Economic Aspects of Integrated Flood Management

APFM

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World Meteorological Organization
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FLOOD MANAGEMENT POLICY SERIES

WMO/GWP ASSOCIATED PROGRAMME ON FLOOD MANAGEMENT

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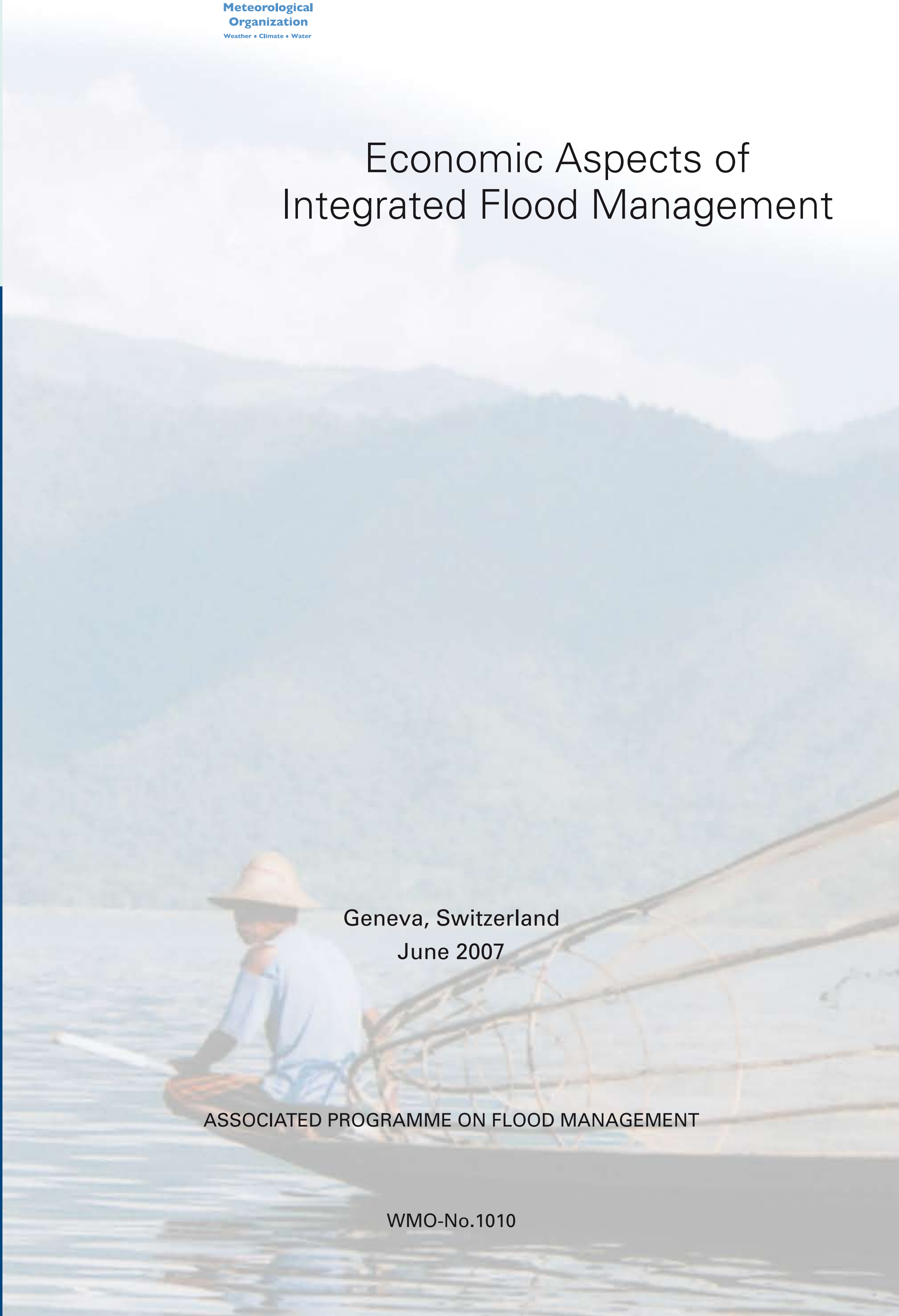

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The Associated Programme on Flood Management (APFM) is a joint initiative of the World Meteorological Organization and the Global Water Partnership. It promotes the concept of Integrated Flood Management (IFM) as a new approach to flood management.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

World Meteorological Organization
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The World Meteorological Organization (WMO) is a specialized agency of the United Nations. It coordinates the activities of the meteorological and hydrological services of 187 countries and territories and as such is the centre of knowledge about weather, climate and water.

Global Water Partnership

The Global Water Partnership (GWP) 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).

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This publication forms part of the Flood Management Policy Series published within the framework of the WMO/GWP Associated Programme on Flood Management. The series comprises publications on various aspects of flood management policy, including economic, environmental, legal and institutional, and social aspects. The series provides an in-depth supplement to the Integrated Flood Management Concept Paper (APFM 2003). The series is based on inputs from experts and leading sector professionals in the area of natural resource management and development policy.

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EXECUTIVE SUMMARY

Historically, flood plains have been the preferred places for socio-economic activity as is evident from the very high densities of human settlement found there. Floods are a natural phenomenon, with both negative and positive impacts, and, generally, should not be considered a hindrance to economic development. Floods play a major role in replenishing wetlands, recharging groundwater and support agriculture and fisheries system, making flood plains preferred areas for human settlements and economic activities. Extreme demands on natural resources due to population growth have forced people and their property to move closer to rivers in many parts of the world. Further, flood control and protection measures have encouraged people to utilize newly protected areas extensively, thereby increasing flood risks and consequent losses.

Recurrent and extreme flooding, however, pose grave risks to development and have negative impacts on lives, livelihoods and economic activity and can cause occasional disasters. Flood disasters result from the interaction between extreme hydrological events and environmental, social and economic processes. These disasters have the potential to put development back by five to ten years, particularly in developing countries. The spiraling economic losses in developed countries also have given rise to grave concerns.

Flood management plays an important role in protecting people and their socio-economic activities in flood plains from flooding. Historically, development in the Mississippi, Rhine and many other river basins in developed countries has been closely linked with successful implementation of flood control projects. In the past, exposure to flood risks has been handled largely through structural measures. However, strategies that rely largely on structural solutions (e.g. dams and reservoirs, embankments and bypass channels) unfortunately alter the natural environment of the river, which may result in loss of habitats, biological diversity and ecosystem productivity. Further, structural approaches are bound to fail the moment an extraordinary or unforeseen event occurs. These traditional approaches, where the risks are merely transferred spatially, are likely to generate conflicts and inequities. Environmental degradation has the potential to threaten human security, including life and livelihoods, and food and health security. This realization has recently led to calls for a paradigm shift from flood control to flood management.

Integrated Flood Management (IFM) is a concept that addresses issues of human security against flood risks and sustainable development within the framework of Integrated Water Resources Management (IWRM). Such an integrated approach to flood management can play an important role in sustainable development and poverty reduction. Integrated Flood Management aims at minimizing loss of life from flooding while maximizing the net benefits derived from flood plains. As part of the approach, the reduction of flood risks is based on a judicious combination of measures dealing with the magnitude of the flood hazard and the community's exposure and vulnerability to it.

There are various constraints—physical, technical, economic and political—in any flood management decision-making. Societal values, perceptions of risks and the trade-offs between development and environmental preservation differ among various stakeholders, but need to be taken into account. Economic analysis helps to select not only the optimum level of adjustment to floods on the basis of risk-safety trade-off decisions but also can help arrive at an optimum combination of measures for the purpose. It provides tools to help make choices. There is now a whole range of strategies for flood management comprising both structural and non-structural measures including the option to live with floods. Which combination of options can provide the maximum positive impact on people's welfare, in any particular area, can be evaluated through economic analysis. This publication addresses the economic aspects relevant to IFM.

Economic analysis provides the rationality for taking action because it provides some perspectives on the scale of impact and feasibility. The expected benefits of the interventions can be evaluated along with the possible costs, to facilitate discussion in the decision-making process.

Cost-benefit analysis (CBA) of various interventions for mitigation of flood risks has been used for more than 50 years. Although the method seems to be able to offer a solution in how to choose the best flood management strategy, it contains many assumptions and has certain limitations. It fails to address the issues of equity. Further, often these benefits and costs are not readily apparent and are beyond assessment. General practice, to date, has been to include only the direct costs as well as benefits, even though intangible benefits are slowly being recognized as important. Methodologies are being developed for the monetary evaluation of the latter.

There are many arguments about the value of ecosystems, how to evaluate the future value in comparison with the current value, and whether we can compare welfare on one hand with the economic profit on the other. Methods are now available and used for estimating the un-marketed environmental values such as the benefits of improved river water quality or the costs of losing an area of wilderness to development.

Cost-benefit analysis can pave the way for decision-making for selecting optimal measures during the planning and implementation process, but there are several limitations in accounting all factors and issues precisely monetarily. For example, policy issues, such as social improvements to alleviate poverty, can not be explained only in economic terms. Different approaches to expand and refine CBA by putting monetary values on social and environmental concerns have been adopted, some of which are discussed in the paper.

Another line of approach has been to develop complementary analytical tools such as multi-criteria analysis (MCA). The subjective factors in arriving at figures which best reflect social valuation are a critical issue. One obvious way in which this problem can be handled is to involve the affected people in various stages of analysis. Since evaluation involves social values, it would be quite appropriate to carry out CBA/MCA in close consultation with and participation of the public affected by a particular project. This requires effective stakeholder participation with appropriate enabling mechanisms.

In order to minimize subjectivity in decision-making, environmentally sensitive economic analysis plays a key role in trade-offs and conflict situations. Multi-criteria analysis is useful in ranking options, shortlisting a limited number of options for subsequent detailed appraisal, e.g. CBA. Multi-criteria analysis can be used for stakeholders to explore the nature of the choices, determine the critical factors, discover their own preferences and simplify the process of selecting critical options. Since economic evaluation involves societal values, it is appropriate to carry out environmentally sensitive economic analysis in close consultation and participation with the public affected by the projects.

Various development activities have the potential to exacerbate the intensity and severity of floods. As such, flood management policy transcends dedicated flood management agencies or departments, involving various development agencies not confined to the water sector, such as land use planning, disaster management and environmental protection.

This publication presents approaches that help address socially relevant and environmentally friendly economic analysis, targeting flood managers in particular. However, it has to be recognized that there are no universal criteria to determine environmentally sensitive economic analysis in flood management. It is crucial to adopt practices that suit the particular circumstances in a given hydro-climatic, topographical and, above all, socio-economic setting and follow a rational and balanced approach. Involvement of various stakeholders in decision-making can help achieve these objectives.

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The publication has exploited the work of many organizations and experts, as listed in the references. The ideas have been assimilated with special reference to Integrated Flood Management and no originality is claimed.

ACRONYMS

ADB	Asian Development Bank
APFM	Associated Programme on Flood Management
BC ratio	Benefit-cost ratio
CBA	Cost-benefit analysis
CVM	Contingent valuation method
EIA	Environmental impact assessment
EIRR	Economic internal rate of return
FIRR	Financial internal rate of return
GDP	Gross domestic product
GWP	Global Water Partnership
IFM	Integrated Flood Management
IRR	Internal rate of return
IWRM	Integrated Water Resources Management
MCA	Multi-criteria analysis
NPV	Net present value
SEA	Strategic environmental assessment
TCM	Travel cost method
WMO	World Meteorological Organization
WTA	Willingness to accept compensation
WTP	Willingness to pay

1. INTRODUCTION

An integrated approach to flood management requires land and water in a river basin to be considered as a single unit and aims at minimizing the losses of life from flooding while maximizing the net benefits derived from flood plains. The net benefits are the overall benefit a society derives from using flood plains (such as agricultural output and other economic activities) minus the overall cost of using the flood plains (flood damages, cost of flood protection, habitat loss etc.). Assessing the net benefits from flood plains involves understanding the social, economic and environmental dimensions of flood risks. It requires a trade-off between development potential and the risks society has to take in occupying flood plains.

Economic analysis forms an essential requirement for meeting the objectives of IFM since the techniques of economics are geared to attempt a "balance" between two or more objectives. An adequate understanding of the economics of flood plains forms an essential requirement of IFM. Economics, for which the most succinct definition is the "application of reason to choice", can both help us understand the issues and determine the best means of managing floods and the risk of flooding. At the same time a clear understanding of the need for, applicability potential, and limitations of economic analysis is indispensable in flood related decision-making.

Integrated Flood Management

Integrated Flood Management represents a paradigm shift from the traditional piecemeal approach to flood management. It is linked to IWRM as conceptualized in 2000 by the GWP in its Technical Background Paper No. 4. The IFM approach lays emphasis on the "need to balance development requirements and flood losses"[1*] since "the objective in IFM is not only to reduce the losses from floods but also to maximize the efficient use of flood plains".[2] Integrated Flood Management aims to maximize economic and social welfare, while recognizing the role of ecosystems in sustainable development processes balancing risks and opportunities.

Integrated Flood Management, like IWRM, is a process promoting an integrated rather than a fragmented approach. It treats flooding as a resource, recognizing its role in all the phases of the hydrological cycle and that a single intervention has implications for the system as a whole. These issues, as in any policymaking, are related to societal values, perceptions of risks and how society deals with the trade-offs between development and environmental preservation. In order to achieve these an environmentally sensitive framework for decision-making is needed.[3] A risk based approach to flood management means that the flood risk issues are addressed by reducing not only the hazard magnitudes but also the vulnerability of the flood affected people.

The need to deal with floods in an integrated manner requires adopting a basin approach rather than a project driven approach where the overall risks due to flooding and other related hazards

* Superscripts indicate the number of the endnotes given from page 45 onwards.

are considered. It requires assessment of multi-functional benefits from flood management measures. While the negative impacts associated with frequent flood losses are well known, the same is not true of the benefits arising out of the fertilizing value of silt deposited and the high degree of soil moisture due to percolation of flood water. Little attention has also been paid to the long-term impact of flooding on the economic well-being of the people inhabiting the flood plains.

Economics of flood plains

The sense of insecurity arising out of the high risks due to recurrence of floods in flood prone but fertile plains dissuades farmers from making long-term investments in farming. It also dissuades other investors, including government agencies, from making investment in infrastructural projects. From this point of view "flood is an inhibiting factor in the process of agricultural growth of areas subject to frequent flooding".[4] Consequently, without flood protection, flood prone areas receive low levels of investment in both the farming and non-farming sectors. These result in low levels of economic development thereby perpetuating the vulnerability of the people. In many developing countries there is a strong need for better utilization of the agro-economic potential of flood plains to provide scope for reducing people's vulnerability and providing enhanced opportunities for food and livelihood securities to the flood affected people. This, in turn, would reduce poverty and improve quality of life.

Purpose and scope

Integrated Flood Management calls for a multidisciplinary approach to flood management, involving various stakeholders. It promotes a dialogue among professionals from various disciplines, coming from different paradigms, to explore, among others, shared perceptions and common goals. These disciplines include practitioners and researchers from various fields: ranging from public administration, agriculture, sociology, ecology, hydrology/hydraulics, morphology, river engineering and economics. Such a multidisciplinary approach must be based on a common language and accessible information for the debate and a transparent decision-making process.

This publication aims to meet the above requirement. The main objective of this publication is to highlight economic aspects relevant to IFM. The publication is addressed to professional engineers and administrators in decision-making positions with respect to flood management. Hence the language used and the style of presentation adopted is made accessible to non-economist professionals. For a deeper understanding of the approaches and techniques mentioned in this paper readers are invited to refer to the references. For a detailed economic analysis of projects or programmes the decision makers will have to summon the expertise of economists.

How economic analysis is geared to making choices and its relevance in IFM decision-making is discussed at the outset in Chapter 2. This includes an exposition of the basic economic concepts which facilitate understanding of the economic aspects of flood issues. Valuation of benefits and costs of a project in monetary terms occupies a key position in economic analysis for decision-making and priority setting related to projects. Cost-benefit analysis (CBA), which forms the centrepiece of all economic analysis in the context of flood management, is discussed in detail in Chapter 3. Tools and techniques used for the valuation of direct/indirect benefits are discussed adequately. The limitations of economic analysis are also pointed out. Chapter 4 deals with the various evaluation techniques. A brief critical review of MCA is provided. Finally, various possible sources of financing a flood management project are very briefly discussed in Chapter 5. The ideas, approaches and techniques discussed here form part of the literature developed by economists around the world. No originality is claimed at that level. The approaches and techniques, however, have been discussed in the context of IFM and illustrated with examples from the flood sector.

Flood Management Policy Series

Integrated Flood Management aims to address flood issues and the related contributing social, economic and environmental factors. To further elaborate the concept the Flood Management Policy Series, focusing on specific aspects of flood management, has been compiled with a view to facilitating the implementation of IFM principles. Apart from the present publication, three other publications in the series deal with legal and institutional, environmental and social aspects of IFM.

The publication, *Legal and Institutional Aspects of Integrated Flood Management* [5] stresses the need for an appropriate legal framework for IFM for professionals working at the interface between the legal world and natural resources management. It also discusses the enabling legal mechanism for community participation in flood management. *Environmental Aspects of Integrated Flood Management*[6] advocates a balanced approach, preserving ecosystems while addressing a society's development needs and factoring in flood risks. It outlines an environmentally sensitive economic analysis approach and highlights the importance of stakeholder participation in the decision-making process. *Social Aspects and Stakeholders Involvement in Integrated Flood Management* [7] identifies various social issues that need to be addressed while dealing with flood issues and explores means of stakeholder participation at various levels of decision-making in the context of flood management.

The present publication complements the other three by assessing the relationship between development and flood disasters and their impacts on the well-being of basin inhabitants and explains decision-making tools to meet societal objectives of poverty alleviation, sustainable development, risk reduction and preservation of ecosystems.

2. MAKING CHOICES

A decision maker who has to allocate limited and scarce resources and is faced with a number of competing goals needs to predict future physical and related economic consequences of a policy or plan and make calculated choices based on the model of physical and economic processes involved. Choices are difficult because they arise from conflict, and are always about the future and so are set in uncertainty.

2.1 Decision-making processes

Flood alleviation benefits are essentially for the public good, and, thus, flood management has to be carried out through a public policy framework. There are various constraints in any decision-making process in flood management, which can be broadly categorized into: physical, financial, social, political, legal and environmental. Physical and financial considerations have largely been tackled through economic analysis with little or no attention to social and environmental concerns. These concerns are related to societal values, either regarding the perceptions of risks or the trade-offs between development and environmental preservation. In order to minimize the role of subjective factors there is need for an environmentally sensitive framework to be established within decision-making processes (Figure 1).

Policies are formulated after processing various alternatives using different criteria. Projects and programmes balancing development, environmental conservation and risks, to achieve societal well-being, have to measure up to these yardsticks. Decision-making in flood management, therefore, is not an isolated exercise. Resource allocation decisions in flood management are made not only by monetary estimates and comparisons but also risk perception and overall development perspectives including equity issues in the area under study.

In addition to the economic analysis, environmental assessment tools provide for intensive examination, necessary for decisions that may have a diverse and significant environmental impact. Environmental assessment is applied at various levels of decision-making. Environmental impact assessment (EIA) is used to identify the environmental and social impacts of a proposed project prior to decision-making in order to predict environmental impacts at an early stage in project planning and design, while strategic environmental assessment (SEA) is used at the policy, planning and programme levels. A combination of these tools presents a framework for environmentally sensitive flood management decision-making.

Perceptions of flood risks vary among people depending on their geographical location. They differ widely between people living within the flood plains and those living on the fringes. Even the perceptions of planners and the people living in the flood plains tend to be quite different. Past flood incidents can either reduce or accentuate the vulnerability, depending on the frequency of such events and the capacity of the effected people to recover. Past events have a significant impact on the risk perception of people. The way people accept a particular strategy of flood management is largely guided by these risk perceptions. The degree of protection flood management measures are required to provide determines the economic viability of projects. This in turn determines how much a society or the government would be willing to pay for reducing flood risks. Who benefits by taking risks and at whose cost is another factor that is central in allocating resources to flood management programmes.

If not managed considering the river basin as a single management unit, flood risks have the potential to be merely transferred rather than mitigated. This has the potential to accentuate the equity issues and generate conflicts.

2.2 Economic analysis

Under the above circumstances economic analysis tools help in putting some order into the decision-making process. Economics is concerned basically with the study of how and why people, make decisions about the use of valuable resources to obtain maximum benefits. It may be said that economic efficiency is not the only objective of society. At the same time,

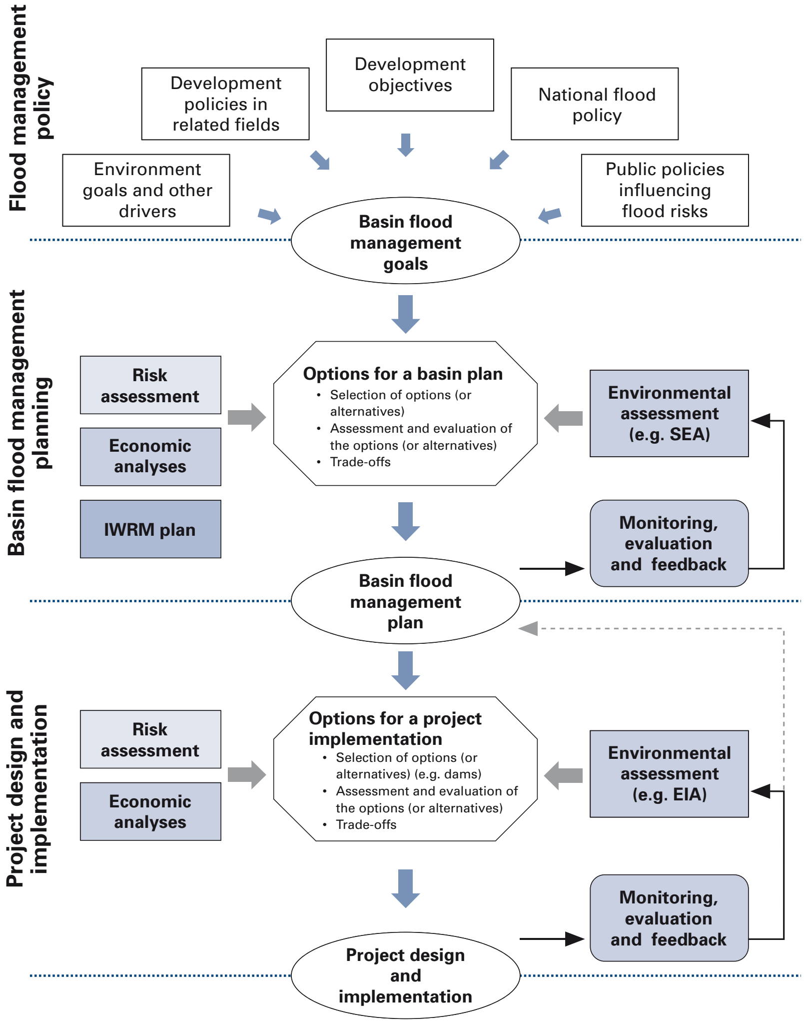

Figure 1. Environmentally sensitive flood management decision-making

economic efficiency issues can never be ignored if society is to progress. Economic issues are always given prominence in planning and management. Economics, therefore, is concerned with the problems of choice related to the use of resources faced by an individual, a family, an institution, a private company, a government department or any other entity. As the application of reason to choice, economics involves the development of a rigorous analytic framework with which to compare the alternative courses of action open.

Economic analysis is an integral part of the formulation of policies related to people's development and it is difficult to conceive of policy formulation in this area without detailed economic analysis. The purposes of economic analysis are both to simplify the complex to a level that we can comprehend and to gain an understanding of what the choice involves. The contribution of economic analysis to decision-making lies in providing a set of fairly reliable tools for an objective evaluation of the benefits and costs of specific flood management projects in monetary terms so as to enable their comparison and judge the economic viability of the proposed projects. Although economics uses numbers, it is the understanding that matters and not the numbers: without the understanding the numbers have no meaning. Conversely, the numbers are often a succinct means of summarizing the complex.

Economic analysis helps to select not only the optimum level of adjustment to floods on the basis of risk-safety trade-off decisions but also an optimum combination of measures for the purpose. There is now a whole range of strategies for flood management comprising both structural and non-structural measures including the option to live with flood. Which combination can provide the maximum positive impact on people's welfare in any particular area can be evaluated through economic analysis.

However, it is impossible to have a mechanical approach that will always result in the best choice being made. Instead, the key requirement is to better understand the nature of the choices available, to address those conflicts that make it necessary and develop the understanding of the processes involved.

Appraisal methods

Various valuation techniques provide yardsticks for assessing a range of direct and indirect benefits and costs of proposed projects and thereby allow policymakers to take an integrated view of these impacts and test the economic viability of a project with the advantage of being free from subjective considerations or biases. The techniques, therefore, help in choosing between different alternatives.

Cost-benefit analysis examines activities in a trade-off or balancing mode and has been used for making decisions in the water sector for more than 50 years. Cost-benefit analysis quantifies in monetary terms as many of the costs and benefits of a proposal as feasible, including items for which the market does not provide a satisfactory measure of economic value.[8] Cost-benefit analysis examines whether the total benefits of a project, evaluated in terms of money, exceed the costs of utilizing resources. Being a monetary-based analysis, CBA does not take into account any moral issues, such as distributional equity. People living in inferior circumstances (lower income, educational level, social status) are unlikely to be able to express their preferences in monetary terms due to their economic, political and technological constraints. Also, their preference will be given less monetary value because of their low income levels compared with their rich counterparts.[9] This is discussed in more detail in Chapter 3.

Cost-benefit analysis has undergone continuous refinement and expansion as the factors in decision-making have changed over the years. The increasing importance of social and environmental concerns in development projects witnessed in recent years and the risk issues that need to be addressed in flood management have underlined the need for some criteria other than the traditional cost-benefit criterion for evaluating the usefulness of a project. One line of approach has been to expand the range of economic analysis and put monetary values to social and environmental concerns.

Another line of approach has been to develop a complementary methodology through MCA. It involves judging the expected performance of each development option against a number of criteria or objectives. These techniques can deal with complex situations, involving uncertainty as well as the preferences of many stakeholders. This is particularly highlighted when the problem presents conflicting objectives and when these objectives cannot be easily expressed in monetary terms. Multi-criteria analysis can be useful in ranking options, shortlisting a limited number of options for subsequent detailed appraisal (say through CBA) or simply separating acceptable from unacceptable options. A review of MCA is briefly presented in section 4.3.

2.3 Understanding financial and economic analysis

Financial and economic analyses have similar features. Both estimate the net-benefits of a project investment based on the difference between the with-project and the without-project situations. The basic difference between the financial and economic benefit-cost analyses of the project is that the former compares benefits and costs to the enterprise, while the latter compares the benefits and costs to the whole economy.[10] Both these analyses are conducted on the assumption of constant prices.

Economic analysis is concerned with the true value a project holds for the society as a whole. It subsumes all members of society, and measures the project's positive and negative impacts in terms of willingness to pay (WTP) for units of increased consumption, and to accept compensation for foregone units of consumption.[11] In addition, economic analysis would also cover costs and benefits of goods and services that are not sold in the market and therefore have no market price. Various techniques of evaluating costs and benefits through the discounting method remain the same in both the cases. These techniques are described in Chapter 4.

There is one more significant difference between financial and economic analysis. While financial analysis uses market prices to check the balance of investment and the sustainability of project, economic analysis uses economic price that is converted from the market price by excluding tax, profit, subsidy, etc. to measure the legitimacy of using national resources to certain project.[12]

In financial analysis, the taxes and subsidies included in the price of goods and services are integral parts of financial prices, but they are treated differently in economic analysis. Financial prices are market prices of goods and services that include the effects of government intervention and distortions in the market structure. Economic prices reflect the true cost and value to the economy of goods and services after adjustment for the effects of government intervention and distortions in the market structure through shadow pricing of the financial prices. In such analyses, depreciation charges, sunk costs and expected changes in the general price are not included.[13]

Adjustments are sometimes made in the exchange rate if it is controlled and deviates from the rate that would have prevailed in the absence of controls. Adjustments are also made in the case of prices of tradeable goods and services. But in recent years, with globalization, exchange control has relaxed in several countries thereby narrowing down the difference between official and shadow exchange rates. Moreover, in the case of flood management projects, where most of the cost incurred is on local or domestic products, the exchange rate valuation may not be that important.

Financial and economic analyses also differ in their treatment of external effects (benefits and costs), such as favourable effects on health. Economic analysis attempts to value such externalities, health effects and non-technical losses.[14] All such side effects, or externalities as they are called, are supposed to be included in both economic analysis and financial analysis. The inclusion of externalities, however, raises difficult questions of their identification and measurement in terms of money. Several methodologies have been developed and will be discussed subsequently.

Financial and economic analyses are distinguished because the financial and economic returns often do not quite converge. This is because what counts as a benefit or a cost to the project operator does not necessarily count as a benefit or cost to the economy as a whole. However, it must be noted that the two are also complementary. For a project to be economically viable, it must be financially sustainable. If a project is not financially sustainable, there will be no adequate funds to properly operate, maintain and replace assets; thus the quality of the service/ benefits will deteriorate, eventually affecting demand and the realization of financial revenues and economic benefits. It has sometimes been suggested that financial viability not be made a concern because as long as a project is economically sound, it can be supported through government subsidies.[15]

Financial analysis of a flood management project, generally executed by governments, will take into account the financial revenue (in terms or additional taxes or fees) that can be obtained by the government from the beneficiaries whereas the economic analysis would be concerned with all the benefits that would accrue to the public from a reduction of flood damages and any other benefits.

3. COST-BENEFIT ANALYSIS

Cost-benefit analysis is the main analytical tool used for investment decisions on a specific project. The first use of CBA in the world was made in the flood sector in the United States in compliance with the United States Flood Control Act of 1936 which specified that participation of the United States Federal Government in projects to control flooding on major rivers of the country would be justifiable "if the benefits to whomsoever they accrue are in excess of the estimated costs". Thereafter, authorities developed procedures to measure these benefits and costs. Its use is now widespread across sectors and countries and the methodology has been much refined.

The essence of CBA lies in:

(i) Identifying items of benefit and cost in the flood management project from an economic viewpoint, i.e. taking into account all the benefits accruing to and all the costs incurred by the economy or society as a whole;
(ii) Selecting appropriate prices for evaluating the benefits and costs in monetary terms; and
(iii) Adjusting the future prices of costs and benefits to present values to make them comparable.

Because benefits and costs stem from many different effects, a systematic procedure is required to make sure that each is considered and evaluated properly. The practice so far has been to include only the direct effects, even though slowly some other effects are also being taken into account.

3.1 Assessment of benefits

Conceptually, the benefits of a project can be divided into two parts: primary and secondary. Primary benefits denote the values obtained from goods and services emanating from the project. These benefits accrue from physical effects of the project on the user as contrasted with effects transmitted through market mechanisms, which are regarded as secondary benefits and which will be elaborated later.

Primary benefits are of two types—direct and indirect. In the case of a flood management project, direct benefits include the reduction in physical damage. Thus, flood damage to crops, cattle, houses, commercial and industrial buildings, infrastructure etc., avoided because of construction of embankments, flood retention reservoirs or flood warning systems, are direct benefits. Indirect benefits may occur by avoiding disruption to business, transport networks and public services and by avoiding the costs of emergency response and recovery.

3.1.1 Assessment of primary benefits

Direct benefits

The direct benefits from flood management projects accrue from the prevention of flood damage. This is determined by the annual average of flood damage minus the residual damage that may continue to take place even after the implementation of the flood management project—a flood moderation reservoir, an embankment or a flood warning programme. Assessment of benefits can be brought about only if the assessment of damage prevented in monetary terms is made in a satisfactory manner.[16]

Monetary assessment of damage can be made based on a methodology from natural disaster damage assessment provided by the United Nations Economic Commission for Latin America and the Caribbean (ECLAC).[17] Approaches to flood damage assessment are also provided by the Department for Environment, Food and Rural Affairs (DEFRA)[18] which are briefly presented in Annex I. The assessment of the annual potential damage is made by averaging the flood damage incurred in the past. A correct idea of the average flood damage can be gained only if figures based on long periods are used; the longer the period the more reliable the average. Ideally weighted average damages can be obtained based on the damage-frequency curve obtained from past floods—their related frequencies and the actual damages recorded. This methodology is explained in Figure 2.

If the time series used in the above analysis is long, the earlier damage estimates are likely to be less reliable because of likely changes in land use, cropping patterns, developmental activities etc. Floods of a similar magnitude could produce a different order of damage today, as compared with 50 years ago. This problem, however, can partly be taken care of by

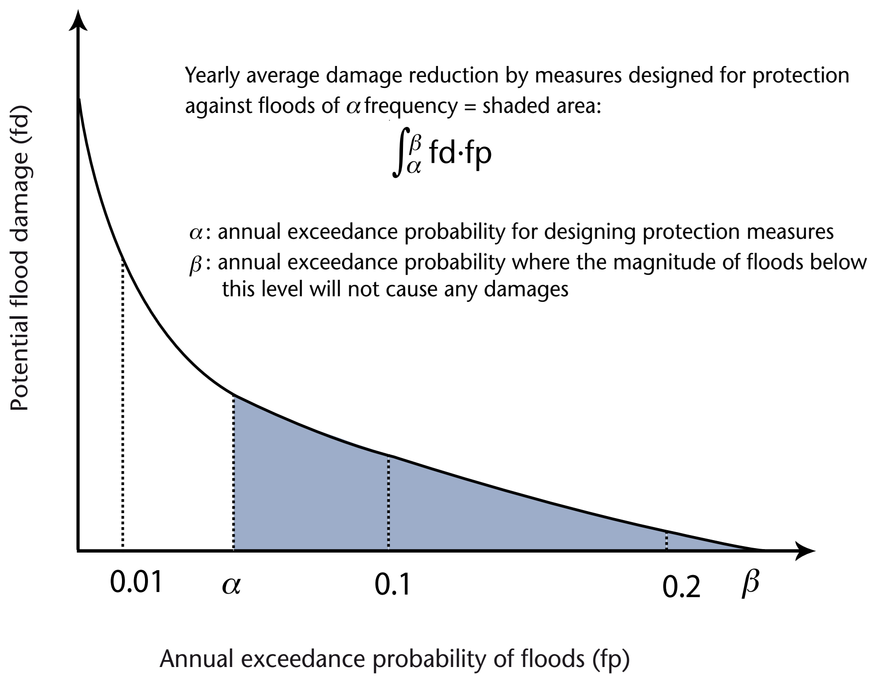

Figure 2. Damage frequency curve

adjusting the past damage estimates for the land use change and increased productivity with the help of standard methods. Considering all factors, damage data for about 20 to 25 years might be considered adequate for deriving the average annual damage.

Application in practice throws up several challenges. Flood management projects are usually taken up in the aftermath of a high flood. Sometimes, the damage data only from such high floods are available. In some cases the number of years taken into account for determining the average varies from five to ten recent years along with the flood of the exceptional year. The inclusion of the damage data of a severe flood year, say of 100 years' flood frequency, in a series containing the preceding five or ten years' data may lead to a marked over-estimation of the average damage figures.

In most cases either the flood damage data from past flood events are not available or are not reliable enough. In such cases, the direct benefits from the flood protection projects are estimated based on synthetic damage frequency relationships developed using physical surveys. The value of damage is assessed for current basin conditions for the various flood return periods.

In addition to the damage prevented, another direct benefit of flood protection schemes is the increase in area which may become available for cultivation as well as for other economic uses due to reduced flood risks. For example, hill torrents emerging from foothills on to the plains keep changing their courses, as a result of which a wide area is rendered unsuitable for cultivation. As no crops are grown on such areas, these do not figure in the calculation of flood losses. After protection, such areas may have potential for development. In such cases the benefits on account of increased area being made available should also be included as an additional direct benefit particularly if fertile lands are under pressure of cultivation to alleviate poverty. The monetary value of this benefit should, however, be assessed with respect to the productivity and other attributes of land of a similar type in the same area and not with respect to relatively more developed or more fertile lands. The annual benefit from such land should be assessed in terms of the value of net agricultural and other production.

Assessment of the fertilizing value of silt due to inundation of flood plains if prevented because of flood protection projects needs to be included as a benefit lost or a negative benefit. The assessment of the fertilizing value of silt will obviously vary from area to area depending upon its quality and recurrence. No precise methods, however, are available for assessing this and no general guidelines can be prescribed. The effect of silt may be determined by comparing data on the yield of a representative sample of flood affected farms with similar farms in nearby flood-free areas (i.e. a with and without approach) for the preceding few years. The difference between the two sets of yields, if any, may be regarded as the combined value of both the fertilizing silt and the groundwater recharge.

Indirect benefits

Indirect benefits come from the effects of technological linkages of a project. These could be described as "technological spill over" or "technological externalities". A project intended for one purpose may be utilized for some other or may have some other effects which are incidental or unintended. Flood management projects may benefit users of transportation by reducing interruptions to traffic. The ecological effects belong to the same category. Many such effects occur away from the project site. Such effects, whether favourable or unfavourable, constitute an important aspect of project impact and should be included in the CBA.

Indirect benefits can be evaluated by developing a checklist of potential project technological external effects and assessing each one of them. For example, the checklist for a flood management project could include the interruptions of transportation and communication facilities avoided, the number of workers and farmers depending on closed plants in the flood effected areas, and the amount of business lost by enterprises providing supplies to and utilizing materials from flooded areas and so on. The magnitude of each effect may be estimated by interviewing those affected during recent floods.

It may, however, be extremely difficult to identify and quantify all indirect effects, which could be attributable to flood management. The list should include only those which may be easily identified as logical consequences of the project at the time of its formulation. The indirect effects which cannot be quantified should, however, be listed and described in a qualitative manner. There may be situations in which even the qualitative descriptions may turn out to be crucial for decision-making. It will be even more useful if the qualitative aspects are quantified through MCA, as explained in section 4.3.

3.1.2 Assessment of secondary benefits

In contrast to the primary effects, whether direct or indirect, which originate from physical aspects or technological linkages of a project, secondary effects cover those activities which originate from economic linkages through the market mechanism. The secondary effects are induced by the project's output. For example, the sense of security against threat of inundation which is an important output of a flood management project may induce farmers to invest in land development and irrigation, change cropping patterns, raise cropping intensity and thereby raise agricultural production. It may induce industrialists to start new food processing plants or other industrial enterprises.

While doing so, the associated costs, such as the additional costs of inputs like fertilizers, irrigation, pesticides, etc. which could be incurred, should be deducted to get an estimate of the net benefits on account of flood protection. Several other economic development activities, including roads, railways, schools and hospitals, may be encouraged due to a reduction of flood risks. However, these might or might not follow the execution of a flood management project in the area. It is a matter of judgement as to how much future development should/could be included. Clearly, the list should include only those effects that may be easily identified within the lifetime of the project and are a logical consequence of it. Another type of secondary benefit (effect) may originate from the need to provide inputs to project activities through backward linkages, in contrast to forward linkages discussed above. For example, a brick or cement manufacturing activity may crop up to provide bricks and cement to a flood management project.

Secondary effects may also take place through scale economies. The construction of a dam, for example, would result in higher demand for cement which in turn might cause higher production in cement manufacturing plants. This might enable these plants to derive economies of scale. But should these plants already be operating at an optimum level, then in place of economies, diseconomies of scale may arise. Such effects are by nature so difficult to evaluate that few attempts have been made to do so empirically or predict their magnitude or occurrence. The analysis has remained at the theoretical level without any operational significance.

There has been much discussion among economists and others as to the extent to which secondary benefits do in fact exist. Many argue that values claimed for such benefits represent outputs that could have been attained even in the absence of flood protection schemes: either the production could have taken place in the region in any event or it could have occurred elsewhere as a result of comparable investment. When viewed from a national perspective this argument is difficult to refute. However, the reasons for developing programmes are often regional or local in focus rather than national and in such instances secondary benefits may well be a very persuasive reason for taking action. But the problems of their measurement are formidable. These provide scope for manipulation so it is prudent to restrict inclusion to only those that can be predicted with a good degree of certainty.

3.1.3 Avoiding double counting of benefits

It is sometimes suggested to assess the benefit of flood management measures through increases in the land value in places of flood damage. In a sense, changes in land value could be regarded as a better approach as they reflect the effect of changes in productivity as well as intangible benefits like sense of security on account of flood management measures. However, land values are affected by other considerations also, such as development of roads and irrigation, which may be taking place at the same time. It is, therefore, not advisable to attribute the entire change in land value to flood protection alone.

3.2 Cost estimation

Like benefits, the costs of a project can also be defined as primary and secondary. However, cost estimation is relatively more accurate and easy. Estimates of costs should represent reality as closely as possible; otherwise a distorted picture of a project is likely to emerge which could result in a wrong choice. Construction quantities and their prices are at the core of cost analysis. Care, therefore, should be taken that their estimates are as accurate as possible.

One method for estimating costs is to proceed step-by-step from the beginning to the end of the activity process of the project and identify the cost components at each step taking due care of the subtleties involved. A schematic representation of these steps, in the form of a flow chart describing the operations performed at each step, helps in giving a definite shape to the underlying cost elements. Another way is to make use of a comprehensive checklist of cost items—there are readily available in the professional literature.[19] Any such list, however, should be updated and modified in the light of the latest thinking and local requirements.

The cost estimates thus made are based on actual market prices even if these are distorted and not suitable for CBA. These prices, which vary from year to year, include indirect taxes, such as excise duties, VAT and import duties, as well as subsidies. Actual wages are taken into account. The cost items included are only those which require payment by the project authorities. In other words, the amount of finance needed for any project is determined by the costs estimated through financial analysis rather than economic analysis. Further, these estimates are made with reference to current prices and not constant prices. Estimation of cost allocation of flood moderation when it is provided as part of a multi-purpose reservoir project is more complicated. Annex II provides a brief discussion on this.

Previous experience in many countries indicates that initial cost estimation for projects is often not realistic even for the financial or direct costs. Upward revision of costs is quite usual due to reasons such as a lack of adequate surveys and investigations and unreliable data etc. Sometimes costs may be deliberately underestimated to get the project cleared by showing a favourable benefit-cost ratio (BC ratio).

Relocation or restoration costs

In the case of flood management projects, especially involving the construction of reservoirs, relocation of existing settlements or archaeological building may be necessary. A good example of this is the relocation of Abu Simbel and other historic sites in Egypt when the waters of the Aswan High Dam threatened them. These costs should be appropriately assessed in close consultation with the people affected. Costs involved in mitigating the adverse effects of the project should also be appropriately accounted for as costs of the project.

Preventive expenditure or mitigating costs

Integrated Flood Management involves various options for mitigating risks to life and property. Floodplain regulation, flood proofing, flood forecasting and warning, emergency response and rehabilitation are some of them. In certain cases the population at risk may adopt flood proofing measures by making modifications in their houses e.g. by raising the plinth level of houses, using flood resistant building materials, building storage places at higher levels in the houses or purchasing boats for emergency evacuation during floods. The expenditure involved in adopting these measures should form part of the costs of the strategy selected to manage floods in a given area.

3.3 Non-market valuation of costs and benefits

Competitive markets tend to ensure efficiency because market demand and supply curves represent willingness to pay (WTP).[20] But this generally does not happen in practice because of so-called market failures which are caused by several reasons including absence of competitive markets, interference by government and presence of externalities. A number of primary and secondary benefits are not amenable to competitive market assessment.

Markets fail to make optimum allocation of resources if prices do not reflect societal values and constraints or if there are no values placed on assets such as water in the river. Existence of environmental values is a major factor behind significant differences between market values and social values. The difficulties increase further because many individuals and institutions are unfamiliar with most of the services and functions that ecosystem and biodiversity provide. Besides many environmental resources have "non-use values" or "passive use values".

Floods produce several direct and indirect effects most of which remain unpriced by the market. Many of the benefits provided by natural resources such as wetlands remain unpriced. The inability to exclude others from enjoying benefits or suffering costs prevents the market price from sending the correct signals about the true economic value of the wetland. Non-market value can be categorized[21] as follows:

- Value of a prevented fatality or prevented injury;
- Value of time lost prevented;
- Value of health benefits;
- Value of design quality;
- Value of environmental services lost (air quality, landscape, water, biodiversity, noise, recreational and amenity values for forests etc.); and
- Value of dis-amenity.

In view of the above failure of the market, there is a need to consider other means to assess the true value of unpriced environmental resources taking into account implicit and explicit trade-offs between conservation and development. This would aid policymakers in their choices on how best to manage the world's natural resources.

Recent years have witnessed an explosion in non-market valuation research. To a great extent this was prompted by court cases in the United States over natural resource damage assessment of Superfund Waste Sites (under the Comprehensive Environmental Response, Compensation and Liability Act 1980) and the 1989 Exxon Valdez oil spill in Alaska.[22]

The non-market valuation methods are derived from two basic concepts namely the WTP for improved ecosystem and the willingness to accept compensation (WTA) for decreased services.[23] [24] Economic analysis deals with the estimation of these measures of value in monetary terms on the fairly realistic assumption that an individual has a set of preferences over goods and services that can be ordered in a logical and consistent manner. The preference ordering determines the manner in which an individual chooses between different consumption baskets. The concept of consumer surplus[25] is used to capture the value of changes in environmental services. The application of these concepts in different methods is explained below.

3.3.1 Estimating non-market values

There are two categories of methods—stated preference methods and revealed preference methods. They are used for estimating the unmarketable environmental quality or value, such as the benefits of improved river water quality or the costs of losing an area of wilderness to development, and are briefly explained below. In stated preference methods the concerned population is asked directly to indicate their WTP or WTA for any specific gain or loss. Contingent valuation method (CVM) is a good example of this. Sometimes, it is also referred to as hypothetical valuation. Revealed preference methods obtain the estimates indirectly by drawing inference from observing the behaviour of concerned people in related markets. Travel cost method (TCM) is the most frequently used example of this. Each of these methods has its merits and shortcomings. Even then, there may be situations when they can be very useful. The choice of method obviously depends on what is being measured, data and resources available and the specific context.

3.3.2 Stated preference method

Contingent valuation method

The CVM, though first used in 1963 and developed during the 1970s, became a legally acceptable method in the United States during the hearings of the case related to the wrecking of the oil tanker, the Exxon Valdez, off the coast of Alaska in 1989. The method is called "contingent" valuation because it tries to get people to say how they would act if they were placed in certain contingent situations. It is essentially a method which provides values (in terms of WTP or WTA) of the concerned people for an environmental good as stated by them during a survey. Rather than prices actually paid or received, WTP and WTA are used because many of the project impacts that are to be included in the economic analysis will be unmarketable, for example, biodiversity preservation, or incompletely marketed, such as water supply and sanitation benefits.

For conducting the survey, details of the matter under study and issues involved are provided to the concerned people. A questionnaire is prepared and responses obtained as per the standard survey methodology. Face-to-face interviews are generally supposed to be the best method of obtaining the information. Individuals are asked to state their maximum WTP and/or minimum WTA for the increase or decrease in environmental quality, which may include "non-use" or "passive" values also.

Another pragmatic concern is just whose preferences should be counted. Certainly it is informative that other citizens in far away regions value the actions of others in other regions, but they are unlikely to support these activities financially.[26] Therefore, the respondents chosen for the survey must be as geographically close to the amenities in question as possible to avoid the potential for undervaluing them by those who are more or less physically removed from them.[27]

The CVM study needs to be detailed enough about the prospective designations to convince respondents that the agency will deliver the non-marketable good promised, e.g. a protected species, cleaner water or air, etc. The payment mechanism must be believable so that the respondents believe they may actually have to pay for the protected amenities. The challenge, therefore, is to design a study that demonstrably provides an unbiased value estimate for each non-marketable good. The survey must attempt to measure the true WTP for the specific resource in a specific location for the protected amenities as precisely as possible. The willingness of a respondent to pay to protect any resource may be expected to drop significantly when the resource is asked to be valued with and in comparison with other resources, rather than in isolation.[28] There are several ways of asking the questions. Some examples are as below:

- A bidding game: higher and higher amounts of WTP or lower and lower amounts of WTA are suggested to the respondents until their maximum WTP or minimum WTA is reached;
- A range of values is suggested from which the respondents may choose one;
- Open-ended questions are asked without suggesting any value. Respondents do not find it easy to answer such questions since they may not have prior experience of trading with the commodity in question; and
- Yes or no option or take-it-or-leave-it experiment. Here respondents are first randomly divided into sub-samples. In each sub-sample, a single payment (offer price) is suggested to which respondents either agree or disagree. Different payments are suggested in different sub-samples. Such responses are often known as dichotomous choice responses. There could be more detailed variants of this.

Each of the above approaches has its own relative advantages and disadvantages, a discussion of which lies beyond the scope of this paper. The person conducting the survey has to decide which approach to adopt after weighting the relevant considerations.[29]

Data obtained from the above surveys are then used to estimate average values through the usual statistical techniques like mean or medium. Quite often attempts are also made to find out the determinants of WTP/WTA—income, education, age and some variable measuring "quantity" of environmental quality being bid for. Thereafter, multiplying the average figure with the total number of relevant households gives the total figures. For this, prior information on what constitutes a relevant number of households is necessary. This would include the households that are affected.

This method, like many other methods is, however, not perfect. It has some problems of which the more important ones are related to biases and inadequate information. First there could be "hypothetical bias" since people might not give an accurate measure of their values if they have no incentive to answer questions correctly, especially when such questions take much time and thought. But, this shortcoming is not very serious since in random samples errors have a tendency to cancel each other in large surveys. A much more serious problem is due to "strategic bias" resulting in a systematic over or under statement of true WTP/WTA. Respondents tend to understate if they expect their responses will be used for fixing charges to be paid by them; they tend to overstate if they expect free supply of benefit. In other words, there is a difference between what people actually do and what they say they will do. This is a part of their strategic behaviour. Experienced surveyors take precautions in their survey design and interview techniques to reduce the magnitude of this problem. The knowledge base of respondents, with respect to the issues on which their views are sought, also has an effect on their responses. Changing the information set that the respondents hold would obviously change their valuation of environmental effects. Hence, those conducting the surveys should provide complete information to respondents so as to minimize this problem.

Because of the considerable expenses involved in CVM surveys, there is sometimes a tendency on the part of authorities to use CVM results from similar studies already conducted. Such an approach may not be appropriate, if the conditions such as socio-economic conditions or depth and duration of flooding etc. are not the same in the two cases. Adjustments would, therefore, be needed. This can be done satisfactorily if empirical knowledge of the determinants of WTP/WTA is available.

Another point that should be kept in mind is that the values of WTP and WTA are always significantly different from each other. Many CVM researchers have found that WTP measures are much less than WTA for the same change in environmental quality.[30] This is because people tend to value losses more highly than the equivalent amount of gains. The loss of welfare because of a decrease in existing entitlement is much more than the gain in welfare due to an equivalent increase in existing entitlement. Thus, WTA exceeds WTP. Hence an estimate for one should not be used in estimating other.

The reliability of CVM results can be checked by repeating the same survey on a different sample, drawn in the same manner as earlier from the same population after a month or two. This is called the test–retest procedure. Another method could be the convergent validity check. Here, CVM estimates are compared with estimates for the same variable from other valuation methods such as the travel cost or hedonic price models, provided that these are available in a comparable form. There are other methods for checking the reliability of CVM results.

Sometimes, implicit values are estimated through the Delphi technique. Here, the respondents are experts in the subject matter. A consensus is arrived at among experts (whose names are kept confidential) through an iterative process. Each successive round contains the results of earlier rounds along with explanations. Results would obviously depend on the quality of experts, the interest taken by them, their ability to reflect societal values and the manner in which the process is undertaken. [31]

3.3.3 Revealed preference method

Travel cost method

The travel cost method (TCM) gained popularity from the 1970s onwards as concern for measuring environmental values started to grow. The method has been widely used for determining the monetary values of outdoor recreation, especially recreation associated with parks, forests, lakes, reservoirs etc. The value of cultural or historical sites threatened by a flood management project such as a reservoir or embankment can also be analysed by this method.[32]

The TCM is based on a comparatively simple logic. If a person incurs a cost $20 for going to a reservoir to enjoy its beauty, then it is assumed that the benefit to the person from the scenic beauty of the reservoir is equal to or more than $20. The cost would be comprised of the costs of a taxi or own car and the opportunity cost of the time spent in commuting and roaming around the reservoir (any admission fees would be added to the cost). The TCM also makes use of an observed phenomenon that the farther a person commutes to the reservoir, then the frequency of visits reduces. Beyond a certain distance people would not commute as the cost incurred would become more than the value of the scenic beauty derived. Thereafter, a statistical relationship between observed visits and the cost of visits is derived and used as a proxy demand curve from which consumers' surplus per visit can be measured. This method, thus involves collection of data on visits to a site from different locations and the costs of visiting from each place. This data can be obtained by means of a survey of reservoir visitors. Respondents would be asked to indicate the time and money they spent travelling to the reservoir, distance to the site and information about other socio-economic variables. One can then derive a visit rate per capita as a function of travel costs; obviously visits per capita would fall as travel costs rise. The existence of other (substitute) sites would affect the outcome. Hence the TCM should take such substitutes into account. Several other refinements of the approach are possible.

One of the problems associated with the TCM relates to multi-purpose trips. Quite often, visitors may have more than one reason for visiting a site. For example, people visiting a reservoir might also like to visit a nearby forest and/or a hydroelectric plant. Hence only some of their travel costs should be apportioned to the reservoir, but how much? Researchers have evolved methods to deal with this problem.[33]

The TCM can be used for estimating the value of changing the characteristics of a site also. Other variants of the TCM are also available.

Hedonic pricing

This method can be used to establish the monetary value of such items as noise, flood risk, air quality etc. It has two variants: (a) property and other land value approaches; and (b) wage differential approaches. Let us first examine property and other land value approaches. We know that a house or land near a noisy place, such as an airport or a railway track, or a house which is exposed to the risk of frequent flooding commands less value than an exactly similar house located in different and better surroundings. In order to estimate how the value of a house is affected by the risk of flooding, it would be necessary to collect information on sale prices of houses with different degrees of flooding, including zero flooding, along with other characteristics of similar houses (such as number of rooms, type of structure, availability of other facilities and quality etc.). Thereafter, a statistical or econometric analysis can be conducted to establish a relationship between extent of flooding and decrease in sale price assuming everything else stays the same. In this manner, the adverse effect of flood on house or land values can be estimated. Studies conducted have found that the results obtained from using the method can be accepted with a fair degree of reliability. The method is, of course, not free from limitations and problems.

The wage differential approach is similar to the property and land value approach. It uses information on differences in wages for similar work in different locations. A higher wage is usually offered to induce workers to work in polluted areas or to undertake risky jobs such as rescue operations during a flood.

Marketed goods as substitutes

Sometimes, the price of a privately marketed good (e.g. a private park) can be used as a measure of value of an unpriced public good (e.g. a public park). Similarly, the price charged by a private company for supply of water may be used to determine the value of unpriced or free water supplied by nature or by government. This method can be applied without much difficulty if the private and public goods are similar or are perfect substitutes. Such cases, however, are very few. Great care, therefore, is needed to ensure that the method is put to appropriate use.

Replacement costs

Flood inflicts damage to houses, roads and other public and private properties. The extent of the damage can be and is often estimated by the replacement cost—after which the asset is restored to its original position. Replacement costs are different from preventive expenditures in that they are not a subjective valuation of potential damages but true costs of replacement after damage has already occurred. It gives an estimate of the upper limit and is not greater than the value of the damage; otherwise it would not make much sense to replace the resource lost.

3.4 Limitations of cost-benefit analysis

While CBA continues to be a primary tool for economic evaluation, adequate use of the tool requires a clear understanding of its limitations and pitfalls. For instance, rough approximations and sometimes even only orders of magnitude, may suffice in CBA. One might also say that the traditional CBA has ignored several indirect or environmental effects, which affect the overall outcome of the project. These effects can be, and are being integrated into CBA without affecting its basic structure. However, where economic values of environmental and societal aspects are not amenable to assessment or are difficult to assess, a CBA may mask the true costs and benefits of a project, particularly the costs associated with the loss of ecosystem. It is not prudent, therefore, to rely exclusively on CBA since it is not perfect or foolproof. A cautious approach is called for. Major limitations of CBA are discussed below.

3.4.1 Market imperfections

Cost-benefit analysis works best in a regime of perfectly competitive markets with a large number of sellers and buyers none of whom are in a position to dominate the market. But this condition is hardly met in actual practice. There are monopolists and monopsonists[34] and other big players. Besides, there are governments whose interventions distort the market still further. Hence, market prices need to be adjusted before these can be used for CBA. While some adjustment methods have been devised these cannot be considered as totally satisfactory.

3.4.2 Quantification of intangibles

There are problems with regard to the quantification of the values of so-called intangibles some of which still persist despite the evolution of several innovative approaches indicated in section 3.3. Attempts made to measure items of value that are generally unmeasurable remain as approximations and cannot be a perfect representation of the true value. The use of value judgements and assumptions becomes unavoidable. These problems are more profound in a developing economy because of the absence of fully developed property markets and the existence of a large non-market sector which restricts the practical application of concepts like WTP, consumers' surplus etc.

3.4.3 Income distribution

The tools of economic analysis have been geared to study economic efficiency. A project or a set of projects would be economically efficient if the difference between the monetary value of benefits and costs measured in socially desirable prices is at a maximum. Here questions related to distribution of income are not taken up for consideration. Efficiency is measured without regard to who would get the benefits and who would incur the costs.

Cost-benefit analysis essentially ignores the question of who is affected altogether. Heinzerling and Akcerman (2002) maintain that CBA should not be used to set the *ends* of policy, but it may be used to set the most cost effective *means* of implementing the predetermined policy. Their strong opposition stems from its intrinsic conflict with the principles of fairness in that the usage of CBA would aggravate the existing patterns of inequality by rationalising and reinforcing them.[35]

But, there is now an increasing trend among governments as well as development banks to be interested in the effects of projects on income distribution. One way in which distributional aspects can be integrated into CBA is by assigning weights to benefits received and costs borne by different socio-economic groups, e.g. giving higher weight to the poorer categories. But how to give weights is a subjective matter which can be decided by the authorities and not by the economic analysts. Another way of handling the distributional aspect is to establish distributional constraint as an additional criterion. For example, a government may prescribe a minimum acceptable distribution of benefits to some designated low-income category of the affected population. It is, therefore, obvious that additional analysis is needed to answer the distributional questions.

For the adjustment of such distributional equity issues, there are arguments that compensation may be given to the losers from the gainers since a project is generally carried out if the gain to the winners is greater than the loss to the losers. However, such compensation rarely happens in reality.[36]

3.4.4 Discount rate and intergenerational equity

The use of discount rate (see section 4.1.1), which has become an integral part of CBA, might result in giving less attention to the interests of future generations. This is because a high discount rate tends to give a lower value to benefits which accrue after longer periods. It does the same for the negative effects that may arise in the distant future. Eliminating discounting, which some people have suggested to deal with this problem, however, is no solution. It would amount to throwing the baby out with the bath water. A better way is to realize this limitation of economic analysis and keep additional considerations in view with respect to deciding on long gestation projects related to the use of non-renewable resources. This would help in safeguarding the interests of future generations without jeopardizing those of the present. As such, since the discounting process calculates its results from the present generation's perspective, one needs to be concerned about inter-temporal equity issues, that is, the fairness of the decision to future generations. In fact, costs that occur far into the future may be given little weight in traditional CBA. Sustainability has developed as an additional consideration for public policy decision-making precisely because of the concern that the process of discounting may steer us towards policies that overly emphasize short-term gain.[37]

The problem arises due to the fundamental mismatch between financial (economic) and environmental (scientific) timescales—whilst 50 years is inconsiderably long to economists, it can be relatively short to ecologists; because financial and environmental consequences unfold over different timespans. As a matter of fact, even if it is possible to give environment a monetary value, it does not mean that the environment grows like a sum of invested capital generating positive returns at a constant pace. There is also another problem of "irreversibility" with the environment regarding changes in ecosystems, exploitation of exhaustible resources, etc.[38]

Whilst there are opponents of CBA who argue that even zero discount rates are not sufficient to protect the environment since CBA is still based on financial not environmental criteria (e.g., Jacobs, 1991), there are scholars who attempt to amend the existing CBA so as to make it more sustainability enhancing, i.e. sensitive to both the present and future, and more consistent with actual individual references. A growing body of empirical evidence suggests that the discount rate which people apply to future projects is inversely proportional to the distance into the future, in particular, that discount functions for utility are loosely approximated by generalized hyperbolas, as opposed to the standard exponential discount function applying a constant discount rate.[39]

The significant advantage of CBA is that it represents a very simple and rational idea that decisions are based on some weighing up of the costs and benefits of an action. Provided that CBA is not unjustifiably costly or biased, CBA may be useful in giving some guidance and providing some "objectivity" to political judgment. Indeed many criticized problems of CBA are not necessarily unique to it, i.e. any decision is biased to some extent, and there is no guarantee that other measures, or for that matter, political decisions, will better incorporate the equity concerns, etc. Although the use of CBA inevitably involves some political bias, it still might reduce such bias more than if no such measure is taken.[40]

One might say that the above analysis may not be relevant if there are professional or departmental norms or standards fixed in physical terms for taking up specific types of flood management schemes. Such standards exist and are followed in several countries.

There is, however, an increasing realization that such standards are inefficient. Firstly the basis of these standards is not known. These could be the outcome of "historic accident"[41] or "conventional practice".[42] Secondly these standards would be having different cost-benefit implications in different areas, which vary with respect to physical features as well as socio-economic development. There cannot be a single physical standard, which would be suitable for universal application. The degree of protection to be provided with respect to flood frequency should, therefore, be determined by the outcome of an economic analysis applied to a specific situation so as to maximize efficiency and people's welfare. This would require working out costs to be incurred on projects of different flood frequencies and the benefits that would be obtained from those projects. That alone would determine the optimal level of protection.

For example, enquiries made by the National Flood Commission of the Government of India and mentioned in its report submitted in 1980 revealed that some of the state governments had fixed standards such as "highest observed flood" or "25 years' flood frequency on small tributaries and 50 years' flood frequency on major rivers" for protecting predominantly agricultural areas; and "100 years' flood frequency" for "town protection works" as well as "important industrial complexes, assets and lines of communication".

4. ECONOMIC EVALUATION TECHNIQUES

4.1 Techniques of evaluating choices

Economic viability of projects is examined with reference to the indicators, namely net present value (NPV), BC ratio or internal rate of return (IRR).

4.1.1 Discounting technique

The costs, benefits and net benefits of any project are spread over a number of years, as long as the project is alive. From the point of CBA, the primary interest is not on costs or benefits separately, but on the net benefits (i.e. benefits minus costs). Two precautions are needed. First, the figures of both costs and benefits should be estimated with respect to constant prices. Second, these should be adjusted for the time value of money.

The value of money changes over time, therefore it is not appropriate to directly compare the net benefits of one year with that of another without adjusting the figures for the time value of money. If information on year-wise costs or benefits is not provided, as happens when we get information only on total cost or total benefit or if these costs and benefits of different years are added at their face value, then a serious mistake is made since the aspect related to time value of money is ignored. As a result, the total cost figures remain the same even if the completion of the project is delayed and the same total cost is staggered over a longer period. A proper comparison is possible only when costs and benefits are expressed in terms of their present day value.

For example, consider a project providing a benefit of $110 at the end of the first year and $110 at the end of the second year. Is it paying more at the end of the first year or the second year? These amounts relating to different time periods cannot be compared by their face value. Considering an interest rate of 10 per cent, the $110 at the end of the first year of project implementation has a present worth of $100 and the $110 at the end of the second year has a present worth of about $91. Hence, the benefits, at the end of the second year in this example are worth less than the benefits at the end of the first year. It is for this reason that the economic viability analysis for a project is conducted by discounting the future stream of benefits and costs to get their NPV. Since most of the costs are usually incurred at the beginning of a project while benefits accrue later, a delay in construction would tend to lower the discounted value of benefits. Hence, the use of discounting technique places a premium on early completion of projects. The essence of discounting lies in re-computing cost and benefit figures of different years with the help of a given interest rate to get their equivalent present day amounts.

4.1.2 Net present value and benefit-cost ratio

Two approaches can be used in NPV calculations. In the first approach the present (discounted) value of cost and benefit figures for each year, with respect to the relevant interest rate, are calculated. The present or discounted value of costs and benefits for each year are then added to get the NPV. Alternatively, the difference between benefits and costs in each year can be worked out to derive figures of net benefit in each year. Each year's net benefit is then discounted to get their present value and added together to get the NPV. Either of the cases gives the same results. Mathematical formulae and computer programmes are available to simplify the calculations.

The NPV is a capsule summary of the viability of a project. A positive NPV implies that the project would have positive gains after paying all costs, including the repayment of loans and operation and maintenance costs, whereas a negative NPV implies that the benefits from the project will not cover all the costs. It is not justified to implement such projects. If one out of several options is to be selected then the option with the maximum NPV should be selected.

Quite often, a ratio between discounted value of total benefit and discounted value of total cost, known as the benefit-cost (BC) ratio is computed. A positive NPV would imply a BC ratio greater than one and a negative NPV would imply a BC ratio of less than one. Only those projects where the BC ratio is more than one should be selected. The BC ratio is usually considered more useful than NPV because it enables easy ranking of different options in terms of their contribution to net benefits per unit of investment. The higher the BC ratio, the more viable is the project. In several countries, the criterion prescribed by the government for selection of flood management projects is in terms of the BC ratio.

4.1.3 Internal rate of return

The NPV or BC ratio of a project is affected by, amongst other things, the rate of interest. The NPV increases with decreases in interest rate and vice versa. For a given project, the NPV can be positive at a given interest rate but negative at another rate. At low interest rates, a project may be able to repay the loan, but at higher interest rates it may not do so. Typically, the relationship between the NPV and the interest rate is of the form displayed in Figure 3.

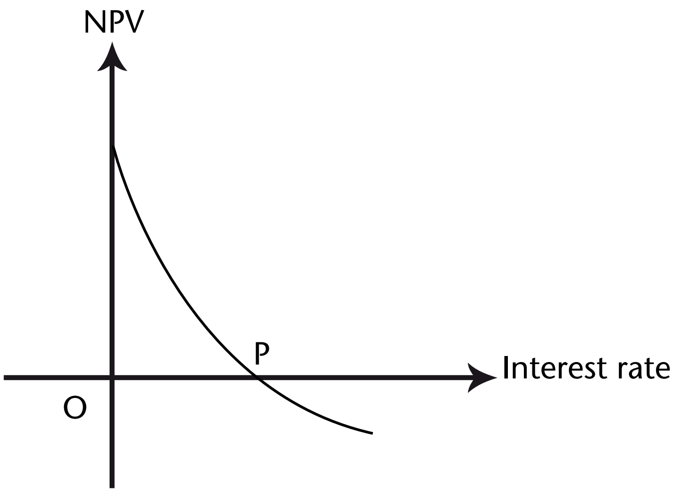

Figure 3. The relationship between the NPV and the interest rate

It is evident from the above that the NPV of a project is zero at a certain interest rate, denoted in Figure 3 by P. This P is the critical interest rate. If the interest rate is less than P, the project is economically viable; otherwise it is not. Thus P is the maximum interest rate at which it would be economical to undertake the project. This rate is called the internal rate of return of a project (IRR). In other words, the IRR of a project is the rate at which the NPV is zero or the present value of costs and benefits are equal or the BC ratio is one.

Computation of the IRR of a project does not require prior knowledge of the actual interest rate. Once the IRR is computed it serves as a point of reference. Whenever someone offers a loan at a rate higher than the IRR, one can look for other creditors because the interest rate should be lower than IRR for economic viability. Thus the IRR also presents the essence of a project in summary form. A project is economically viable if the IRR is greater than the interest rate; it is unviable if the IRR is less than the interest rate.

The IRR can be calculated for both financial and economic analyses. Some agencies like the Asian Development Bank (ADB) give separate names for the two. The financial internal rate of return (FIRR) will indicate the viability of a project for the project-operating entity, while the economic internal rate of return (EIRR) will indicates the real worth of a project to the country.[43] The EIRR is more focussed on the efficiency of investment. The ADB set the minimum line of discounting rate for the EIRR as 12 per cent or 10–12 per cent with additional unvalued benefits. On the other hand, the discounting rate used in CBA for government activities is normally 4–6 per cent (in the United Kingdom it is 3.5 per cent), because the purpose is to check the rationality of the project in using national resources.

4.1.4 Cost-effectiveness analysis

Cost effectiveness refers to the comparison of the relative costs of two or more options to meet the benefits specified in non-monetary terms. There are occasions when a decision to moderate the incidence of flooding in a particular area is made under political compulsions as a result of public pressure or out of electoral commitments. In other words, the objective is already decided without making any quantitative estimate of the benefit. What is left to be decided is the most cost effective means of achieving the objective, e.g. whether by constructing embankments, improving drainage channels or having a detention basin etc. The costs of these alternatives to achieve the given objectives are estimated in order to find out the least costly alternative. The costs need not be restricted to purely financial ones but might include economic costs also. This method is called cost-effectiveness analysis. Cost-effectiveness analysis results in the least cost solution that meets some predetermined requirements. By analysing the monetary value of various alternative undertakings, a ranking can be made according to their costs. This is one of the most common forms of analysis used by governments, especially for small projects.

4.2 Risks, uncertainty and sensitivity analysis

In calculating the BC ratio, EIRR or NPV, the most likely values of the variables are incorporated in the cost and benefit streams. However, future values are difficult to predict and there is always some uncertainty about the project results. An advantage of economic analysis conducted through NPV, BC ratio or EIRR is that it is capable of incorporating risks and uncertainties, which surround projects in the flood management sector. There are uncertainties with regard to many aspects—the behaviour of the river, floods of different frequencies, probability of failure of embankments, actual lifespan of a project, time actually taken for construction, future prices and yields, occurrence of indirect and secondary effects, etc. Hence an assessment of benefit cannot be made with certainty.

The technique of sensitivity analysis has been developed within the overall framework of CBA to take risks and uncertainties into account. Here alternative assumptions about key variables are made and their effects on the project's net effect (BC ratio, B/C or EIRR) are worked out. Suppose the project has a BC ratio of 3:1 on the assumption that it will be completed in three years. What happens to the BC ratio if the completion is delayed to five years or ten years? This requires calculation of the BC ratio on the assumption of a completion time of five years and also ten years. It may turn out that these BC ratios are 1.5 and 0.8 respectively. This shows that the project is sensitive to the period of construction but remains viable even in the case of delay of up to two years. But it becomes unviable if its completion is delayed by seven years. Another key variable could be the interest rates.

If changes are expected in several other variables at the same time, then the effect of all of them on the BC ratio or IRR can be calculated in the same manner to find out the likely impact on the viability of the project due to particular uncertainties. If a project may become unviable in some cases then this aspect has to be viewed quite seriously and modifications in the project design considered to ensure its viability under varying expected conditions. Such an exercise also throws light on the variables, which would have the most pronounced effects on benefits and costs.

The Monte Carlo analysis[44] allows an assessment of the consequences of simultaneous uncertainty about key inputs, and can take account of correlations between these inputs. It involves replacing single entries with probability distributions of possible values for key inputs. Typically, the choice of probabilistic inputs will be based on prior sensitivity testing. The calculation is then repeated a large number of times randomly (using a computer program) to combine different input values selected from the probability distributions specified. The results consist of a set of probability distributions showing how uncertainties in key inputs might impact on key outcomes.

4.3 Multi-criteria analysis

Multi-criteria analysis is a complementary approach to CBA. It is a two-stage decision procedure. The first stage identifies a set of goals or objectives and then seeks to identify the trade-offs between those objectives for different policies or for different ways of achieving a given policy. The second stage seeks to identify the "best" policy by attaching weights (scores) to the various objectives.[45] It involves judging the expected performance of each development option against a number of criteria or objectives. These techniques can deal with complex situations, involving uncertainty as well as the preferences of many stakeholders. This is particularly highlighted when the problem presents conflicting objectives and when these objectives cannot be easily expressed in monetary terms.

There are several variants of the MCA technique. These techniques do not necessarily rely on monetary variables even though monetary variables can also be accommodated in them. Multi-criteria analysis involves judging the expected performance of each development option against a number of criteria or objectives and taking an overall view on the basis of a pre-assigned importance to each criterion. The essence of MCA lies in the preparation of a performance matrix with several rows and columns in which each row describes one of the options and each column describes criterion or performance dimension. Thereafter, scores for each option with respect to each criterion are assigned. These scores are supposed to represent performance indicators and are worked out through specific graphs or value functions for each criterion as based on scientific knowledge. Generally a scale of 1 to 10 or 1 to 100 is adopted. In the more sophisticated versions of MCA, weights are assigned to each criterion. Thereafter, a weighted average of scores is worked out. This average provides the overall indicator of performance of each option. The higher the weighted average of scores, the better the option.

There is no doubt that MCA is much better than informal or intuitive judgments often made by decision makers. Such an approach provides an analytical base to decision-making which is transparent and based on data. It is especially useful to sellers of consumer durables since the matrix provides an opportunity to get an idea of consumers' preferences for particular attributes of their products. The size of the matrix can be increased to take care of a large number of criteria as well as options. It is a physical method based on numerical rating and scaling of various environmental impacts. As such, the difficulties faced in quantification in monetary terms are avoided. The methodology, however, has several shortcomings.

The usefulness of MCA is most apparent when one option emerges as the dominant one in the matrix with respect to all the criteria. Such an option can easily be selected without any hesitation, though in that case also, a doubt arises as to whether all relevant criteria have been taken into account. Generally, some option would be better against one criterion but worse against another. How can one judge whether a good performance against one criterion would compensate for poor performance against another? This, again, is a question of trade-off which occupies a central place in decision-making having multi-dimensional aspects. Weighting or ranking becomes necessary to handle such cases. But does one determine weights and what is the sanctity behind them? This becomes a really critical issue to which no satisfactory answer is available. Weights determined by experts, even through a rigorous method such as the Delphi technique, cannot be regarded as free from subjective biases. Weights determined by the concerned public would be regarded as free from the above problem. But what would be the reliability of such weights on so many performance criteria if the public is not fully aware of or conversant with them as is often the case with regard to many environmental attributes? Many of the problems, which are faced in CBA, would be faced here also.

Multi-criteria analysis is also weak with regard to making inter-temporal comparisons. Impacts during the project construction phase are not distinguished from impacts during the operational phase. Multi-criteria analysis has no analytical technique like discounting to compare impacts (benefits and costs) occurring in different years. If there are some implicit procedures, then these cannot be as effective as the transparent and explicit ones. Value scores depend upon value functions, which could be linear, non-linear or even kinked. Sometimes even experts have inadequate or uncertain knowledge of the value functions. In such cases the outcome may be influenced by the subjective biases of the experts, which could be dangerous if experts are not disinterested.

Notwithstanding the above shortcomings, MCA can be a useful supplement to CBA under certain situations. It could be used for shortlisting options, which can then be subjected to the more rigorous CBA for a final decision. In this respect MCA can be used as a framework for the stakeholders to explore the nature of the choice to identify the critical factors to discover their own preferences etc. Further, MCA can take over from the stage where CBA stops. As explained earlier, despite much progress made recently, CBA is still not fully equipped to take care of all the environmental intangibles. Hence a recommendation has been made in the paper, *Environmental Aspects of Integrated Flood Management* (WMO, 2006), for listing of qualitative statements. These intangibles may be quantified by MCA and the result be taken as an additional input to decision-making. The best way, therefore, is to regard the two methods as supplements rather than substitutes.

4.4 Role of public participation

From the above discussion it is clear that both CBA and MCA have to strive to minimize the role of subjective factors and arrive at figures which best reflect social valuation. One obvious approach is to involve all stakeholders, particularly the affected people, at various stages of analysis. Since evaluation involves social values, it would be quite appropriate to carry out CBA/MCA in conjunction and close consultation with and participation of the public affected by the project. It is impossible to include the social dimension, especially the equity issue, in CBA but MCA can have the possibility of including this issue. This becomes even more useful in view of the widespread gaps in reliable data and information, which prevail in developing economies. This does not imply that CBA, as discussed earlier, is to be jettisoned. What it implies is that it is the voice of the public that should determine the weights of the qualitative and subjective elements forming a part of CBA.

The opinion of the public may be sought at different stages in the CBA/MCA exercise. The first inclusion of local values in the CBA/MCA process comes at the “scoping” stage, resulting in selection of the more important impacts for further study. But it is in the valuation of intangibles that public participation is expected to be most useful. One society may place great value on an ancient religious site while another may not. The public may also be invited to give comments on a CBA/MCA worked out by experts whether with or without public participation. These comments should be taken into account while finalizing CBA/MCA.

Public participation in decision-making and CBA/MCA is likely to raise the level of their consciousness and to make them more societally responsive. Group behaviour in community meetings need not be a mere replica of individual behaviour in isolation. This may increase the probability of giving more accurate responses on their WTP for damage abatement. As a result, the objection raised against getting a correct measure of WTP on account of the so-called “free rider” problem gets eroded. This would facilitate quantification of several intangible impacts.

Other advantages include the ability to ensure environmental safeguards for cumulative effects, better conflict management in the project area and offering of creative solutions to complex problems. There are some disadvantages also including delays in decision-making, additional costs involved etc. However, the advantages of public participation surpass considerably such disadvantages.

The defining characteristic of stakeholder involvement is clearly the interaction between the stakeholders; hence a primary requirement of the project appraisal technique is that it supports and enables such an interaction. The requirement is to support stakeholders in the process of making a choice, to provide a rigorous analytical framework in and through which they can argue, debate and negotiate the choice. An important requirement of the project appraisal technique is, then, that it enables communication between the stakeholders. In short, we have to learn and to agree what is the best choice—what is required is a project appraisal technique that helps that process.

It would, however, be necessary to educate the public before seeking their opinion. There may be elements in analysis, for example water and air pollution, the full implications of which may not be known to the public, many of whom may not be literate. It would also be necessary to develop an appropriate institutional mechanism to ensure that public opinion is not dominated by the opinion of a few powerful elements in the community as happens quite often in developing countries. Unless the authorities in charge of CBA/MCA make a special effort, the viewpoint of the weaker sections, which constitute the majority, would not be known.

However, the institutional mechanism for public involvement in CBA/MCA should be developed in the light of the possibility of conflicts between different sections of the public, which often arise in the case of large development projects. The problems become complex if the conflicting segments belong to different political or administrative entities. Conflict resolution may involve incorporation of suitable damage mitigation policies, which need to be evolved in consultation with those segments of the public whose interests are adversely affected by the project.

5. SOURCES OF FINANCING

Sources of financing largely depend on the political and economic structure of the country. Different levels of government share the responsibility of financing flood management and disaster management responsibilities. In some countries, for example Switzerland, the federal, state and local governments share the costs, while in others it is generally shared between the federal and the state level entities. Further, federal governments may give subsidies if flood management is implemented according to federal and state laws and policies. In most cases the state authorities are the executing agencies with the responsibility of maintenance. In developed countries, where local government is strong, the responsibility of maintenance can be passed on to local or state authorities.

5.1 Financing flood management programmes

Financing a project raises several issues from an economic angle. The costs of flood management activities can be placed at different levels in society ranging from individual (the beneficiary), local community, regional government, national government, up to the international community, particularly in the aftermath of a catastrophic flood. The scale of financing is determined by cost estimation. Generally, the structural options are capital intensive. The way the society decides to distribute these costs will to a certain extent determine the acceptance of choices.

Different societal mechanisms for spreading the financial burden can be discussed in terms of efficiency and fairness. A complicating feature of this type of comparison is that while normally there is consensus on what efficiency means, there is seldom consensus on interpretations of equity or fairness. Who should pay for the risks being taken by a few living in the flood prone areas is always debatable and would depend on the societal context.

"It has been relatively rare to view risk mitigation as an economic good which can be subject to market discipline. There is no doubt that the demand to "consume" safety will outstrip the capacity of the sector to deliver it unless mechanisms exist to make consumers aware of the provision costs involved"[46]. However, flood management benefits, being public goods, it is not easy to collect charges from the beneficiaries since it is not easy to determine the extent of benefit derived by any particular beneficiary from a flood management project. This is the main reason why flood management projects are usually financed by governments. The private sector is usually disinterested in financing flood management projects.

In this connection, the following observation of the National Floods Commission of the Government of India made in 1980 deserves to be highlighted. "Once beneficiaries come to know that they have to pay for the schemes, they would themselves moderate this demand for projects which can not be justified on economic grounds. This may also exercise some checks on the present practice of overvaluing benefits to show a favourable BC ratio. Consequently, this is expected to provide a built-in mechanism for a more correct assessment of benefits and cost".[47] Long-term sustainability of the development process (including flood control/management projects) requires that a project should generate financial resources greater than or at least equal to the funds invested in the project.

These considerations, along with the need for cost recovery and providing resources for further financing of projects, suggest the need for recouping at least part of the cost from the beneficiaries. This realization has been articulated through advocacy for levying taxes from owners of property receiving protection from flood.

The poverty of the beneficiaries of flood management projects is often cited as a reason for not levying any tax. But this argument does not provide any justification for exempting the non-poor or well-off beneficiaries. Particularly, for urban flood mitigation programmes, the municipal authorities can levy a charge on the households proportional to the extra run-off being generated by them due to urbanization. Moreover, the poor also derive benefit and become better off. The fact that absolute flood protection benefits are not guaranteed is cited as another reason for not levying any tax. But this argument too is not valid since benefit is derived from partial protection also, which goes into the CBA. The financial contribution from the beneficiaries would be based on the actual benefits derived by them duly accounting for the residual risks the community has still to undertake. Part of the funds saved or income raised due to avoidance of losses could be contributed for financing flood management projects.

It is true that benefits from a flood management project, being of the nature of avoiding losses, are not as obvious as in the case of irrigation, which produces visible additional income. But avoiding loss of income and damage to house property and cattle etc., is a real benefit which the flood affected people also realize whenever a major flood comes. An awareness generation campaign can be of great help in this connection. In local projects, including those dealing with flood management activities such as flood rescue and relief operations, financial contribution by beneficiaries would encourage people’s participation and involvement which would augur well for their efficiency.

In view of the considerations mentioned above, financial contribution from beneficiaries can be included as one of the sources of finance. Questions related to the form of this contribution, the rate per beneficiary, exemptions if any, etc. should be handled at the local level depending upon local circumstances. But it is also obvious that given the public nature of flood management benefits, the poverty of many beneficiaries and administrative difficulties, the bulk of the funds might continue to be provided by governments.

Often the discussion on an individual’s ability to pay and participate in flood mitigation financing is focussed on structural measures. These measures require large financial resources. In such an approach the inherent capacities of the communities (including financial) which have received flood protection measures have never been factored in and utilized. As a result these communities have remained largely uninvolved in dealing with the flood risks and developed a passive attitude, expecting governments to deal with the issue.

It is within this context that the risk-based approach to flood management, duly addressing the various options of mitigation, prevention and preparedness, response and recovery phases, presents opportunities and needs to be considered. Options such as flood proofing, preparedness, emergency response and recovery from smaller flood events do provide challenging but ample opportunities for financial contributions from individuals and communities. The source control of floods by adopting individual house level measures, such as increasing infiltration or retention to decrease run-off, is one of the strategies which can encourage financial participation by individuals.

The involvement of affected communities in particular and civil society in general, from planning to implementation, provides communities with sufficient exposure to the issues. For example, the total contribution from individual beneficiaries may be limited in monetary terms, but they can contribute towards the maintenance and other activities such as the patrol of dykes or flood fighting, which will reduce the burden of government and the budget.

5.2 Financing recovery from catastrophic flood

The governments in developing countries are ill prepared to assume the financial costs of flood risk mitigation, response and rehabilitation. After a disaster, governments often experience difficulties in raising funds to assist the recovery process because of political or other constraints on borrowing, taxes, diverting funds from other government or internationally financed projects. This is particularly true following large-scale disasters where the damage is high relative to the country's gross domestic product (GDP), as with Hurricane Mitch which devastated Honduras in 1998. International lending organizations, such as the World Bank, are under pressure following catastrophic events to provide loans to aid the recovery process, thus diverting funds from other development projects.

The governments of developing countries often experience difficulties in providing funds for flood disaster response and rehabilitation, as well as mitigation of the losses. These difficulties can have long-term effects on the economies of these countries and the welfare of the public. In the absence of private insurance, governments fund the costs of recovery through various financing instruments. An example of a pre-disaster measure is a public catastrophe fund where 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. Another mechanism, the hedging instruments, are pre-disaster arrangements in which the government incurs a relatively small cost in return for the right to receive a much larger amount of money after a disaster occurs. Insurance and capital market-based securities are examples of hedging instruments.

An additional advantage is the incentives these instruments can create for preventing losses. Because of these incentives, it may be desirable for the national government to require regional authorities to hedge their risks especially if they would otherwise under invest in mitigation due to misperceptions of the flood risk and myopia. Both mandatory insurance and capital bonds can provide economic incentives for regional government authorities to invest in cost-effective mitigation measures. Helping poor countries to afford these pre-disaster protective measures may not only be desirable on equity grounds, but would avoid having investors depicted as capitalizing on the potential catastrophic losses facing poor countries from future natural disasters.

5.3 Flood insurance

Flood insurance has often been advocated as a long-term non-structural measure for building resilience among flood victims. But the status in this respect in developing countries has been highly unsatisfactory. Either there are no flood insurance schemes or their coverage is insignificant and impact negligible. There could be several reasons for this of which the most important is economic.

Insurance companies have been reluctant to promote flood insurance because the cost of operating it is expected to be more than the revenue to be earned by them from flood insurance. In view of the vast expanse of flood prone areas having little or inadequate transport facilities, the cost of administering any flood insurance scheme would also be quite high.

The capacity of the flood affected people to pay commensurate high premiums would be limited because a majority of them belong to economically weaker sections of the society. If uniform rates were charged, then an insurer would find themselves burdened with an adverse selection of risks because people exposed to higher flood risks are the ones who are most likely to take out such a policy. If rates charged are proportionate to the risks, then the insurance premium might become much higher than the paying capacity of the poor property owners in flood prone areas. Thus people who need insurance most would be the ones who could least afford to pay the premium. Moreover, flood risk in chronically flood-affected areas like parts of Bangladesh and India is not random. When a major flood comes, everyone is affected. And if floods come in succession, as they often do, then companies might have to pay out claims for several years in succession. This might result in companies going bankrupt.

Flood insurance can be an economically viable proposition for insurance companies if governments subsidize such schemes. The extent of subsidy can be minimized if some other steps are taken. First, a part of the money spent by the government as flood relief may be utilized for this purpose. Second, flood insurance may be linked to some scheme of reinsurance. The total pool at the disposal of the reinsurance companies would be considerably higher. The additional claims that may arise on account of flood damages are likely to be a small fraction of other claims and could become manageable within the resources of insurance. Third, the administrative cost could be reduced by taking the help of local communities and local administrations in the collection and compilation of basic data for working out a fair and equitable premium and settling claims for areas of varying flood risks. Fourth, costs can be reduced if local communities are fully involved in the process.

Communities can play a major role in awareness generation, information dissemination, on the rationale of insurance and the mechanism of its operation. The community can be a bridge between the insurance company and the flood affected people.

ANNEX I: APPROACHES TO FLOOD DAMAGE ASSESSMENT

The following include some of the different approaches adopted, reflecting different purposes and the availability of source data.[48]

Real flood damage data

It is usually tempting to try to incorporate as much real flood damage data as possible from recent floods into a database. A difficulty experienced in the United Kingdom is that this often biases the results, by over-emphasizing damage to building contents (which appear to be devastated following a flood) and underestimating long-term effects on the building fabric. This is partly because the assessments of real flood damage data are usually done in the immediate aftermath of a flood, when salvage and other recovery values cannot realistically be known. Or it is done some time later, when damaged items may be missed but damage to the building becomes more easily identified. There is therefore, no ideal, time to do such an assessment of real flood damage to individual properties, and often the appraisal falls between two stools. Having said this, it is obviously important to use insight and information obtained from real floods to populate any flood damaged database.

Unit area approach

This approach looks at individual properties and assesses damage per square metre of floor space. In the United Kingdom this approach is thought appropriate for commercial, retail and industrial premises, where size is an important variable affecting flood damage potential. This approach can be adopted by those constructing real flood damage databases or using the "synthetic" approach, and is simply designed to allow for one particular variable (size) in assessing flood damage potential.

Percentage of property value approach

This is a completely different approach commonly used in several continental European countries. It uses the market value of the property concerned, preferably just for the building rather than the land the building occupies, and expresses flood damage potential as percentages of that value. Therefore, for example, a particularly serious flood might cause damage to the extent of 65 per cent of the total value of the property concerned if substantial rebuilding was necessary and a majority of the contents were destroyed. A minor flood might result in just 10 per cent of the property's value being representative of flood damages.

The advantage of this approach is simplicity, because many data sources are available on the value of property in flood risk areas. In the United Kingdom data from the Land Registry or from commercial databases could be used to determine the value of both residential and industrial/ commercial properties. On the other hand, the market value of a property is related to the demand for that property (and, in the commercial sphere, goodwill values), and it is not necessarily correlated with flood damage potential. Thus a property might have substantial value because of the value of the land it occupies. In another case, the flood damage potential of a warehouse will be related more to the value of the contents than the value of the building itself. But property databases containing information on property values tend not to include the contents of the property, quite naturally, but only record the value of the land and buildings.

Nevertheless, and notwithstanding these limitations, this approach could well be one that is most applicable across Europe, rather than the unit area "synthetic" approach developed in the United Kingdom.

Weighted annual average damage approaches

One limitation of all the above approaches to flood damage potential is that they only record the damage from one particular flood event. Yet in many applications what we need to know is the total exposure of a property or land use item to the full range of floods that might cause it damage, thus recording its total hazard exposure. To do this, it is necessary to incorporate flood probability into the assessment of flood damages. Ideally, the full range of flood probabilities needs to be deployed, and the annual average damage calculated weighted by the appropriate flood exposure. This can be a complex operation, incorporating data from a range of floods, and in the United Kingdom has only been attempted on a regional basis. An example of such a data set for the United Kingdom, developed by John Chatterton, incorporates the results from several dozen individual project appraisals.[49] What this does is to weight damage potential by the probability of flooding of particular depths, taken from a range of project appraisals, resulting in the weighted average. This approach has the great advantage in producing data which calculate or record total exposure to a range of floods, but it is a complex operation to achieve and requires considerable data to be accomplished successfully.

Synthetic approaches

These approaches are sometimes misunderstood. By the term "synthetic" we do not mean arbitrary or artificial. What we mean is that the approach involves a synthesis of all available data, from both secondary sources and from the real experience of floods. This is the approach which has been adopted in the United Kingdom. Flood damage data is built up from an accumulation of knowledge about the effect of floodwaters on household or building contents and the effect on the fabric of the building and its repair and renovation. Many thousands of items of data are considered, based on typical properties flooded to a range of depths from floods with different severities. In this way data on the range of experiences that are likely in flood risk areas are included, rather than the one-off situations represented by individual actual (historical) floods. The synthetic approach has the limitation that it is not necessarily applicable for measuring the effect of particular floods (all of which are likely to be different), and therefore experience of damage by particular owners in particular properties may not fit the average synthetic set of data. On the other hand there are advantages in that the synthetic data set can be more comprehensive.

ANNEX II: ALLOCATION OF COST IN MULTI-PURPOSE PROJECTS IN THE WATER SECTOR

An aspect of CBA to be considered is related to estimating the share of flood mitigation in the cost of a multi-purpose projects. This aspect becomes much more important in the context of IFM where a holistic approach, covering several types of projects, is adopted. This aspect assumes even more critical significance where the costs and benefits of a project are spread over more than one country or political entity such as federal states or an internationally shared river basin. Hence, an objective basis of cost allocation is needed to avoid, international inter-state or inter-group disputes.

Several methods have been used for this purpose. These include alternative justifiable expenditure, ultimate utility of water for various purposes and proportion of common facilities used for different purposes. Experience from India provides good illustrations for each of these. According to the Damodar Valley Corporation Act of 1948, the alternative justifiable expenditure method was adopted where the joint costs were allocated to different purposes in proportion to the expenditure which could have been incurred in constructing a separate structure solely attributable to the object. In the case of the Hirakud Project, the same principle of alternative justifiable expenditure was originally followed and accordingly the allocation of the costs of storage capacities between flood mitigation, irrigation and hydropower was in the ratio of 38:20:42. Later, in 1952, this was changed in favour of a new method based on the ultimate utility of water for various purposes. In this method, the joint costs were allocated in proportion to the amount of benefit from different purposes. Subsequently, in 1961 it was decided that joint costs should be allocated to various purposes in proportion to the reservoir capacity or quantity of water utilized for each purpose. In the case of the Kosi Project in Bihar, the proportion of common facilities used for different purposes method was adopted, where the costs for common facilities were apportioned to different uses according to the storage volume for each purpose. In this case, the cost of the barrage was deemed to be a common facility for flood mitigation and irrigation and its cost divided equally between them. In the case of the Rengali Project in Orissa, the cost of stage one of the works had also been allocated equally between flood mitigation and irrigation since the same storage capacity could be used equally for both the functions. In April 1967, the Government of India, in the then Ministry of Irrigation and Power, recommended the adoption of the "facilities used" method for the allocation of joint costs of multi-purpose river valley projects.[50]

But there is no guarantee that the "facilities used" method would always satisfy the basic principle of joint cost allocation, which is where costs assigned to any purpose should not be greater than the amount which would be incurred if that function was to be performed by the most economic alternative single-purpose project. Alternative costs are the costs of the most economical single-purpose project, which can provide the same benefit, and in the same area as the multi-purpose project. In other words, the alternative single-purpose project establishes the maximum price which can be charged for any one of the purposes. Another basic principle of joint cost allocation is that the assigned costs of any purpose should not exceed the value of its benefits.

The above two principles are taken care of by another method known as "separable costs-remaining benefits method"[51] which is followed in several countries. As the name suggests, separable costs, which can be separately attributed to any particular use, are borne by that use itself. It is only the remaining costs, which are considered joint costs that are to be shared by all the users. The estimation is done in seven steps as below. This method is a little complex but is better than others.

Step 1. Justifiable expenditure

Justifiable expenditure for each use is calculated as the lesser of (a) the benefits from each use and (b) the alternative costs of each use.

Step 2. Separable costs

Separable cost is calculated as the extra cost accrued by the participation of a particular use.

Step 3. Remaining justifiable expenditure

Each separable cost (Step 2) is subtracted from justifiable expenditure (Step 1) to obtain the remaining justifiable expenditure for each use.

Step 4. Proportion of remaining justifiable expenditure

Proportion of remaining justifiable expenditure among each of the uses is worked out.

Step 5. Remaining joint costs

The total of separable costs for all uses is subtracted from the total cost of the dam to obtain the remaining joint costs.

Step 6. Proportional distribution of remaining joint costs

Remaining joint costs are distributed as per proportional distribution of the remaining justifiable expenditure for each use (Step 4).

Step 7. Costs allocation

Finally the distributed costs (Step 6) are added to the separable costs (Step 2) to obtain costs allocated to each uses.

Example: a multi-purpose dam is planned for water supply, hydropower and flood mitigation

Step 1. Justifiable expenditure

- Justifiable expenditure for water supply: JE_1
- Justifiable expenditure for hydropower: JE_2
- Justifiable expenditure for flood mitigation: JE_3

Step 2. Separable costs

(TC: total cost of multi-purpose dam for water supply, hydropower and flood mitigation)

- Separable costs for water supply (SC_1):
  SC_1 = TC – (cost of dam construction for hydropower and flood mitigation)

- Separable costs for hydropower (SC_2):
  SC_2 = TC – (cost of dam construction for water supply and flood mitigation)
- Separable costs for flood mitigation (SC_3):
  SC_3 = TC – (cost of dam construction for water supply and hydropower)

Step 3. Remaining justifiable expenditure

- Remaining justifiable expenditure for water supply: $RJE_1 = JE_1 - SC_1$
- Remaining justifiable expenditure for hydropower: $RJE_2 = JE_2 - SC_2$
- Remaining justifiable expenditure for flood mitigation: $RJE_3 = JE_3 - SC_3$

Step 4. Proportion of remaining justifiable expenditure

$$RJE_1 : RJE_2 : RJE_3$$

Step 5. Remaining joint costs

Remaining joint costs: $RJC = TC - (SC1+SC2+SC3)$

Step 6. Proportional distribution of remaining joint costs

- Proportional distribution of remaining justifiable expenditure for water supply:

$$RJ_1 = RJC. \frac{RJE_1}{RJE_1+RJE_2+RJE_3}$$

- Proportional distribution of remaining justifiable expenditure for hydropower:

$$RJ_2 = RJC. \frac{RJE_2}{RJE_1+RJE_2+RJE_3}$$

- Proportional distribution of remaining justifiable expenditure for flood mitigation:

$$RJ_3 = RJC. \frac{RJE_3}{RJE_1+RJE_2 3RJE_3}$$

Step 7. Costs allocation

- Cost allocated to water supply: Cost (water supply) = $SC_1 + RJC_1$
- Cost allocated to hydropower: Cost (hydropower) = $SC_2 + RJC_2$
- Cost allocated to flood mitigation: Cost (flood mitigation) = $SC_3 + RJC_3$

REFERENCES

Endnotes

1 WMO, 2004. *Integrated Flood Management Concept Paper*, APFM Technical Document No. 1, second edition, Associated Programme on Flood Management, World Meteorological Organization, Geneva, p. 17, http://www.apfm.info/pdf/concept_paper_e.pdf.

2 WMO, 2004. *Integrated Flood Management Concept Paper*, APFM Technical Document No. 1, second edition, Associated Programme on Flood Management, World Meteorological Organization, Geneva, http://www.apfm.info/pdf/concept_paper_e.pdf.

3 WMO, 2006. *Environmental Aspects of Integrated Flood Management*, APFM Technical Document No. 3, Flood Management Policy Series, Associated Programme on Flood Management, World Meteorological Organization, Geneva. http://www.apfm.info/pdf/ifm_environmetal_aspects.pdf.

4 Government of India, 1980. *Report of the National Flood Commission*, p. 57.

5 WMO, 2006. *Legal and Institutional Aspects of Integrated Flood Management*, APFM Technical Document No. 2, Flood Management Policy Series, Associated Programme on Flood Management, World Meteorological Organization, Geneva. http://www.apfm.info/pdf/ifm_legal_aspects.pdf.

6 WMO, 2006. *Environmental Aspects of Integrated Flood Management*, APFM Technical Document No. 3, Flood Management Policy Series, Associated Programme on Flood Management, World Meteorological Organization, Geneva. http://www.apfm.info/pdf/ifm_environmetal_aspects.pdf.

7 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, Geneva. http://www.apfm.info/pdf/ifm_social_aspects.pdf.

8 HM Treasury, 2003. *The Green Book*, Glossary, http://www.hm-treasury.gov.uk/economic_data_and_tools/greenbook/data_greenbook_index.cfm.

9 Omura, M., 2004. *Cost-benefit analysis revisited: Is it useful tool for sustainable development?* Kobe University Economic Review 50, http://www.econ.kobe-u.ac.jp/katudou/publication/review/pdf/50/omura.pdf.

10 Asian Development Bank, 1999. *Handbook for the Economic Analysis of Water Supply Projects*, Chapter 1, http://www.adb.org/Documents/Handbooks/Water_Supply_Projects/.

11 Asian Development Bank, 1997. *Guidelines for the Economic Analysis of Projects*, http://www.adb.org/Documents/Guidelines/Eco_Analysis/default.asp.

12 Asian Development Bank, 1999. *Handbook for the Economic Analysis of Water Supply Projects*, http://www.adb.org/Documents/Handbooks/Water_Supply_Projects/.

13 Asian Development Bank, 1999. *Handbook for the Economic Analysis of Water Supply Projects*, http://www.adb.org/Documents/Handbooks/Water_Supply_Projects/.

14 Asian Development Bank, 1999. *Handbook for the Economic Analysis of Water Supply Projects*, http://www.adb.org/Documents/Handbooks/Water_Supply_Projects/.

15 Asian Development Bank, 1999. *Handbook for the Economic Analysis of Water Supply Projects*, http://www.adb.org/Documents/Handbooks/Water_Supply_Projects/.

16 Queensland Government, 2000. *Guidelines for Financial and Economic Evaluation of New Water Infrastructure in Queensland*, http://www.treasury.qld.gov.au/office/knowledge/docs/water-infrastructure/index.shtml.

17 Economic Commission for Latin America and the Caribbean, 1991. *Manual for Estimating the Socio-economic Effects of Natural Disasters*, Programme Planning and Operations Division, http://www.reliefweb.int/lib.nsf/db900SID/LGEL-5E2CLJ?OpenDocument.

18 Penning-Rowsell, E., Tapsell, S., Johnson, C. and Wilson, T., 2006. *Development of economic appraisal methods for flood management and coastal erosion protection, Objective 14: Strategies for the future updating of flood damage tables and related indices*, DEFRA R&D Technical Report FD2014/TR2, Joint DEFRA/EA Flood and Coastal Erosion Risk, Management R&D Programme.

19 Asian Development Bank, 2005. *Financial Management and Analysis of Projects*, 3.4.3 Preparing Project Cost Estimates, http://www.adb.org/documents/guidelines/financial/.

20 See "*Markets and prices*" in Terminology.

21 HM Treasury, 2003. *The Green Book*, http://www.hm-treasury.gov.uk/economic_data_and_tools/greenbook/data_greenbook_index.cfm.

22 For further reading please refer to entries F5, F20 and F31 in Further reading.

23 See "*Willingness to pay (WTP)*" in Terminology.

24 See "*Willingness to accept compensation (WTA)*" in Terminology.

25 See "*Consumers' surplus*" in Terminology.

26 National Center for Environmental Decision-Making Research. *NCEDR TOOLS Cost-Benefit Analysis*, http://www.ncedr.org/tools/othertools/costbenefit/lead.htm.

27 American Society of Civil Engineers, 2003. *Comments on Draft Guidelines (Appendix C) of the Draft 2003 Report to Congress on the Costs and Benefits of Federal Regulation*, http://www.asce.org/pdf/commentsappendixc.pdf.

28 American Society of Civil Engineers, 2003. *Comments on Draft Guidelines (Appendix C) of the Draft 2003 Report to Congress on the Costs and Benefits of Federal Regulation*, http://www.asce.org/pdf/commentsappendixc.pdf.

29 For further reading please refer to entries F7 and F20 in Further reading.

30 For further reading please refer to entry F20 in Further Reading.

31 For further reading please refer to entries F3, F19 and F27 in Further reading.

32 For further reading please refer to entry F10 in Further reading.

33 For further reading please refer to entry F20 in Further reading.

34 See "*Monopsonists*" in Terminology.

35 Omura, M., 2004. *Cost-benefit analysis revisited: Is it useful tool for sustainable development?* Kobe University Economic Review 50, http://www.econ.kobe-u.ac.jp/katudou/publication/review/pdf/50/omura.pdf.

36 Omura, M., 2004. *Cost-benefit analysis revisited: Is it useful tool for sustainable development?* Kobe University Economic Review 50, http://www.econ.kobe-u.ac.jp/katudou/publication/review/pdf/50/omura.pdf.

37 National Center for Environmental Decision-Making Research. *NCEDR TOOLS Cost-Benefit Analysis*, http://www.ncedr.org/tools/othertools/costbenefit/lead.htm.

38 Omura, M., 2004. *Cost-benefit analysis revisited: Is it useful tool for sustainable development?* Kobe University Economic Review 50, http://www.econ.kobe-u.ac.jp/katudou/publication/review/pdf/50/omura.pdf.

39 Omura, M., 2004. *Cost-benefit analysis revisited: Is it useful tool for sustainable development?* Kobe University Economic Review 50, http://www.econ.kobe-u.ac.jp/katudou/publication/review/pdf/50/omura.pdf.

40 Omura, M., 2004. *Cost-benefit analysis revisited: Is it useful tool for sustainable development?* Kobe University Economic Review 50, http://www.econ.kobe-u.ac.jp/katudou/publication/review/pdf/50/omura.pdf.

41 Rees, J.A., 2002. *Risk and Integrated Water Management*, Global Water Partnership, TEC Background Papers No. 6, *op. cit*. p. 19, http://www.gwpforum.org/gwp/library/TEC%20background%20paper%206.pdf.

42 Rees, J.A., 2002. *Risk and Integrated Water Management*, Global Water Partnership, TEC Background Papers No.6, *op. cit.* p. 44, http://www.gwpforum.org/gwp/library/TEC%20background%20paper%206.pdf (August 2002).

43 Asian Development Bank, 1999. *Handbook for the Economic Analysis of Water Supply Projects*, Chapter 1, http://www.adb.org/Documents/Handbooks/Water_Supply_Projects/.

44 HM Treasury, 2003. *The Green Book*, Annex 4 Risk and Uncertainty, http://www.hm-treasury.gov.uk/economic_data_and_tools/greenbook/data_greenbook_index.cfm.

45 Department of the Environment Transport and the Regions, Department for Environment, Food and Rural Affairs (DEFRA), 1999. *Review of Technical Guidance on Environmental Appraisal*, http://www.defra.gov.uk/environment/economics/rtgea/.

46 Rees, J.A., 2002. *Risk and Integrated Water Management*, Global Water Partnership, TEC Background Papers No. 6, *op. cit*. p. 18, http://www.gwpforum.org/gwp/library/TEC%20background%20paper%206.pdf.

47 For further reading please refer to entry F16 in Further reading.

48 Penning-Rowsell, E., Tapsell, S., Johnson, C. and Wilson, T., 2006. *Development of economic appraisal methods for flood management and coastal erosion protection, Objective 14: Strategies for the future updating of flood damage tables and related indices*, DEFRA R&D Technical Report FD2014/TR2, Joint DEFRA/EA Flood and Coastal Erosion Risk, Management R&D Programme.

49 Penning-Rowsell, E., Johnson, C., Tunstall, S., Tapsell, S., Morris, J., Chatterton, J. and Green C., 2005. *The benefits of flood risk and coastal management, A manual of assessment techniques*, Middlesex University Press, London.

50 For further reading please refer to entry F16 in Further reading.

51 World Bank, 2005. *Cost Recovery and Water Pricing for Irrigation and Drainage Projects*, http://siteresources.worldbank.org/INTARD/Resources/Cost_Recovery_final.pdf (2005).

52 Wikipedia, http://en.wikipedia.org/wiki/Delphi_technique.

53 Wikipedia, http://en.wikipedia.org/wiki/Monopsony.

54 For further reading please refer to entries F18 and F30 in Further reading.

Further reading

F1 Arrow, K., Solow, R., Portney, P., Leamer, E., Radner, R. and Schuman, H., 1993. *Report of the NOAA Panel on Contingent Valuation*, Resources for the Future, Washington, DC.

F2 Bartik, T., 1988. Evaluating the benefits of non-marginal reductions in pollution using information and defensive expenditures, *Journal of Environmental Economics and Management,* 15, 111–27.

F3 Bateman, I. and Willis, K., (eds), 1995. *Valuing Environmental Preferences: Theory and Practice of the Contingent Valuation Method,* Oxford University Press, Oxford.

F4 Baumol, W.J. and Blinder, A.S., 1991. *Microeconomics, Principles and Policies*, Harcourt, Dallas.

F5 Braden, J. and Kolstad, C., (eds), 1991. *Measuring the Demand for Environmental Quality,* North-Holland, Amsterdam.

F6 Dixon, J.A. and Hufschmidt, M.M., (eds), 1986. *Economic Valuation Techniques for the Environment: A Case Study Work Book*, Johns Hopkins University Press, Baltimore.

F7 Dixon, J.A., Scura, L.F., Carpenter, R.A. and Sherman, P., 1994. *Economic Analysis of Environmental Impacts,* Earthscan Publications, London.

F8 Dodgson, J., Spackman, M., Pearman, A. and Phillips, L., 2000. *Multi-Criteria Analysis: A Manual*, Department of the Environment, Transport and the Regions (DETR), London.

F9 Field, B.C., 1994. *Environmental Economics: An Introduction,* McGraw Hill Book Co., Singapore.

F10 Fletcher, J., Adamowicz, W. and Graham-Tomasi, T., 1990. The travel cost model of recreation demand, *Leisure Sciences,* 12, 119–47.

F11 Freeman, A.M., 1993. *The Measurement of Environmental and Resource Values: Theory and Methods,* Resources for the Future, Washington, DC.

F12 Gibbons, D.C., 1986. *The Economic Value of Water*, Resources for the Future, Washington, DC.

F13 Gittinger, J.P., 1982. *Economic Analysis of Agricultural Projects*, Johns Hopkins University Press, Baltimore.

F14 Global Water Partnership, 1998. *Water As A Social and Economic Good: How to Put the Principle into Practice*, TAC Background Paper No. 2, Stockholm.

F15 Global Water Partnership, 2000. *Integrated Water Resources Management*, TAC Background Paper No. 4, Stockholm.

F16 Government of India, 1980. *Report of the National Flood Commission,* Rashtriya Barh Ayog, New Delhi.

F17 Green, C.H., 2003. *A Handbook of Water Economics*, Wiley, Chichester.

F18 Hanemann, M., 1991. Willingness to Pay and Willingness to Accept: How Much Can They Differ?, *American Economic Review,* 81, 635–47.

F19 Hanley, N. and Spash, C., 1993. *Cost-benefit Analysis and the Environment,* Edward Elgar, Aldershot.

F20 Hanley, N., Shogren, J.F. and White, B., 1997. *Environmental Economics in Theory and Practice*, Macmillan, London.

F21 Harrington, W. and Portney, P., 1987. Valuing the benefits of health and safety regulation, *Journal of Urban Economics,* 22, 101–12.

F22 Hicks, J.R., 1939. Foundations of Welfare Economics, *Economic Journal*, 49 (196).

F23 Koutsoyiannis, A.C., 1979. *Modern Microeconomics*, Macmillan, London.

F24 Kreps, D., 1990. *A Course in Microeconomic Theory,* Princeton University Press, Princeton.

F25 Little, I.M.D. and Mirrlees, J.A., 1974. *Project Appraisal and Planning for Developing Countries*, Basic Books, New York.

F26 Mishan, E.J., 1982. *Cost-Benefit Analysis*, Allen & Unwin, London.

F27 Mitchell, R. and Carson, R., 1989. *Using Surveys to Value Public Goods: the Contingent Valuation Method,* Resources for the Future, Washington, DC.

F28 Pearce, D.W. and Turner, R.K., 1990. *Economics of Natural Resources and the Environment*, Johns Hopkins University Press, Baltimore.

F29 Pigou, A.C., 1920. *The Economics of Welfare*, Macmillan, London.

F30 Shogren J., Shin, S., Dayes, D. and Kliebenstein, J., 1994. Resolving Differences in Willingness to Pay and Willingness to Accept, *American Economic Review*, 84, 255–70.

F31 Smith V.K., 1993. Non-market valuation of environmental resources, *Land Economics,* 69, 1–26.

F32 Smith V.K. and Desvoges, W., 1986. *Measuring Water Quality Benefits,* Kluwer Nijhoff, Boston.

F33 Ward, W.A., Deren, B.J. and D'Silva, E.H., 1991. *The Economics of Project Analysis: A Practioner's Guide,* Economic Development Institute, World Bank, Washington, DC.

F34 Winpenny, J.T., 1991. *Values for the Environment: A Guide to Economic Appraisal,* Her Majesty's Stationery Office, London.

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Constant price and current price: the monetary value of flood damages for several years is needed for estimating the benefits of flood management projects. Available data on the year-wise monetary value of flood damages or of the costs of projects are often with respect to the prices of the same year (called current prices). If prices are changing over the years, then a part of the change in the value of flood damages or of the costs would be due to changes in prices. For example, a doubling of the price level would double the monetary value of flood damages even if the physical magnitudes of flood damages remain the same. In order to avoid such problems, the effects of changes in prices are neutralized by valuing physical magnitudes of different years in terms of the prices of a given year, known as the base year. Such a price, which is assumed to remain the same over the years, is known as the constant price. Hence, an initial step in economic analysis is to convert the monetary values of different years to constant prices, i.e. the prices of the prevailing year.

Consumers' surplus: The difference between WTP as based on utility derived and the amount actually paid for a good or service is called the consumers' surplus.

Delphi technique: The Delphi technique is a method for obtaining forecasts from a panel of independent experts over two or more rounds. Experts are asked to predict quantities. After each round, an administrator provides an anonymous summary of the experts' forecasts and their reasons for them. When the experts' forecasts no longer change or change very little between rounds the process is stopped and the final round forecasts are combined by averaging.[52]

Discount rates and time value of money: Money deposited in a bank or given as a loan to others earns interest. If the rate of interest is 5 per cent per annum, then the value of $100 would become $105 after one year, $110.25 after two years, $115.512 after three years and so on. In other words, the value of money changes with time. Money, therefore, has a time value. It may be noted that this is different from change in the value of money due to a change in the price level. Changes in the time value of money take place even when prices remain the same.

Hence, it is not appropriate to add figures of costs incurred in different years to arrive at a total cost of the project as is often done in flood management projects in some countries. These figures should be made comparable by adjusting them with respect to the prevailing rate of interest or rate of discount. This concept provides the basis for an economic as well as a financial analysis of all projects whose costs and benefits are spread over more than one year.

The rate of discount to be used would be determined by the concerned person or institution with respect to the rate of interest being paid or received by him/her/it. In a way, it represents the opportunity cost of capital. Hence, prior knowledge of the rate of discount is necessary when making an economic analysis of any project.

Diseconomies of scale: IFM represents a paradigm shift from the traditional piecemeal approach to flood management. The process of integration has the additional advantage of raising the economic efficiency of the utilization of resources. The reasons are given below.

If several projects initially conceived in isolation become part of an integrated project covering all of them and some others in an integrated framework, then many of them might turn out to be interdependent or complementary to each other. If they are complementary or interdependent then the combined cost of all of them would be less than the sum of their individual costs and the combined benefit would be more than the sum of the individual benefits. This is a principal reason why the net benefit (benefit minus cost) of a multi-purpose project turns out to be more than the sum of net benefits of independent projects.

Economic theory tells us that the cost per unit decreases as the scale of operation increases. Thus, a dam of a larger size would have a lower cost per unit of water impounded than a smaller dam. Water engineers are well aware of this. In addition, the project derives other advantages such as the benefit of bulk buying of raw materials; bulk borrowing of capital, advantages from employing more qualified specialists and better division of labour etc. Or there could be economies of scale in the input supplying industries, for example cement or steel; thus prices of cement or steel may start falling thereby reducing the cost further. These are the reasons why there is a natural tendency for production or marketing units to expand in size. One reason why a community approach to flood management is more efficient than an individual approach is because of the presence of economies of scale.

However, if the size goes on increasing, then a stage is reached when diseconomies of scale start arising. For example, the rehabilitation problems of a large dam may start becoming more acute or wage rates may start rising. Hence, economists have developed the concept of an optimum size beyond which costs per unit start rising instead of falling. Such an optimum is different for different units and has to be estimated in each case after considerable research. In the light of the above, the average cost curves as drawn in economics are U-shaped, falling in the beginning as the scale of operation increases, hitting a bottom and then starting to rise. This information should be of much use to project planners and developers.

Markets and prices: Markets and prices occupy a central place in the functioning of a modern economic system. A market is an institution which allows interaction between demand and supply and helps bring about equality between the two through variations in prices. The market provides information on prices and also uses that information for its own functioning. It helps the society to make the best possible allocation of resources to different individuals, groups, commodities, sectors, areas etc. Prices, which emerge from the markets, communicate society's desires as well as constraints. Prices provide signals to the markets for making appropriate adjustments as needed in view of ever changing situations. Markets and prices, which are interlinked and interdependent, have become such an integral part of modern economic systems that it is hard to imagine an efficient economic system without them.

Monopsonist: Monopsony is a market form with only one buyer, called the monopsonist, facing many sellers. It is an instance of imperfect competition, symmetrical to the case of a monopoly, in which there is only one seller facing many buyers.[53]

Multiplier effects: There are income generation induced effects, which are in addition to the forward and backward linkage effects. The project results in the generation of additional income to people of the area. The additional income will be spent (leaving aside the possibility of hoarding, which can be neglected at the level of the present discussion). This will bring about a corresponding rise in the final demand for several goods and services which in turn will raise income further through the multiplier effect process. The effect, of course, might not be visible immediately but would be prolonged over the project period. But the effect would be there when the conditions necessary for the operation of the multiplier process in real terms are present in the project area. These conditions include the existence of unemployed labour and unutilized capital assets.

Opportunity cost: Resources have alternative uses. Utilization of resources for one purpose or project implies foregoing benefits from another purpose or project that could be obtained by utilizing the same resources. Since the objective is to maximize return, the alternative project that is relevant here is one with the maximum output or benefit. Hence the opportunity cost of using resources in any project is equal to the maximum value of the output that could have been produced elsewhere with the same resources. For example, the opportunity cost of money invested by a farmer is the annual interest that the money would have received had the farmer given it as a loan to somebody or deposited it in a bank. Similarly, the opportunity cost of producing one unit of hydro-electricity is the cost of producing one unit of thermal energy. More importantly, this concept can be used to find the value of unpriced assets. Thus the opportunity cost of preserving land for a national park can be estimated by deriving the income from other uses of the land that have had to be given up or forgone for the sake of preservation. This technique is also used to evaluate the benefits of preservation, which are not themselves valued.

Price rise and value of money: An increase in price level means a decrease in the value of money and vice versa. But this aspect of change in the value of money is not relevant for the economic analysis of projects since this analysis is conducted on the assumption that prices remain the same. This aspect, however, would be most relevant for making an estimate of funds required for the implementation of any project.

Public good: Flood management, like a lighthouse, belongs to the category of public goods or services whose one distinguishing characteristic is that once its services are made available to one person, others can not be excluded from making use of the same services. Second, consumption by one does not reduce the consumption of others. In other words, public goods are characterized by non-excludability and non-subtractability.

Willingness to accept compensation (WTA): Sometimes, construction of a flood management project results in the loss of income or other amenities to people. This happens in the case of those whose land or property is acquired by authorities for the construction of the project, say a reservoir. The affected people in such cases would like to receive compensation so as to induce them to part with their property. The minimum amount that they would be willing to accept as compensation is regarded as a measure of the value of loss suffered by them. WTA like WTP is also dependent on the income of an individual.[54]

Willingness to pay (WTP): People derive benefit from something which they prefer to have. Preferences, of course, differ from person to person. But there is a good degree of commonality also so that an idea of average preferences for the whole community or a country can be derived. If people prefer something because they derive satisfaction from its use, then they are prepared to pay a price for it. How much a person or a nation is willing to pay for a good or a service that is preferred by them is the true measure of its value or of the benefit derived from the concerned item. WTP is partly dependent on the income of an individual. This WTP for something also determines the prevailing market price if there are no distortions in the market.

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