Assessing Household Vulnerability and Coping Strategies to Floods: A Comparative Study of Flooded and Non-flooded Areas in Bangladesh, 2005

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Table of Contents

Abstract

The frequent occurrence of disastrous floods results in losses for both human life and property values in Bangladesh. This study thus is set forth to examine the relationships between socioeconomic conditions and vulnerability to flood hazards. A cross sectional household survey was carried out two weeks after floods in four districts of Bangladesh in the year 2005. In total 1050 households in rural areas were interviewed through a three stage stratified random sampling. Among the four sampled districts, three were affected by monsoon floods and only one, the Nilphamari district, was affected by a flash flood. Bivariate analyses depict that floods have significant downside effects on households' wellbeing, as overall headcount poverty level deteriorates by 17 percent. The worst welfare loss is measured in Jamalpur district where the majority of households are involved with agriculture.

A multivariate regression model is carried out that shows that some demographic, socioeconomic and community variables along with flood shock variables have a noteworthy impact on flooded and non-flooded households' income. Estimates of a multinomial logit model illustrate that flood height, duration and loss of working days are significant for the poor households' income deterioration, whereas non-poor households are significantly affected by flood duration and loss of assets during floods. To assess households' vulnerability to floods, this study incorporates four methodologies from the poverty dynamic literature. Vulnerability estimates from the 'vulnerability to expected poverty' approach depict that flooded households have a higher risk of falling below the poverty line compared with the non-flooded households. This is the only methodology out of four used in this study that could estimate households' vulnerability from cross-sectional data and thereby allowing to estimate non-flooded households' vulnerability. The results show that idiosyncratic vulnerability is higher for households affected by monsoon flood, whereas flash flood worsens households' covariate vulnerability. Households involved with agriculture are found to be more vulnerable than other income groups. The 'vulnerability to expected utility' approach illustrates that elimination of poverty would increase household welfare and thus lessen vulnerability the most. Poverty

1and idiosyncratic flood risks are positively correlated and highly significant. Households with higher educated members, being male-headed and owner of a dwelling place have been found to be less vulnerable to idiosyncratic flood risks. Possession of arable land and a small family size can reduce poverty and the aggregate flood risk. The vulnerability of households from flooded regions, estimated by the 'vulnerability to poverty line' and the Monte Carlo Bootstrap methodologies, shows higher values compared to actual poverty rates. In this study, stationary environment is assumed with measurement errors in cross sectional surveyed data, so that the 'vulnerability to expected utility' approach demonstrates better results and closer estimates with respect to actual poverty levels after floods than the other three methodologies.

This study also deals with the query whether crop diversification would be an option for mitigating flood risk for farmers and concludes with the finding that mix-crop culture with cash and staple crops would lessen households' vulnerability. In the time of the flooding, rural people in Bangladesh suffer from the lingering effects of labor market disruption, price fluctuations, and consumption deficiency. Households initiate coping with borrowing money after the realization of floods and gradually lead to cope with savings and selling assets as the duration of flood increases, which is illustrated from a tobit model approach. In addition, empirical analyses explain that the decision to migrate is often guided by the aspiration to replenish asset values damaged by the floods, as rural-urban migration emerges as a source of credit. Participation in social networks plays an important role for the households during flood crisis to get information about potential host areas for migration.

Keywords: Flood, Vulnerability, Coping Strategy

Zusammenfassung

Die in Bangladesch häufig auftretenden Überschwemmungen haben negative Auswirkungen auf Menschenleben und Besitz der Menschen. Die vorliegende Arbeit untersucht daher Zusammenhänge zwischen sozioökonomischen Gegebenheiten und der Anfälligkeit für Schäden durch Überschwemmungen. Dazu wurde in 2005, zwei Wochen nachdem es zu Überschwemmungen gekommen war, in vier Bezirken eine Querschnittsuntersuchung von Haushalten durchgeführt. Insgesamt wurden 1050 ländliche Haushalte, welche mittels einer dreifach geschichteten Zufallsstichprobe ausgewählt wurden, befragt. Drei der vier untersuchten Bezirke waren von Monsunfluten betroffen, lediglich Nilphamari war von einer unvorhergesehenen flutartigen Überschwemmung betroffen. Eine bivariate Analyse zeigt, dass Überschwemmungen erheblichen Einfluss auf die wirtschaftliche Situation der Haushalte haben, da in Folge von Überschwemmungen die Gesamtzahl der am Existenzminimum lebenden Personen um 17 Prozent zunimmt. In Jamalpur, einem Bezirk in dem die meisten Familien von der Landwirtschaft leben, wurden die größten Einkommenseinbußen nachgewiesen.

Im multivariaten Regressionsmodell ergeben sich als wichtige Faktoren für das Haushaltseinkommen, sowohl von Überschwemmungen betroffener als auch nicht betroffener Haushalte, demografische, sozioökonomische und Infrastruktur bezogene Variablen zusammen mit Variablen bezüglich Schocks durch Überschwemmungen. Die Multinominale Logit-Schätzung zeigt, dass Fluthöhe, Dauer der Überschwemmung sowie die Anzahl verlorener Arbeitstage erheblichen Einfluss auf die Einkommensentwicklung armer Haushalte haben, während Haushalte, die oberhalb des Existenzminimums leben, eher von Dauer der Überschwemmung und Verlust von Eigentum während der Überschwemmung betroffen sind. Zur Berechnung der Verwundbarkeit von Haushalten bei Überschwemmungen wurden in dieser Arbeit vier Methoden aus der Literatur zur dynamischen Armut angewandt.

Der Ansatz ‚vulnerability to expected poverty' schätzt, dass von Überschwemmungen betroffene Haushalte ein größeres Risiko haben, unter das Existenzminimum zu fallen als

nicht betroffene Haushalte. Die von Monsunfluten betroffenen Haushalte werden eher durch *idiosynkratische Schocks* tangiert, die von unvorhergesehenen flutartigen Überschwemmungen betroffenen hingegen von *kovariaten Schocks*. Von der Landwirtschaft lebende Haushalte sind verwundbarer, als Haushalte, die anderen Einkommensgruppen angehören. Dies ist die einzige Methode von den vier in dieser Studie verwendeten, welche die Verwundbarkeit der Haushalte aus Querschnittsdaten schätzen konnte. Hieraus ergibt sich, dass die Verwundbarkeit von Haushalten, die nicht von Überflutungen betroffen waren, nur mit Hilfe dieses Ansatzes geschätzt werden kann.

Der Ansatz ‚vulnerability to expected utility' zeigt, dass eine Eliminierung von Armut zu einer Verbesserung der Haushaltseinkommen führt und die Verwundbarkeit somit am stärksten verringern würde. Armut und das Risiko für idiosynkratische Überschwemmungen korrelieren positiv und höchst signifikant miteinander.

Es konnte weiterhin festgestellt werden, dass qualifizierte und männlich geführte Haushalte mit eigenem Wohnsitz weniger verwundbar gegenüber spezifischen Überschwemmungsrisiken sind. Besitz von landwirtschaftlicher Fläche sowie eine geringe Anzahl von Haushaltsmitgliedern können demnach zu Reduzierung von Armut und Verwundbarkeit bei Überschwemmungen führen.

Im Vergleich dazu ist die Verwundbarkeit von Haushalten in Überschwemmungsgebieten verhältnismäßig größer, wenn sie mit dem Ansatz ‚vulnerability to poverty line' sowie dem Monte Carlo Bootstrap-Ansatz gemessen wurde. In der vorliegenden Studie ist führt der Ansatz der ‚vulnerability to expected utility' zu besseren Ergebnissen als die drei anderen verwendeten Methoden, da die geschätzten Werte des Armutsausmaßes nach Überschwemmungen der Realität am nächsten kommen.

Die in der Arbeit ebenfalls untersuchte Fragestellung, ob Diversifizierung im landwirtschaftlichen Anbau das Risiko von Schäden durch Überschwemmungen senken könnte, kam zu dem Ergebnis, dass eine Mischung der Anbaukulturen bestehend aus

Export- und Grundnahrungsmitteln die Verwundbarkeit reduzieren würde. Während der Überschwemmung leidet die ländliche Bevölkerung Bangladeschs unter den andauernden Folgen der Marktzerrüttung, Preisschwankungen und Konsumrückgang. Haushalte begegnen diesen negativen Folgen der Überschwemmungen, indem sie sich Geld leihen und nach und nach ihre Ersparnisse aufbrauchen oder ihre Vermögenswerte verkaufen, wenn die Überschwemmungen andauern. Dies wurde durch den Tobit-Modell-Ansatz illustriert. Darüber hinaus zeigt die empirische Analyse, dass die Entscheidung zu migrieren oft durch die Hoffnung getragen wird, die Vermögenswerte, die durch die Überschwemmungen beschädigt wurden, wieder aufstocken zu können, da die Stadt-Land-Migration als eine Art Finanzierungsquelle angesehen wird. Die Integration in soziale Netzwerke spielt eine große Rolle, da die Haushalte, die sich mit der Frage der Auswanderung beschäftigen, auf diesem Weg Informationen über potenzielle Zielregionen in Erfahrung bringen.

Schlagwörter: Überschwemmungen, Verwundbarkeit, Bewältigungsstrategie

Chapter One

1. Introduction

The characteristics and enormity of risks that households face, the access to risk management mechanisms, and the surroundings in which households operate their activities, play a significant role in poverty dynamics - these findings are supported by some theoretical analyses and empirical evidences (Holzmann and Jørgensen 2000, Heitzmann et al. 2002). Measurement of vulnerability would be an apposite approach to think about forward looking anti-poverty interventions, by explaining who is probable to be poor, how prone are they to be poor, why are they expected to be poor, and how poor they will be in the future. Vulnerability estimates could highlight the ex ante poverty reduction and alleviation efforts with some intrinsic instrumental values, such as: the risks that households face may cause a large variation in their income. In the absence of adequate assets and insurance to smooth income or consumption, such risks may lead to irreversible losses, such as damage of productive assets, the fall in a vicious cycle of debt, reduced nutrient intake, or disruption of education that eternally reduces human capital (Jacoby and Skoufias 1997). Therefore, vulnerability estimation to a recurrent flood disaster in Bangladesh could be an inherent aspect of well-being.

Bangladesh consists mostly of a low-lying river delta with over 230 rivers and tributaries situated between the foothills of the Himalayas and the Bay of Bengal. The country lies within the catchment areas of the Ganges, Brahmaputra and Meghna rivers which mainly drain through Bangladesh into the Bay of Bengal. In Bangladesh, floods are usually defined as the submerge of land by water which can damage crops and property, disrupt people's normal living conditions, communities infrastructures, household's communications and economic activities and endanger the lives of people and their livestock. The extent and depth of flooding vary from year to year depending on rainfall and river levels. Damages of floods also differ both in time and places. There may be a local flood affecting only a relatively small area in a particular part of the country, as in the year 2000 when a flash flood affected northern and eastern parts of the country. Or the floods may be extensive, as in the years 1988, 1998 and 2004, affecting large parts of

8

the country's major floodplains. Flood damages are reported in one or more parts of Bangladesh almost every year. Even in years with average rainfall, large areas of low-lying floodplains go under water for several weeks or months, as in the year 2005.

1.1 Problem Statement

With a population of 123.85 million and an area of 147,570 sq. km, Bangladesh is one of the world's most densely populated countries (839 per square km; BBS 2003). The combination of its geography, population density, and extreme poverty makes Bangladesh very vulnerable to disasters.

According to the *World Disasters Report 2003* (IFRC 2004)*,* Bangladesh is among the top three most disaster-prone countries in the world, being vulnerable to cyclones, tidal surges, tornadoes, floods, droughts, earthquakes, and cold spells. Every year, on average, one million people are affected by disasters, 500,000 people are made homeless, and the nation's rivers consume around 9,000 hectares of fertile land. Since its independence in 1971, serious floods occurred in 1971, 1974, 1980, 1984, 1987, 1988, 1998, 2004 and 2007 as disastrous events[1]. In addition, some cyclones and storm surges happened in May 1985, November 1988, April 1991 and November 2007. The 1974 flood was followed by a famine and as a result 30,000 people died (Alamgir 1980). In 1987, about 40 percent of the country was flooded in Bangladesh, affecting 30 million people and causing about 1,800 deaths. Loss of the main crop (paddy) was estimated to be 0.8 million tons. The floods in 1988 were even more serious, covering about 62 percent of the land area, affecting about 45 million people, and causing more than 2,300 deaths[2]. In 1998, Bangladesh experienced the worst flood in its history. Over 68 percent of the country was inundated (Ninno et al. 2001), there were about 2,380 deaths, 1.56 million hectares of crops were lost, and over 900,000 houses destroyed. In the years 2000 and 2002, floods affected some 20 million people. In the year 2004, during July and August, devastating monsoon floods submerged two-thirds of the country, resulting in 35.9 million affected people, 726 deaths, 160,000 cases of disease and millions of homeless

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[1] Disaster Management Bureau of Bangladesh 2005 and
http://www.reliefweb.int/rw/rwb.nsf/doc109?OpenForm&rc=3&cc=bgd (last access March 3, 2008)
[2] Irrigation Support Project for Asia and the Near East (1993: 1) by FAP, Bangladesh

people; overall flood damages were approximately Taka 127 billion (about US $2.2 billion) or 3.9 percent of GDP (US $56.9 billion; ADB 2004). Residential housing, roads, bridges, crops, fisheries, and livestock suffered the most damage. The largest asset and output losses occurred in the agriculture (including livestock and fisheries) sector, which was estimated at Taka 34 billion (US $580 million) or 27 percent of overall loss. About 12 percent of the country's area was flooded in the year 2005. Figure 1.1 below shows the frequency of floods by each year and the percentage of inundation area of Bangladesh since independence in 1971.

Figure 1.1: Frequency and area covered by floods in Bangladesh
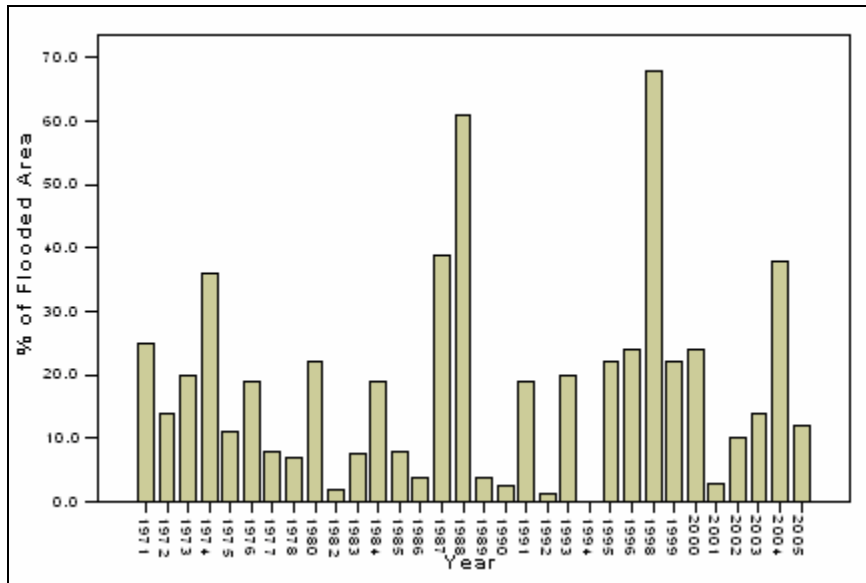
Source: Flood Forecasting and Warning Centre, Bangladesh (2006)

1.2 Research Objectives and Questions

The frequent occurrence of disastrous floods results in losses for both human life and property values in Bangladesh. This study thus is set forth to examine the relationships between socioeconomic conditions and vulnerability to flood hazards. Such examinations would be instructive for both short term and long term poverty alleviation programs and risk management strategies in rural Bangladesh.

The endeavor of this study is to search the answers of the following key questions:
1. Who are the most vulnerable to monsoon and flash floods and how vulnerable are they?
2. What are the significant factors of vulnerability to floods in rural Bangladesh?
3. What coping strategies are followed by the flooded households and why?
4. Which methodology is suitable to estimate household vulnerability to floods in Bangladesh?
5. Which types of interventions are most likely to reduce vulnerability in rural Bangladesh?

Only a few studies exist which deal with floods and vulnerability in Bangladesh. Ninno et al. (2001) describe their findings from a survey of 757 rural households in seven flood-affected regions in Bangladesh after the flood in 1998. According to the authors, overall rice crop losses accounted for over half of the total agricultural losses that represent 24 percent of the total value of anticipated agricultural production for the year 1998. Brouwer et al. (2007) conduct a study on about 700 floodplain residents along the river Meghna in the southeast region of Bangladesh and show that households with lower income and lesser access to natural productive assets face higher exposure to risk of flooding. Kuhn (2002b) describes in his study from a floodplain in Bangladesh that households facing agricultural deficit are using remittances from urban migrants as a coping strategy instead of taking loans. Afsar (1999) shows from a study in rural Bangladesh that poorer households of the population tend to leave their homes immediately after the great floods and view migration as a temporary measure. In addition, households who lost their durable and productive assets are forced to become

11

permanent migrants to nearby urban areas. Recurrent floods that cause crop and livestock losses impoverish many farmers, especially small-scale farmers, resulting in increased indebtedness, land sales, unemployment and migration to urban areas in Bangladesh (Currey 1978). Montgomery (1985) illustrates, from Bangladesh's crop production statistics from 1969 to 1984, that diversified rice production is usually higher in years with high floods. Farmers who cultivate deepwater rice instead of low-water rice during flood seasons get benefit in high flood years. The extra moisture provides a bumper production of wheat just after the flood season (Brammer 1990). Therefore, to unveil the main research questions this study initiates with the following hypotheses:

1. Flooded households are more vulnerable than non-flooded households in rural Bangladesh.
2. Households whose main source of income is from agriculture are more vulnerable than others.
3. Income and crop diversification reduce households vulnerability to floods.
4. Rural-urban migration plays a significant role to mitigate vulnerability to floods.

1.3 Outline of this Study

This study inaugurates with the introductory chapter that depicts the reasons for choosing this topic and the main objectives. Chapter two describes the conceptual ideas on vulnerability from a literature review. The theoretical framework and four different methodologies are shown in detail in chapter three. Chapter four delineates the historical background of floods in Bangladesh and gives a short description of the topography of Bangladesh. This chapter also illustrates the sampling design and a brief description of surveyed areas, exploration of data, detection of outliers and results of descriptive analyses. Econometric analyses on households' poverty and vulnerability and their estimates are revealed in chapter five. Chapter six enumerates the coping strategies of flooded households and some diversification issues to mitigate further flood risk to rural livelihoods of Bangladesh. Finally, chapter seven summarizes the findings from this study and derives some policy recommendations.