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Assessing the Economic Impacts of Natural Disasters: a Literature Review

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Introduction

The purpose of the document is to summarize the literature in the field of the economics of natural disasters. Not only does it provide an historical overview of the topic, outlining earlier researches and empirical evidences, but it provides also a background of what has been published on this topic in the past years.

This literature review allowed hence to:

- make a state of the art in the field of the economics of natural disasters;
- identify gaps in previous work, questions left unanswered or areas for further research;
- look at best practices in terms of surveys and empirical studies.

This document is the result of a work undertaken during the year of 2007 by the different partners of the Economic Working group of the Microdis project. It does not pretend to be exhaustive although, as mentioned above, we have carried out this work by screening a high number of sources of bibliographical information.

The review has been undertaken by searching within a number of literature indexing databases to locate the literature on the economics of natural disasters. The type of key words and terminology that was used to do the search were both those related to the field of natural disasters (eg extreme events/floods/windstorms/migration, etc.) and to the field of economics (eg microeconomics/households/welfare/cost benefit analysis/valuation/risk management, etc.). The journals with referees/peer reviewers and papers in published books from recognized publishing houses such as university presses were reviewed in priority.

A variety of information sources were employed for this literature review. Internet is a valuable source of information but was used in conjunction with other sources. For instance, a major way to identify new documents was to look at the biography of seminal papers that were identified and reviewed at the beginning of the process. Bibliographies from such key articles relevant to the topic appeared to often lead to other relevant papers.

In doing the literature review, the following criteria were considered as important:

- Provenance, eg arguments supporting by evidence especially for case studies and when statistics were presented, or for recent scientific findings;
- Objectivity, in the sense that contrary data or arguments where considered in the paper
- Value, ie does the reviewed literature contribute in any significant way to an understanding of the subject?

The literature review is divided into two broad sections:

- Methodologies to assess the economic impacts of natural disaster and other theoretical aspects
- Case studies and empirical evidences

Finally, the last section proposes further readings, such as books, reports, guidelines and additional papers.

Methodologies to assess the economic impacts of natural disasters and other theoretical aspects

Andersen T.J., (2005), Applications of Risk Financing Techniques to Manage Economic Exposures to Natural Hazards.
Technical Papers Series, Sustainable Development Department, Inter-American Development Bank. October 2005, Washington DC.

Abstract

Direct economic exposures to natural disasters have been increasing significantly throughout the world and have hit the developing countries, including Latin America and the Caribbean, disproportionally hard. This development is partly a function of an expanded base of economic assets in a growing global economy that has increased direct economic exposures. It also reflects a shortage of effective efforts to mitigate the implied risks and, possibly, a higher frequency and intensity of certain natural phenomena. In the face of mounting direct losses associated with natural disasters, countries throughout the region have received help also from multilateral institutions to provide the needed funding for post-disaster reconstruction.

The availability of such ex post funding constitutes a moral hazard issue as it favors political inaction and displaces the need to consider the socioeconomic consequences of natural disasters before they happen.

The direct losses from catastrophe events have been expanding at a much higher rate than average GDP growth over the past decades. In addition, international aid flows in general and those dedicated to disaster recuperation efforts, specifically, have not grown. Consequently, the current situation is likely to have repercussions sooner or later for exposed countries unless they seek increased action in prevention and a more pronounced participation of the private sector in the funding of disaster reconstruction projects. There seems to be a need to take a more proactive approach to assess, manage, and finance underlying catastrophe risk exposures. In this process governments should assess a country's overall catastrophe risk exposures on an ongoing basis, evaluate potential payoffs from risk mitigation efforts, and establish reasonable funding arrangements for retained risk exposures to obtain reasonable financial cover in advance. Such an approach represents an opportunity to turn potential future disaster situations into positive economic growth scenarios, as the catastrophe financing arrangements allow faster replacement of old capital investment with new more productive assets.

The catastrophe risk financing approach can be applied effectively to country settings by adopting simulation techniques or other methodologies to analyze catastrophe risk exposures and, using different risk transfer and financing instruments available in international financial markets, to shield nations from the extreme economic effects of these exposures. Governments can approach this challenge in practical terms by establishing different insurance vehicles to create reasonable and affordable covers for excessive economic

effects associated with natural hazards. This implies that governments should consider different types of insurance vehicles geared to cover public and private asset exposures respectively. As the supply of insurance in Latin America and the Caribbean grows, so should the coverage of public assets. This could take place partly through local insurance companies as well as by exploiting risk transfer opportunities available in the international financial markets. This coverage can be combined with financial protection through conventional calamity funds, especially for higher risk situations.

Insurance pools backed by governments may be established to deal with economic exposures of private assets, notably housing, because they provide the means to offer commercially based insurance policies to the public without any direct operational involvement by the government. The insurance pools could work closely together with local insurance companies, whenever possible, and take advantage of new international risk financing solutions. Ideally, these insurance vehicles have the potential to support local insurance industry development while instituting more viable practices in the national insurance markets.

For the multilateral institutions an increased focus on risk management practices and alternative risk financing instruments through the establishment of different insurance vehicles provides an opportunity to make existing catastrophe risk exposures more transparent than currently is the case. As a de facto lender-of-last-resort to the region, the IDB is already exposed to the economic effects of natural catastrophes. However, these risks are not currently being treated explicitly as financial exposures in the institution's lending practices. This situation creates disincentives to engage in risk mitigation and has a potential adverse effect by increasing economic exposures to natural catastrophes throughout the region.

Auffret P., (2003), High Consumption Volatility: The Impact of Natural Disasters?
World Bank Policy Research Working Paper 2962, January 2003

Abstract

The paper focuses on the impacts of natural disasters in the Caribbean region. It shows that despite high consumption growth, the Caribbean region suffers from a high volatility of consumption which decreases household welfare.

Methodology

After presenting some empirical evidence that consumption volatility is higher in the Caribbean region than in the rest of the world, the paper makes some empirically testable inferences that help explain consumption volatility. It proceeds by developing a conceptual framework for analyzing the impacts of catastrophic events on household and aggregate welfare. According to this framework, the volatility of consumption comes from production shocks which are transformed into consumption shocks mostly because of underdeveloped or ineffective risk-management mechanisms. The paper conducts an empirical analysis of the impact of catastrophic events on 16 countries (6 from the Caribbean region and 10 from Latin America) for the period 1970-99 and shows that catastrophic events lead to: (i) a substantial decline in the growth of output, (ii) a substantial decline in the growth of investment, (iii) a more moderate decline in consumption growth (most of the decline is in private consumption while public consumption declines moderately), and (iv) a worsening of the current account of the balance of payments.

It disagrees with some studies claiming that international risk-sharing would decrease consumption volatility and hence increase country specific welfare. The main criticism to these analyses is that it does not take into account the impact of international risk-sharing on consumption growth.

The point made by the paper is that international risk-sharing may also lead to a decline in consumption growth for some countries, decreasing their welfare. It gives the hypothetical example of a country with a production growth of 5 percent and no volatility. This country would not find it advantageous to share risks with another country which grows at 1 percent and is volatile.

The paper explains that most studies that seek to derive the benefits from international risk-sharing use as examples developed economies with comparable levels of consumption growth and volatility but asymmetric shocks. It shows that when these conditions are not met, international risk-sharing does not systematically increase welfare.

The paper also lists the main expected macro-economic post-disaster effects.

Macroeconomic Indicators	Expected Post-Disaster Effect
Physical Stock	Destruction of capital stock followed by reconstruction.
1. Production (2+3+4)	Decrease followed by increase.
1.1 Agriculture	Significant drop in production (if hurricane, flood or drought).
1.2 Industry	Decrease due to disruption of transportation, reduced capital stock and production capacities.
1.3 Service	Decrease due to disruption of transportation and payment system.
2. Consumption	Decrease due to decline in production
2.1 Private	Decrease due to decline in production.
2.2 Public	Decrease somewhat mitigated by ex-post international financing and counter-cyclical fiscal policy.
3. Investment	Decrease in investments in the aftermath of the disaster.
4. Net Exports of Goods and Services	Decrease in exports due to disruption of production process including transportation infrastructure. Increase in imports as part of the reconstruction process.
Public Finances	Increase in fiscal deficit due to a decline in tax revenues linked to the decline in production and the increase in public expenditures for reconstruction.
Inflation Rate	Increase caused by the disruption of production and distribution and increasing transportation costs.

Source: Adapted from Albala-Betrand (1993) and Downing, Holstoom and Tol (1999). As reported in Charveriat (2000), Table 1.2 p.

Abstract

The study examines the short- and long term economic and financial impacts of natural disasters. The authors explore the relationship between integration in the global economy and sensitivity to natural hazards, using a macro economic perspective. Their work relies in part on in-depth case studies of overall sensitivity to natural hazards in the small island economy of Dominica; public finance consequences of disasters in Bangladesh; and the economic consequences of climatic variability and the use of climatic forecasting in Malawi and southern Africa. Policy implications are drawn, and, where appropriate, recommendations are made. Finally, directions for future research and cooperation are outlined.

In one section they consider the implications of aspects and impacts of globalisation for forms and nature of vulnerability to natural hazards. These aspects are illustrated by examples from Dominica, Bangladesh and Malawi, respectively. The authors discuss how aspects of globalisation – like international trade, labour mobility, and economic growth may influence the ability to handle natural disasters.

Major natural disasters can and do have severe negative short-run economic impacts. Disasters also appear to have adverse longer-term consequences for economic growth, development, and poverty reduction. But negative impacts are not inevitable. Vulnerability is changing quickly, especially in countries that are experiencing economic transformation—rapid growth, urbanization, and related technical and social change. In the Caribbean area and in Bangladesh, there is evidence of declining sensitivity to tropical storms and floods and increased resilience as a result of economic transformation and public measures for disaster reduction. The largest concentration of high-risk countries—which are increasingly vulnerable to climatic hazards—is in Sub-Saharan Africa. Risks emanating from geophysical hazards need to be better recognized in highly exposed urban areas across the world, as the potential costs are rising exponentially with economic development. Natural disasters cause significant budgetary pressures, with both narrowly fiscal short-term impacts and wider long-term implications for development. Reallocation is the primary fiscal response to disaster. Disasters have little impact on trends in total aid flows.

A full reassessment of the economic and financial impacts of a major disaster should be made 18 to 24 months after the event. It should be taken into account in reviewing the affected country's short-term economic performance and the assistance strategy for the country.

Governments need appropriate risk management strategies for future disasters, including medium-term financial planning covering 8 to 10 years. The basis of funding has to be broadened, using a range of insurance and

other mechanisms for different layers of loss. Natural hazard risk management should be integrated into longer-term national investment policies and development strategies and appropriately reflected in the allocation of financial resources. High-quality, reliable scientific information is a necessary condition for effective disaster risk management. The international community should support global and regional research and information systems on risk. It should also ensure that there are adequate complementary monitoring and dissemination programs at the national level. Priorities include climatic variability, regional and national flood forecasting, and geophysical hazards.

Vulnerability to natural hazards is determined by a complex, dynamic set of influences that include the country's economic structure, stage of development, and prevailing economic and policy conditions. To understand and assess the economic consequences of natural hazards and the implications for policy, it is necessary to consider the pathways through which different types of hydro-meteorological (climate-related) and geophysical hazard affect an economy, the different risks posed, and the ways in which societies and economies adapt to or ignore these threats. The eclectic approach adopted in this study, which employed largely qualitative methods, is particularly useful in exploring the many complex and dynamic pathways through which extreme hazard events influence an economy and its financial system, as well as for identifying areas and issues where further investigation, including quantification, would be worthwhile.

Cheze B., (2006), Meta-Analysis of economic valuation of environmental damages of waste Sites.
EconomiX, Universite Paris-X. Paper presented at The Ninth Biennial Conference of The International Society for Ecological Economics, "Ecological Sustainability and Human Well-being", December 16-18,2006, New Delhi, India.

Abstract

This paper presents the results of a meta-analysis that seek to summarize the available information to provide readers with factors influencing the estimations of external costs of waste sites. There is a debate on the extent to which certain land uses impact on households living around. Incinerators and toxic or solid waste landfills are commonly considered a form of nuisance. It can include noise, flies and other insects, odors, traffic, appearance and air and soil quality reductions. A significant literature exists that analysis economic valuation of environmental damages of waste sites. These estimates can help policy makers asses the external effects of waste sites and may also be useful in both prioritizing and assessing projects and the benefits of cleanup. A literature search provides 27 studies from which 81 estimates are made. These case studies have been used either contingent valuation method (CVM) or hedonic pricing technique to obtain willingness to pay (WTA) measures to avoid living in proximity to a waste site. Meta analysis is a quantitative research method to review and synthesize literature and have been used, more recently, in benefit transfer. This meta regression analysis examines the variability in the external costs estimations that might be due to country, year, income, sample size, model specification, environmental valuation methods, waste sites characteristics like size or toxicity levels, personal attitudes and knowledge levels. The analysis indicates that income, environmental valuation methods, waste sites characteristics and knowledge levels have some effects on the measured external costs, but the other variable have little systematic.

Methodology

These case studies have been used either contingent valuation method (CVM) or hedonic pricing technique to obtain willingness to pay (WTA) measures.

*Chhibber A., Laajaj **R., (2008),** Natural Disasters and Economic Development, Impact , Response and Preparedness*
Paper presented at the Ninth Annual Global Development Conference Security for Development: Confronting Threats to Survival and Safety Brisbane, Australia, 29 – 31January 2008.

Abstract

This paper explores the links between natural disasters and economic development, and attempts to outline a framework for thinking about these links. The short-term effects of disasters are well documented, but the long-run impact of natural disasters on economic growth and development remain a subject of debate. The paper summarizes the available knowledge of the long-term economic impact of natural disasters on economic development. It also draws links between disasters, resource management and conflict. The paper argues that developing countries - especially those where disasters appear to strike with remarkable frequency, need to develop a more robust adaptation and response capability to disasters as part of development planning. The paper makes the case for better global and regional financing mechanisms to respond to disasters and more market-based financing mechanisms than have been used hitherto and an emphasis on forecasting research. It also highlights the need for more work on the links between climate change and the frequency of disasters (with climate change as the ultimate natural disaster but whose manifestation will come through more frequent smaller disasters) and a new way of looking at disaster resilience as a part of, rather than as an add-on to development strategy.

a. Possible Long-Run Impact of Successive Disasters on Income
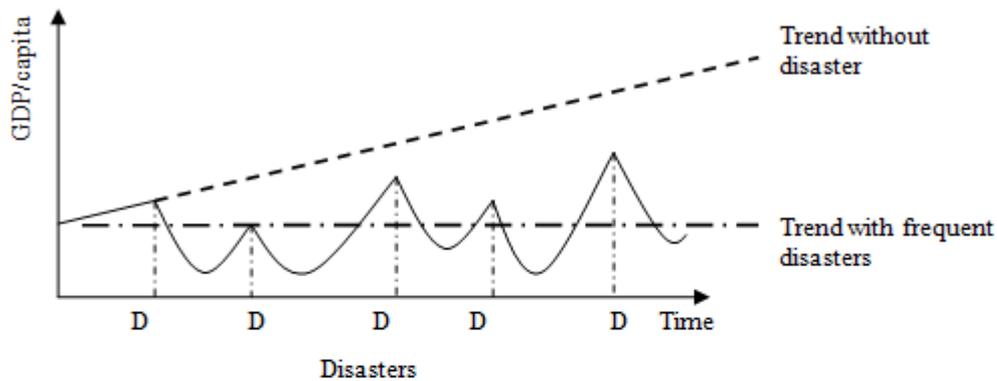
b. Possible Long-Run Impact of Climate Change on Income
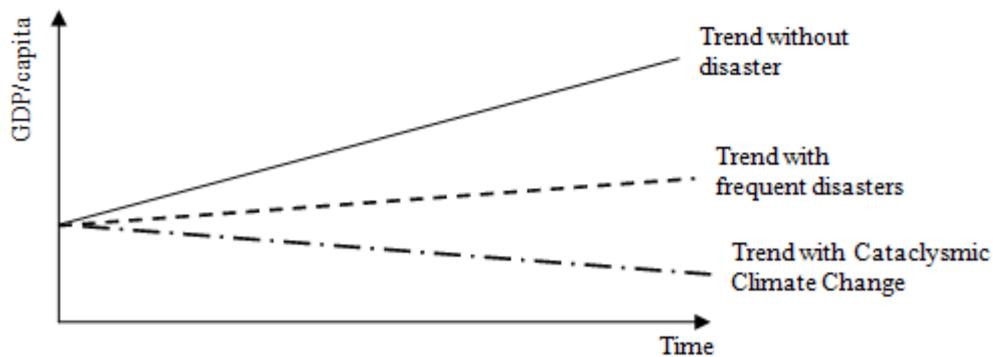
Comments

The paper presents the relationship between natural disasters and development, at the macroeconomic level. Hence, it mainly focuses on long term impacts on the national economies. It provides a rather broad and exhaustive view on the matter, including references to other papers concluding that natural disasters could have positive effects on the GDP of the affected countries. However, the paper does not come to this conclusion. It does not make any conclusion on this topic, but instead, concludes that further empirical research is needed to have a better understanding of the positive and negative macroeconomic impacts of natural disasters.

Another interesting point made in the paper relates to a differentiation in the impacts between the type of natural disasters (geological versus hydro meteorological / small size versus big size / repetitive natural disasters eg floods in Vietnam versus extraordinary natural disasters eg the tsunami). As for the previous point, it comes to the conclusion that more research is required.

The paper is essentially listing empirical research topics. In addition to long term impacts and a differentiation of impacts by natural disasters type, it suggests assessing the link between natural disasters and conflicts and the role of funding mechanisms. It is also to notice that the paper links hydro meteorological disasters to climate change and hence proposes also to focus on adaptation.

An important part of the document is dedicated to policy issues (for developing countries) and how to cope with natural disasters. In this sense, it is more a policy brief than a research paper. And it does quite well by raising all the concerns and detailing where more economic research would be useful.

In conclusion, the paper provides a good overview of the issues related to the macroeconomic effects of natural disasters and proposes interesting research issues to further investigate.

Kunreuther H., (1996), Mitigating Disaster Losses through Insurance.
Journal of Risk and Uncertainty, 12:171-196.

Abstract

Kunreuther's paper examines why homeowners do not always voluntarily adopt cost effective protection measures to natural disasters and why they usually have limited interest in purchasing insurances.

One reason he suggests is that there is an under estimation of the probability that a natural disaster occurs and that individuals apply high discount rates so that future benefits are not given much weight.

Also the way risk is perceived is important in the decision to purchase an insurance or not. He suggest that the role of post disaster assistance is not significant in individuals decisions not to take insurances. This can be arguable, since if people can rely on public aid to cope with the impacts of disasters, there should be no reason to be covered by insurance, unless they want duplicate the benefits from both assistances.

Methodology and Conclusions

Kunreuther is presenting empirical evidence from Kunreuther and *ali* (1995) that private insurers do not promote the coverage of natural disasters for which there is an uncertainty of risk and a fear of the financial cost of a catastrophic disaster.

The author finally proposes some measures link improving risk estimates or expanding protection to insurers against catastrophic losses. While insurance is a valuable tool, it has to be coupled with other policy tools (eg enforced building codes in hazard prone areas).

Malik R.P.S., (2006), Towards a More Comprehensive Assessment of Impacts of Dams.

Paper presented at The Ninth Biennial Conference of The International Society for Ecological Economics "Ecological Sustainability and Human Well-being", December 16-18,2006, New Delhi, India.

Abstract

Dam projects generate a vast array of impacts – socio – economic, health, institutional, environmental, ecological, and cultural. Many of the benefits and costs associated with dam development have quite different time streams and have different effects on different sectors. In addition, the effects of dams are distributed across different spatial scales, from local to basin, to regional to national, and in some cases, to trans-national. The net effect of this is that dam assessment, by its very nature becomes a complex undertaking and that no comprehensive assessment of the effects of dams has so far been undertaken. The paper discusses the nature of some key indirect and induced economic, distributional and poverty reduction impacts of dam projects, present the methodologies that are available for their assessment and performs an ex-post evaluation of their magnitude taking an illustration of Bhakra Dam located in North-West India. The main focus of the study is the estimation of multipliers and other measures of production-related and consumption-induced impacts of the Bhakra dam, and the assessment of its income distribution and poverty reducing impact.

Objectives

The objective is two folds:

(a)   To estimate 'multiplier', a measure that reflects production – related and consumption – induced indirect economic impacts of dams; and
(b)   To assess the income distribution and poverty reducing impacts of the dams.

This paper elaborates the methodological framework by providing empirical results in respect of estimation of multiplier value in respect of Bhakra multipurpose dam system in India.

For the purpose of the study, direct costs and benefits as those raised from the construction of the dam, as well as the benefits accruing to all beneficiaries of the water stored and other services provided by the structure and the impacts – both positive or negative – to all populations, species and ecosystems affected either by the construction or by the changed regime of the river.

Methodology

The major direct outputs from a dam generate both inter – industry linkage impacts and consumption – induced impacts on the regional/national economy. Multiplier analysis offers one of the approaches to quantify the magnitude of inter-industry linkages and consumption-induced effects in relation to purely directs impacts.

In the study, the following multi – sectoral models have been proposed to estimate indirect and induced impacts of dam projects:

(i)   Input – output and Semi Input – output Models;
(ii)   Social Accounting Matrices (SAM) based on Multiplier Models;
(iii)   Computable General Equilibrium (CGE) Models.

The input output model and the SAM required for estimating the multiplier were available only for the state of Punjab and not for the entire Bhakra system encompassing other states.

In order to estimate income distribution impacts from the SAM based model, households have been divided in to five categories: Self employed rural households; Agricultural labour; Rural non agriculture, Rural others; and Urban households.

Results and conclusion

The simulation results based on a SAM based multiplier model show that the Bhakra dam project has generated significant indirect or downstream effects in the Punjab state. The value of estimated multiplier is 1.90. Thus for every rupee generated directly, another 90 paise were generated in the region as indirect effects. The results on income distribution show that the gains to the agricultural labour households from the dam have been higher than the gains to other rural households and to urban households.

Mechler R., (2003), Natural Disaster Risk and Cost-Benefit Analysis.
In Building Safer Cities: The Future of Disaster Risk, Ch.3, Edited by A. Kreimer, M. Arnold and A. Carlin, Disaster Risk Management Series, World Bank, Washington DC.

Abstract

This paper discusses the impacts of natural disasters and the basic elements of CBA. It also looks at the incorporation of natural disaster risk into CBA with a review of the current shortcomings in using CBA in the context of natural disaster risk and resulting consequences. A short case study illustrates some of the issues discussed. At the end it summarizes the findings and provides recommendations for using cost-benefit analysis in assessing natural disaster risk.

Methodology

The proposed methodology to assess the impacts of natural disasters is straightforward. The figure below presents the various economic impacts (direct, indirect and macroeconomic).
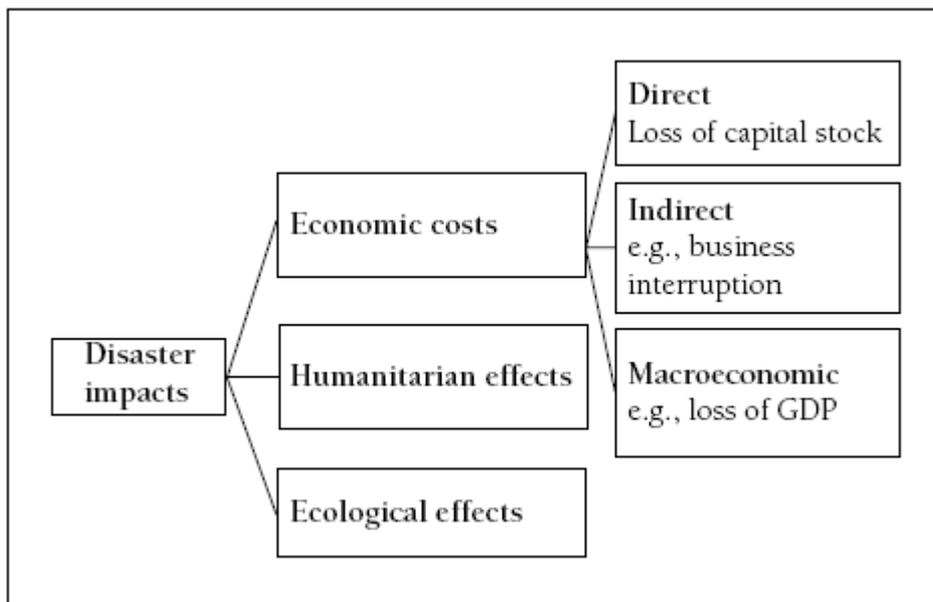
After a brief review of the literature, the author comes to the first concluding stage that natural disaster risks are often not considered sufficiently in CBA. Three issues are identified and analyzed:

- Natural disaster risk is commonly not accounted for in CBA for investments and primary projects.
- Secondary (risk management) projects are rarely assessed in a CBA framework. When this is done, the focus is on mitigation only.
- Risk is generally not included explicitly, but by averages.

The author presents an example in Honduras on a CBA of risk transfer.

Conclusions

The paper concludes that "Cost-efficiency as measured by CBA should not be the sole criterion when planning and assessing development and risk management projects, but it provides important information for a more efficient, less risky allocation of scarce funds and thus can aid in bringing about more robust development." The limits of this conclusions is that no alternative assessment tools are provided, pointing-out a field of research to be further explored.

Abstract

The current state-of-the-art in flood damage analysis mainly focuses on the economic evaluation of tangible flood effects. It is contended in this discussion paper that important economic, social and ecological aspects of flood-related vulnerabilities are neglected. It is a challenge for flood research to develop a wider perspective for flood damage evaluation.

Summary

Recent events like the 15 extreme floods that occurred 2002 in various parts of Europe showed that floods continue to pose serious risks in many EU countries. Indeed there is evidence that flooding is getting more serious over time, in terms of the number of floods occurring as well as the damage and the loss of life being caused. The social purpose of flood risk management is to reduce flood damages. Since flood risk management strategies can require a significant diversion of resources from other purposes, it is desirable to determine whether the reduction in flood damages justifies the resources so expended.

Equally, only if we are in a position to evaluate alternative intervention strategies in terms of their relative benefits and costs we are able to make better choices and introduce more effective flood risk management strategies. As a consequence, the quantification and evaluation of flood damage is practiced in a growing number of EU countries as an important factor to be considered in the decision process about particular flood risk management measures. Unfortunately, the methods used are quite diverse and they sometimes do not reflect the state-of-the-art in flood damage evaluation.

The major purpose of these guidelines is, therefore, to give guidance for practitioners of governmental authorities and executing bodies dealing with ex-ante flood damage evaluation in order to appropriately appraise public flood defence projects or strategies on different spatial scales. With these guidelines we want to address a large community. On the one hand, we want to give guidance to countries just starting with flood damage evaluation studies. For this group we want to demonstrate how to proceed step by step in flood damage evaluations (especially chapters 3-4).

Chapter 3 describes the state-of-the-art in evaluating direct, tangible flood damages. This chapter can be used by practitioners of countries with few or even no experience in flood damage evaluation in order to find an appropriate start into the endeavour of applying flood damage evaluation as a decision support tool. Chapter 4 reveals the principal rules and the procedure of building up a proper flood damage data base in order to ensure a consistent

set of flood damage data, which is needed if flood damage evaluation is to be used as a long-term decision support tool.

On the other hand, we want to address flood damage evaluators in countries which already possess some experience in this field and we offer our guidelines to them as a checklist and want to inspire them to improve their evaluation methodology, e.g., by including methods for damage types which have been neglected hitherto in their work (especially chapters 5-9). Chapter 5 outlines the approaches to evaluate flood effects on industrial production. Chapter 6 indicates possible procedures to include social flood effects. Environmental flood effects and methods of their evaluation are described in chapter 7. Thereafter, chapter 8 focuses on damage reducing effects of flood warning in order to support specific decisions on flood warning systems. Chapter 9 gives an overview of flood damage categories which have not been considered in more detail in these guidelines and indicates relevant literature sources for further reading. Last but not least we want to provide fundamental standard knowledge, specify key principles for economic evaluation of damages and reveal the sources of uncertainty that need to be considered. Hence, we want to help preventing errors in flood damage studies (chapter 2).

Noy I., (2007), The Macroeconomic Consequences of Disasters.
Working Paper n°07-7. University of Hawaii at Manoa . February 2007.

Abstract

The aim of this study is to describe the macroeconomic dynamics of natural disasters and their determinants in a large sample of disaster events, the first such attempt we are aware of. Our research shows that natural disasters have a statistically observable adverse impact on the macroeconomy in the short-run. Not surprisingly, costlier events cause more pronounced slowdowns in production. Yet, interestingly, developing countries, and smaller economies, face much larger output declines following a disaster of similar relative magnitude than do developed countries or bigger economies. A close study of the determinants of these adverse macroeconomic output costs reveals several interesting patterns. Countries with a higher literacy rate, better institutions, higher per capita income, higher degree of openness to trade, and higher levels of government spending are better able to withstand the initial disaster shock and prevent further spillovers into the macroeconomy. These all suggest an increased ability to mobilize resources for reconstruction. Financial conditions also seem to be of importance; countries with more foreign exchange reserves, and higher levels of domestic credit, but with less-open capital accounts appear more robust and better able to endure natural disasters, with less adverse spillover into domestic production.

Okuyama Y., (2003), Economics of Natural Disasters: A critical review.
Research paper 2003-12. Regional Research Institute, West Virginia
University.

Abstract

Significant progress has been made in recent years for modeling spatial economic impacts of disasters in a regional context (for example, Okuyama and Chang eds. *Modeling the Spatial Economic Impacts of Disasters*, forthcoming). While these advancements are more toward modeling strategies based on conventional frameworks, little has been dealt with the theory on economics of disasters, since the pioneering work by Dacy and Kunreuther (*The Economics of Natural Disasters*, 1969). In this paper, "The Economics of Natural Disasters" is reviewed and updated for providing a theoretical perspective toward disaster related research. The review is carried our through restructuring the framework of Dacy and Kunreuther with new findings from the recent studies and extending it to a regional context. In addition, the paper proposes the research directions for constructing further the theory on economics of disaster.

Overseas Development Institute, (2005), Aftershocks: Natural disaster risk and economic development policy.
Briefing Paper, November 2005.

Abstract

The briefing paper considers questions from a macroeconomic perspective, exploring the impacts that disasters can have on both short and long-term development and options for reducing impacts. The implications for private sector risk management investment strategies and how to address exposure, especially of poorer people to disaster risk at a personal, community level is addressed too.

The briefing paper includes some useful definitions of often used terms related to natural disasters:
-       A natural hazard is a geophysical, atmospheric or hydrological event that has potential for causing harm or loss.
-       Risk is a combination of the probability, or frequency, of occurrence of a defined hazard and the magnitude of the consequences.
-       Vulnerability is the potential to suffer harm or loss, expressed in terms of sensitivity and resilience or of the magnitude of the consequences of the potential event.
-       A natural disaster is the occurrence of an extreme or infrequent hazard that affects vulnerable communities or geographic areas, causing substantial damage, disruption and perhaps casualties and leaving the affected communities unable to function normally.

The briefing paper further gives lots of important state-of-the-art knowledge concerning natural disasters and economy, and we will quote several parts, which may be important for the work in Microdis.

On the relationship between disasters and development, the paper states:
"Major natural disasters can and do have severe negative short-run economic impacts which need to be distinguished from physical damage. Disasters also appear to have negative longer-term consequences for economic growth, development and poverty reduction. (….) However, some economists question whether natural disasters necessarily are adverse economic shocks and even argue the opposite – that disasters can have a positive economic impact, because of a post-impact boom in construction and upgraded infrastructure and technology. Such a debate suggests context specific outcomes that depend on the sequencing of impacts, the type of hazard experienced, the influences underlying vulnerability to a particular hazard, and other concurrent influences on economic performance.

Figure 1: a Kuznets' Curve or inverted U relationship between economic development and disaster vulnerability.
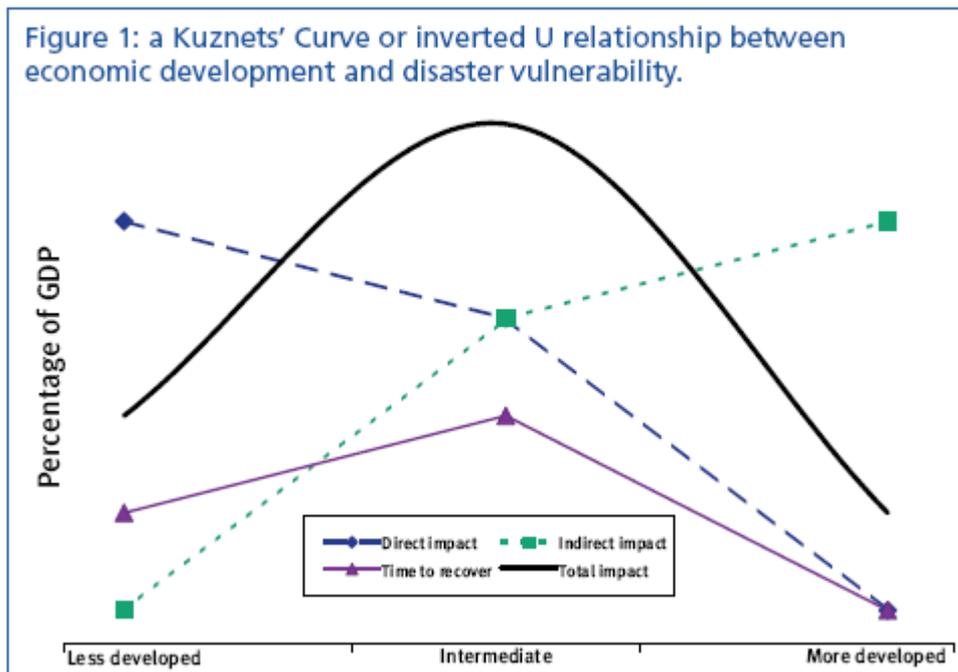
From an economic perspective, a disaster is a "shock" that results in a combination of losses in the human, social and physical capital stock and a reduction in economic activity such as income generation, investment, production, consumption and employment. There are substantial distributional implications, because the poor are likely to be worst affected. There may also be severe effects on financial flows such as the revenue and expenditure of public and private bodies.

Disaster experts commonly distinguish direct impacts, including physical damage (stock of capital) and some of the reduction in output as "losses" such as crops destroyed and reduced fish catch, from indirect impacts, including most changes in the "flows of economic activity". However, many also commonly and confusingly add together damage and the indirect, immediate reduction in activity to estimate the total cost of a disaster. The most widely quoted "cost" for Indonesia of the December 2004 Tsunami has been US$4.45 billion, which includes damage of US$2.9 billion and the initial reduction in economic activity estimated at $1.53 billion. However, as disaster sceptics point out the net reduction in activity should account of responses such as crop replanting and rebuilding. In Thailand the initial assessment of the tsunami's impact indicate a net increase in economic activity in the following months."

The briefing paper makes distinguish between two broad categories of physical hazards that are likely to have different human and economic impacts. The first category are so-called hydro-meteorological (floods, droughts, storms), the second are geophysical (earthquakes, volcanic eruptions and related tsunamis) – which are associated with distinct patterns and forms of economic vulnerability. This is in part because of differences in their frequency of occurrence and predictability.

The recognisably recurrent nature of hydro-meteorological hazards, associated with climatic variability, encourages adaption in economic and social activity such that shaping the evolution of almost all rural economies. One example is the distinctive crops and cropping patterns in flood or drought prone areas of Bangladesh, where villages are also artificially elevated on the unprotected Ganges-Brahmaputra floodplains.

Extremes of rainfall are usually slow to impact, leading to the distinction made in disaster management, because of the greater opportunities for preparedness with rapid onset events.

Geophysical hazards are mostly low-probability or seemingly random events (location specific annual risks of under 1 in 100 or considerably less): These risks are often almost wholly discounted unless there has been an extreme event that is recent in the public and political consciousness…..The potential consequences need to be recognised in highly exposed areas because they can cause enormous loss of life, and massive physical damage and disruption to public infrastructure and private assets. As economies growth and mega-cities emerge, swelling number of people and expanding levels of capital across the globe are also at risk from earthquakes as demonstrated by the recent Marmara disasters in Turkey and Kobe in Japan. The Indian Ocean Tsunami showed that coastal locations, which have a disproportionate share of human urban activity, are vulnerable to the tsunamis that seismic and volcanic activity may unleash.

The geo-extent or localisation of the hazard is another purely physical determinant of an economy's relative vulnerability. A micro island economy can be overwhelmed by an event of a scale that scarcely would disrupt the national economy of a larger country.

The paper further discuss economic influence on vulnerability, and note that the vulnerability of an economy to natural hazards is determined by a complex, dynamic set of influences relating to factors such as economic structure, stage of development, prevailing economic conditions and the polity environment.

Further they note that the relationship between the level of development of an economy and the impact of a disaster is particularly complex. Influences include the physical infrastructure, the degree of sectoral and geographical integration, economic specialisation, the coverage and robustness of the financial sector, government revenue-raising capabilities and the openness of the economy.

Least-developed economies are widely perceived as most vulnerable, experiencing the greatest direct losses relative to a country's wealth. However, where a high proportion of impacts are on the assets and livelihoods of poor, self-provisioning households these losses were likely to be inadequately recorded.

Economic development can increase vulnerability at both micro and macro-economic levels. Poor and socially disadvantages groups can become more vulnerable: socio-economic change may lead, for instance, to the breakdown of familial support, a decline in traditional coping mechanisms etc.

At a macro-level many middle income economies at an intermediate level of development are typically more integrated both sectorally and geographically. This can increase the indirect macro-economic multiplier effects of adverse performance in a particular sector or regional economy. And, because of related lags in these effects feeding through the economy, recovery may be slower.

At higher levels of development, the financial costs of capital losses are massive (as illustrated by Kobe and Hurricane Katrina), but the economic impacts of disasters are proportionally less. This partly reflects increased investment in mitigation and preparedness measures, improved environmental management, greater access to financial resources and lower associated opportunity costs and a reduction in the scale of absolute poverty and thus of household vulnerability. A greater share of private sector economic assets is also likely to be adequately insured against disaster and the burden diffused by global reinsurance.

It is sometimes argued that the eventual net macro-economic impact of some disasters may even be positive. A major earthquake may trigger a construction-led boom. There are significant opportunities for upgrading of infrastructure and technology, spawning growth. In contrast, drought or erratic rainfall may cause little direct physical damage, but sharply reduced output and force affected households to dispose of assets to sustain consumption. So a drought shock increases poverty through direct impacts on households and indirectly through reduced longer-term economic growth. The likely unequal distribution of losses and gains also has to be included in the challenging economic calculation.

Measurement difficulties complicate estimation of disaster impacts. Sensitivity to a disaster shock at a macroeconomic or sectoral level is reflected in the deviation of economic aggregates from expected trends. But an economy is also sensitive to many other influences, making it potentially difficult to isolate the specific impacts of a disaster. Also assessment of the economic impacts of disasters typically concentrates on the most easily measured direct losses – the financial costs of visible physical damage. Of ten little information is available on indirect, so-called secondary flow impacts of a disaster shock spreading through the economy, affecting for example, output and consumption of goods and services, the balance of payments, the government budget, and ultimately, economic growth, income distribution and the incidence of poverty.

Governments and aid agencies regularly ignore potential hazard related risks in the design of infrastructure. Hazards related risks should be explicitly recognised in both the economic and social criteria by which investments are appraised and evaluated. Mitigation opportunities exist in the retrofitting of

existing structures and in the design and siting of new roads, power generation and supply, telecommunications, water and sewage infrastructure, as well as health facilities and schools.

In order to improve public financial management, the briefing paper notes that the risk of potential disasters should be a factor in the allocation of public potential disasters and could trigger related improvements in financial planning.

They suggest disaster contingency plans are more important in the light of the declining aid for middle income countries and increasing losses. Annual calamity funds should be established and pre-designated in countries where disaster-related expenditure occurs almost every year. This would at least reduce the practice of regularly reallocating resources and strengthen fiscal discipline. Financial risk transfer instruments should be explored for well-defined hazards in the middle-risk range with an average 10 year return period. They include both conventional insurance and reinsurance and newer instruments like weather derivatives and catastrophe bonds linked solely to a most extreme event. A combination of financing mechanisms for different layers of loss should be tried.

A better economic understanding of the vulnerability to specific hazards faced by developing countries is required, including potential short and longer term impacts and knock-on or multiplier effects of a shock….Special regard needs to be given to ways of minimising adverse impacts of disasters on priority policy areas such as poverty reduction.

Vulnerability can quickly change, particularly in countries that experience rapid socio-economic change. These developments can also have environmental effects, again altering the nature of vulnerability.

Improved impact assessment would facilitate better management of the macroeconomic and public financial consequences of disasters and help inform future risk reduction initiatives.

Better documentation on expenditure on disaster responses and measures to reduce risk helps to inform governments and the international community about appropriate spending levels on mitigation and preparedness. Total expenditure on post-disaster relief and rehabilitation is rarely reported. Reallocations, in particular, are poorly documented both by affected governments and aid agencies.

Scientific understanding of the nature of hazards has to be continuously extended and information on hazards and related risks needs to be generated and disseminated in a use-friendly form.

Mainstreaming implies considered and proportionate response to natural hazard risks. Sceptics point to the problem of moral hazard, that those individuals and enterprises most at risk may be less inclined to prevent damage or losses if they are insured. Similarly local authorities and national

government may be willing to overlook risks if others have accepted the contingent liability of bailing them out after a disaster. But these are arguments for context specific and consistent informed decision-making that reflect societal and international choices about levels of acceptable risk. Successful mainstreaming of disasters will require multi-party agreements and long-term national and international commitments with transparency and accountability for both funding and over the actions of those undertaking risk reduction.

***Patwardhan A., Sharma U. (2005), Improving the methodology for
assessing natural hazard impacts.***
Global and Planetary Change n°47 (2005) 253-265. (1 3s).

Patwardhan and Sharma (2005) note that the impacts of natural hazards
typically have been measures through changes in human, social and
economic capital, typically represented by stock variables such as population,
built property and public infrastructure, livestock, agricultural land, etc. In their
paper they develop an alternative approach that seeks to quantify impacts as
changes in flow variables. They explore in specific whether changes in annual
agricultural output can be used to measure impacts associated with tropical
cyclones in coastal regions of India. They claim that assessing impacts of
cyclones in terms of changes in stocks of economic capital and infrastructure
may be appropriate in developed countries. On the other hand, they think that
in most developing countries the quantity and value of economic capital,
property and infrastructure at risk is often not s large. Therefore the focus on
flow variables is likely to be more relevant and useful in developing countries,
where the maintenance of economic activity directly affects livelihood and is
perhaps of greater importance than loss of built property or other physical
capital.

They refer to Pielke and Landsea (1998) who describe three layers of impacts
du to cyclones – direct, secondary and tertiary. Primary impacts are described
as those resulting directly from the meteorological characteristics of the event
– they are manifest immediately and best captured in terms of direct damage
to stocks of human and economic capital. Secondary impacts may be realised
weeks to a few months after the event in the form of disease outbreaks or
disruption of economic activity. They may occur not only at the location of the
event itself, but in neighbouring regions as well. Tertiary impacts may take
months to years to be realised, such as changes in insurance rates and
property taxes.

The authors suggest that the lack of resilience and adaptive capacity in many
developing countries may increase the relative importance of secondary
factors while in many developed countries normal economic and social
activities may be resumed in the affected regions quite quickly. They further
suggest that these secondary impacts may be best measured or through flow
variables.

They mention that there have attempts to develop methodology and
guidelines for assessing such secondary impacts on flow variables by
organisations like UNECLAC (2002) and some studies assessing impacts on
the economic activity. However, these studies have been mainly at the
aggregate economic level while there is little literature that examines the
impacts on different economic sectors at a disaggregated level and for
individual events.

Patwardan and Sharma suggest the following main advantages in focusing on
the flow variables:

i)   Estimation of the length of the recovery period
ii)   Linking impacts metrics to adaptive capacity

For the remains of the paper the authors develop an example of how consequences on agricultural output caused by cyclones can be assessed using trends in output of paddy rice within regions and years. They conclude as follows: "impact of cyclones on the paddy output can be detected at an appropriate spatial and temporal resolution. "…..but even with this limited data set, it is clear that the impacts of cyclones on the flow of agricultural output can be detected." And" Impacts of a cyclone can be measure in terms of flow of goods and services of the affected socio-economic sectors, if appropriate spatial and temporal resolution is chosen."

However, we may add, that this approach claims rather detailed analyses of trends and outputs, and the possibility to distinguish flow changes due to the hazardous event from other factors influencing trends (in agriculture: for example weather, droughts etc).

Skoufias, E. 2003: Economic Crises and Natural Disasters: Coping Strategies and Policy Implications.
World Development, Vol 31, No. 7, pp 1087-1102.

Abstract

Skoufias (2003) reviews 12 studies presented at a conference examining two broad themes: i) the interplay between household coping strategies and the impact of crises and natural disasters on various dimensions of well-being (e.g. consumption and child nutrition) and ii) some of the strategies that public agencies can adopt so they can be more effective in protecting households and their members from the potentially adverse impacts of aggregate shocks.

In the first part of the paper, Skoufias describes and discusses studies on the impacts of crises and natural disasters and household coping strategies. In addition to the different ways natural disasters can affect households, the consequences will also depend on the variety of risk management arrangements and risk management strategies that are available and in use, for protection. With risk management arrangements the author means "all the informal, and formal (market based and public) arrangements that have evolved for the purposes of providing some protection for households in the event of a crisis." With risk management strategies he means "typically cover all the prevention and mitigation strategies that households may implement prior to the crisis event, as well as all the coping arrangements that are available to households after the realisation of a crisis."

On the methods for evaluating economic effects of natural disasters Skoufias notes: "….most research on the impacts of economic crises and natural disasters has to rely either on cross sectional surveys conducted during or after the crisis event, or on short panel surveys that happened to have at least two observations on households either one being before the crisis and the other during or soon after the crisis."

One of the papers described in the summing-up paper by Skoufias uses cross-sectional household survey data for 1998 to assess the distributional impact of the recent economic crisis in the Philippines. The survey includes direct questions on the crisis, where households were asked if they were adversely affected by the crisis in five different ways including loss of jobs, reduced wages and drought or El Nino. Their results suggest that the impact of the crisis was modest, leading to 5% reduction in average living standards and a 9% increase in the incidence of poverty. The largest share of the overall impact on poverty appeared to be attributable the El Nino shock as opposed to the economic crisis. Both household and community characteristics mattered to the differential impact of the crisis, with the poorer households being less able to protect their consumption.

In another paper exploring effects of crisis (Handa and King) investigates the effects of the September 1991 liberalisation of the exchange rate in Jamaica on the weight for height of children, which is an indicator of a child's nutritional

status that is insensitive to short-term fluctuations in living conditions. The conclusion is that economic crises have an adverse impact on child nutrition. Two other papers suggest that the effects of crisis on household education spending and schooling seem to be much milder (Skoufias 2003).

Skoufias also discuss the findings of Ninno, Dorosh and Smith who examine the coping strategies of households as well as the role of public policies and markets following the 1998 flood in Bangladesh. They find that the impacts of the floods on flood-exposed households were examined using a panel data set covering 750 households in three rounds over a 13-month period. The study found that private sector borrowing, a major household coping strategy, played a key role in helping households to maintain consumption.

On the subject of ex-ante and ex-post public actions to minimise exposure to and impact of shocks, Skoufias present some of the instruments available to governments in the event or and economic crisis or a natural disaster. The list of instruments include: cash transfer and public work programs, unemployment assistance, wage and commodity price subsidies, targeted human development or cash transfer programs conditioned on school attendance and regular visits to health centres, service fee waiver, food and fund programs. The targeting methods commonly used with each intervention and advantages and disadvantages associated with them.

The paper by Owens, Hoddinott and Kinsey discusses the potential effects of shifting government interventions from ex-post mitigation to ex-ante risk reduction programs. The paper shows that re-allocation of funds from ex-post response to ex-ante intervention is successful at reducing poverty in non-drought years while at the same time allowing households to build up additional stocks of livestock that help buggering consumption in the aftermath of the 1994-95 drought. Thus shifts to ex-ante policy responses to potential shocks promise to be welfare enhancing as well as poverty reducing.

Another paper, by Sumarto, Suryhadi and Pritchett on Indonesia shows how important adequate targeting system are in designing programs that help households cope with crisis.

The total of the findings suggest that aggregate shocks, even if short-lived, are likely to have irreversible consequences on the prospects of future generations due to deteriorations in the nutritional status of children and reduced access to health services for poor and vulnerable households.

Conclusions

Some of the conclusions of the paper are as follows:
i)   Ex-ante risk reduction programs offer "a bigger bang for the dollar" relative to ex-post mitigation and coping programs since they appear to be welfare enhancing as well as poverty reducing.
ii)   Government led reforms such as and earlier trade liberalisation combined with well functioning private markets, public and non-governmental organisations interventions have the potential of being successful at

preventing major crises as was the case in Bangladesh after the 1998 flood (del Ninno). Insofar as governments have the foresight and the discipline to adopt such strategies there are serious opportunities for reducing the adverse effects of crises.

iii)   Programs that target the structurally poor do not necessarily reach households that can be affected by economic crises and disasters.

iv)   The nature of the aid that a program provides may constrain the extent to which a program can help poorer or more needy households.

v)   The design of crisis relief and social safety net programs directed to specific members of households must also take into consideration the intermediary role of families. Person-specific transfer programs run the risk of having a lower effect on the intended individuals due to reallocations of resources within families over which policy makers have no direct control.

Abstract

The paper presents the different ways people adjust to the risks presented by natural disasters. The differentiation is as follow: "they can move out of harms way, they can self protect, or they can insure". The authors use a largest natural disaster prior to Katrina - Hurricane Andrew - to evaluate how people and housing markets respond to a large disaster.

Methodology and results

The analysis combines a unique *ex post* database on the storm's damage along with information from the 1990 and 2000 Censuses in Dade County, Florida where the storm hit.

The results suggest that the economic capacity of households to adjust explains most of the differences in demographic groups' patterns of adjustment to the hurricane damage. The findings of the paper are that:

Low income households respond primarily by moving into low-rent housing in areas that experienced heavy damage.

Middle income households move away to avoid risk, and the wealthy, for whom insurance and self-protection are most affordable, appear to remain. This pattern of adjustment with respect to income is roughly mean neutral, so an analysis based on measures of central tendency such as median income would miss these important adjustments.

Wreford A., Adger N., Hulme M. (2006), Assessing the Future Economic Impact of Extreme Climate Events in Europe.
Paper presented at The Ninth Biennial Conference of The International Society for Ecological Economics "Ecological Sustainability and Human Well-being", December 16-18,2006, New Delhi, India.

Abstract

Events such as heatwaves, floods and storms can have severe economic impacts and their occurrence is predicted top increase as a result of climate change. However, the magnitude of these events is likely t decline as these events occur more frequently, because society may be better prepared as a result of learning from previous events. This paper try to develop a method for valuing the future impacts of extreme events associated with climate change, incorporating a function, which represents learning from previous events. Some events have cumulative impacts therefore adaptation is constrained by greater frequency. Yet other events as they become the norm are adapted to and have a reduced impact over time. The approach differs from production function approaches and uses a more Ricardian based approach to forecast future impacts using observed social costs of present day events. The heatwaves of 1995 and 2003 in Europe are discussed, focusing on their impact on agriculture and human health. The documented social cost of these events is used as a base from which they forecast the impact of similar events more frequently in the future.

Model

The general framework for this research is as follows, if sectors such as agriculture, government and individuals do not learn and adapt to extreme events, the costs will follow the horizontal line, remaining at the initial high level of damage, unchanging over time. If however, as is proposed in this research and demonstrated in some areas and studies, autonomous and planned adaptations occur, the costs in the future may follow the exponentially declining curve. Realistically it is unlikely that it will ever be possible to have costless extreme events, thus there remains what we have termed "frictional costs" that society will have to bear. The level of these frictional costs is also a topic for discussion- how much damage is society prepared to accept?

The model for estimating these curves is likely to follow the following equations,

$$\text{Cost}_{NA} = \sum_{1}^{t} p^* \, Ag_t + \text{Health}_t^{-rt}$$
$$\text{Cost}_{A} = \sum_{1}^{t} p^* \, Ag_t + \text{Health}_t^{-rt-x}$$

Where Cost_{NA} is the cost of the event occurring the future, without adaptation, and Cost_A is the future cost of the event occurring including adaptation, p is the probability of the event occurring, Ag_t is (social) cost to agriculture of the event occurring in time t, Health_t is the (social) cost to the health sector of the

event occurring in time t, r is the discount rate at time t, and x is the learning/adaptation function.

These estimations will be carried out under several assumptions. Firstly it is assumed there will be no significant demographic change in the future, that is, the proportion of elderly people for example, will not change significantly, an assumption, which may prove unrealistic. It also assumes a single extreme impact, such as a heatwave, will occur in isolation from other potential extremes. A further assumption is that future economic assumptions will remain constant, such as changes in trade policy or regimes, which could also alter the economic impact in the future.

Conclusion

This paper has laid out the issues and issues and ideas surrounding the valuation of future economic costs from increased the frequency of extreme events. The cases of heatwaves were used as an illustration of the possible impacts and responses to previous events. The issues surrounding the effects of heatwaves on the agricultural and health sectors were examined, including previous physical and economic costs and the ability and evidence of these systems to learn from events and adapt to changing conditions. This paper serves as a background and rational fro future research, which will estimate then future costs of extreme events, taking into account adaptation and learning, and discounting to a net present value based on an assumption of increasing probability of these events occurring.

Yezer A., (2000), The Economics Of Natural Disasters.
Center for Economic Research Discussion Paper n°98-11. The George
Washington University. January 2000.

Abstract

The economic problems produced by natural disasters have long occupied
the attention of mankind. Along with preparation for war and self defense, the
response to problems of flood, drought, earthquake, and windstorms has
been used as a test of the ability of governments and economic institutions to
serve a population. In our own time, there is increasing concern with the
unwillingness of private insurers to operate in high risk areas and with the
escalating cost of government disaster assistance. In spite of all this rationale
for studying of the economics of natural disasters, a search of on-line sources
for books, articles, and other academic publications on the subject provides
only a modest number of references. Apparently governments have found
little need to examine the economic effects of their policies towards actual or
potential natural disasters. Although the literature is thin, it includes a
surprising diversity of theoretical models and empirical results responding to a
number of different issues and problems. Unfortunately, these individual
approaches to the economics of natural disasters often bear little relation to
one another because they proceed from very different assumptions and
analyze different aspects of the relation between disasters and the economy.
The first task of this review is to organize these approaches under a modest
list of headings and to show the relations among them. Ideally, they would all
be placed within the context of an overarching general statement of the
economics of natural disasters but this review will settle for the more modest
goal of identifying distinctive approaches and pointing out differences in their
assumptions and purposes. Probably the most familiar branch of literature
dealing with the economics of disasters involves various aspects of economic
impact analysis in which the effects of a disaster event on a local or regional
economy are modeled. Because it is important to understand the theoretical
basis for expecting an economic response to disasters before reviewing
empirical models, these economic impact models will be discussed in the last
section of this review. The next section will discuss attempts to model the
theoretical effects of natural disasters within the contest of a general
equilibrium theory of regional development. An intermediate section considers
disaster insurance and mitigation models, leaving economic impact analysis
for the final section.

Conclusions

There are two obvious conclusions from this review. First, the economic
effects of natural disasters is a remarkably under researched area. The total
number of citations to research in economics of disasters is very small and
the number of potential topics is quite large, leaving a very thin rate of
coverage.

Second, various approaches to the economics of disasters have remained
segregated. Theoretical models including information effects have had little

effect on economic impact modeling. There are few empirical tests of information effects. The relation among insurance, mitigation, and post disaster relief has been examined but the exploration is far from complete. One branch of literature has concentrated on the response of households and residential housing markets while the economic impact literature has dealt largely with firms. Hopefully this review will inspire additional efforts to fill in gaps between the literatures and, more important, to produce models that integrate the economic effects of disasters on both households and firms.

Case studies and empirical evidences

Abstract

This paper investigates the complex relationship between environment risk, poverty and vulnerability in a case study carried out in one of the poorest and most flood prone countries in the world: Bangladesh, focusing on household and community vulnerability and adaptive coping mechanisms. A large-scale household survey carried out in the south-east of Bangladesh covered almost seven hundred floodplain residents living without any flood protection along the river Meghna about their flood risk exposure, flood problems, flood damage and coping mechanism. They show that as expected, households with lower income and less access to productive natural assets face higher exposure to risk of flooding. Disparity in income and asset distribution at community level furthermore tends to be higher at higher risk exposure levels, implying that individually vulnerable households are also collectively more vulnerable.

Methodology

Based on the existing literature in this field they developed and tested their own analytical model. They emphasize that the analysis presented in this paper is primarily based on observed associations and relationship, using linear correlations and nonparametric testing procedures.

Survey set – up and sampling procedure

A total of 672 people were interviewed face – to – face from the last week of March until and including the second week of May 2005 by local (male and female) interviewers. Each interview lasted on an average of 30 minutes. A stratified sampling procedure was used where 32 villages were chosen based on their distance from the river Meghna. In each of these 32 villages every fifth house along one side of the main village road was selected in the sample.

Risk exposure and socio – economic vulnerability

There exists a significant positive relationship between the distance people live from the river Meghna as an indicator of risk exposure and household income – residents living in villages away from the river have higher income levels. A significantly negative relationship is found between distance and

income distribution (measured by Gini coefficients – the lower the Gini coefficient, the more equal the income distribution). Inundation depth is another indicator of risk exposure. A small but significant negative relationship is found between income levels and inundation depth – lower incomes suffer higher inundation levels, and are more exposed to flood risks. The same significant negative relationship is also found between inundation depth and land ownership and land ownership is significantly and positively correlated to household income. These results are confirmed when comparing the same risk exposure indicator for respondents living under and above the poverty threshold value.

Risk exposure and flood damage

The consequences of risk exposure, measured through economic damage cost, are negatively correlated with the distance from the river. However, this correlation is not statistically significant at 5 or 10% level. Comparing the damage costs across different inundation levels, it is found that damage costs are more or less the same at lower inundation levels, but increase as inundation depth increases. The outcome of the Kruskal – Wallis test confirms that this increase is statistically significant.

Analytical framework underlying the case study:
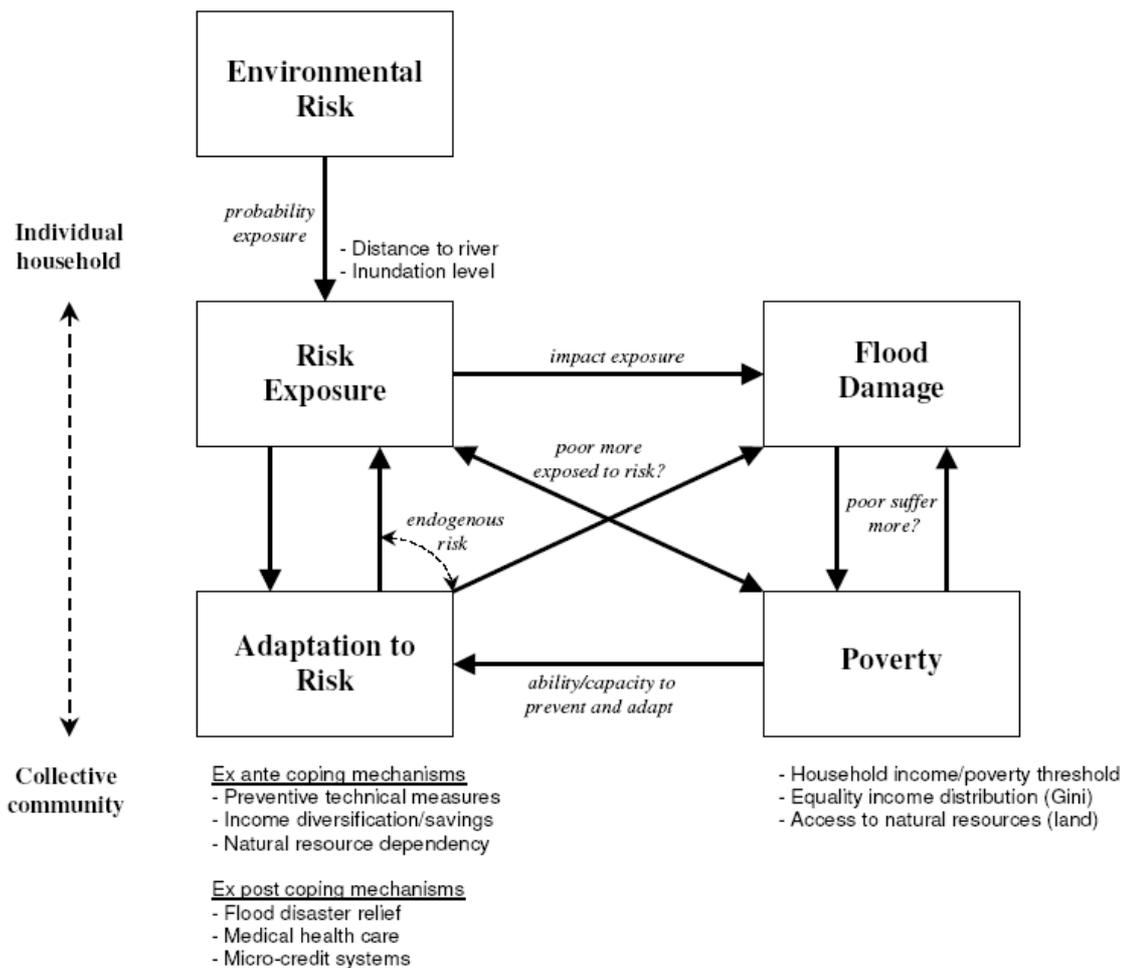
Results

Their results confirm the positive relationship between environmental risk, poverty and vulnerability. Poorer segments of the society live closer to the river, therefore face a higher risk of flooding and are thus more vulnerable and the actual inundation levels are indeed significantly higher for poorer households. Again the environmental risk exposure level is closely related with the income inequality and assess to natural resources, the higher the exposure level the higher the inequality and the less access a household has to land. Inequality also results in higher flood damage. However the relationship between poverty and damage costs appears to be more complex. The poor suffers more in relative terms, but not in absolute terms. Average damage costs in absolute terms are significantly higher for wealthier households. Moreover, their coping capacity is as expected also greater than poorer households, reflected by the fact that the relative proportion of the flood damage costs in total household income is significantly lower for wealthier families. Farmers and fish cultivators suffer most damage, both in absolute and relative terms.

Flood problems and flood damage

A majority of 96% of the interviewed floodplain residents are exposed every year to flooding during the rainy season and 25% of the population mentions flooding as the main problem in the region followed by other important problems such as bad roads (23%), unemployment (20%) and lack of electricity (17%). In more than one third of the cases the water comes waist high (approx. 1.5 feet) and in another one third of the cases even shoulder high (approx. 3 feet) during monsoons. 46% of the population mentions that they suffer each year from diarrhea and 99% seeks medical treatment for this during rainy season.

Average flood damage costs are estimated as US$ 200 per household per year, which is approximately 20% of average household income. Median damage costs are half of this amount (US$ 95). The share of damage in household income calculated by dividing the median damage costs by the median value for household income comes 16%. The minimum damage costs are zero and the maximum limit is US$ 16,000. Trimming off the five percent lowest and highest values, the average damage cost is estimated at US$ 140 per household per year. Most flood damage is caused by property and crop damage, followed by damage to fishponds (loss of fish stock). The other damage category includes loss of income from day labour and trade.

Conclusions

Floodplain households that fully depend on natural resources (poorer segments in the society) for their livelihood suffer significantly less damage, but this does not exclude income diversification as an effective flood coping strategy. On the contrary, more income sources appear4 to result in lower average damage costs, suggesting that spreading the environmental risk across multiple economic activities pays off. However, we find that income diversification is primarily a strategy followed by wealthier families and communities living further away from the river. Families living nearer to the river seem to have newer opportunities to engage in multiple economic activities, which make them more vulnerable to natural disasters and may keep them trapped in a poverty cycle.

Athukorala P., Resosudarmo B., (2005), <u>The Indian Ocean Tsunami: Economic Impact, Disaster Management and Lessons</u>.
<u>Departmental Working Papers</u> 2005-05, Australian National University, Economics RSPAS.

Abstract

The paper analyzes the immediate economic impact of the Indian Ocean tsunami generated by the Sumatra-Andaman earthquake of 26 December 2004 and the disaster management process in the immediate aftermath of the disaster with a focus on the two worst affected countries – Indonesia (Aceh province) and Sri Lanka. The paper is arranged in three main sections, beginning with a broad-brush picture of the tsunami disaster – the nature and extent of the calamity and the international donor response – from a comparative perspective. The next two sections contain case studies of the two worst affected countries – Indonesia (Aceh province) and Sri Lanka.

Methodology and results

Using economic losses data from the World Bank, the authors compare the two situations. Their findings points to the importance of educating the public about simple precautions in the event of a disaster and enforcement of coastal environmental regulations as disaster prevention policies. The findings also makes a strong case for designing policies and programs, as an integral part of national development strategy, for mitigating the impact of natural disasters on the poor and highlights the need for combining international aid commitments with innovative approaches to redressing problems of limited aid absorptive capacity in disaster affected countries.

Table 6. Indonesia: Estimated Damages and Losses

	Total Impact			Property	
	Damage	Losses	Total	Private	Public
Social Sectors	1674.9	65.8	1740.7	1440.6	300.1
Housing	1398.3	38.8	1437.1	1408.4	28.7
Education	110.8	17.6	128.4	9	119.4
Health	82.5	9.4	91.9	23.2	68.6
Culture and Religion	83.4		83.4		83.4
Infrastructure	636	240.8	876.8	325.9	550.8
Transport	390.5	145.4	535.9	165.8	370.1
Communications	18.9	2.9	21.8	8.6	13.2
Energy	67.8	0.1	67.9	1.1	66.9
Water and Sanitation	26.6	3.2	29.8	18.3	11.4
Flood control, irrigation and sea protection works	132.1	89.1	221.2	132.1	89.1
Productive Sectors	351.9	830.2	1182.1	1132	50.1
Agriculture and Livestock	83.9	140.9	224.8	194.7	29.9
Fisheries	101.5	409.4	510.9	508.5	2.5
Enterprises	166.6	280	446.6	428.9	17.7
Cross Sectoral	257.6	394.4	652	562.9	89.1
Environment	154.5		154.5	548.9	
Governance and administration	89.1		89.1		89.1
Bank and Finance	14		14	14	
Total Impact	2920.4	1531.2	4451.6	3461.4	990.1

Source: World Bank (2005)

Table 9: Sri Lanka: Preliminary Estimates of Asset Losses due to Tsunami and Financial Needs for Reconstruction

Sector	Asset losses	Reconstruction needs		
		Short term	Medium term	Total
Housing	360-341	50	387-437	437-487
Roads	60	25	175	200
Water and sanitation	42	64	53	117
Railway	15	40	90	130
Education	26	13	32	45
Health	60	17	67	84
Agriculture	3	2	2	4
Fisheries	97	69	49	118
Tourism	250	130		130
Power	10	27	40-50	67-77
Environment	10	6	12	18
Social welfare		30		30
Miscellaneous and contingency expenses	90	30	120	150
Total, US$ million	970-1000	500	1000-1100	1500-1600
Percent of GDP	4.4 – 4.6			7.0-7.3

Abstract

The Leuser Ecosystem in Northern Sumatra, an Indonesian national park remains under severe threat of deforestation. Rainforest destruction has caused a decline in ecological functions and services. It is also affecting numerous economic activities in and around the park. The objectives of this study are twofold:

(i)   to determine the total economic value (TEV) of the ecosystem through a systems dynamic model, impact pathway approach;
(ii)   to evaluate the economic consequences of deforestation versus conservation, disaggregating the economic value for the main stakeholders and regions involved.

Using the dynamic model TEV was estimated over the period 2000 – 2030. Three scenarios are considered: 'conservation', 'deforestation' and 'selective use'. The results are presented in terms of:

(i)   the type of benefits: the economic benefits considered include water supply, fisheries, flood and drought prevention, agriculture and plantations, hydro-electricity, tourism, biodiversity, carbon sequestration, fire prevention, non-timber forest products, and timber;
(ii)   the allocation of these benefits among stakeholders, which include local community members, the local government, the logging and plantation, the national government and the international community; and
(iii)   the regional distribution of benefits which cover the 11 districts involved in the management of the Leuser Ecosystem.

With a 4% discounted rate, the accumulated TEV for the ecosystem over the 30 year period is: US $ 7.0 billion under the 'deforestation scenario', US $ 9.5 billion under the 'conservation scenario' and US $ 9.1 billion under the 'selective utilization scenario'. The main contributor is the conservation and selective scenarios are water supply, flood prevention, tourism and agriculture. Timber revenues play an important role in the deforestation scenario. Compared to deforestation, conservation of the Leuser Ecosystem benefits all categories of stakeholders, except for the elite logging and plantation industry.

Methodology

In this study, economic valuation is used as the main analytical tool to compare the advantages and disadvantages of three scenarios in Leuser. In order to make sound policy decisions with regard to environmental problems the underlying study has adopted the 'Impact pathway approach', starting with the cause, followed by the resultant physical impact and finally the social and economic effects. It proceeds in this study in a series of methodological steps. These include:

(1)   defining the study boundaries (i.e., impacts on ecological functions/services);
(2)   identifying the physical impacts that are economically significant;
(3)   quantifying the significant socio-economic effects; and
(4)   calculating monetary values and conducting a sensitivity analysis.

The impact pathway for Leuser is shown in following figure:
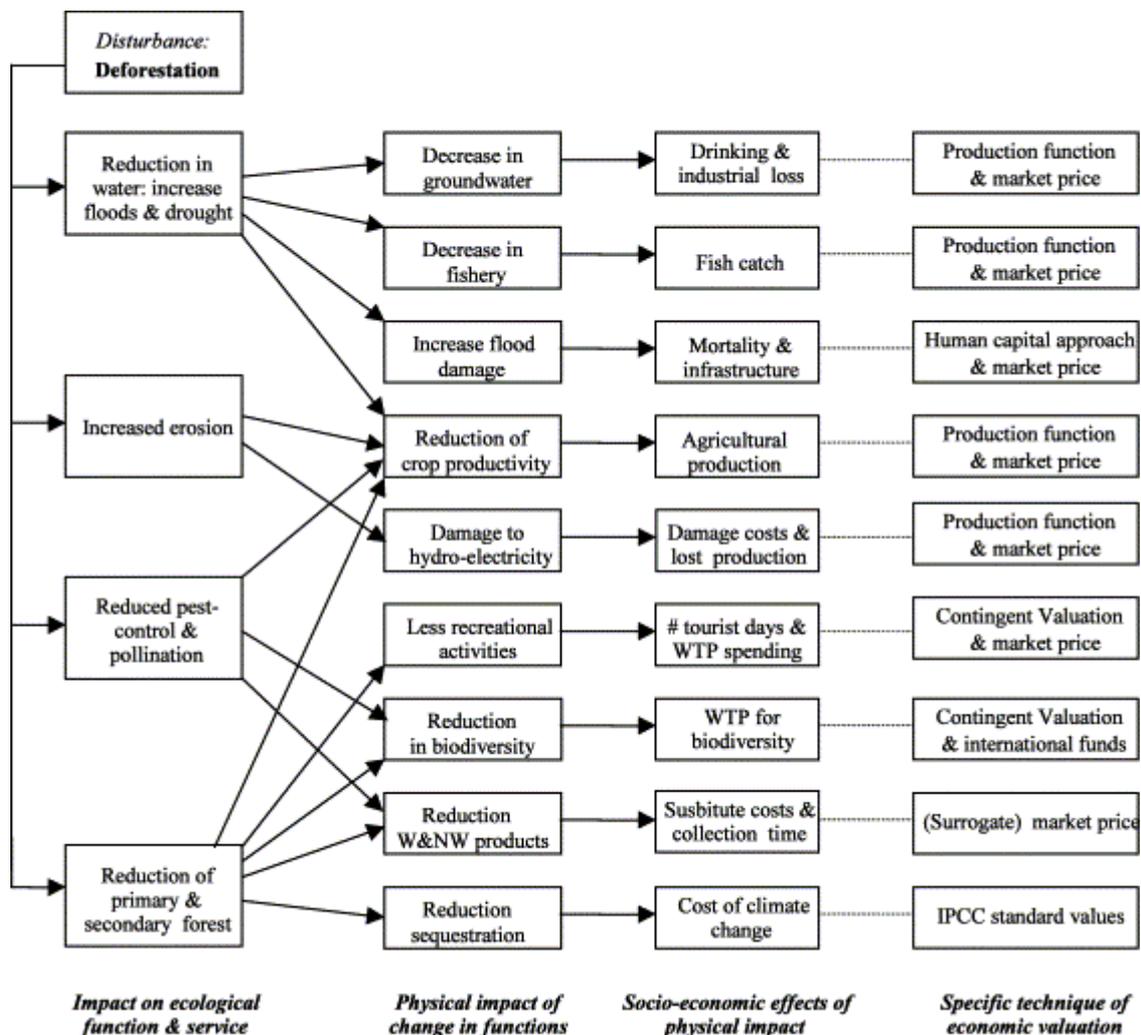

Figure: Impact pathway of deforestation of the Leuser Ecosystems

For the study, the following three damage categories of floods and droughts are identified: (1) residential houses; (2) infrastructure (such as bridges and roads); and (3) mortality. A simplified dose – response relationship is applied to estimate agricultural losses due to flooding, erosion and droughts. In the case of flooding, damage is estimated based on the following parameters: area of inundation, and depth, duration, seasonality, intensity and frequency of flood events.

Results

The results are presented in several forms:

(1)   TEV at different levels of discounting;
(2)   Distribution of TEV among different sectors;
(3)   Distribution of TEV among different regencies; and
(4)   Distribution of TEV among different stakeholders.

TEV is calculated as NPV for a time period of 30 years and at a 4% discount rate.

Sensitivity Analysis

A large number of assumptions have been made in order to generate the results given data, budget and time constraints. Several crucial parameters are tested for robustness, which include population growth, the deforestation rate and the value of timber and water. None of these parameters change the results significantly. Thus conclusions hold.

Conclusions

Economic valuation (impact pathway approach) has proved to be a strong and useful tool in the analysis of welfare changes for the different scenarios in the Leuser Ecosystem. The study concludes:

(1)   with a 4% discount rate, the accumulated TEV for the ecosystem over the 30 year period is: US $ 7.0 billion under the 'deforestation scenario', US $ 9.5 billion under the 'conservation scenario' and US $ 9.1 billion under the 'selective utilization scenario';
(2)   conservation spreads the benefits of Leuser equally among regencies and thus prevents further social conflict, while deforestation widens the regional income gap and thus may be a social conflict; and

(3)   finally, conservation promotes social and economic equity because it mainly supports the underprivileged majority of society. Deforestation widens the gap between rich and poor.

Blöchl A. Braun B., (2005), Economic Assessment of landslide risks in the Swabian Alb, Germany – research framework and first results of homeowners' and experts' surveys.
Natural Hazards and Earth System Sciences, 5:389-396. (8s)

Abstract

Blöchl and Braun report on landslides risks and the work to develop a systematic approach to the analysis and evaluation of economic landslide risks at a local and regional scale. The project's aim is to determine the extent of potential damage and economic losses caused by landslides, to analyse individual and collective patterns of risk assessment and to develop recommendations for pro-active risk management. The abstract tells that "The research methodology includes GIS-based risk analyses and interviews with relevant actors in politics, administration and planning, private households and land owners. The research findings will facilitate a better-informed, efficient and sustainable use of natural resources and natural risks. The research project also aims to contribute to methodological progress in risk research".

Methodology

The research area is the Swabian Alps, an area in south-western part of Germany. The research design includes to sub-designs; research design one analyses and evaluation of risks at the regional level. The other, research design two, investigates risk perception and the vulnerability of elements at risk and analyses preventive strategies at an individual level.

On the regional level, they gather information about previous hazardous events and their consequences for people, organisations, firms and infrastructure by collecting and analysing documents and available statistics. Possible economic damage will be shown on a map of monetary valuations for endangered areas. On the basis of information from part 1, persons are selected for detailed interviews. In sub-design two private households, firms and landowners in the research area were interviewed using standardised questionnaire surveys. The main issues in the questionnaire were: damage to buildings (caused by landslides), value of land and buildings, experience with prevention, protection and safety measures, individual risk evaluation by the person interviewed. Interviews with experts in administration, planning, politics etc are also conducted, to increase the background information and the determination of collective interests.

The authors note that modern approaches in analysis and evaluation of natural risks are based on the relations between risk analysis – risk evaluation and risk management. They state that risk analysis focus on the question: What can happen? and consists of three steps: identification of danger, analysis of relevant processes and estimation of potential damage or loss and its consequences.

Risk evaluation focuses on the question: What is allowed to happen? and is a characterisation (qualitative or quantitative) of damage regarding likelihood and extent.

Risk management focus on the question: What has to be done? and deal with the preventive measures for reducing, controlling and regulating natural risks. (Blöchl and Braun, 2005; pp 391-392).

The project in the Swabian Albs work with an economic worst case scenario, further they use a financial analysis, not an economic analysis of costs to society. Still, their methods and preliminary results may be of interest to our project in Microdis, especially regarding their questionnaires to individual households and experts in the field.

Blöchl and Braun, 2005 also focus on the problem of vulnerability in risk assessment, because vulnerability is important in the analysis of consequences – it is related to the extent of loss and damage to an element at risk. They suggest an approach developed by Leone et al. (1996) where different categories of damage are established. For damage to buildings, Leone et al (1996) determine five categories, ranging from "no structural damage" to "partially or totally destroyed". The project also has another focus – of interest to Microdis project: They aim at integrating social and non-pecuniary aspects into risk assessment – aspects which influence vulnerability are particularly interesting.

Results

The preliminary results from questionnaires to individual households, presented in the paper, may be of interest:
- The average market value of buildings ranges from EUR 350 000 to EUR 850 000. Almost all house owners are insured against damage by the elements including landslides. Therefore, the reconstruction and repair costs are paid by the insurance companies.
- Preventive measures were taken by many house owners (39%) with costs ranging from a few hundred Euro to EUR 50 000.
- Perceptions of landslide risks differ considerably from place to place and from household to household. Landslide risks are seen as a predominantly small-scale problem by most of the interviewees.

Some results from structured interviews with experts are of interest to our project as well:
- It was clear that individual cost-benefit analyses with regard to landslides play only a marginal role in decision making. The only exception is the increase in construction costs due to preventive measures. More important reasons for choosing a house location, are the topographic situation, the scenic beauty, the social environment or prestige.
- According to the experts, individual voluntary preventive measures are taken by a relatively small number of house owners.

-    Many people in the research area are insured against damage caused by natural hazards because there was a mandatory insurance for buildings in the actual area (Baden Wurttenberg) until 1994.

-    In general, the experts assume that the only natural hazards that are seriously taken into account in choice of construction sites etc are floods and earthquakes.

Brouwer R., van Ek R., (2004), Integrated ecological, economic and social impact assessment of alternative flood control policies in the Netherlands.
Ecological Economics, 2004 (Vol. 50) (No. 1/2) 1-21.

Abstract

The main objective of the paper is to "combine and integrate environmental, economic and social impact assessment procedures in order to support decision making in the context of flood control policy in the Netherlands. The hydraulic, hydrological, ecological, economic and social effects of alternative flood control policies, such as land use change and floodplain restoration, are evaluated using a combination of advanced quantitative modelling techniques and qualitative expert judgement. The results from the ecological, economic and social impact assessment are evaluated in an integrated way through cost-benefit analysis (CBA) and multi-criteria analysis (MCA). As expected, these methods produce different outcomes"…….."An important research question remains how to assess, integrate and trade-off (1) significantly different types of impacts in a methodologically sound way in both cost-benefit and multi-criteria analysis, and (2) significantly different types and quality of available knowledge and information about these impacts."

The paper evaluates different flood preventive measures. The main parts of the analysis are environmental impact assessment, social impact assessment and economic impact assessment. The environmental impact assessment includes predicting the expected magnitude of the environmental impacts, usually at project level, and evaluating their significance for decision-making purposes. In case of the Dutch study hydrological and ecological impact assessment are carried out.

The authors note that there exists no clear definition of social impact assessment in the literature, but that it usually includes a systematic effort to identify, analyse and evaluate the social effects of projects or policy on individuals, groups of people or society as a whole. In the Dutch paper the social impact assessment in based on available literature and expert judgement regarding the most important stakeholders involved (stakeholder analysis), the effect of the proposed measures on their interests in the area and stakeholder perception of the proposed measures. The stakeholders affected by the proposed measures are identified as the following: Inhabitants (people living in the area), agriculture, nature conservation organisations, water supply companies, recreation sector. The proposed measures' expected effects on the social sector was assessed using a qualitative social impact score card, based on the most important social criteria identified by two independent experts involved in the analysis. It is worth noting, that both experts strongly felt that it was necessary to explicitly distinguish between short and long term expectations regarding the various aspects involved.

Methodology

Economic assessment was carried out using Cost Benefit Analysis (CBA) and Multi Criteria Analysis (MCA). In this case study a financial, economic and extended (that is including also non-priced external effects in money terms) CBA was carried out, as the proposed land use changes and floodplain restoration measures involve relatively large projects with wider socio-economic consequences.

Results

The main costs identified are related to:
- land use changes in areas where current land use and future flood protection can not go hand in hand (and corresponding purchase of land);
- damages to crops or decreasing grazing density in areas where incidental flooding takes place or a structural rise in water tables (and corresponding compensation payments);
- protection of existing infrastructure (rail and road networks etc) and designing new spatial infrastructure in designated floodplain areas;
- operation and maintenance of the proposed measures.

The most important benefits consist of the protection of people, houses, infrastructure, industrial activities, crops and livestock. These benefits were calculated using material damage estimates. The benefits of public safety are included in the extended CBA. Recreational benefits were assessed. The most important financial and economic benefits consist of the material damage avoided by the proposed measures compared to a do nothing scenario. The material damage avoided was estimated with the help of an existing flood damage model. Assuming an average economic growth of 2% per year and a return period of 4000 years, the expected present value (discount rate 4%) of the damage avoided over the next 100 years (the time period over which the proposed measures are expected to have effect) is 3.3. billion.

Conclusions

In the extended CBA, the total economic value of the non-priced benefits such as public perception and valuation of safety, biodiversity preservation and landscape change is calculated based on the economic value for flood water retention and wildlife habitat and landscape diversity, based on a previous Dutch meta-analysis of 30 international studies looking at the economic value of various wetland ecosystem functions.

Gupta V., (2006), Non-market Valuation of the Benefits of Environmental Quality of Powai Lake, Mumbai.
National Institute of Industrial Engineering (NITIE), Mumbai. Paper presented at The Ninth Biennial Conference of The International Society for Ecological Economics "Ecological Sustainability and Human Well-being", December 16-18,2006, New Delhi, India.

Abstract

The Powai Lake in Mumbai, India is now increasingly being impacted by human waste, pollution, silt and excessive growth of weeds, which is resulting in chocking off the shoreline, and deteriorating water quality. This paper attempts to estimate non-marketed benefits to the users and non-users of Powai Lake due to hypothetical improvement in the environmental quality and to estimate the costs of hypothetical deterioration in the environmental quality of it.

Methodology

To achieve the objective, a random sample of 298 respondents living in approximately five kilometers radius of the lake has been chosen to apply Stated Preference or Contingent Valuation Method (CVM) with open and closed ended referendum to elicit their willingness to pay (WTP) to make the lake from the present state to boat able, fishable and potable state. The paper also attempts to analyze willingness to accept (WTA) for further environmental; quality deterioration from its present state.

Results

A positive "yes" response is obtained from 67% of the total number of respondents and the mean value of WTP is estimated to be Rs. 169.69 as one time payment. The direct non-consumptive use value for aesthetics has been estimated as Rs. 145.07 and recreational values as Rs. 151.78. The direct consumptive economic use value (fishing) has been estimated as Rs. 50.6 while direct non-consumptive uses value as Rs. 120 and indirect non-use value Rs. 88.47. Finally, the paper analyses the influence of qualitative parameters such as age group, gender, education, occupation, incomes, the purpose of visit, the mode of payment etc. on the WTP.

Conclusion

In this study, the CV survey was carried out for Powai Lake in Mumbai. A random sample of 298 respondents living around the lake was interviewed. The results indicate that 68% of the respondents are willing to pay for the betterment of Powai Lake. It is also concluded that people want to enjoy aesthetics and recreational value of the Powai Lake. The further statistical analysis is to be taken up on the collected data to provide statistical soundness to the study.

Hallegatte S., (2006), A Cost-Benefit Analysis of the New Orleans Flood Protection System.
AEI-Brookings Joint Center. Regulatory Analysis 06-02. March 2006.
http://www.aei-brookings.org/admin/authorpdfs/page.php?id=1260&PHPSESSID=2ffcf169a849eea9069256ca374a7ede

In the early stages of rebuilding New Orleans, a decision has to be made on the level of flood protection the city should implement. Such decisions are usually based on cost-benefit analyses. But in such an analysis, the results are contingent on a number of underlying assumptions and varying these assumptions can lead to different recommendations. Indeed, though a standard first-order analysis rules out category 5 hurricane protection, taking into account climate change and other human-related disruptions of environment, second-order impacts of large-scale disasters, possible changes in the discount rate, risk aversion and damage heterogeneity may make such a hurricane protection a rational investment, even if countervailing risks and moral hazard issues are included in the analysis. These results stress the high sensitivity of the CBA recommendation to several uncertain assumptions, highlight the importance of second-order costs and damage heterogeneity in welfare losses, and show how climate change creates an additional layer of uncertainty in infrastructure design that increases the probability of either under-adaptation (and increased risk) or over-adaptation (and sunk costs).

Building a flood protection system able to cope with a category 5 hurricane in New Orleans is a huge investment, and it is wise to precisely assess its benefits before any implementation decision, as other, less-costly projects might be more efficient to improve the population's well- being. One must, however, be very careful of the underlying assumptions used in the benefit assessment. Indeed, using probabilities derived from historical experience and direct cost estimates produced by insurance companies lead to low assessments of benefits and rule out any additional flood protection system. Nonetheless, making less optimistic assumptions about possible anthropogenic increases in flood probabilities and taking into account estimates of second-order disaster costs, public risk-aversion, and damage heterogeneity can reverse the conclusion of the CBA, even if countervailing risks and moral hazard issues are accounted for.

These results suggest that a CBA is useful but should encompass the whole set of possible assumptions to check its robustness. In the New Orleans case, the recommendation is highly sensitive to these assumptions, even if the protection system is found worth building only for pessimistic assumptions on climate change.

This analysis also shows that second-order damages and impact heterogeneity are responsible for a large increase in welfare losses. Climate change, even though negligible during the next decades compared to other drivers, might also be an important factor of hurricane risk over the long-term. More generally, climate change creates an additional layer of uncertainty in

infrastructure design that increases the probability of either under-adaptation (and increased disaster risk) or over-adaptation (and sunk costs in protection).

Krithika V., (2006), Economic and Ecological Consequences of Tsunami in the East Coast Region of Tamil Nadu.
Paper presented at The Ninth Biennial Conference of The International Society for Ecological Economics "Ecological Sustainability and Human Well-being", December 16-18,2006, New Delhi, India.

Abstracts

The Indian coastline experienced the most devastating 'tsunami' on December 26,2004, and thousands lost families, dwellings and livelihoods. In India, three states and two unions territories were affected radically. Among the states, Tamil Nadu faced major damage with loss of lives of 8,009 people, and it also affected the livelihood structure of about 8.97 lakh people. This total loss estimated was found to be substantial and hence the present study was undertaken with the objective of analyzing the economic impact of tsunami on resource endowment, agriculture, human and livestock and studying the environmental externalities and other socio-economic repercussions of tsunami.

Methodology

Percentile primary survey and sensitivity analysis.

Results

This study was undertaken in Samiyarpettai village in Chidambaram block of Cuddalore district in Tamil Nadu during 2005-06. For the study, 60 farmers and 30 fishermen were selected. The study revealed that the tsunami had caused a crop land damage of 14.15%, crop damage for cashew was recorded at 11.44% and yield loss in principal crops such as paddy (42.20%), cashew (31.68%), mango (15.67%) and groundnut (10.45%). The land quality was reported to be poor by about 41% of the respondents. The taste of both drinking and irrigation water was reported to be sour by 80 percent of respondents after tsunami. Tsunami also led to loss of livestock, which resulted in loss of income of 18.23%. These losses together resulted in 12.05% overall loss of income to the farming communities. However, 53.88 % increase in income was observed in non-farm sector, which was due to the income generated by the Self-Help Groups formed after tsunami by both institutional and non-institutional organizations.

It has also created some negative externalities on the sustainability of fish biomass in the coastal region. After tsunami, amount of fish catch had been increased by 21.23% and variety of prawn species are caught in huge quantities, which fetches higher price in the international markets. The higher catch of fishes was due to mechanized boats provided to the tsunami affected communities by religious organizations and government institutions. This has undoubtedly resulted in an increase in the income of fishing communities by 31.05 percent and the social cost incurred by providing mechanized boats to affected fishermen in the study village was found to be Rs 23 lakhs.

Tsunami has also widened the income disparity among the affected and unaffected communities. It was noticed that the use of mechanized boats had resulted in over exploitation of fish biomass and oil spill were also reported

around the vicinity of the area of operation of the fisher-folk and it is expressed that it would affect the marine eco-system in the long run. The opportunity cost incurred by the affected household in village due to loss in paddy and 92% of yield loss in groundnut were explained by land & irrigation water quality indices and proximity of the farms from the sea.

From the sensitivity analysis it is understood that if the land quality index shifts from poor to medium, the yield loss would decrease by 11.67kg/tree in mango, 211.41 kg/ha in paddy and 25.97 kg/ha in groundnut. Similarly, if irrigation water quality index shifts from poor to medium, the yield loss would decrease by 11.67kg/tree in mango and 356.17kg/ha in paddy. In the same way, if distance of the farm from the sea increases by one km, the yield loss would decrease by 97.31kg/tree in cashew, 85.36kg/tree in mango, 1225.02kg/ha in paddy and 307.28kg/ha in groundnut. It is apparent that the tsunami led to a heavy loss to the society in terms of human lives, material, resource endowments, eco-system and production environments. Hence it is suggested that the people should be educated and trainings imparted about the calamities, for-warning mechanisms etc. The fisher folks should also be exposed of to the ecological sustainability, consequences of over-exploitation of fish biomass, the use of mechanized boats and the external effects of oil spills to minimize the long term impacts on the bio-resources.

Lahiri A. K., Sen T.K., Rao R.K., Jena P. R., (2001), Economic Consequences of the Gujarat Earthquake.
New Delhi: National Institute of Public Finance and Policy.

Abstract

The paper discusses the economic consequences of Gujarat earthquake in India, January 26, 2001 already in a paper dated April 21, the same year. Extensive losses of lives, injuries and material losses were reported. At the time of the paper, more than 18 000 people were counted dead. The authors note that normalisation of a disaster induced deaths, homelessness and economic loss by the population or Gross Domestic Product (GDP) of a country can reduce the apparent scale of a disaster in a large country. As they write" While the inherent magnitude of the loss and the tragedy is a given quantum, it looks very different depending on whether the loss to life and income are expressed as a proportion of the population of the district itself or of Gujarat or India".

They distinguish between various types of losses; casualties, number of homeless, impairment of functionality of essential facilities, and loss of output. Most earthquake-caused deaths and injuries as well as stoppage of production result from damage buildings. This implies that the loss from an earthquake depends on the density of buildings in the affected zone as well as their structural and non-structural problems.

Methodology

The authors divide the economic impacts of natural disasters – including earthquakes – into i) losses to immovable assets; ii) losses to moveable assets; iii) economic losses due to business interruption; iv) public sector economic costs; and v) household income losses due to death, injury and job disruption.

Lahiri et al. note that the most affected district, Kutch, the injuries and deaths were devastating, while five other districts were affected as well. They note that the low density of population in the most affected district, somewhat contained the extent of the loss.

In Kutch, the quake-induced death rate was high. Many of the severely injured people would be handicapped for the rest of their lives. Precise estimates of quake-induced deaths and disabilities will emerge only with the passage of time.

No information existed on the age and gender distribution of the diseased at the time the paper was published. The authors note however, that the death of many adults in their productive age may exacerbate the problems of staying alive in many affected families.
They also notice a general finding that the exact time of a disastrous event may have large influence on its consequences – especially regarding people

injured and dead – depending on where the majority of people - and divided into age and gender – typically are at the time the hazardous event takes place.

The people affected were entitled to two social security benefits – Ex gratia payments and Insurance benefits, and the paper estimates the insurance sums paid, however, the final total is not yet clear at the time the paper is published.

Medium- and small-scale industries in the affected areas suffered large-scale damage, and has resulted in loss of employment for thousands of people, according to Lahiri et al. They further assume that the demand for labour in the most affected areas will not revive before the reconstruction gets well underway.

The earthquake's impact on employment was not uniform across districts. Lahiri et al. assume 80 per cent loss of employment in Kutch district, 30 per cent in the adjoining districts and 10 per cent in the less affected districts. The duration of the quake induced employment is hard to predict, because it depends to a large extent on the speed and strength in revival of economic activity. For the people engaged in crop production and plantations, no major loss of employment was expected according to Lahiri et al.

Lahiri et al. go on with discussing disaster loss and effect on GDP and growth. They write that the government of Gujarat has estimated the disaster loss at Rs 14,454 crore, and the authors take this as a good guide to the enormous damaged caused by the quake.

However, they note some standard problems in the estimation of disaster loss:
1)   The question of assessing the damage to buildings. They note that loss of buildings and structures accounts for the bulk of the material losses from an earthquake. However, due to lack of inventory, registration etc, there is no or lacking data on the real values of affected buildings and structures.
2)   Second, they underline that it is important to distinguish between the value of buildings and the value of land. The site will normally continue to have value, the value of land may actually go up.
3)   There is a need to carefully distinguish between stocks and flows. Adding the loss of fixed capital in value terms to the value of output lost because of production stop amounts to adding of a stock and a flow.
4)   Reconstruction invariably involves upgrades of structures, buildings and facilities. Valuing the loss at the cost of reconstruction costs therefore involves and upward bias to the replacement cost of the lost asset with cost of upgrading.
5)   The notion of who is likely to bear the costs of damage is interwoven with the cost figures themselves. The authors underline the necessity to distinguish between public sector losses that will be borne by the government from private sector losses that accrue to the non-government sector.

Lahiri et al. estimate the quake's impact on GDP and growth. They show that estimating the short-run impacts by applying a straightforward application of an incremental capital output ratio (ICOR) need modifying for deriving the real output loss estimation. They also call for dynamic considerations in estimation, because a disaster only interrupts economic trend and more often that not is followed by a continuation of the pre-disaster economic decline or advance. Furthermore, they state that the growth path of the local economy can undergo substantial improvements after a major disaster.

The earth quake in Gujarat was not found to have effects on the prices or the balance of payments of India.

On the expenditure side however, the paper notes that the earthquake required intervention by the government in two major ways: 1) Relief measures for providing immediate relief and 2) Rehabilitation measures to ensure rehabilitation starts.

The paper also discusses effects on deposits and financial markets, which will not be dwelled upon here.

Conclusions

Some of their concluding remarks are especially interesting for Microdis – taking a micro level view on disasters, we quote: "The recent earthquake devastated large parts of Gujarat and the toll in terms of human lives and residential property has been enormous. The loss of a large number of housing units of low value may constitute a relatively small economic loss for the state in rupee terms, but is a very large loss in terms of the people's low-cost housing needs. The total impact of the earthquake on Gujarat's GSDP may not exceed a quarter per cent, but the challenge of reconstruction and rehabilitation in the affected areas remains. Putting in place a proper policy framework may not only restore normalcy in the region, but can start a recovery boom.

Gujarat, like most other states in India, is going through a period of fiscal distress. The quake is likely to have an adverse impact on the state's finances through lost revenues and additional expenditure. What is important, however, is to limit the damage by avoiding unnecessary tax exemptions and overgenerous compensation. Even if financing is available it is important to remember that loan financed quake related expenditures will have an enduring impact on the state's finances through the dynamics of public debt. Furthermore, the quake should not be allowed to postpone the long overdue adjustment of the user-fees for public services.

Devising a reconstruction and recovery package provides an opportunity for up-grading the infrastructure, including buildings and structures, and making them appropriate for the seismic characteristics of the region. What is important, however, is to distinguish between public sector and private sector losses. More work needs to be done on estimation of likely loss from future earthquakes, to assist the politics of earthquake hazard mitigation,

consciousness raising and understanding the commercial aspects of earthquake insurance and construction of earthquake resistant buildings."

Santos I. (2007), Essays on Natural Disasters and Household Income.
PhD dissertation, Harvard University, Cambridge, Massachusetts, May 2007.

Abstract

This dissertation explores the impact of natural disasters on household welfare. It is comprised of three essays exploring the ex-post mechanisms of insurance used by households in the aftermath of natural disasters, including inter-household transfers and reductions in the investment in children's human capital. In addition, the mechanisms through which natural disasters have an impact on children are analyzed. Two natural disasters are used as natural experiments: Hurricane Mitch in Nicaragua in 1998 and the 2001 earthquakes in El Salvador.

Panel household datasets from Nicaragua and El Salvador and difference in differences analysis to find that inter-household transfers only partially insure households after a natural disaster and that families significantly reduce their investment in children's schooling and health as a way to deal with the effects of the shocks. In fact, children seem to be disproportionately affected in their respective households, as similar negative effects on adults' nutrition and consumption are not found.

Conclusions
Finally, results indicate that the effect of natural disasters on households' income is the main mechanism through which natural hazards have a negative impact on children's welfare outcomes.

In terms of inter-household transfers as an insurance mechanism, there is evidence of a crowding out effect of public transfer: the findings are that a $1 increase in public transfers crowds out 25 % of inter-household transfers.

While there is a discussion on the motivation to have altruistic behaviors, or on the reasons why there are inter-households transfers, the paper does not take into account moral hazard. It assumes that affected individuals do not over-estimate their economic losses due to natural disasters or do not seek to receive both public and private transfers. In this prospect, it opens an additional area of research.

Summing up and conclusions of the literature review

Although there are several studies and papers which report the economic costs of disasters, it seems evident that these numbers are very uncertain. Further, there are several methodological approaches used in estimation, and especially in aggregate numbers it is hard to see how these numbers have been- and can be- aggregated.

At large – one can take a macro-economic approach or a micro-economic approach in estimating costs of natural disasters. One cannot say that one approach is more correct or more useful than the other. It depends on what the numbers are for. However, it is clear that in using such numbers, one should take a bit more care about what are included (or not included) in them.

From the reported numbers on how large share of population or damage is insured, it tells us that although insurance figures may give us a pretty good (but far from perfect) picture of the economic losses in Western countries, like Europe and North-America. They are very poor indicators in most developing countries, where insurance rates often are below 10 %, and the insurance rates are lowest among the poorest - and often most vulnerable – part of the population.

The studies also show that going into the micro-level approach often imply time-and resource-consuming studies, as shown by Krithika (2006) who estimate economic losses to paddy rice production due to cyclones. Thus using, these kinds of studies in order to get "the large picture of economic losses due to disaster" seems to be very time-and resource consuming, and hardly practically possible for all effects and disasters.

Another important lesson from the different studies is the distinction between short-term and long-terms effects and costs, and between direct and indirect effects and implied costs. The further away in time, and the more "indirect" the harder it may be to distinguish between disasters caused effects and effects due to other causes.

Also the links between disasters, environment, and socio-economic-cultural factors may make the effects caused by the disaster hard to distinguish from effects with other causes. And the effects and costs are larger the less prepared and otherwise vulnerable the affected area and population or country is.

The need for economic calculation of benefits of preventive measures is underlined by several authors. However, as others have pointed out, the benefits of "events that do not happen" or of "less disastrous effects" may be harder even to estimate than the effects and costs of events that do happen and have disastrous effects.

It leads us to distinguish 5 types of options for estimating costs of disasters:

i)   Macro – micro

ii) Short-term versus long-term (or both)

iii) Stocks versus flows (or both but not double counting)

iv) Costs of ex-ante versus ex-post mitigation measures

v) Costs in absolute versus relative number (per cent of GDP, percent of population affected, $ 50, per cent of household income reduction etc)

Further readings

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