the peaks or volatility of catastrophe risks. The principal obstacles to greater use of the capital markets are: the higher prices; the possibility of basis risk, because the bond is triggered by objective conditions, not actual losses to the insurer; unfamiliarity with the instrument; and regulatory limitations as a result of accounting rules.

90. In the capital market they are considered as investment opportunity that diversifies the risks away from the financial markets and into natural hazards. Cat Bonds are not closely linked with the stock market or economic conditions and offer to investors a good diversification of investment risks. The key advantage of the Cat Bonds is that they help transfer risks to a large group of investors.

4.4.3 Micro-insurance[37]

91. Micro-insurance is the financial arrangement to protect low income segment of society against specific hazards in exchange for regular premium payments proportionate to the likelihood and cost of the risk involved. It has evolved in conjunction with micor-credit and uses insurance as an economic instrument at the micro (smaller than national) level of society. "Micro" does not refer to the size of the risk carrier, some are small or even informal, while others very large companies; or of the scope of the risks, which are by no means micro to the households that experience them.

92. In cases where the individual values insured are often small in relation to the insurance transaction cost micro insurance could be a more suitable instrument. It can be delivered through a variety of different channels, including small community based channels, credit unions or other types of micro-finance institutions, but also by enormous multi-national insurance companies etc. They are also useful in promoting the culture of risk reduction.

93. It is the insurance with low premiums and low caps- coverage and is sysnonymous with community based financing arrangements. "Bundled" microinsurance are provided to clients of micro-finance where insurance is linked to a loan. Communities are involved in the important phases of the process such as package design and rationing of benefits.

94. Community is involved in revenue collection, pooling, resources allocation and frequently service provison. Decisions in micro-insurance are made within each operational unit, rather than far away, at the level of governments, companies, NGOs that offer support in operation etc. This instrument is particularly beneficial in developing countries. However, even in developed countries the excluded sections of the society can make use of this option. Microinsurance schemes which operate

[37] Roth J, McCord M and Liber D, 2007, 1-6

microfinance institution or community-based organization in Bangradesh, India, Malawi, Nepal Pakistan and four Caribean countries[38]

95. Micro-insurance links multiple small units into larger structures, creating networks that enhance both insurance functions, through broader risk pools and support structures for improved governance e.g., trainings, data banks, research facilities, access to re-insurance etc. This mechansim is concieved as an autonomus enterprise, indepenedent of permanent external financial life lines and its main objective is to pool both risks and resources of whole groups for the purpose of providing financial protection to all members agaist the financial consequences of mutually determined risks. The essential role of the network is to enhance risk management of the members of the entire pool of micro insurance units over and above what each can do when operating as a stand alone entity.

4.4.4 Government Financing Instrument

96. There are two principal types of mechanisms available to governments to fund the costs of recovery from flooding: hedging instruments and financing instruments[39]. Insurance and capital market-based securities, where the financial risk of the losses from future disasters is borne by another party as ex ante risk transfer mechanisms, are examples of hedging instrument. On the contrary, financing instruments are arrangements whereby the government sets aside funds prior to a disaster to taps its own funding sources after the event occurs. For instance, the government implicitly self-insures by setting aside money to finance some of the recovery needs following a disaster. Alternatively, the government can mobilize its own financing sources by such policy instruments as imposing taxes, borrowing domestically or internationally, or diverting from the public budget. Alternatives for financing disaster response and rehabilitation include[40];

- a catastrophe tax,
- a catastrophe reserve fund,
- government debt instruments,
- international loans, and
- budget diversions.

97. These financing instruments have been traditionally used in emerging-economy countries to fund disaster recovery. However, these options may be politically difficult, such as imposing a disaster tax, or economically undesirable, such as transferring funds from other budgetary commitments. Catastrophe risk financing refers to the combination of all methods used to pay for financial losses incurred during a disaster. This has in the past in developing countries focused on post-disaster aid and lending. It is clear, however, that such “ex-post” strategies are not efficient or sufficient. Risk financing now stresses “ex-ante” (before the disaster) measures such as risk transfer and sharing. While use of ex-ante risk financing methods is increasing, during most disasters in developing countries some degree of ex-post support will always be needed[41].

[38] Provention/IIASA, 2006
[39] Neil A. Doherty, 1997
[40] Kunreuther H. & Linnerooth-Bayer J., 1999
[41] Provention, 2009

5. EXAMPLES OF SHARING FINANCIAL RISK

5.1 NATIONAL FLOOD INSURANCE PLAN (USA)

98. In the US, based on the National Flood Insurance Act of 1968, the National Flood Insurance Program (NFIP) has enabled property owners in participating communities to purchase insurance as a protection against flood losses in exchange for state and community floodplain management regulations that reduce future flood damages[42]. The 1973 Act prohibits federal agencies from providing financial assistance for acquisition or construction of building and certain disaster assistance in the floodplain in any community that did not participate in the NFIP. The purchase of flood insurance was voluntary, but there have been several incentives to join the system. For instance, regulated lending institutions could not make, increase, extend, or renew any loan secured by improved real estate located in a designated Special Flood Hazard Area (SFHA, the 100-year floodplain) in a participating NFIP community unless the secured building and any personal property securing the loan were covered for the life of the loan by flood insurance since 1973.

99. Another policy schemes motivating community based activities from economic incentives is flood insurance with community-based rating system[43]. NFIP requires communities to maintain a minimum level of floodplain management for its residence to eligible to purchase flood insurance and established the Community Rating System (CRS) to encourage communities to exceed the minimum requirements. For CRS participating communities, flood insurance premium rates are discounted in increments of 5%; for example, a Class 1 community would receive a 45% premium discount, while a Class 9 community would receive a 5% discount (a Class 10 is not participating in the CRS and receives no discount). The CRS classes for local communities are based on 18 creditable activities, organized under four categories; public information, mapping and regulations, flood damage reduction, and flood preparedness[44]. However, the program fell short of meeting its goals in part because of its limited ability to guide development away from floodplains and cannot restore beneficial floodplain functions once they have been impaired[45].

5.2 CATNAT (FRANCE)

100. The CatNat ("catastrophe naturelle" in French, which means natural disaster) system in France shows the state involvement only for reinsurance and/or catastrophe situations[46]. The system has been running since 1982 under which government acts as a reinsurer. A commission, formed of representatives of central government, decides whether a given occurrence is deemed a natural disaster and hence makes claimants eligible for reimbursement[47]. Property insurance is almost compulsory among property owners while all insurance companies offering property insurance in a specific area are oblidged to include protection against natural disasters. There is a publicly owned reinsurance company, the Caisse Centrale de Réassurance (CCR). Reinsurance is not compulsory but the state

[42] FEMA, 2002
[43] FEMA, 2008
[44] G. E. Galloway, 2004
[45] AIR 2006
[46] David Crichton, 2008
[47] Jametti, M., 2006

reinsurance is potentially attractive both because the reinsurance premiums are low and because it can offer unlimited cover. The rates of additional premium set by the government are[48];

- from 1982 to 1983: 5.5% of premium or contribution in respect of basic insurance,
- from October 1983 to August 1999: 9% of premium or contribution in respect of basic insurance, and
- since September 1999: 12% of premium or contribution in respect of basic insurance.

101. The system can reduce problems of adverse selection because the property insurance is almost compulsory, but there is still the problem of moral hazard. Since January 2001, a sliding scale has been introduced so as to encourage loss provention measures. This scale applies to those districts which do not yet have a prevention plan for foreseeable natural risks (PPR).

5.3 TURKISH CATASTRPHIC INSURANCE POOL [49]

102. After the Marmara earthquake causing massive losses in terms of life and property on 17 August 1999, the Turkish government recognized the partnership between the public and the private (insurance industry) to transfer most of catastrophie risk to international reinsurance and capital markets and to encourage risk mitigation and safer construction practices. The Turkish Catastrphic Insurance Pool (TCIP) was established in accordance with the Mandatory Earthquake Insurance framework of the decree. The obligation of the government to extend credit and construct dwellings for the public in the event of an earthquake was abolished. The World Bank provided technical and financial assistance to TCIP. The compulsory scheme covers only residential buildings that fall within municipal boundaries. Industrial and commercial risks as well as residential buildings in local villages without establishing municipality can be insured on a voluntary basis. TCIP also transfers the responsibility for post disaster relief and recovery from the government to households in the risk zones. Pricing matrix used by the TCIP takes into account seismic risk (five risk areas) and construction type (three categoris: steel, concrete, masonry, and other)[50]. In so doing provides incentives for property owners to retrofit their apartments and take other risk-reducing measures.

5.4 CAT BONDS

103. Europe's biggest insurer A*llianz SE* issued the first ever Blue Wings Cat Bonds worth150m$ to provide cover against flood risks *in April 2007*. They covered Allianz against severe losses from river floods in Britain and earthquakes in Canada and United States, *excluding California.* The trigger for the flood component was a parametric index, based on flood depths at more than 50 locations across Britain. At the time of launch that the Blue Wing transaction was oversubscribed with demand from investors including dedicated insurance linked securities funds, hedge funds and money managers. Allianz has now called for an early redemption of its Blue Wings Cat Bonds. The Bonds will be repaid on Jan 10 2009, three years earlier than expected. Subsequent to a revision of the catastrophe model that was upgraded by RMS based on its UK inland flood model on which the bonds were based made, the instrument became uneconomic for Allianz. The original estimate of the risk was very high and now it is very low so using a complex and fairly expensive instrument like a catastrophe bond was no longer justifiable.

[48] CCR, 2008
[49] TCIP, 2005
[50] Yazici S., 2003

5.5 MICRO-INSURANCE (INDIA)

104. Disaster microinsurance can be distinguished as two categories; an extention of microcredit and microsavings program and stand-alone insurance [51] . India features a large number of microinsurance programs partly because there is a provision that regulated insurers must increase their shares of low-income clients over time. Swayamkrushi of Andhra Pradesh provides bundled schemes as an extention of microcredit. It has been providing microfinance since 1997, and added a compulsory life and property insurance in 2001. Offered independently and voluntarily, the Self-Employed Women's Association has been offering health, property, and life insurance with disaster-risk cover since 1992. Along with the extention schemes, stand-alone programs for disaster microinsurance also can been seen in India. The Gujarat State Disaster Management Authority established a compulsory group-based housing insurance scheme for those households that had been completely destroyed and rebuilt with government assistance. Deducted from the final installment of housing assistance, the policy provides protection for 10 years for 14 types of natural and homan-induced disasters.

105. Furthermore, some voluntary stand-alone miscroinsurance schemes were initiated in India. The NGO, All India Disaster Mitigation Institute (AIDMI), has been offering a disaster insurance program, *Afat Vimo* covering households and microbusinesses in the state of Gujarat. There was close collaboration between public insurers and AIDMI, premiums are kept low and affordable because of the pro-poor regulatory requirements. The *Afat Vimo* schemes provides life and non-life disaster insurance to low-income clients for losses incurred in the case of 19 eventualities, such as cyclone, lightening, landslide and earthquake. The AIDMI also supports communities by relief, rehabilitation and development assistance to vulnerable communities [52]. In 2003 the first index-based weather scheme in a developing country was launched in the Mahbugnar district of Andhra Pradesh by the rural microfinace organization BASIX with a technical assistance of the commodity risk management group (CRMG) of the World Bank. During 2004, not only did BASIX expand weather insurance program, a number of other institutions bagan expanding the markent for weather insurance in India[53]. It will be necessary to learn how the purchases are changing farmers behavior.

[51] ProVention/IIASA, 2006
[52] AIDMI, 2006
[53]World Bank, 2005

6. CONCLUSIONS

106. Integrated Flood Management (IFM) calls for a proactive strategy of risk mamagement through a three-pronged attack on reduction of flood risks by reducing magnitudes, vulnerability and the exposure of the economic activities. In practical terms, flood risks should be treated as the costs of taking risk. These costs incluides the cost of risk reduction, costs of managing the residual risks and the flood losses that finally materialize.

107. It is impossible to avoid the contentious issue of how to share the burdens placed on society from floods between different stakeholders, especially in societies which are regularly affected by floods. First, in the public interest, governments ultimately from tax payers provides to the extent possible flood defences to reduce or prevent the risk up to a certain design flood. For the remaining residual risks, further public finances are utilized to a large extent in early warning, evacuation and preparation for disaster relief and flood proofing, mainly for emergency response to reduce these residual risks. The decision should be made on how to share the cost of risk reduction among governments (central, regional and local governments), interested parties (such as private companies), communities and residents.

108. Second, transferring of flood risks physically is an important option for flood risk management. Physically transferring risk, say through diversion of flood waters to less vulnerable areas can help. Third, with all the efforts in place, flooding results in losses due to damage to properties and interruption of economic activities. Some of the losses absorbed by the element at risk are retainded risk. Transferring risk through insurance is the last step in a systematic risk management. This can be addressed through sharing the financial risks associated with actual flood losses between the state and all other groups affected. The question posed by many is if the current and in many cases ad-hoc and uncoordinated approach to risk sharing is corresponding to the shared principles of equitable treatment of and fairness towards various groups in society on the one hand, and if changes to the current system would allow the solidarity principle to be strengthened. It is here necessary to take a comprehensive approach to distributing risks posed by flooding across the stakeholder spectrum, which includes various layers of the government, private sectors such as insurance industry, and individual users and residents of areas liable to flooding. In addirion, flood management practitioners and policy makers should pay an additional consideration for uncertainty stemmed from climate change and how to distribute the cost of related flood risk reduction measures across society. Following issues need to be addressed while sharing flood risks.

1) The governments are traditionally responsible for protecting the public, so they have the major role in bearing the cost of flood risks, particularly on behalf of the poor. They seek measures to share the costs of risks between various tiers of governments (federal, state and local) and households and businesses.

2) It is arguable as to what extent the risk can be shared by the poor who are generally land up in risk prone areas. A transfer of burden to an already vulnerable population cannot be justified by argument of efficiency and loss reduction.

3) Sharing financial flood risks can take place in various forms be it through allocation of calamity or reconstructions funds in the Governmental budgets, internal and external solidarity funds,

flood insurance, and catastrophic bonds.Governments can provide the financing in a number of ways that still provide incentives to domestic insurers to operate in a proper fashion.

4) Often consumers have low risk awareness, particularly regarding low-frequency, high-impact events. Consumers do not usually willingly purchase insurance. The private market can play a useful role in awareness-raising, since it has a profit motive to increase market penetration.

5) Having poor data increases the risk of uncertainty, and means that the private market will be less able, or unable, to bear some of the risk. Hydro-meteorological, geographical, and economic data tend to be more readily available for developed countries than for developing countries. Climate change is likely to create new weather patterns, so new techniques would need to be developed to interpret historical data on floods and on losses to derive meaning full insight into the potential flood losses. There is need for more rigorous research and analysis to support flood risk assessments.

6) In general, accessing and using data requires a fee. Efforts should be made to make the climatological data public good and its collection fully funded through public funds. Governments would have to reduce this uncertainty by investing more in hydro-meteorological and other data collection.

7) Risk transfer requires the establishment of new mechanisms whereby the flood risks to the vulnerable caused by climate change are spread more widely. In addition to humanitarian motives, there are strong socio-economic reasons for developed countries to participate in new insurance mechanisms.

8) Financial risk transfer mechanism should be considered in the broader context of flood risk management while developing river basin flood management plans. Although a last resort in the risk management process, it should be considered as one of the management options right from the beginning. It would require greater local participation at every stage of an insurance programme's design, implementation, and monitoring. Such a participation of stakeholders at all levels remains a key challenge and yet is crucial to its success. Engage in the development of the institutional framework necessary to link risk reduction and risk transfer together.

9) Donors' need to Invest in knowledge generation and facilitate knowledge sharing and dialogue among all stakeholders involved, start pilot projects and investigate financial viability, potential and the limits of these projects. Support the risk data collection and modeling activities and bring them into the public domain as "open" resources, so that they can be applied elsewhere in order to reduce the start-up costs for future projects.

10) Some of those mechanisms above have almost exclusively been employed in developed countries and a developing country perspective needs to be brought into the financial risk sharing debate. The discussion on these financial mechanisms can contribute on public finances in developing countries in all stages of flood risk management and relieve constrains in their development process and governmental services. Civil Society should monitor the impact Insurance schemes have on people with different levels of vulnerability.

ANNEX GLOSSARY

NOTE: (*1) FEMA 2008b, (*2) III 2009, (*3) Swiss Re 2009, (*4) Munich Re 2009, (*5) HM Revenue &Customs, 2009, (*6) Crosby, Everett, 1905

ADVERSE SELECTION. The tendency of those exposed to a higher risk to seek more insurance coverage than those at a lower risk. Insurers react either by charging higher premiums or not insuring at all, as in the case of floods. (Flood insurance is provided by the federal government in the US but sold mostly through the private market.) In the case of natural disasters, such as earthquakes, adverse selection concentrates risk instead of spreading it. Insurance works best when risk is shared among large numbers of policyholders. (*2)

BOND. A security that obligates the issuer to pay interest at specified intervals and to repay the principal amount of the loan at maturity. In insurance, a form of suretyship. Bonds of various types guarantee a payment or a reimbursement for financial losses resulting from dishonesty, failure to perform and other acts. (*2)

CATASTROPHE BONDS. Risk-based securities that pay high interest rates and provide insurance companies with a form of reinsurance to pay losses from a catastrophe such as those caused by a major hurricane. They allow insurance risk to be sold to institutional investors in the form of bonds, thus spreading the risk. (*2)

CLAIM. Demand by an insured for indemnity under an insurance contract. (*3)

CO-INSURANCE. An insurance, usually of large risks, by two or more direct insurers on a joint basis as a means of spreading the risk. The risk is shared between the insurer and the insured. (*5)

COMMISSION Fee paid to an agent or insurance salesperson as a percentage of the policy premium. The percentage varies widely depending on coverage, the insurer, and the marketing methods. (*2)

COVER Insurance and reinsurance protection based on a contractual agreement. (*3)

DEDUCTIBLE The amount of loss paid by the policyholder. Either a specified dollar amount, a percentage of the claim amount, or a specified amount of time that must elapse before benefits are paid. The bigger the deductible, the lower the premium charged for the same coverage. (*2)

DERIVATIVES Contracts that derive their value from an underlying financial asset, such as publicly traded securities and foreign currencies. Often used as a hedge against changes in value. (*2)

DIVERSIFICATION. Risk reduction technique that limits the risk of accumulation by spreading an organisation's risks across different geographical locations as well as across different lines of business, in order to increase the number of mutually independent risks. (*3)

ECONOMIC LOSS Total financial loss resulting from the death or disability of a wage earner, or from the destruction of property. Includes the loss of earnings, medical expenses, funeral expenses, the cost of restoring or replacing property and legal expenses. It does not include noneconomic losses, such as pain caused by an injury. (*2)

EQUITY In investments, the ownership interest of shareholders. In a corporation, stocks as opposed to bonds. (*2)

EXCLUSION A provision in an insurance policy that eliminates coverage for certain risks, people, property classes, or locations. (*2)

Floodplain. Any land area susceptible to being inundated by flood waters from any source.(*1)

Floodproofing. Any combination of structural and nonstructural additions, changes, or adjustments to structures, which reduce or eliminate risk of flood damage to real estate or improved real property, water and sanitation facilities, or structures with their contents. .(*1)

INCURRED LOSSES Losses occurring within a fixed period, whether or not adjusted or paid during the same period. (*2)

INDEMNIFY Provide financial compensation for losses. (*2)
INDEX. An indicator showing the changes to particular parameters and allowing comparisons, especially between values and prices, to be made. (*4)

INSOLVENCY Insurer's inability to pay debts. (*2)

INSURANCE A system to make large financial losses more affordable by pooling the risks of many individuals and business entities and transferring them to an insurance company or other large group in return for a premium. (*2)

INSURANCE POOL A group of insurance companies that pool assets, enabling them to provide an amount of insurance substantially more than can be provided by individual companies to ensure large risks such as nuclear power stations. Pools may be formed voluntarily or mandated by the state to cover risks that can't obtain coverage in the voluntary market such as coastal properties subject to hurricanes. (*2)

LAW OF LARGE NUMBER. The observed frequency of an event more nearly approaches the underlying probability of the population as the number of trials approaches infinity. (*5)

LIQUIDITY The ability and speed with which a security can be converted into cash. (*2)

LOSS A reduction in the quality or value of a property, or a legal liability. (*2)

MORAL HAZARD The possibility that an insured party may take more risk-taking behaviors because of being insured. (*6)

OPERATING EXPENSES The cost of maintaining a business's property, includes insurance, property taxes, utilities and rent, but excludes income tax, depreciation and other financing expenses. (*2)

OPTIONS Contracts that allow, but do not oblige, the buying or selling of property or assets at a certain date at a set price. (*2)

PERIL A specific risk or cause of loss covered by an insurance policy, such as a fire, windstorm, flood, or theft. A named-peril policy covers the policyholder only for the risks named in the policy in contrast to an all-risk policy, which covers all causes of loss except those specifically excluded. (*2)

POLICY. The entire written contract between the insured and the insurer. It includes:
• The printed policy form;
• The application and Declarations Page;
• Any endorsement(s) that may be issued; and
• Any renewal certificate indicating that coverage has been instituted for a new policy and new policy term. .(*1)

PREMIUM The payment, or one of the periodical payments, a policyholder makes for an insurance policy. (*3)

REINSURANCE Insurance for insurance companies which spreads the risk of the direct insurer. Includes various forms such as facultative, financial, non-proportional, proportional, quota-share, surplus and treaty reinsurance. (*3)

RETENTION. That part of the risk assumed which the (re)insurer does not (retro)cede. (*4)

RISK. Condition in which there is a possibility of loss; also used by insurance practitioners to indicate the property insured or the peril insured against. (*3)

SALVAGE Damaged property an insurer takes over to reduce its loss after paying a claim. (*2)

SOLVENCY Insurance companies' ability to pay the claims of policyholders. (*2)

VOLATILITY. Volatility designates the degree to which individual securities or whole markets fluctuate in value. Volatility is frequently quantified using statistical methods, e.g. by measuring the standard deviations of the relative price differences. (*4)

REFERENCE

AIDMI, 2006, *Community Risk Transfer through Microinsurance : An Opportunity for South Asia ?* (21 January 2008)
http://www.proventionconsortium.org/?pageid=19

AIR (American Institute for Research), 2006, *The Evaluation of the National Flood Insurance Program, Final Repor*, (28 January 2009)
http://www.fema.gov/business/nfip/nfipeval.shtm

APFM (Associate Programme on Flood Management) 2004, *Integrated Flood Management- Concept Paper*, (2 February 2009)
http://www.apfm.info/pdf/concept_paper_e.pdf

Cabinet Office, Government of Japan, *Scheme for disaster management* (in Japanese), (23 January 2009)
http://www.bousai.go.jp/hou/index.html

CCR (Caisse Centrale de Réassurance), 2008, *Natural disasters in France*, updated in September 2008 (21 January 2009)
http://www.ccr.fr/gb/pdf/BD_62484_CATNAT_INTER_08.pdf,

Crosby, Everett, 1905, Fire Prevention, *Annals of the American Academy of Political and Social Science* **26**: 224–238

David Chricton, 2008, Role of Insurance in Reducing Flood Risk, *The Geneva Papers* 33, 117-132

Dlugolecki A, 2001, Climate Change and Insurance, Chartered Insurance Institute, London (27 January 2009)
http://www.cii.co.uk/knowledge/research/res00-3.pdf

FEMA (Federal Emergency Management Agency), 2002, National Flood Insurance Program, Program Description (1 August 2008)
http://www.fema.gov/about/programs/nfip/index.shtm

FEMA, 2008, *National Flood Insurance Program (NFIP)*, Floodsmart.gov, (19 February 2008)
http://www.floodsmart.gov/floodsmart/pages/aboutnfip.jsp

FEMA, 2008b, *National Flood Insurance Program, Flood Insurance manual*, (28 January 2009)
http://www.fema.gov/pdf/nfip/manual200810/21def.pdf

Flood Fighting Law in Japan (in Japanese) (23 January 2009)
http://law.e-gov.go.jp/htmldata/S24/S24HO193.html

Floodsite, 2005, *Research, Technological Development and Innovation Activities* (27 January 2009)
http://www.floodsite.net/html/work_programme.pdf#Theme1

G.E. Galloway, 1994, *Sharing the Challenge: Flood Plain Management Into the 21st Century*, Report of the Interagency Flood Plain Management Review Committee to the Administration Flood Plain Management Task Force (22 January 2009)
http://www.floods.org/PDF/Sharing_the_Challenge.pdf

G.E. Galloway, 2004, *IFM Case Study: USA: Flood Management – Mississippi River*, (28 February 2008)
http://www.apfm.info/pdf/case_studies/cs_usa_mississippi.pdf

GWP (Global Water Partnership) 2008, *Water Financing and Governance*, TEC Background Papers No.12, (7 August 2008)
http://www.gwpforum.org/gwp/library/TEC%20Paper%2012.pdf

HM Revenue &Customs, 2008, General Insurance Manual: Legal and economic basis of insurance (29 January 2009)
http://www.hmrc.gov.uk/manuals/gimanual/GIM1130.htm

III (Insurance Information Institute), 2009, Glossary of Insurance Terms (28 January 2009)
http://www.iii.org/media/glossary/

Ingram, H., 1988. Comments on T. Schad presentation "Evolution and Future of Flood Control in the United States". In H. Rosen and M. Reuss (eds.) *The Flood Control Challenge: Past, Present, and Future*, Proc. of a National Symposium, Public Works Historical Society, Chicago, IL, p. 49-51.

Jametti, M., 2006, *Risk Selection in Natural Disaster Insurance- the Case of France*

JICE (Japan Institute of Construction Engineering), 2003, *2002 Floods in Europe* (in Japanese) (30July 2008)
http://www.jice.or.jp/jishu/t1/pdf/kouzuihoken.pdf

Judith Rees, 2002, *Risk and Integrated Water Management*, GWP Technical Background Papers No 6 (27 January 2009)
http://www.gwpforum.org/gwp/library/TEC%20background%20paper%206.pdf

Kunreuther H. & Linnerooth-Bayer J., 1999, *the Financial Management of Catastrophic Flood Risks in Emerging Economy Countries*, conference on Global Change and Catastrophic Risk Management, IIASA, Austria (21 July 2008)
http://www.iiasa.ac.at/Research/RMP/june99/presentations.html

Lewis M. and Murdock K.C. 1996, The Role of Government Contracts in Discretionary Reinsurance Markets for Natural Disasters, The Journal of Risk and Insurance 63(4), 567-597

Linnerooth-Bayer, J. and A. Vari 2003, *Floods and Loss Sharing: A Clumsy Solution from Hungary*, Presentation at PWRI on 28 January 2004 (21 July 2008)
http://www.pwri.go.jp/team/suiri/hp/joanne_top.htm

MCII (Munich Climate Insurance Initiative), 2008, *Insurance Instruments for Adapting to Climate Risks*, (22 January 2009)
http://unfccc.int/resource/docs/2008/smsn/ngo/019.pdf ,
http://unfccc.int/parties_observers/ngo/submissions/items/3689.php

MLIT (Ministry of Land, Infrastructure, Transport and Tourism, Japan), Rivers in Japan (in Japanese) (23 January 2009)
http://www.mlit.go.jp/river/index.html

Munich Re 2009, Glossaries (29 January 2009)
http://www.munichre.com/en/ir/contact_and_service/glossaries/

Neil A. Doherty, 1997, Financial Innovation in the Management of Catastrophe Risk, Financial Institutions Center, Wharton School, University of Pennsylvania (29 July 2008)
http://fic.wharton.upenn.edu/fic/riskinfo.html

ProVention/IIASA, 2006, *Disaster Insurance for the Poor? A review of microinsurance for natural disaster risks in developing countries* (1 August 2008)
http://www.proventionconsortium.org/themes/default/pdfs/Microinsurance_study_July06.pdf

Provention, 2009, *Risk financing* (21 January 2009)
http://www.proventionconsortium.org/?pageid=19

River Law in Japan, (in Japanese) (23 January 2009)
http://law.e-gov.go.jp/htmldata/S39/S39HO167.html

Roth J, McCord M and Liber D, 2007, *The landscape of Microinsurance in the World's 100 Poorest Countries* (27 January 2009)
http://www.microinsurancecentre.org/UploadDocuments/Landscape%20study%20paper.pdf

Swiss Re, 1998, *Floods – an insurable risk?* (survey) (22July 2008)

http://www.swissre.com/resources/50b7ff80455c7c31b5b0bf80a45d76a0-floods.Paras.0001.File.pdf
http://www.swissre.com/resources/62f26780455c7c4ab5e0bf80a45d76a0-floods.Paras.0015.File.pdf

Swiss Re 2009, Glossary (29 January 2009)
http://www.swissre.com/pws/research%20publications/glossary/glossary.html

TCIP (Turkish Catastrophe Insurance Pool), 2005, *TCIP Annual Report 2005* (21 January 2009)
http://www.dask.gov.tr/data/2005_FAALIYETRAPORU_eng.pdf

UK Defra/Environment Agency, 2003, *Risk, Performance, and Uncertainty in Flood and Coastal Defence – Review*, R&D Technical Report FD2302/TR1 (27 January 2009)
http://sciencesearch.defra.gov.uk/Document.aspx?Document=FD2302_3433_TRP.pdf

USACE (US Army Corps of Engineers), 1996, *Risk-based analysis for flood damage reduction studies, Engineer Manual*, EM 1110-2-1619, Washington, D.C. (30 January 2009)
http://140.194.76.129/publications/eng-manuals/em1110-2-1619/toc.htm

USAID (US Agency for International Development), 2006, *Index insurance for weather risk in lower-income countries* (27 January 2009)
http://microlinks.org/file_download.php/Index+Insurance+Primer.pdf?URL_ID=14239&filename=11656047761Index_Insurance_Primer.pdf&filetype=application%2Fpdf&filesize=286990&name=Index+Insurance+Primer.pdf&location=user-S/

WMO, 2006, *Social Aspects and Stakeholders Involvement in Integrated Flood Management*, APFM Technical Document No 4, Flood Management Policy Series, Associated Programme on Flood Management, World Meteorological Organization, Geneve (23 January 2009)
http://www.apfm.info/pdf/ifm_social_aspects.pdf

WMO, 2006b, Legal and Institutional Aspects of Integrated Flood Management, Case Studies, Associated Programme on Flood Management, World Meteorological Organization, Geneva (23 January 2009)
http://www.apfm.info/pdf/ifm_legal_aspects.pdf

WMO, 2007, *Economic Aspects of Integrated Flood Management*, APFM Technical Document No 5, Flood Management Policy Series, Associated Programme on Flood Management, World Meteorological Organization, Geneve (27 January 2009)
http://www.apfm.info/pdf/ifm_economic_aspects.pdf

World Bank 2005, *Managing Agricultural Production Risk- Innovations in Developing Countries*, Agriculture and Rural Development Department, World Bank (6 August 2008)
http://siteresources.worldbank.org/INTARD/Resources/Managing_Ag_Risk_FINAL.pdf

Yazici S., 2003, *The Turkish Catastrophe Insurance Pool (TCIP) and the Compulsory Earthquake Insurance Scheme*, The Role of Local Governments in Reducing the Risk of Disasters , Istanbul, 2003 (21 January 2009)
http://info.worldbank.org/etools/docs/library/114715/istanbul03/paperistanbuldocs.htm

Yoshioka, K., Wakigawa, K., Yanagisawa, O., Uchikura, Y., Kumagai, T. and Todo, M, 2002, Study on Flood Insurance Programs: Comparison between Japan and other Countries, *River Engineering* 8, JSCE, 167-172

FURTHER READING

CRS, 2005 (21 July 2008) http://fpc.state.gov/documents/organization/56095.pdf

ISO, 1999 (29July 2008)
http://www.iso.com/index.php?option=com_content&task=view&id=983&Itemid=211

NFIP (21 July 2008) http://www.dem.dcc.state.nc.us/mitigation/Library/NFIP/NFIP_Unit2.pdf

US Code (21 July 2008)
http://www.realhazards.com/docs/floodact.pdf
http://www.law.cornell.edu/uscode/uscode42/usc_sec_42_00004011----000-.html
http://www.law.cornell.edu/uscode/html/uscode42/usc_sup_01_42_10_50notes.html

UNECE 2007 (14 November 2008)
http://www.unece.org/env/water/publications/documents/PES_Recommendations_web.pdf

USG (21 July 2008) http://www.floods.org/PDF/Sharing_the_Challenge.pdf

FAA (21 July 2008)
http://www.faa.gov/about/office_org/headquarters_offices/ast/industry/advisory_committee/meeting_news/media/Vedda.ppt

IWR (21 July 2008) http://www.iwr.usace.army.mil/nfrmp/guidance.cfm

OECD-Japan, 2006 (21 July 2008) http://www.oecd.org/dataoecd/55/57/37378001.pdf

IPCC, chap 8 (21 July 2008) http://www.grida.no/climate/ipcc_tar/wg2/index.htm

UK (21 July 2008)
http://www.preparingforemergencies.gov.uk/business/bagcp_flood_presentation0707.pdf

UNC (21 July 2008) http://www.unc.edu/finance/risk/property.htm

"A Cat Bond Premium Puzzle?" By: Bantwal, Vivek J.; Kunreuther, Howard C.. *Journal of Psychology & Financial Markets*, 2000, Vol. 1 Issue 1, p76-91, 16p, 11 charts, 4 graphs; (*AN 3176633*)

Munich Re 2005 (4 August 2008)
http://www.munichre-foundation.org/StiftungsWebsite/Projects/DisasterPrevention/SymposiumDisasterPrevention/2005_International_Symposium_Documents.htm
http://quick-centre.or.id/index.php?option=com_content&task=view&id=15&Itemid=18 related workshops

LEAP (5 August 2008)
http://www.hoefsloot.com/index.php?title=LEAP:_Improving_Weather-based_Insurance_Indices_for_Ethiopia

WB (5 August 2008) http://www-esd.worldbank.org/ais/index.cfm?Page=mdisp&m=10&p=2
