

Introducing a Micro-Flood Insurance Market in Bangladesh: Institutional Design and Commercial Viability

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Abstract

The main objectives of this paper are to design and test the commercial viability of the introduction of different flood insurance schemes in Bangladesh, one of the poorest and most flood struck developing countries in the world. The study presented here takes place in the context of both low supply due to the inherent risky nature of high expected losses caused by flooding and low insurance demand due to lack of financial income resources of large parts of the floodplain populations. In this paper we compare the expected compensation payment by potential insurers with the expected premium for different flood insurance schemes under two different institutional-analytical models: a partner-agent and full service model of micro-insurance. We find that although demand and willingness to pay (WTP) for flood insurance are low in flood risk areas in Bangladesh, commercially viable markets exist for house property and unemployment insurance. However, administrative implementation costs of micro-insurance play a significant role in determining the viability as well as the long-term sustainability of micro flood insurance schemes. The policy implication of the work presented here is that partner-agent models of micro-insurance organization are a precondition for the long-term sustainability of a micro flood insurance market. We conclude that a full service based organizational structure is only viable in places where flood probability is considerably low.

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1. Introduction

Impact assessments carried out by the Intergovernmental Panel on Climate Change (IPPC) identify Bangladesh as one of the world's worst possible victim countries to negative impacts of anticipated climate change. Both coastal as well as inland habitants in Bangladesh face increased risk of natural disasters due to its geographical location and very low land elevation. The amplified volume of rainfall caused by climate change during the past decades has already intensified the flood problem, especially in riverine floodplain areas. Those expected to be hardest hit by flood disaster are the poorer segments of society who lack adequate means to take protective measures and have very little capacity to cope with the loss of property and income (IPPC 2001). Traditionally, the management of flood disaster risks in Bangladesh is focused on infrastructural measures such as building embankments, and ex-post flood relief measures, including an increasing access to post-disaster credit facilities etc. In recent years, the concept of 'pro-active adaptation' has gained increased attention in poverty alleviation programs in Bangladesh to deal with natural disaster risks. The National Adaptation Programme of Action (NAPA), prepared by the Ministry of Environment and Forest (MOEF), suggests exploring options for spreading natural disaster risks by investigating the potential of a flood insurance market so that the poor counterpart of the populace is better prepared to cope with increased climatic disasters such as flood, cyclones and drought. Two feasibility studies, one by the Ministry of Commerce and another by the Department of the Environment, are currently underway to test the feasibility of crop insurance in the most calamity prone areas of Bangladesh.

In the literature about climate change and adaptation, micro-insurance is often referred to as an effective tool for reducing, sharing or spreading climate-related costs and risks (Bouwer and Vellinga 2002, Hoff et al. 2003 Mills 2004). However, besides its political-institutional embedding and public trust in the micro-insurance providing agents, the commercial viability of such insurance schemes has always been a key challenge for poor developing economies as the transfer of losses from affected groups to the community at large is not feasible at an affordable premium rate (Skees et al. 1999). As a result, the associated costs of providing such insurance schemes historically outweighed the gains from risk spreading. Although the experience and available information are too limited to reach any conclusion about such schemes, disaster risk insurance has overall not been very successful based on standard commercial criteria throughout the world. Especially in developing countries where the poorest parts of the population often find themselves in a spiral of recurrent damages due to natural calamities, disaster insurance schemes fail to earn premium income to cover payouts as well as administrative costs (Hazell, Pomarelda and Valdes 1986, FAO 1991, Anderson 2001, Quiggin et. al 1993, Spaulding et. al 2003, Gurenko and Mahul 2004).

The aim of the study presented here is to design various micro flood insurance schemes and test their viability as an important alternative poverty alleviation and natural disaster mitigation strategy by referring to empirical evidence collected through a large-scale rural household survey in different risk areas in Bangladesh. 2400 floodplain residents living near the three major rivers in Bangladesh are asked for their preferences for a number of possible micro flood insurance schemes using the contingent valuation (CV) method, i.e. asking them for their willingness to pay (WTP) for different insurance schemes to eliminate future flood risks by paying a risk premium amount. We compare the expected WTP for different flood insurance schemes with expected payouts by insurance providers assuming different flood probabilities (measured through disaster flood return periods) and interest rates under two different institutional micro-insurance models: (a) a partner-agent model (PA) and (b) a full service (FS) model. Although signifi-

cant number of theoretical and empirical work exist in the literature of catastrophic insurance, such an extensive ex-ante feasibility test to determine institutional framework of catastrophe insurance in a developing country is currently lacking. Our results indicate that the institutional framework of micro-insurance play a significant role in determining the viability as well as the long-term sustainability of micro flood insurance schemes. We find strong evidence in favour of a PA model for achieving commercial viability and hence, long term sustainability of flood insurance market in Bangladesh. We conclude that a FS based organizational structure of micro-flood insurance is commercially viable in places where flood probability is considerably low.

The remainder of this paper is organized as follows. Section 2 presents and details the analytical framework underlying this study, and section 3 the survey design. General characteristics of the floodplain residents included in our sample and the nature and extent of the flood damages suffered are the main subject in section 4. The results regarding demand and WTP for the various flood insurance schemes are presented in section 5. The commercial viability of the various micro flood insurance schemes is addressed in section 6. Finally, Section 7 concludes.

2. Analytical framework

For longer term sustainability of micro insurance in effectively transferring and hedging natural disaster risk, the existing literature considers four key criteria, i.e. contribution to risk reduction, financial robustness, affordability and governance (ProVention/ IIASA 2005). Among these four criteria, the conditions of financial robustness and affordability are often considered the most challenging criteria to be fulfilled in developing economies given the nature of the environmental and financial risks faced by the insurer and the financial constraints faced by the insured. Natural disaster insurers often face the risk of having to compensate very large losses due to a disaster event that affects clients in an entire community or region. As a result, the standard principle of paying out damage compensation to affected clients by pooling resources from non-affected clients is not applicable due to the scale and nature of the disaster risk, and the scope of reinsurance for disaster insurance scheme is marginal or the cost of reinsurance extremely high (ProVention/ IIASA 2005).

On the other hand, in low-income economies insurance demand often is substantially low due to limited financial resources and has therefore been found inadequate to ensure risk pooling even within the community or region. Based on the assumption that an individual can correctly assess and estimate the probability of a catastrophe and associated possible losses, factors that have been found to have a significant effect on insurance demand are wealth, loss probability, insurance premium, the kind of product exposed to damage risk and the nature of the individual' utility function (Smith 1968). Households exposed to the risk of natural catastrophe in poor economies usually make up the poorer segments of society. A previous case study in one of the most flood prone areas in Bangladesh shows that poor households are indeed more exposed to the risk of flooding than wealthier households, who are furthermore also able to better cope with preventing damage costs (Brouwer et al. 2007). This study also revealed that poorer households suffer from relatively higher damage costs as a result of flooding. Another study conducted in the same floodplain area revealed that 60 per cent of the floodplain residents refuse to pay for the construction of a protective embankment (an implicit insurance scheme) in the region. 80 per cent of these floodplain residents are unable to pay because of a lack of financial means (Brouwer et al. 2006). The study furthermore reveals a positive relation between WTP for flood protection through the construction of an embankment and average annual household income, which suggests that higher income households are

willing to spend more money (i.e. pay a higher flood protection premium) to protect themselves against flood damage risk. The findings of these two studies explain why poorer segments in low-income economies are under-insured. Floodplain residents are more than anyone else aware of the risk exposure level they face. However, they exhibit low demand for flood insurance because of lack of adequate financial income resources.

In the context of both low demand and supply of natural disaster insurance schemes, we construct a model to test the commercial viability of such an insurance scheme in Bangladesh. The theoretical model of this study is adopted from a simple analytical model used by Hazell (1992) to evaluate the sustainability of public crop insurance programs in seven countries from different parts of the world. According to this study, the premium collected on an insurance scheme must exceed average payouts in order to ensure the viability of the insurance contract, where average payout is modeled by summing up both administrative costs per insurance contract and indemnities. The condition for a viable and sustainable insurance contract is of the following form (Hazell 1992):

$$(A + I) / P < 1 \quad (1) \quad (1)$$

Where A = average administrative costs per insurance contract

I = average indemnities paid

P = average premiums paid

Hazell (1992) uses time series data over the period 1975-1989 for seven different countries to test the long-term viability and sustainability of crop insurance programs. In our study we do not have actual insurance data in view of the fact that there does not exist an insurance market yet. Instead we estimate the model using expected values of indemnity and household's WTP a premium per insurance scheme using data obtained from a large-scale rural household survey. Hence, the average costs and revenues in Hazell's (1992) formula are replaced by expected values.

Expected indemnity payments for different insurance schemes are proxied by average damage costs incurred by households in the disaster flood year of 2004. The term 'Indemnity' refers to the compensation sum that insurers make to the holder of the insurance contract upon post assessment of damage due to a disaster flood. We hypothesized a simple design of indemnity function of the following form:

$I_i = D_i$ If Disaster flood strikes

$I_i = 0$ If Disaster flood does not strike

Where,

I_i = indemnity paid

D_i = damage incurred by insured

i refers to a specific insurance scheme.

We use the amount of average damage incurred by households during the disaster flood in 2004 as average expected compensation amount that insurers need to pay upon submission of a legitimate compensation claim. The information about the administrative implementation costs of an insurance scheme is collected from the largest micro-credit provider in Bangladesh (Grameen Bank). Over the period 2002 to 2005, Grameen Bank incurred an average administrative cost of US\$10¹ per borrower per year for all its mi-

¹ The exchange used here is 65 taka per US \$.

cro-credit transactions (Grameen Bank 2006). We use this information as a proxy for the expected administrative cost of the introduction of a new micro flood insurance contract, ignoring for the moment any possible economies of scale, start-up and learning costs by assuming that the micro-flood insurance will be introduced and supplied within the existing institutionalized network of micro-credit provision. We test the financial viability of the introduction of a new micro flood insurance contract applying a higher (US\$15) and lower (US\$7.5) bound around these administrative transaction costs.

We furthermore apply two different institutional-organizational models: a ‘Partner–Agent’ (PA) model and a ‘Full-Service’ (FS) model (Cohen and McCord 2003). The basic difference between these two models arises due to the institutional-organizational structure that causes a substantial difference in terms of the implementation and administration cost of the supplied micro flood insurance contracts. In a PA model, insurance companies and micro-credit providers collaborate to jointly offer the insurance schemes. Generally, insurance companies bear the full risk, while micro-credit providers carry out most of the field level operational and administrative work through their established extensive client network. Administrative cost of offering, distributing and maintaining insurance contracts under such a scheme is reduced either to zero or to a very negligible amount per insurance contract. On the other hand, in a FS model, commercial and/or public insurers provide all kinds of services, starting from risk bearing, product designing, distribution, premium collection, damage assessment and compensation disbursement. This kind of institutional organizational structure of offering insurance involves a significant amount of administration and transaction cost.

Expected premiums per contract for different insurance products are estimated on the basis of data originating from a large-scale CV survey. In this study, we use a double-bounded dichotomous choice (DB DC) elicitation method. The DC CV format was originally developed to increase the incentive-compatibility of the valuation question (e.g. Mitchell and Carson 1989). Kriesel and Randall (1986) show that this format gives respondents the most appropriate incentive to reveal their preferences. In this method respondents are asked two WTP questions: do you accept a start bid c_i and do you accept a follow-up bid b_i . Based on these two questions, four possible intervals for WTP can be constructed, namely:

- WTP=1: Rejecting both the start bid (c_i) and follow-up bid (b_i)
WTP=2: Rejecting the start bid (c_i) and accepting the follow-up bid (b_i)
WTP=3: Accepting the start bid (c_i) and rejecting the follow-up bid (d_i)
WTP=4: Accepting both the start bid (c_i) and follow-up bid (d_i)

In other words,

- WTP=1 if $WTP < b_i$
WTP=2 if $b_i < WTP < c_i$
WTP=3 if $c_i < WTP < d_i$
WTP=4 if $WTP > d_i$.

Mean and median WTP are inferred from the underlying statistical distribution of the probability that respondents say ‘yes’ or ‘no’ to different bid levels (Hanemann and Kanninen 1999). Different mean WTP values can be calculated depending on the statistical specification of the valuation function and the applied truncation strategies.

3. General Survey Design

Five different districts located near or at the three major rivers in Bangladesh (Padma, Meghna and Jamuna) were selected on the basis of damage intensity levels observed and monitored during the 2004 disaster flood. Based on the flood damage intensity map published in the Rapid Flood Assessment Report by the Centre for Policy Dialogue (CPD 2004), we originally selected one district with low flood damage intensity, two districts with medium and two districts with a high flood damage intensity level. From these five main districts we selected six sub-districts (called ‘upazilla’) that lie closest to the main rivers. Lower administrative units such as ‘district unions’ and ultimately individual villages were chosen from these sub-districts based on random sampling. Approximately 120 interviews are conducted in four villages in one union. In total around 600 household heads were interviewed in each sub-district. The area-wise distribution of the sample is presented in Table-1.

Table 1 Distribution of sample across different districts with different risk levels.

District name	Risk level	Sample size
Homna	High	361
Meghna	High	240
Harirumpur	High	399
Sariakandi	Medium	600
Bera	Medium	200
Veramara	Low	601
Total		2401

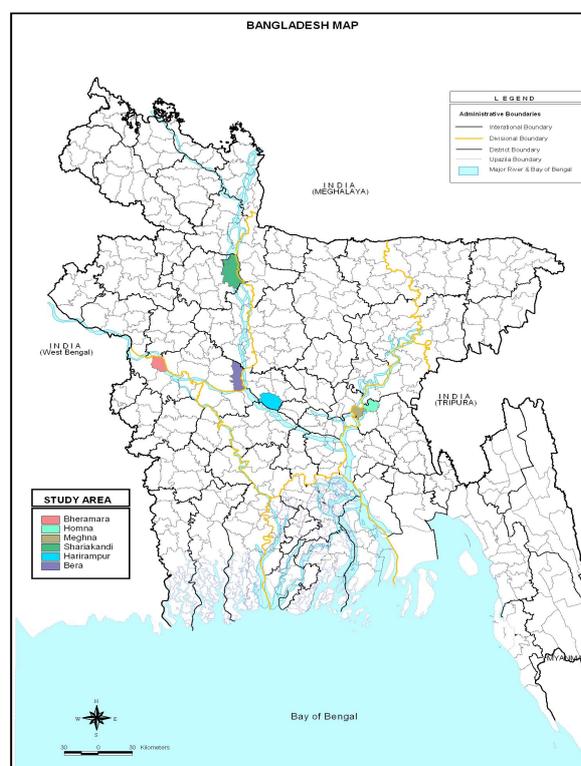


Figure 1 Geographical location of the case study area.

See Figure 1 for geographical location of these study areas. The selection of households in each of the villages followed a systematic random sampling method where every fifth household located along the right side of the main village road was interviewed. Only head of households were interviewed in this survey. The questionnaire used in this case study was developed based on one focus group discussion and three pre-tests with approximately 40 individual household heads in different parts of the study area. Questionnaire design started in June and lasted until August 2006. In total, 2400 household heads were interviewed during the final survey from the third week of August until the first week of October 2006 by 15 trained and experienced interviewers. The interviewers used for the general survey also participated in the pre-tests and were trained during a three day long training session.

The questionnaire that was used for the final survey consisted of around 50 questions and was divided into three sections: 1) Socio-demographic respondent characteristics (e.g. age, occupation, educational background, family size, sources of income, assets, standard of living etc.); 2) Type and extent of suffering from annual and incidental disaster flooding (e.g. flood frequency, flood duration, inundation level, flood damage (type and extent), level of preparedness etc.); 3) CV questions. In the CV part of the questionnaire, respondents were able to freely choose payment frequency, insurance provider and insurance products. The 'flood insurance product' was offered to the respondents in the following form:

I would now like to ask you a number of questions related to the potential of introducing a flood insurance scheme in this area. The principle of the proposed insurance scheme is as follows: you pay a fixed amount of money for the next five years - an insurance premium - every week, two weeks or month depending on your preferred payment frequency. Only in the case of an officially acknowledged disaster flood, like the one in 2004, you will get compensated for any losses you suffered due to the disaster flood. If there is a disaster flood and you claim compensation, an independent surveyor will visit you and assess the extent of damage you suffered. Based on the surveyor's independent assessment you will be compensated. The terms and conditions of your insurance scheme are protected by law.

After a detailed description of the insurance scheme, respondents were asked three WTP questions. First, respondents were asked whether or not they would be willing to participate in principle in an insurance scheme to reduce the risk of various forms of flood damage. Respondents who replied positive to the first WTP question were then asked how frequently they would want to pay for their most preferred insurance scheme and who they would prefer to have as the provider of the insurance scheme. The valuation question was introduced after this, asking respondents for a weekly premium ranging between Tk 5 (US\$ 0.07) and Tk 50 (US\$ 0.71). A total of six different start bids were used. The bid levels were assigned randomly across respondents to avoid starting point bias (Mitchell and Carson 1989). The weekly premiums were based on a previous large-scale CV survey carried out in March 2005 to test household WTP for a flood protection embankment in one of the study areas (for details see Brouwer et al 2006) and thorough pre-testing in three pre-tests. The yes/no DC question were followed up by two closed-ended WTP questions, asking participants whether they would be willing to pay a higher or lower amount.

4. Floodplain resident characteristics, flood risk exposure and flood damage

99 per cent of the 2400 household heads interviewed are men. Most people (85%) are furthermore born and raised in the sub-district where they are interviewed. The average age of the respondents is between 42 and 44 years. About half of the respondents are unable to read and write. Just over a quarter finished primary school and only ten per cent finished high school. The households consist, on average, of five family members. Around one third (35%) of our sample households are involved in agricultural activities to support their livelihood. In addition, approximately 16 per cent of the sample population consists of agricultural day labourers. Trade (15%), transport (taxi, ferry) (5%), service (administrator) (6%) and fishery (1.5%) are other livelihood sources of sample households. Almost all households own the house they live in, and a majority of 57 per cent owns the land they grow their crops on. A tube well is the main source of drinking water for a majority (99%) of the households and only one quarter of the households has a sanitary latrine in their dwelling. Half of the sample households do not have an electricity connection. Most of the households use leaves and cow dung as their main source of energy.

Average annual household income (related to the past 12 months) is about US\$ 1,291, while half of the sample population earns US\$ 846 per year. Dividing the median yearly income by average household size and 12 months, average per capita income equals US\$ 14 per month, which is exactly the same as the national average rural per capita income (BBS 2005). Using the poverty income definition of the Bangladesh Bureau of Statistics (poverty threshold value of US\$ 125 per capita per year), 43 per cent of the floodplain residents included in the sample appear to live below this poverty threshold. According to the Report of Household Income and Expenditure Survey, 2000, 49 per cent of the total population in Bangladesh lives below the upper poverty line (HIES 2003). We hence conclude that our sample is more or less representative in terms of household and per capita income levels.

A majority of 97 per cent of the interviewed floodplain residents are exposed to catastrophic flooding occurring once every five years. On average, each disaster flood lasts for 35 days, with a maximum duration of 90 days and a minimum duration of only one day. The disaster flood risk exposure level of sample household is presented in Figure 2. Around two thirds of the sample suffer from inundation inside their house during a disaster flood event, whereas in about half of the cases households suffer from inundation depths of up to one feet or more inside their house.

Average flood damage costs are US\$ 365 per household per catastrophic event. This amounts to approximately 30 per cent of average household income. Median flood damage costs are half of this amount (US\$ 190). Dividing this by the median value for household income, the share of damage in household income is slightly lower, namely 22 per cent. The minimum damage costs are zero and the maximum US\$ 12,500. Trimming off the five per cent lowest and highest values, the average damage cost estimate is US\$ 277 per household per year. Most flood damage is caused by damage to fishponds, followed by damage to agricultural crops and house property. Other damage categories include income losses due to unemployment, damage to livestock, poultry and fruit trees. The relative share of these different damage cost categories to the total damage costs are presented in Figure 3.

5. Floodplain residents' WTP for different micro-insurance schemes

In this section, we present the general WTP results of our study and the calculation of average expected premium to be paid by floodplain residents for three most preferred insurance schemes. After a detailed description of the hypothetical flood insurance program, respondents were first asked whether or not they were willing to buy insurance in principle to reduce the risk of various types of flood damage. 51 per cent (n=1240) of the 2400 respondents said 'yes' to the first WTP question. A majority (45%) of those who were not WTP for flood insurance in principle indicated lack of money income as the most important reason. A considerably high number of respondents (n=366 or 31%) refused to buy flood insurance, because they disliked the stated terms and conditions of the proposed insurance schemes. Other reasons for not wanting to participate in a flood insurance scheme included "I am unable to assess the usefulness of such an insurance scheme (7%)" and "I do not believe that I will actually be compensated (5%)".

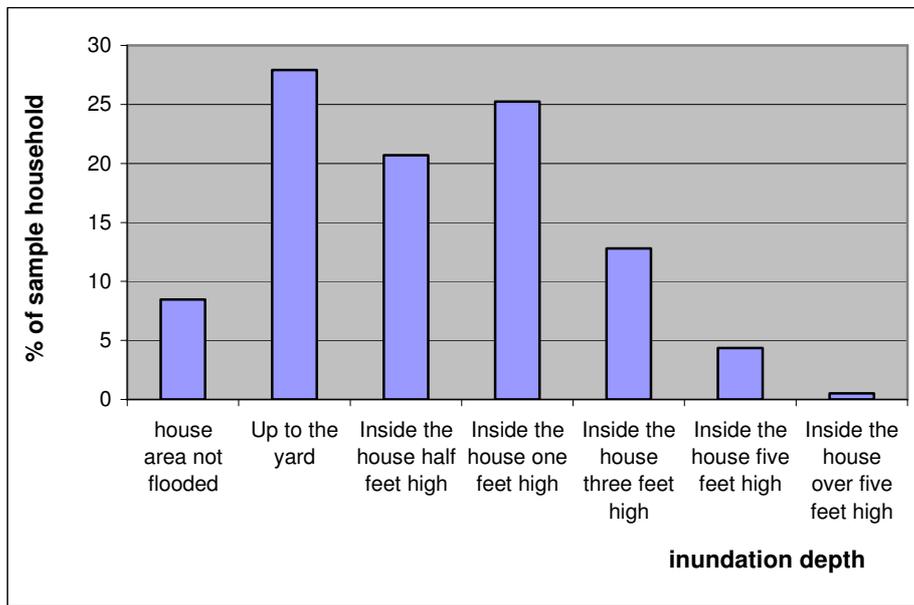


Figure 2 Percentage of households suffering from flood at different inundation levels.

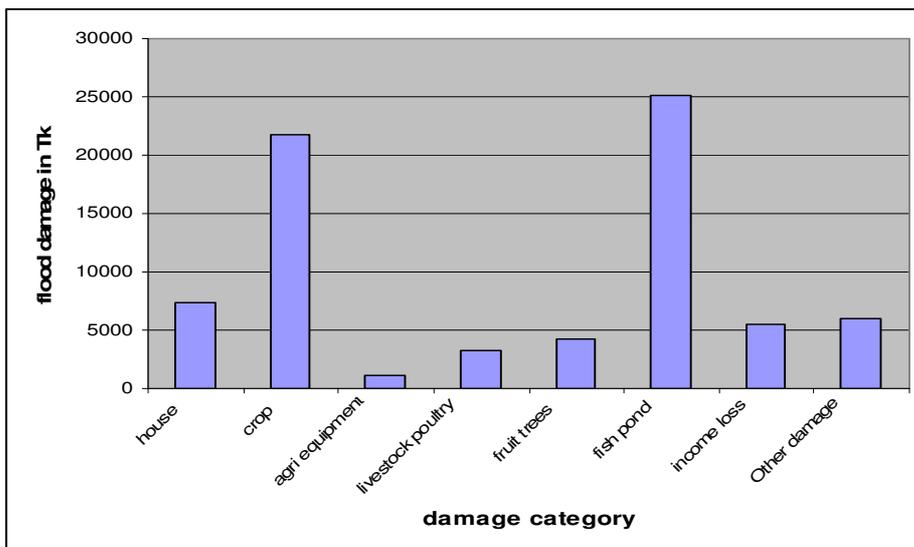


Figure 3 Average disaster flood damage incurred by floodplain households, distinguishing between different damage categories.

Respondents, who agreed to buy flood insurance scheme in principle, were given the opportunity to choose insurance products (they are allowed to choose multiple insurance products). Figure 4 presents floodplain residents' preference for different insurance schemes. Two third of the sample households wanted to insure their crop yield against flood risk while over more than 40 per cent of the sample floodplain residents wanted to buy insurance for house property damage followed by around 35 per cent of the respondents who preferred unemployment insurance. Respondents were, furthermore, offered monetary premium amount for their desired insurance scheme in DC CV format. 60 per cent of the respondents (n=744) who agreed to buy flood insurance in principle accepted the first bid amount. This group of respondents (who accepted the first bid amount) were offered a higher bid value in a follow-up question in DC format. Majority (80%) of the respondents who accepted the first bid value also accepted the higher bid value. On the other hand, 40 per cent of the respondents who rejected the first bid amount were offered a lower bid amount in a follow-up question. Majority (75%) of the respondents who rejected first bid accepted the lower bid amount. Respondents who rejected the higher bid value or both first bid as well as second bid value were subsequently asked the reason for rejecting the bid amount. 90 per cent of the respondents indicated that the bid amount they were asked to pay is too high in comparison of their available financial resources.

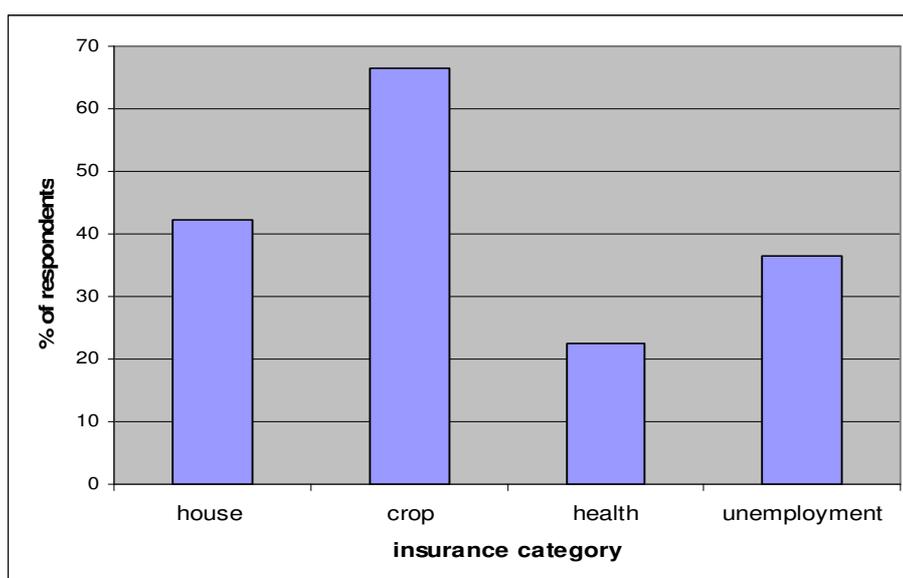


Figure 4 Floodplain residents' preference over different insurance scheme.

At this stage, we derive mean WTP from a simple model where the bid intervals are regressed on the starting bid (e.g. Hanemann and Kanninen 1999), following the conventional procedures for binary WTP response data (Hanemann 1984). Standard errors of the WTP values are calculated based on bootstrap procedures (e.g. Efron and Tibshirani 1993). The results are presented in Table 2. Because of the fact that estimation of average WTP requires considerably large number of observations, we could only calculate average WTP for three most preferred insurance schemes and we ignore the rest. Floodplain residents' WTP is highest for the crop insurance scheme, followed by WTP for the house property insurance and lowest for the unemployment insurance. Although the difference between mean WTP for the house and unemployment insurance are very close, the difference is nevertheless statisti-

cally significant. Mean WTP for the crop insurance is almost 40 Taka per household per week, almost 30 Taka for the house insurance and 28 Taka per week for the unemployment insurance.

Table 2 Mean WTP (in US \$/household/week) for three different insurance schemes².

	Insurance scheme		
	House property	Crop	Unemployment
Mean WTP (US\$/week)	0.45	0.60	0.43
Standard error	0.00123	0.00123	0.00123
95% CI	0.43-0.47	0.57-0.62	0.408-0.46
N	527	822	453

Using the WTP results presented in Table-2, we calculate the future value of the average expected premium receivable by insurer using the following formula:

$$P_{ei} = WTP * \frac{(1 + r)^n - 1}{r} \quad (2)$$

Where

P_{ei} = Future Value of insurance premium (per insurance contract)

r = nominal interest rate

n = number of payments

WTP= average willingness to pay for insurance scheme

i refers to a specific insurance scheme.

We used three different flood probabilities to measure the number of payments households make (n): a) high b) medium and c) low. The high, medium and low flood probabilities refer to situations when disaster event triggers off once in every five years, eight years and ten years respectively. We, furthermore, used two different market interest rates, namely: i) 5% and ii) 10%. Table 3 presents results of estimated future value of expected insurance premium receivable by the insurance provider for different insurance schemes based on various flood probabilities and market interest rates. The future values of the expected insurance premium presented in Table 3 are affected by three key factors: 1) average WTP for each insurance scheme 2) flood probabilities (used to calculate the number of installments) and 3) rate of interest. The higher is the estimated average WTP for an insurance scheme, the higher the future value of the expected insurance premium. Consequently, crop insurance has the highest expected insurance premium receivable by the insurance providers and unemployment insurance scheme has the lowest. Furthermore, the lower the probability of disaster events, the higher is the number of premiums paid by the insured and therefore the higher the future value of the expected insurance premium receivable by the insurer. Finally, future expected premium receivable varies positively with market rate of interest. The lower the rate of interest, lower is the future value.

² The exchange used here is 65 taka per US \$.

Table 3 Future Value of Expected Insurance Premium for different insurance schemes in (US\$).

Flood Probability		High		Medium		Low	
Interest rate		5%	10%	5%	10%	5%	10%
Insurance product	Crop	173.42	199.56	298.70	376.93	392.54	528.41
	House Property	131.53	151.35	226.55	285.88	297.72	400.77
	Unemployment	126.13	145.13	217.24	274.13	285.49	384.30

6. Testing the commercial viability of different micro-insurance contracts

Table 4 presents our results of the commercial viability test of the different insurance schemes that we calculate using equation 1 presented in Section 2, assuming a PA model where administrative cost is assumed to be zero. The indemnity to premium ratio (I/P) for crop insurance remains marginally below one in a PA model when flood probabilities (measured through flood return period) are medium and low (once in every eight years and ten years) and the market interest rate is high (10%). In all other combinations of flood probabilities and interest rates, the I/P ratio for crop insurance exceeds one, which implies that the expected average premium floodplain households are willing to pay to reduce crop damage risk due to disaster flooding is too low to cover the expected average indemnity, even at a zero administrative cost. However, the I/P ratios for the two other insurance schemes, house property and unemployment, are less than one for every possible combination of flood probability and interest rate. This implies that in a PA model house property insurance and unemployment insurance are financially viable as households' expected average WTP exceeds expected indemnity values.

Table 4 Financial viability of three micro-flood insurance contracts assuming zero administration costs of implementation (PA model).

Flood Probability		High		Medium		Low	
Interest rate		5%	10%	5%	10%	5%	10%
		I/P	I/P	I/P	I/P	I/P	I/P
Insurance product	Crop	1.93	1.68	1.12	0.89	0.85	0.63
	House Property	0.86	0.75	0.50	0.40	0.38	0.28
	Unemployment	0.67	0.59	0.39	0.31	0.30	0.22

Changing the institutional design from a PA to a FS model results in a substantially different outcome in the insurance contracts' commercial viability. Table 5 presents the ratio of expected average payouts (indemnities plus positive administration costs) to expected premium $[(A+I)/P]$ for different insurance contracts assuming a FS model. To test the financial viability of the various insurance schemes in a FS model, we now combine one more criterion (administration cost) with flood probability and interest rate. In the case where we assume the highest flood probability (flood return period once every five years), the ratio of expected pay-out (including administrative cost per insurance contract) to expected premium exceeds one for all flood insurance schemes irrespective of the level of market interest rate and the amount of administrative cost incurred by the insurance providers. However, the $[(A+I)/P]$ ratio exceeds one in almost all possible com-

binations of flood probability, interest rate and administration cost for the crop insurance scheme except in one case where both the flood probability and administrative cost are low and market interest rate is high

Incorporation of administrative costs shows interesting results for other two insurance schemes. Given the fact that the insurance provider incurs low supply cost per insurance contract per year, both house property and unemployment insurance schemes are financially viable in a medium flood probability zone irrespective of the market interest rate. In the event of high an administrative cost per insurance contract, the financial viability prospect of these two insurance schemes does not seem very bright as the ratio of expected pay-out (including administrative cost per insurance contract) to expected premium exceeds one as administrative cost goes up. Both of these insurance schemes are, furthermore, financially viable in a low flood probability zone irrespective of the level of administrative cost and market interest rate; the (A+I)/P ratio lies below one in all possible combinations of interest rate and administrative cost in a low flood probability area. This implies that house property and unemployment insurance schemes are financially viable in a low flood probability area under FS model. The commercial viability and long term sustainability of house property and unemployment insurance schemes under a FS model in a medium flood probability zone largely depends on the level administrative cost incurred by the insurance provider.

Table 5 Financial viability of three micro-flood insurance contracts assuming positive administration costs of implementation (FS model).

Flood Probability		High				Medium				Low			
Interest rate		5%		10%		5%		10%		5%		10%	
Administrative Cost (US\$/ year)		7.5	15	7.5	15	7.5	15	7.5	15	7.5	15	7.5	15
		(A+I)/P											
Insurance product	Crop	2.18	2.42	2.15	2.62	1.37	1.61	1.12	1.36	1.04	1.23	0.87	1.10
	House Property	1.19	1.51	1.37	1.99	0.82	1.15	0.70	1.01	0.63	0.87	0.59	0.89
	Income loss	1.01	1.35	1.23	1.88	0.73	1.07	0.63	0.95	0.56	0.81	0.54	0.86

7. Discussion and conclusion

The main objectives of this paper were to design and test the commercial viability of various flood insurance schemes in Bangladesh in the context of both low supply due to the inherent risky nature of this business and low insurance demand and WTP due to a lack of financial income resources of floodplain residents. We compared the expected compensation payments by insurers with the expected premiums for three most preferred flood insurance schemes under two different institutional models: a partner-agent (PA) and full service (FS) model of micro-insurance.

Average expected premium per insurance contract for different kinds of insurance product is estimated on the basis of CV survey. We used DB DC CV format to elicit respondents' WTP premium for flood insurance schemes where the first yes/no DC question was followed up by two closed-ended questions setting upper or lower bounds. We found around half of the sample households willing to buy flood insurance schemes in principle which indeed indicates quite low demand for flood insurance in riverine floodplain areas of Bangladesh. Majority of those respondents who did not agree to buy insurance indicated lack of money income as reason for not buy-

ing insurance. This finding one more time confirms that income constraint is major demand side obstacle to set-up flood insurance scheme in Bangladesh. Floodplain residents, who were willing to buy flood insurance schemes, exhibited highest WTP for the crop insurance scheme, followed by WTP for the house property insurance and lowest for the unemployment insurance.

On the basis of the WTP data obtained from our household survey, we calculate expected average premium receivable by insurance providers and the values have been further tested for sensitivity by varying flood probabilities (measured through different flood return periods) and interest rates. Expected average premium receivable per insurance schemes increases with the decrease of flood return period and decrease of interest rate. Furthermore, we found average expected premium receivable varying significantly across insurance schemes. Crop insurance scheme have the highest premium receivable, followed by house property insurance and unemployment insurance scheme the lowest.

Crop insurance has been proven to be a losing venture in both organizational structures of micro-insurance models (PA and FS) that we tested for and all kinds of flood probabilities (high, medium, low) and interest rates. However, house property and unemployment insurance schemes have been found to be financially viable irrespective of the flood probabilities and interest rates in a PA model. On the other hand, all kinds flood insurance schemes have been found to be not viable in a FS model when flood probability is very high (once in every five years). When flood probabilities goes down (once in eight years and less) house property and unemployment insurance have been found to be viable conditional upon the fact that administrative cost of insurance contract is low.

The findings of the study help us to reach the following conclusions: (1) although demand as well as WTP premium for flood insurance scheme is very low in Bangladesh, commercially viable market exists for some insurance schemes namely house property and unemployment insurance. (2) Administrative cost plays significant role in determining the commercial viability and long run sustainability of flood insurance schemes. The policy implication of our study is this that for Bangladesh, PA model of microinsurance organization structure is a precondition for long term sustainability of flood insurance market. A FS based organizational structure is still viable in places where flood probability is considerably lower.

References

- Bangladesh Bureau of Statistics. (2003). *Report of Household Income and Expenditure Survey, 2000*.
- Bangladesh Bureau of Statistics (BBS). (2001). *Population Census 2001*. Preliminary Report. Government of Bangladesh, Dhaka
- Brouwer, L. M. & Vellinga, P. (2002). Changing Climate and Increasing Costs – Implications for Liability and Insurance. In: M. Beniston (ed.) *Climatic Change: Implications for the Hydrological Cycle and for Water Management*, pp. 429–444 (Dordrecht and Boston, Kluwer Academic Publishers).
- Brouwer, R., Akter, S., Brander, L & Haque, A.K.E. (2007). Socio-economic vulnerability and adaptation to environmental risk: A case study of climate change and flooding in Bangladesh. *Risk Analysis*, 27 (2), pp. 313-326
- Brouwer, R., Akter, S., Brander, L., & Haque, A.K.E. (2006). *Economic valuation of flood risk exposure and flood control in a severely flood prone developing country*. PREM Working Paper 06-02.

- Centre for Policy Dialogue. (2004). *Interim Report-Rapid Assessment of Flood (2004)*. Dhaka, August 2004.
- Cohen, M. & M. McCord (2003). *Financial Risk Management Tools for the Poor*. In ADA, Microinsurance Centre Briefing Note #6. MicroinsuranceCentre.
- Efron, B. & Tibshirani, R.J. (1993). *An introduction to the bootstrap*. (Chapman and Hall, New York).
- Grameen Bank Performance Indicators & Ratio Analysis (2006). <http://www.grameen-info.org/bank/performanceindicators.html>
- Hanemann, W.M. (1984). Welfare evaluations in contingent valuation experiments with discrete responses. *American Journal of Agricultural Economics*, 66, pp.332-341.
- Hanemann, W.M. & Kanninen, B. (1999). The statistical analysis of discrete-response CV data, In: Bateman, I.J. and Willis, K.G. (eds.) *Valuing Environmental Preferences: Theory and Practice of the Contingent Valuation Method in the US, EU, and Developing Countries*, pp. 302-441 (Oxford University Press).
- Hazell, P.B.R. (1992). The appropriate role of agricultural insurance in developing countries. *Journal of International Development* 4, pp.567-581.
- Hoff, H., L. M. Bouwer, G. Berz, W. Kron & Loster, T. (2003). *Risk Management in Water and Climate – the Role of Insurance and Other Financial Services*. International Dialogue on Water and Climate, Delft, and Munich Reinsurance Company, Munich.
- IPCC. (2001). *Climate Change 2001: Impacts, Adaptation, and Vulnerability*. Intergovernmental Panel on Climate Change, Geneva.
- Kriesel, W. & Randall, A. (1986). *Evaluating national policy by contingent valuation*. Paper presented at the annual meeting of the American Agricultural Economics Association, Reno, Nevada.
- McCord, M. & Cohen, M. (2005). *Microinsurance and Disasters, Steps to Take to Mitigate Risk Next Time*. MicroinsuranceCentre.
- Mills, E. (2004). *Insurance as an Adaptation Strategy for Extreme Weather Events in Developing Countries and Economies in Transition: New Opportunities for Public-Private Partnerships*. Lawrence Berkeley National Laboratory. Report No. 52220. Berkeley.
- Mitchell, R.C. & Carson, R.T. (1989). *Using surveys to value public goods: The contingent valuation method*. Resources for the future. Washington D.C.
- National Adaptation Programme of Action. (2005). *Ministry of Environment and Forest Government of the People's Republic of Bangladesh*. Final Report, November 2005
- ProVention/IIASA. (2005). *Invest to Prevent Disaster Risk*. The potential benefits and limitations of micro-insurance as a risk transfer mechanism for developing countries. Viewpoint for International Day for Disaster Reduction – 12 October 2005, Geneva.
- Skees, J., Hazell, P., & Miranda, M. (1999). *New approaches to crop yield insurance in Developing countries, Environment and Production*. Technology Division (Eptd) discussion paper no. 55, International Food Policy Research Institute, Washington, D.C. 20006 U.S.A.
- Smith, Vernon L. (1968). Optimal Insurance Coverage, *Journal of Political Economy*, 76, pp 68-77.