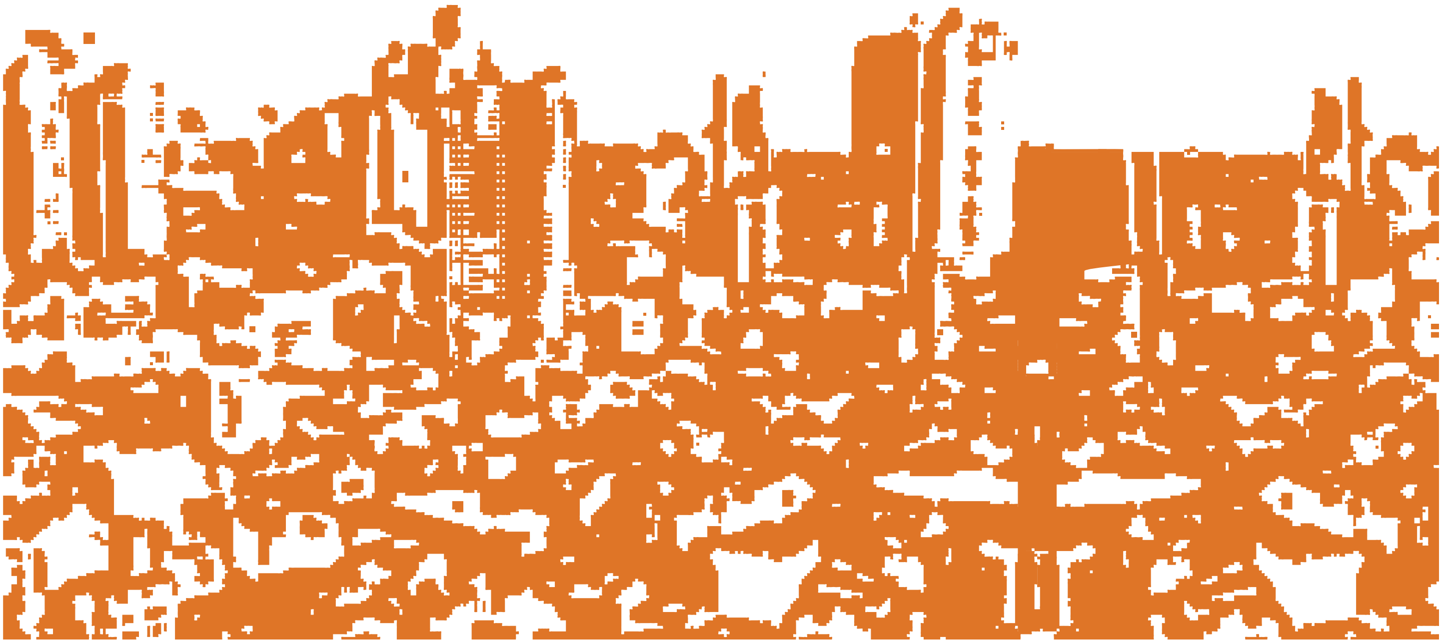
Asian Cities Climate Resilience

WORKING PAPER SERIES 10: 2014

Modelling demand for catastrophic flood index-based insurance in Da Nang City, Vietnam

Using choice experiments

BY BUI DUC TINH AND NGUYEN MANH HUNG



About the authors

Bui Duc Tinh is a lecturer and researcher at the Faculty of Economics and Development Studies, Hue College of Economics, Hue University. He specialises in sustainable development and farm and household economics. He gained his PhD in sustainable development at Auckland University of Technology, New Zealand in 2008 and an MA in sustainable development at Chiang Mai University, Thailand in 2003. He is now a member of the science committee of the Faculty of Economics and Development Studies. Since 2008, Dr Tinh has conducted research relating to climate change, vulnerability, risk and adaptation analyses, funded by the European Framework 6, Economy and Environment Programme for Southeast Asia (EEPSEA), International Development Research Centre (IDRC), Nordic Assistant to Vietnam and Food and Agriculture Organisation of the United Nations (FAO). Parts of these project findings have been published in book chapters and peer-reviewed journal articles. In 2011, Bui Duc Tinh received the Emerald Literati Network's Outstanding Author Contribution Award. Email: bdtinh@yahoo.com.sg

Nguyen Manh Hung holds a Master of Science degree in agricultural economics and rural development from Hue College of Economics, Hue University. He is now a researcher and lecturer for the Faculty of Economics and Development Studies and specialises in agricultural economics and econometrics. Since 2010, he has been involved in research projects on climate change, vulnerability and adaptation. He has had a number of papers published in journals. Email: hunghce83@gmail.com

Hue College of Economics
100 Phung Hung, Hue City, Vietnam
Phone: (+84 54) 3538 332; Fax (+84 54) 3529 491

Acknowledgements

The authors wish to thank the International Institute for Environment and Development (IIED) for funding this research and especially for the support of Diane Archer and Essam Yassin Mohammed from IIED and Tran Huu Tuan from Hue College of Economics, for their valuable supervision and comments on our study proposal and analysis. Without their support, we believe that this working paper could not have been completed.

We would like to express our sincere thanks to Nguyen Hoang Diem My and Vo Viet Hung from Hue College of Economics, Hue University for their support in conducting the fieldwork. Special thanks are also extended to Nguyen The Huynh from Bao Viet Insurance Company and Nguyen Thi My Hanh, Da Nang Women's Union for contributing to the completion of this study.

The analyses and opinions in this report are those of the authors and do not necessarily reflect the views of IIED. The authors alone remain responsible for any errors in this report.

Contents

List of tables and figures

Abstract

Insurance for catastrophic disasters, despite being in the interest of policy makers and private insurers in the context of climate change, has not achieved significant penetration and suffers low financial performance due to a lack of well-designed insurance products. Index-based insurance is one measure to bridge that gap and to cope with weather-related risks, especially in developing countries lacking mechanisms like risk-sharing and pooling programmes. This paper presents the results from modelling demand for catastrophic flood index-based insurance for Da Nang City, Vietnam, by using choice experiments. Da Nang is very vulnerable to climate change-induced disasters, particularly typhoons and floods. Using a combination of qualitative and quantitative methods, the results show that households have taken adaptive measures to minimise the impacts of annual floods, such as moving their assets to safer places, evacuation and building houses with higher foundations, but not for catastrophic floods. The situation has been exacerbated by rapid urbanisation and water discharge from upstream hydropower plants. Annual flood damage costs has reached about VN$ 8.2 million (about US$ 400)/household) in which about 50 per cent of total costs is from damage to houses. The costs for damage caused by extreme floods now reach about VN$ 20 million/household, in which damage to properties is VN$ 12 million/household.

The results from the choice experiment show that households living in Da Nang have a high demand for flood index-based insurance. About 87 per cent of total respondents are willing to pay for index-based insurance, and expect reasonable insurance premiums to be VN$ 10,000–20,000/household/month and insurance payouts for damages to be VN$ 10–20 million. Based on the study results, developing and piloting flood index-based insurance for households living in the city are strongly recommended. This will reduce households' exposure to flood damage as well as the financial burden for both government and households in the context of rapid urbanisation and climate change.

1 Introduction

Insurance can play an important role in reducing risks. It can help affected communities to recover from catastrophes such as floods and typhoons through financial compensation. But it also influences or encourages behaviours that could reduce the exposure of vulnerable communities to risk (Parry *et al*. 2007). Examples of such behaviours would be avoiding vulnerable areas with limited insurance coverage or taking measures to lower risk, for example by planting drought/flood-resistant crop varieties or building/reinforcing houses with disaster-resistant measures. By transferring risk and providing a safety net against extreme events, index-based insurance offers the opportunity to protect the poorest and most vulnerable members of communities. According to the World Bank (2012) index-based insurance provides low-income populations with an efficient and reliable risk management tool. It can also increase low-income populations' willingness to engage in riskier but more profitable activities.

Climate change is projected to increase the frequency and severity of weather extremes, which is likely to have considerable consequences for the insurance sector (Parry *et al*. 2007). Several previous studies have examined the impact of climate change on insurance claims (e.g. Mills 2005; Kunreuther and Pauly 2006; Dlugolecki 2008). Few empirical studies have examined the effects of climate change on the demand for natural disaster-related insurance (e.g. Botzen and van den Bergh 2008). Thus, insights into the effects of climate change on willingness to pay (WTP) for disaster insurance remains very useful for helping insurers to assess the future profitability of offering insurance against weather-related risks.

1.1 Possibilities for disaster risk insurance

There are many difficulties and challenges constraining the development of disaster risk insurance, such as the lack of insurance product development, limited delivery channels, lack of technical capacity, or low insurance education and awareness on exposures to disaster risk. However, there is high demand for in-depth insights and development of index-based insurance among policy makers and private (non-life) insurance companies. Markets for disaster index-based insurance are awakening, but need more engagement from both governments and the private sector (AM Best 2011).

Reviewing index-based insurance schemes that provide cover for disaster risks to assets in developing countries shows that some schemes are being developed. About 1 to 3 per cent of households and businesses in developing countries have insurance coverage against catastrophe risks to their properties (Mechle-Kerianr and Kousky 2008). Due to the limited number of insurance schemes available, households and business often rely on savings, mortgaging their land and assets, or even emergency loans from credit institutions and money lenders (Mechler-Kerjan and Kousky 2008). It is stated that the benefits of disaster insurance need to be weighed against its cost and limitations and also needs support from governments. Moreover, in immature and unregulated insurance markets in developing countries, there is a high risk of insurer insolvency and defaults on claims in the case of large catastrophes (Mechler-Kerjan and Kousky 2008).

1.2 Study objectives

The aim of this study is to build a model of local demand for catastrophic flood index-based insurance and to provide policy recommendations for public and private partnerships in developing a flood index-based insurance service for local communities in Da Nang City, Vietnam.

In order to achieve this goal, the specific objectives of study are:

- To elicit household preferences for the use of a flood index-based insurance.
- To derive economic welfare measures related to households' willingness to pay (WTP) for a flood index-based insurance to reduce flood risks. This will take into account varying climate change conditions and different demographic characteristics of household groups.
- To investigate whether flood-risk exposure levels and subjective risk perception influence households' preferences for flood-risk insurance.
- To examine whether different attributes of flood index-based insurance will affect households' marginal WTP for flood-risk insurance.
- To provide recommendations for policy-makers and insurance companies to design appropriate flood index-based insurance products for insurance markets, particularly urban markets.

This valuation study is of interest from an academic perspective because it provides valuable insights into the reasons behind the absence of or, alternatively, opportunities for a market for flood index-based insurance. The study is also of practical interest for policy makers and insurance companies that are considering offering flood index-based insurance. These stakeholders can use the results of this study to assess WTP for flood insurance coverage and to analyse the profitability of a market for this. The results of this study can also help the government in assessing whether private demand for flood index-based insurance will be sufficiently high to make a public and private partnership market viable. Finally, insights into how insurance arrangements can promote damage mitigation are relevant to climate change management policy in Vietnam.

1.3 Overview of existing local insurance markets

1.3.1 Insurance markets in ASEAN

Many governments in the Associations of South East Asian Nations (ASEAN) region are taking action to facilitate the development of index-based insurance markets, especially through public–private partnerships, such as Thailand and the Philippines. The interest of ASEAN governments in promoting index-based insurance market development has contributed to its growth and encouraged increased interest from the private sector. Index-based insurance programmes have gained interest among ASEAN policy makers and were identified as key area for engagement under the work programme of the ASEAN Agreement on Disaster Management and Emergency Response. Index-based insurance programmes were also highlighted as an area for regional cooperation at the ASEAN +3 Finance Ministers' meeting in 2011. It is stated that disaster risk insurance can ensure access to fast and cost-effective liquidity, post-disaster. It could also speed up recovery and help to maintain the country's long-term development (World Bank 2012). However, the evidence basis for the effectiveness of disaster insurance remains thin, and this is a major knowledge gap given the groundswell of interest in insurance products. Insurance for catastrophic perils is limited by the relatively limited development of markets for non-life insurance. There are many unknowns about this measure, particularly the experiences of people involved in such schemes, or of those who cannot afford to insure themselves but experience impacts indirectly (World Bank 2012).

Like many ASEAN countries, the government of Vietnam recognises the importance of having index-based insurance programmes which are effective in order to reduce the burden of finance for government and low-income populations after the hazards. In the context of increasing frequency and intensity of climate change-related disasters and impacts, the Vietnamese government has embraced insurance mechanisms for disaster risk management and agriculture more vigorously than most developing countries. In 2011, Prime Minister Nguyen Tan Dung signed Decision No. 315/QD-TTg to develop a proposal for very high levels of premium subsidies on crops, livestock, poultry and aquaculture, but only underwritten on very small scale (AM Best 2011). In 2008, insurance company Bao Viet designed and implemented insurance for commercial crops such as rubber and coffee. However, this insurance programme has not yet achieved significant penetration and has a low financial performance. Farmers have not been very interested in the Bao Viet insurance scheme due to the lack of well-designed insurance products.

1.3.2 The insurance market in Vietnam

Located on the South Central Coast and the tropical storm belt, Da Nang City faces some of the biggest annual catastrophes in Vietnam. Da Nang, the focus of this study, is characterised by topography typical of many provinces in Central Vietnam with three sub-regions and coastal, low-lying delta and upland areas. The topography slopes from west to east with many short rivers. Because of this topography, Da Nang is one of most disaster-prone cities in Central Vietnam. From 1997 to 2011, there were 25 typhoons and 39 floods which caused 206 deaths, many thousands of injuries, and the collapse of 15,410 houses. Total damages came to about VN$ 8,416 billion (Da Nang CSFC 2011). Great efforts have been made by government organisations and NGOs to reduce households' vulnerability to climate change-related disasters. However, many households, particularly the poorest, are still vulnerable and have suffered huge damages.

Da Nang has seen a rapid process of economic development and urbanisation. However, a high proportion of households remain dependent on agriculture for their livelihoods. Many of them are living in poorly-constructed and temporary housing located in low-lying areas along rivers and in new resettlement areas. These households are recognised as the most vulnerable to typhoons and floods. Their lives and property are often damaged, thus forcing them into a vicious cycle of poverty and vulnerability to hazards. In many cases, when their houses have collapsed, or their livelihoods have been affected, these households have had to take loans to recover from the damage. As a consequence, many are in debt even though they receive considerable subsidies from the government. For example, each household who either lost a roof of whose home totally collapsed received VN$ 2–10 million (Hoa Quy Commune People Committee, 2009).

The government of Vietnam has shown its intention to develop disaster index-based insurance schemes for agricultural production and the property insurance sector. The government has also set regulations on subsidising the considerable premiums for households with collapsed houses or lost roofs, or with a family member dead or injured. Meanwhile, private insurance companies have shown an interest in non-life index-based insurance market development for catastrophe damages (AM Best 2011). It is the conviction of the authors of this report that if the assets and agricultural processes of poor and vulnerable households are insured by index-based insurance schemes, this will help them to increase their resilience to catastrophes. In other words, if they are able to claim financial compensation for damage to their property, they will increase their resilience to annual catastrophes.

Like many other developing economies in ASEAN countries, flood index-based insurance is currently not available in Vietnam. This absence could be due to supply-side problems, such as covariate risks, the ambiguity of flood probabilities, adverse selection and moral hazards, or to a lack of demand for flood insurance coverage (World Bank 2012). This implies that flood index-based insurance demand cannot be analysed using data on revealed preferences, as this method analyses the preferences of a consumer among bundles of goods based on a diminishing marginal rate of substitution, given their budget constraints. The revealed preference method uses data based on actual market behaviour with limited attribute range. However, stated preference methods use data based on hypothetical scenarios with an extended attribute range, and are thus relevant here. This study estimates demand for flood index-based insurance under climate-change scenarios with increasing flood probabilities, using stated preferences. The study aims to assess whether WTP is sufficient to make a (partly) public–private partnership market viable. This is of special interest since the government has recently discussed plans to introduce disaster insurance and due to the interest of private insurance companies and Institute of Policy and Strategy for Agriculture and Rural Development.

2 Theoretical framework and literature review

2.1 Climate change, flood risks and flood management in Vietnam

Situated in the tropical monsoon zone close to the typhoon centre of the western pacific, Vietnam is one of the most disaster-prone countries in the Mekong regions (Shaw 2006). With 3230 km of coastline and a dense network of steep river systems, Vietnam has a long history of coping with natural disasters such as coastal storm surges, floods, landslides, typhoons, droughts and saline water intrusion. Floods have been the most frequent disasters during its history. In some areas such as the central provinces, floods appear to be increasing in both frequency and intensity. Flood damage is expected to be aggravated by an increase in daily rainfall of 12–19 per cent by 2070, affecting both flood-peak discharges and the return period of floods (MoNRE 2009). Shaping the demographic and economic landscape, floods have forced the population to adjust its lifestyle. An example of such an episode was in 2005, when eight typhoons hit Vietnam's coastal areas. The seventh, named Typhoon Damrey, generated waves as high as four metres, destroying in its passage 25km of sea dykes and 130,000ha of rice fields in the country (Mai *et al*. 2009). Total damages reached US$450 million. In September 2009, the Ketsana typhoon hit central Vietnam, killing 170 people and injuring 860 others. Over 21,000 homes were completely destroyed, forcing 356,000 people to evacuate. In addition, food security was in danger because of the 39,000 tonnes of rice that were destroyed.

Over the past 20 years, natural disasters have resulted in the loss of over 13,000 lives and annual damage equivalent to an average 1 per cent of GDP (residential housing and public-sector property, agriculture and infrastructure) (World Bank 2010). Between 1989 and 2008, almost ten natural hazard events were reported every year, totalling disaster losses of US$6.4 billion, an annual average of US$332 million or equivalent to 1 per cent of GDP (World Bank, 2010).

Future climate change will potentially affect all aspects of the rainfall regime in many areas of Vietnam. McElwee (2010) show that the changes in annual rainfall in Vietnam under a medium emission scenario is projected to increase across the nation (see also Table 1). This makes the three major geographical divisions more vulnerable to flood risks: in the north, the Red River/Thai Binh river system; in the central coastal region, small-scale coastal river systems; and in the south, the Mekong/Dong Nai river system. Yusuf and Francisco (2009) indicate that annual small-scale flooding is happening more frequently across the central coastal region. This result is confirmed in numerous other studies in many regions in the country such as Ho Chi Minh City in the south (Tu and Nitivattananon, 2011) and the Day River area (Dang *et al.* 2011).

Table 1. Changes in annual rainfall in Vietnam (%) relative to 1980–99 period, under medium emission scenario (B2)

Climatic region	Change in annual rainfall in Vietnam relative to 1980–1999 (%)								
	2020	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**	**2090**	**2100**
North West	1.4	2.1	3.0	3.8	4.6	5.4	6.1	6.7	7.4
North East	1.4	2.1	3.0	3.8	4.7	5.4	6.1	6.8	7.3
North Delta	1.6	2.3	3.2	4.1	5.0	5.9	6.6	7.3	7.9
North Central	1.5	2.2	3.1	4.0	4.9	5.7	6.4	7.1	7.7
South Central	0.7	1.0	1.7	1.7	2.1	2.4	2.7	3.0	3.2
Central Highland	0.3	0.4	0.7	0.7	0.9	1.0	1.2	1.3	1.4
South	0.3	0.4	0.8	0.8	1.0	1.1	1.2	1.4	1.5

Source: MoNRE (2009)

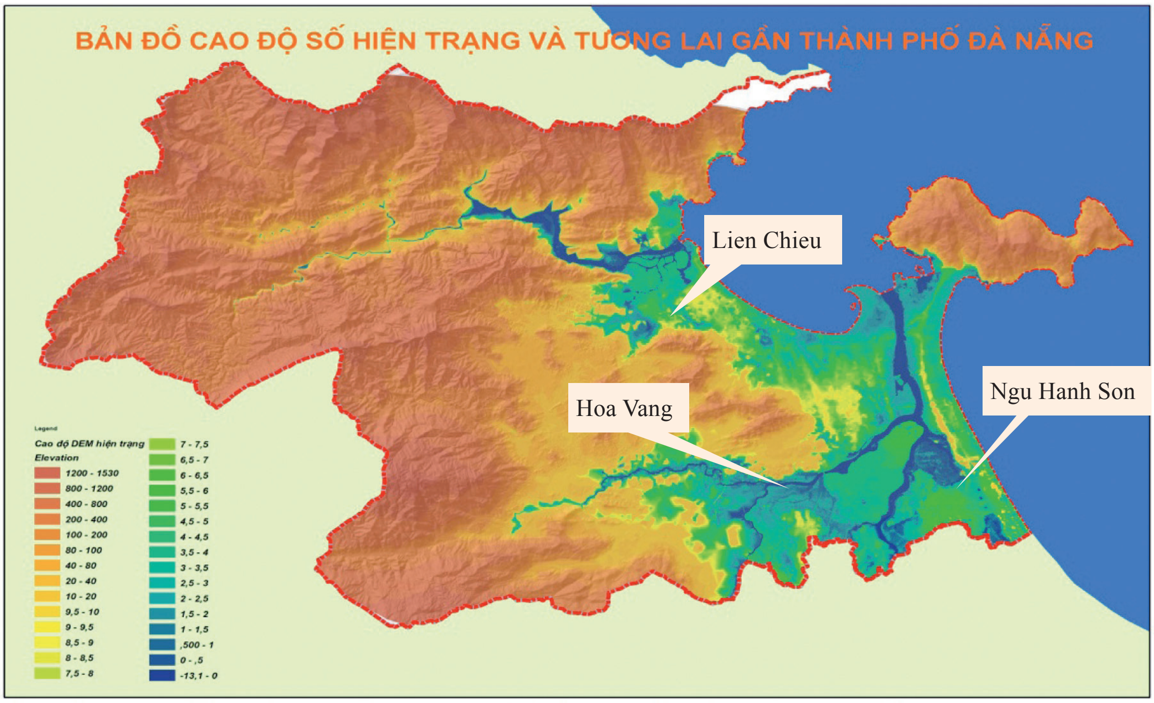
Flood vulnerability is more severe in Vietnam due to the density of people living on flood plains. Most of the population (70 per cent) live in coastal areas to take advantage of economic activities generated within the flood plains. The population along the coast is particularly vulnerable to typhoons and floods since people usually live only one metre above sea level in these areas (Mai *et al*. 2009). Unfortunately, it is important to note that typhoon and floods often occur together, causing more severe damage to infrastructure and the livelihoods of communities. This high degree of exposure has increased in the recent years as a result of the rapid economic growth and urbanisation and increase in population density in Vietnam and particularly in Da Nang city. Due to the steepness of the land, river beds are easily filled by the monsoon rains and thus frequently lead to flashfloods, causing a substantial number of deaths and injuries in the past. From 1970 to 2000, the number of deaths due to storms reported for Vietnam was 5,858, with 4,859 of them due to floods (Pilarczyk and Nuoi 2005). Additionally, with a projected sea-level rise of one metre, Vietnam would see 10.8 per cent of its population affected and 10 per cent of its GDP reduced. The production of spring rice is projected to decrease by 2.4 per cent by 2020 and by 11.6 per cent by 2070, making it one of the most impacted countries in the world (MoNRE 2009). Furthermore, floods also cause serious damage to household property. Housing is considered one of the highest losses due to natural disasters (Ahmed, 2011). In Vietnam, the government views housing as one of the four sectors most vulnerable to climate-extreme events (MoNRE 2009).

2.2 Socio-economic conditions and vulnerability to climate change in Da Nang City

2.2.1 Natural conditions

With a 92km coastline Da Nang, the study site, plays an important role in the Greater Mekong sub-region, as the city is one of the gateways to the Eastern Sea of the East–West Economic Corridor linking Myanmar, Thailand, Laos and Vietnam. Da Nang is the biggest city in the central region and the midpoint between Hanoi and Ho Chi Minh City. The digital elevation map of Da Nang shows that the city consists of plains and mountains with 70 per cent mountainous areas. The high mountain area is sloping and mainly lies to the west and northwest of the city. It also shows that the flood basins of Da Nang are in Ngu Hanh Son District, Hoa Vang District and Lien Chieu (Figure 1). There are some inner flooding areas within Da Nang City such as in Hai Chau, Thanh Khe and in centre of city. However, these areas are inundated due to the low drainage capacity of canals rather than due to floods. Thus, the districts of Ngu Hanh Son, Lien Chieu and Hoa Vang were selected for this study.

Figure 1. Digital elevation map of Da Nang



Nguồn: Bản đồ xây dựng từ bản vẽ khớp nối giao thông thoát nước do Sở Xây Dựng Tp Đà Nẵng cấp năm 2011 (hệ Tọa độ HN72)

Source: Da Nang Department of Construction 2011

2.2.2 Socio-economic conditions

Da Nang is a dynamic city within the key economic zone of Central Vietnam. It is an important communication hub of the central region with its international airport, deep-water seaports and north–south roads and railways. Being located on a World Heritage route, it also has tremendous potential for tourism development in addition to the potential for economic development.

a. Economic growth

The economic growth rate (GDP) of the city reached 9.98 per cent in 2000 and 11.2 per cent in 2009. It is projected to reach 11.6 per cent in 2010 and approximately 12–13 per cent in 2020. Da Nang's GDP currently accounts for approximately 1.6 per cent of the country's GDP and is projected to account for 2.8 per cent by 2020. GDP per capita (current prices) in 2010 is 33.2 million Dong (Da Nang City People Committee 2011).

b. Social conditions

In 2012, the approximate population of Da Nang City was 842,500, a 1.93 per cent increase from the previous year. Women accounted for 51.13 per cent, with the birth rate decreasing to 3.2 per thousand. The rural population within city boundaries was 108,000. Regarding healthcare, by the end of 2009, the average number of hospital beds available for admitted patients was 45.6 beds per 10,000 patients. The number of households with a toilet was 156,900 while the number of households without a toilet was still high – nearly 5000. According to a survey conducted by the Ministry of Labour, Invalids and Social Affairs (MOLISA) in the beginning of 2009, the city had 32,800 poor households out of a total of 170,250 households, which accounted for 19.26 per cent of the total population. In 2010, the city was expected to create jobs for more than 32,000 labourers (Da Nang Office of Statistics 2011).

2.2.3 Hydrological conditions and disaster profile

a. River systems

Rivers in Da Nang City originate from the west and southwest of the city. Da Nang has two main river systems, the Cu De and the Han (which originates from the lower section of Vu Gia–Thu Bon River), and two smaller rivers, the Phu Loc and the Co Co. All of the rivers flow into the Gulf of Da Nang. The Vu Gia River originates from the southwest of the city, with a total basin area (from Kon Tum to Quang Nam) of 5180km^2 including the basin in Da Nang. The Co Co River links the Thu Bon river mouth and the Han river mouth. It is important to note that the agricultural production and residential areas on the small plain deltas along these rivers are the main flooding areas in Da Nang City. Thus, floods often cause severe damage to agricultural production and community infrastructure in these areas.

b. Natural disasters and extreme weather

Da Nang is one of the cities in Vietnam most affected by natural disasters (typhoons, floods, drought, erosion or saline intrusion etc.) and extreme weather (extremely hot spells or heavy rain etc.). There is an annual average of 1–2 typhoons and 2–3 floods of Level 3 or higher directly hitting the city. The city's annual average temperature is 25.7C.

c. Storms

Between 1998 and 2010, 21 typhoons directly affected Da Nang City. Most of them had wind forces of over Level 11 on the Beaufort scale, or over 103km/hour. Before 1998, there was only one typhoon or tropical low pressure incident annually, and there were few cases in which the wind force exceeded Level 11 (ISET 2011).

d. Floods

River flooding usually occurs due to heavy and concentrated precipitation and extended rains. In addition, due to the change of rainfall in the last 10 years, flooding has occurred earlier and in a sudden and unpredictable manner, at a higher frequency and with more extreme intensity. Before 1998, there was one flash flood every ten years, whereas between 1998 and 2009 there were six flash floods. All floods were above Level 3 and one reached approximately the level of historic flooding of 1964 (Da Nang CSFC 2012).

Participants in the focus group discussions (FGD) carried out for this study reported that

> *…households living in the flooding basin, particularly near rivers, are expecting to be resettled and receive support from government to mitigate the impact of floods, particularly in recent years when hydropower plants upstream have been in operation. These hydropower plants discharge water combining with rainfall, thus causing more severe flood inundations and damage to our agricultural production and properties.*

Additionally, flooding in Da Nang City is also exacerbated by incomplete and improper urban development and planning (e.g. many flood retention basins and shallow lakes are filled for urbanisation) and the improper exploitation of upstream forests in river basins of rivers running through the city. According to one key informant, the lack and limited capacity of flood early warning systems and the shortage of human resources and rescue facilities, preventive care equipment, solid houses, and particularly the limited awareness of city residents – especially those who are the most vulnerable – have strongly contributed to the level of flood damage. Floods cause damage to infrastructure, such as destruction of houses, property and facilities of households; destruction of construction works and infrastructure such as traffic and irrigation systems (dams, dykes and water reservoirs), and the destruction of services such as schools, hospitals and health clinics. Extended flooding also causes environmental pollution (i.e. the contamination of groundwater, surface water, soil and ecosystems from human and solid waste, and industrial waste).

e. Drought

Under the impacts of increased temperature and changes in precipitation, droughts in Da Nang have become prolonged with more severe intensity. During the 33 years from 1960 to 1983, there was only one severe drought in 1983; in the period from 1988 to 2006 there were four severe droughts. The drought in 2002 (considered the worst in 20 years) lasted from May to mid-August, resulting in saltwater incursion far up-river and the drying out of dozens of lakes around the city (ISET 2011).

The precise nature of changes to the climate is uncertain, particularly for those extreme events which tend to lead to flooding. Increases in rainfall at all scales will increase the risk of flooding to a greater extent. Possible future changes in precipitation can be ascribed to broad-scale changes in the annual or seasonal regimes, changes in the nature of both short- and long-duration events, or changes in precipitation variability.

Evidence is mounting regarding an increase in flood risk in certain areas from a warmed world. Large flood events have increased in the last century and a link has been established between higher temperatures and more heavy rain events. Climate models predict increases in both the frequency and magnitude of heavy precipitation in Da Nang in correlation with the sea-level rise, which will exacerbate flood risks. The pattern of typhoons along with floods, especially in Da Nang during the past few decades, forms a major concern for both the city government and local communities. The historical floods of 1999, 2006 and 2007 and the recent floods in 2009 are some examples of events which have caused severe damage to communities, particularly to assets of vulnerable households. Many of them dropped back below the poverty line and have found it particularly hard to recover from damage caused by the floods.

Natural disasters in Da Nang may become more severe due to climate change. Assessments by ISET (2011) shows that changes in temperature, precipitation and sea level will cause more severe typhoons, floods, droughts, land erosion and saline intrusion in the city, consequently increasing the city's vulnerability to climate change (see Appendix 3).

The increase in intensity and frequency of floods has caused severe damage to both properties and agricultural production, particularly for poor households whose livelihoods are mainly dependent on agricultural production. Great efforts have been made to project and mitigate the impacts of floods by both government and non-governmental organisations. However, a lack of resources and budget often constrains government agencies from the efficient implementation of adaptation and mitigation strategies (Neelke 2013, World Bank 2012). There are also limitations of probabilistic flood-risk assessments combined with the design and selection of flood-risk management strategies in the existing literature. These factors prompt the need for a framework for building a model for flood risk index-based insurance. Experiences of adopting flood risk index-based insurance in some Asian countries such as Thailand, the Philippine and Indonesia have shown both its low penetration of and low suitability for local communities in Vietnam, as it was designed for different local demands and participation. It has also shown that there are fewer countries operating public–private partnerships in delivering flood risk index-based insurance schemes (World Bank 2012).

2.3 Index-based insurance and flood-risk management

2.3.1 Existing experiences with index-based insurance

Insurance-related products are believed to be a good way for a country to cope with weather-related risks (Warner *et al.* 2010), especially in developing countries where there is a lack of mechanisms like risk-sharing or pooling programmes. According to Warner *(2010),* insurance can provide tangible and intangible benefits and that are very important to developing countries. These include (i) building resilience and (ii) providing timely financial liquidity. Recently, there has been a growing interest in using index-based insurance products for risk transfer in developing countries for agriculture (Skees *et al*. 2007) due to its advantages over more traditional insurance products. Index-based insurance has showed its high penetration thank to its transparency, low transaction costs, faster pay-outs and objectivity. Because index-based insurance relies on publicly available data, and because there is not much historical data available in developing countries, there needs to be flexibility to try out different types of index-based insurance based on data availability (Rao 2010).

Flood index-based insurance works by using suitable indicator variables. It is triggered when the risk outcome being insured against takes place. It is different from traditional insurance as index-based insurance is based on monitoring an index of occurrence events. For example, if a household buys flood index-based insurance against flood damages to their house, then if a flood crosses agreed trigger points, such as rainfall or flooding levels, they will receive an insurance payout.

Many countries have piloted some sort of index-based insurance in agriculture thanks to advocacy by the World Bank. These include Tanzania, Nicaragua, Thailand, Kazakhstan, Senegal, Morocco, Bangladesh, Vietnam and the Caribbean Islands (Rao 2010). Skees *et al*. (2007) provide a good summary of practice all over the world in the Table 2 below, and demonstrate that farmers are the key target market. In general, indices used to design index-based insurance products are weather indices such as rainfall, wind speed and temperature. These indices are subjective, readily available and accurate enough for both insurers and insurance buyers. A review of the relevant literature reveals that the low penetration of disaster insurance, particularly in ASEAN countries such as the Philippines, Thailand and Indonesia, occurs where insurance products are not index-based ones.

Table 2. Summary of index-based risk transfer products in lower-income countries

Country	Risk event	Contract structure	Index measure	Target user	Status
Caribbean	Hurricanes and earthquakes	Index insurance contract with pooling for reinsurance coverage	Indexes data from National Oceanic and Atmospheric Administration	Caribbean country governments	Implemented in 2007
Ethiopia	Drought	Index insurance	Rainfall	World Food Programme operation in Ethiopia	US$7 million insured for 2006; policy not renewed for 2007
Mexico	Natural disasters impacting smallholder famers, primarily drought	Index insurance	Rainfall, wind speed and temperature	State government for disaster relief	Began in 2001; available in 26 of 32 states
Bangladesh	Drought	Index insurance	Rainfall	Smallholder rice farmers	In development, pilot launched in 2008
Honduras	Drought	Index insurance	Rainfall	Smallholder farmers	In development
India	Drought and flood	Index insurance linked to lending and offered direct to farmers	Rainfall	Smallholder farmers	Pilot launched in 2003
Malawi	Drought	Index insurance linked to lending	Rainfall	Groundnut farmers	Pilot launched in 2005
Mongolia	Large livestock loss due to severe weather	Index insurance with direct sale to herders	Area livestock mortality rate	Nomadic herders	Pilot completed in 2007

Source: Skees *et al*. (2007)

2.3.2 Challenges of implementing index-based insurance

Although most scholars agree that index-based insurance is a practical tool to insure communities against disaster risks, the institutional structure of insurance provision is still debated. Dworkin (2000) emphasises the role of state governments in the provision of insurance. In contrast, Schiller (2003) argues for private insurance in an economy without any intervention from government. Others proposed public–private partnerships in providing it. Nguyen (2013) argues that due to the characteristic of low frequency/high severity risks, catastrophic events are uninsurable to private insurers in Vietnam. To cope with this market failure, the government should participate in insurance programmes to make insurance both available and affordable. Nguyen holds that the government should give state guarantees or participate in private–state insurance solutions to avoid a collapse of insurance markets. Premiums can be kept more affordable if government covers part of the costs for extreme damage because in a private market, premiums often considerably exceed 'actuarially fair' values. But government risk-sharing must not be used to subsidise certain enterprises or branches (ibid). Subsidised low premiums remove important incentives for preventative measures and directing building activity toward less risky areas.

Suarez and Linnerooth-Bayer (2011) state that index-based insurance can play a key role in climate change adaptation by providing the security necessary to shoulder the burden of uncertainties inherent in managing changing climate risks and reducing poverty. However, in reality in hazard-prone areas, property owners often do not invest in cost-effective loss-reduction measures. For instance, farmers rarely take into account rare weather events when planning their crops, and government units typically do not invest adequately in infrastructure or enforce regulations designed to reduce the livelihood impacts and consequences of catastrophic events. Many stakeholders living in hazard-prone areas often take responsive actions after the disaster, rather than pre-emptive adaptation measures (Suarez and Linnerooth-Bayer 2011).

Despite the promise of risk-transfer instruments as effective elements in disaster risk management, index-based hazard insurance has both low financial performance and low penetration, particularly in developing countries. Therefore policy makers must consider how to encourage stakeholders to invest in this risk-reduction measure. Suarez and Linnerooth-Bayer (2011) highlight the fact that there are still many challenges and issues regarding index-based insurance such as affordability, attribution of schemes, the relative prevalence of weak institutions and financially illiterate citizens, the unreliable nature of climate-related hazard parameters and an insufficient understanding of index-based insurance. These pose challenges to the design and implementation of insurance systems.

Mills (2005) argues that catastrophe insurance provides peace of mind and financial security for vulnerable groups. Climate change can have adverse impacts on insurance affordability and availability, potentially slowing the growth of the industry and shifting more of the burden to governments and individuals. Most forms of insurance are vulnerable, including property, liability, health and life insurance. It is incumbent on insurers, their regulators, and the policy community to develop a better grasp of the physical and business risks. Insurers are well positioned to participate in public–private initiatives to monitor loss trends, improve catastrophe modelling, address the causes of climate change, and prepare for and adapt to the impacts.

The Turkish Catastrophe Insurance Pool provides an example of how a pooling facility combined with mechanisms for enforcing compulsory insurance purchase can contribute to a significant increase in take-up rates for catastrophe risk insurance. The pricing takes into account seismic risk and construction types. Turkey is divided into five risk areas and three categories of construction. The number of insurance policies reached 2.43 million insured dwellings after 13 month of implementation (Selamet undated). The insurance effectively maintains social solidarity and risk sharing by the payment of affordable insurance premiums. It is stated, however, that among the main reasons for low coverage rates are a lack of public knowledge of the benefits of insurance, the traditional role of government in compensating for disaster losses and difficult economic experiences.

The government of Vietnam encourages the development of a private disaster-insurance market, which could contribute to transferring disaster risks from households and farmers to the private sector, thus ultimately reducing the government's contingent liability. The Vietnamese government places special attention on local property catastrophe insurance markets, particularly for urban dwellings of middle-and high-income households (World Bank 2010). There were 39 registered insurance companies in 2012, of which 11 companies offer life insurance and 28 offer non-life insurance. The non-life insurance market offers a range of property insurance cover including basic fire, explosion and natural catastrophes including earthquakes, typhoons, storms and floods. The World Bank (2010) states that there is practically no penetration of commercial property insurance into rural or vulnerable areas most properties are uninsurable under a commercial insurance policy. The major issue is a lack of knowledge and expertise on the part of local Vietnamese insurance companies regarding the design and implementation of insurance products and programmes. Additionally, property owners' demand for property insurance is low due to a lack of any insurance culture among property owners (MoF 2009; Nguyen 2013). This study is designed to address this weakness of property insurance with a special focus on natural disaster index-based insurance for properties of households living in urban Vietnam.

3 Research method and study design

3.1 Choice experiments and their use in flood index-based insurance

Flood-risk valuation studies using stated preference (SP) methods are rare (Brouwer *et al*. 2009). Contingent valuation (CV) studies have been applied in climate change and flood-risk analyses (e.g. Clark *et al*. 2002; Zhai *et al*. 2006; Brouwer *et al*. 2009). Choice experiments (CE, see section 3.2 below) have become increasingly popular in the area of economic valuation (Birol and Koundouri 2008). However, few applications of choice experiments exist for climate change and flood risks.

CE methods have been previously used to evaluate the willingness to pay for non-marketed public and environmental goods. Some papers (Brouwer *et al*. 2009; Navrud *et al.* 2012) have implemented these methods to evaluate WTP for flood insurance. These provide an indirect measure of household flood-risk preferences. We provide here a brief summary of this literature.

Botzen and van den Bergh (2009) have used a CE method to examine the effects of climate change and availability of government compensation for the demand for flood insurance by Dutch homeowners. Using a mixed logit, they estimate the dependence between WTP and prior risk perception, actual measures of risk, risk aversion, and socioeconomic characteristics. Their findings show that the likelihood of homeowners buying flood insurance decreases considerably if climate change results in large increases in flood probabilities and if insurers adjust risk premiums in accordance with this risk.

In many situations, before establishing an insurance scheme, insurers may not know whether the insurance premium will exceed or not the household's willingness to pay for the disaster insurance schemes. Some disaster insurance schemes may require households to undertake some measures that may mitigate damages. Botzen *et al.* (2009a) examine how homeowners in The Netherlands have been induced to take some precautionary measures to mitigate flood damage, in exchange for a reduction in their flood-insurance premium. Their results indicate that many homeowners are willing to make investments in mitigation. They found that two thirds of them are willing to invest in water barriers in exchange for a premium reduction. About a fifth are willing to replace floor types that are vulnerable to flooding with water-resistant floor types and about a quarter are willing to move central-heating installations to levels safe against flooding.

As climate change mitigation and adaptation measures are likely to be insufficient, insurance arrangements can have a useful role in reducing the uncertainty associated with climate change impacts. Botzen and van den Bergh (2009) have examined the demand for such insurance arrangements. More specifically, they propose to estimate the WTP for flood insurance in The Netherlands using rank-dependent and prospect-theory utilities under different climate change scenarios. In these non-expected utility frameworks, risk-averse behaviours are related to over-weighting of probabilities of badly ranked outcomes and to concavity of the utility function in the loss domain. Their estimation of the risk premium for three climate scenarios indicates that the WTP for insurance increases more than the expected value of premiums does when the probability of flooding rises. Their estimation results imply that a profitable flood insurance market should be feasible and that climate change has the potential to increase the profitability of flood insurance.

Estimating the market demand for flood index-based insurance is difficult due the high level of risk preference heterogeneity across households. Within an expected utility maximisation model, Petrolia and Coble (2011) examine the microeconomic factors influencing flood insurance demand. They combine household-level flood insurance subscription data with measures of household risk preference and subjective risk perception. The data indicates that experiences with previous flood events increases the likelihood of holding flood insurance. The perceived insurer credibility also has a positive influence on the probability of holding flood insurance. The results provided empirical evidence to support models of decision making under risk, showing that probabilities and the magnitude of losses are important determinants of behaviour under risks.

Brouwer and Schaafsma (2009) apply choice experiments to simulate household choice behaviour under varying climate change conditions and derive economic welfare measures related to society's WTP to reduce climate change-induced flood risks through private insurance. The results show that WTP is substantial, implying a more prominent role of the external social damage costs in a cost-benefit analysis of climate change- and flood-mitigation policies, while at least part of the financial responsibility for flood risk can be shifted from the public to the private sector.

In Vietnam, Reynaud *et al*. (2012) designed a pilot CE study to investigate the willingness to pay for proposed flood insurance schemes in Nghe An Province. They found that there was a considerable preference heterogeneity across households and significant relationships between WTP with other attributes of flood management policies (reduction of economic and human losses, political levels in charge of implementing the flood management policy).

3.2 Modelling the choice experiment for the study

The choice experiment method (CE) is an approach to consumer theory (Lancaster 1966). In choice experiments, respondents are presented with a number of choice sets consisting of a menu of alternatives (also called scenarios). They are asked to choose their preferred alternative from each of these choice sets. The choice experiment approach was initially developed by Louviere and Hensher (1982) and Louviere and Woodworth (1983). Choice experiments share a common theoretical framework with a dichotomous-choice contingent valuation in the random utility model (Luce 1959; McFadden 1973), as well as a common basis of empirical analysis in limited dependent variable econometrics (Greene 1997). According to this framework, the indirect utility function for each respondent (U) can be decomposed into two parts: deterministic and stochastic components. The deterministic component (V) is a vector of observable alternative (and sometimes individual) specific attributes. It usually takes the form of a linear index of those attributes. The stochastic component – commonly known as the error term (ε) – stands for all the influences affecting the choice that are not observable by the researcher. It is an error term that comes from the fact that the choice is random from the researcher's viewpoint. The details of model development used for this study are described in Appendix 4.

The model enables the researcher to measure the effect of each choice-specific explanatory variable on the individual choices. Estimates of consumers' surplus associated with changes in the level of attributes can be derived from that maximum likelihood estimation of the conditional logit model. When estimating the model, if 'X' is composed of 'X1, X2, …, Xa' attributes, then the parameter estimate of the specific attribute 'Xa', denoted 'ba' , can be interpreted as the marginal utility of that attribute, and the parameter estimate of the price attribute, denoted 'bp', as the marginal utility of money. Hence, observing the choices that individuals make when some attribute level changes and observing the price associated with this particular scenario of change, we can derive marginal values for each attribute when moving from the initial level of the attribute to the final level of this attribute (see Appendix 4). Therefore, the marginal willingness to pay (also called 'implicit price') which can be obtained for each attribute and levels is given by the formula:

$$WTP_a = -\frac{\beta_a}{\beta_p} \text{ or } IP_{Product\_attributes} = -\left(\frac{\beta_{Product\_attributes}}{\beta_{Monetarr\_attributes}}\right)$$

3.3 Study design

3.3.1 Data collection

There were two sets of data collected for this study: a quantitative dataset collected using a questionnaire survey method and qualitative data collected from focus group discussions and key informant interviews.

a. Quantitative data collection

The questionnaire survey was conducted in seven wards in flooding districts in Da Nang City as mentioned in the above table. There were 395 households selected and surveyed for this study. Seven questionnaires were eliminated from survey due to incomplete responses from respondents. Therefore, 387 questionnaires were entered into SPSS, a software package used for statistical analysis.

b. Qualitative information collection and management

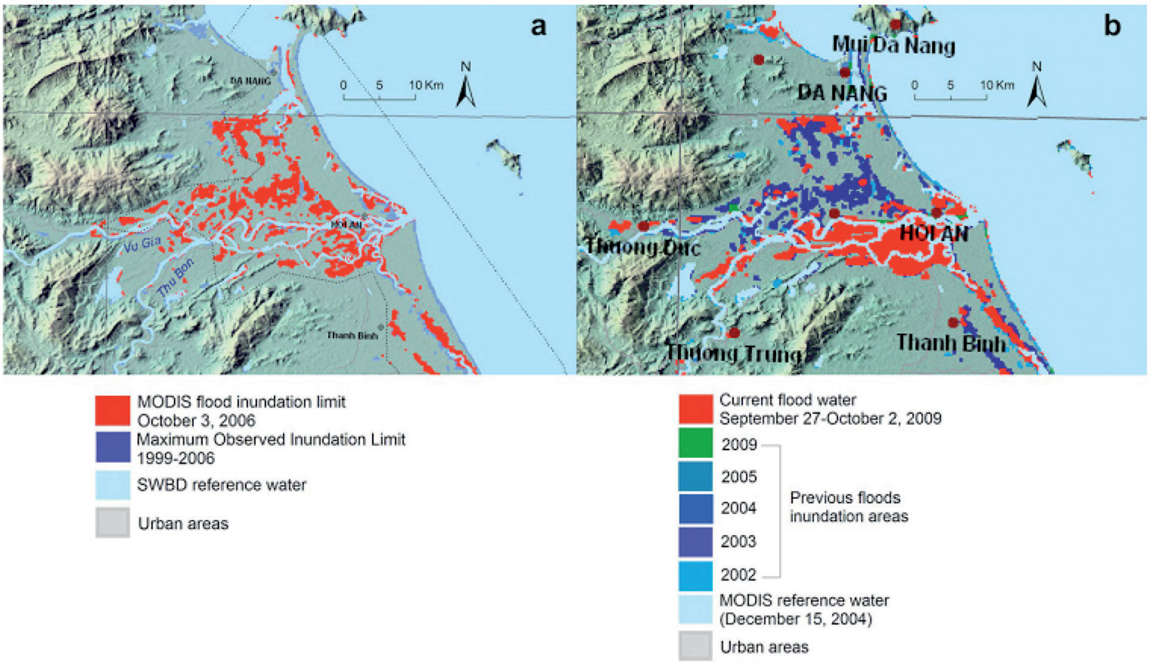
Qualitative data for this study was collected using key informant interviews and focus group discussions. Eight key informant interviews conducted. Two key informants were from the Da Nang Committee for Storm and Flood Control, two were from the Bao Viet Insurance Company, and four were from district-level government. There were also four focus group discussions conducted for this study. One FGD was conducted at city level, one at the district level, and two at the household level.

3.3.2. Sampling method

Defining the target group for this study was an essential step contributing to the validity and reliability of this study. With the main objective to design a flood index-based insurance suitable for households, this study defines ‘households’ as those living in flood basins in Da Nang City. The study used flood-inundation maps of Da Nang to identify flooded areas from 2002 to 2009 and from 1999 to 2006, particularly areas inundated during the 2006 Typhoon Xangsane and 2009 Typhoon Ketsana. Three districts were identified as often inundated by annual floods: Lien Chieu, Hoa Vang, and some wards in Ngu Hanh Son District (Figure 2). To increase the feasibility of the study results, project site selection was targeted in these flooded areas. There were seven wards selected for this study: one in Ngu Hanh Son, one in Lien Chieu, three in Hoa Vang and two in Cam Le.

The focus group discussions were conducted in selected wards. The results showed that annual floods cause considerable damages to household property, particularly for households living in poorly constructed and temporary houses and houses located on riversides and in low-land areas in Da Nang City. Poor households, households headed by women, and households with children were considered as the groups most vulnerable to flooding. The result of the FGDs showed that the main damage caused by floods are damages to property and agricultural production, and environmental pollution (see Table 3). The participants in FGDs reported that these households found it hard to recover from such damage after floods, particularly damages to housing. Many of them had lived in damaged houses for a long time following the floods as they could not afford to repair their house. Participants in the FGDs also showed their interest in and demand for flood-risk insurance.

Figure 2. Flood mapping in Da Nang



Source: Ho and Umitsu (2011)

Table 3. Selected sites and flood vulnerability assessment in Da Nang City

District	Ward	Vulnerable groups	Flood Impacts
Ngu Hanh Son	Hoa Quy	Households living in poor and temporary housing particularly houses located by rivers and on low land Women-headed households Poor households Children and elderly people	Damage to homes and livestock pens Damage to agricultural production (rice and vegetables) Prolonged inundation and environmental pollution Epidemic diseases (waterborne diseases)
Hoa Vang	Hoa Chau Hoa Tien Hoa Khuong		
Cam Le	Hoa Xuan Hoa Tho Dong		
Lien Chieu	Hoa Hiep Bac		

3.3.3 Index selection and choice set designed

A literature review related to index-based insurance studies revealed that weather indices made a significant contribution to the success of disaster risk insurance in countries such as Mexico, India and Bangladesh (Skees *et al*. 2007). Weather indices are publicly available, reliable and accurate, which could increase the penetration of insurance buyers.

Using secondary data recorded from past floods and the results of FGDs conducted in flooded areas, four flood scenarios were designed for this study (see Table 4). It is important to note that tropical low pressure and typhoons often cause floods, thus wind speed was also included in the weather index as recommended by participants in FGDs.

Table 4. Weather indices designed for catastrophe index-based insurance design

Flood scenario	Weather index
F1	Rainfall: 600–1000mm; River level: <4.5m; Wind level: Tropical cyclone
F2	Rainfall: 1000–1500mm; River level: 4.50–4.75m; Wind level: Tropical cyclone
F3	Rainfall: 1500–2000mm; River level: 4.75–5.00m; Wind level: Typhoon level 6–8
F4	Rainfall: >2000mm; River level: >5.00m; Wind level: Typhoon level >=9

(Source: FGDs in 2013 in study site and Da Nang Center for Hydromereology and Da Nang Committee for Storm and Flood Control, 2012)

a. Index selection

The purpose of this study was to increase the feasibility and reliability of catastrophe index-based insurance products designed for households living in flooded areas in Da Nang City and to scale up its application for other flooded areas in Vietnam. Therefore, selecting the correct attributes for flood designing an index-based insurance product were considered as an important step in contributing to the success of this study.

Table 5 shows the six attributes which were selected for the choice sets designed for this study. These attributes were selected based on the results of a literature review, FGDs and key informant interviews. The indices were designed based on calculations of secondary data and were validated by key informant interviews and FGDs with household participants, representatives of Bao Viet Insurance Company and local government units.

Table 5. Attributes and choice sets designed

	Attribute description	Measure	Attribute levels
1	Weather index		Four scenarios from F1 to F4 vary the weather index
2	Flood-return period (years)	Annually	5, 10, 20, 30, 50
3	Flood damage	Million Dong	25, 50, 75, 100
4	Fatality probability	Probability	1:1000, 1:2000, 1:5000, 1: 10,000
5	Payout rate	Million Dong	10, 20, 30, 50
6	Insurance premium	Thousand Dong	10, 20, 30, 50

3.3.4 Choice experiment design

Using above the attributes, demand for flood index-based insurance was expected to increase when the weather indices and the frequency of flood increase. In the choice experiment, households were given four scenarios of weather indices and five probabilities which were calculated from the secondary data and focus group discussions. The willingness to pay and demand for index-based insurance were also expected to increase in relation to any increase in fatality probability and damage costs.

The choice of theoretical insurance schemes was offered to households involved in this study when they were first presented with the weather indices, flood-return periods, fatality probabilities and damage costs. The insurance schemes were subsequently described in terms of insurance premium and insurance coverage. By doing so, the study was able to evaluate the characteristics of different endogenous components and insurance schemes. Alternative insurance schemes were designed by combining the six attributes shown in Table 5 based on their levels. Because the respondents could not be shown all possible choice sets of attributes, the number of choice sets was reduced to 12 sets of six choice tasks, each based on the D-efficient fractional factorial design technique using the software Sawtooth.[1] The respondents were asked to choose between 196 alternatives presented in pairs on 96 choice cards, which were divided into 16 sets of six cards. The choice card designs are shown in the questionnaires in Appendices 1 and 2.

Based on the choice set, a questionnaire was designed for the survey (see Appendix 1). The first section includes questions about the demographic characteristics of respondents and households such as age, gender, income, livelihoods and education. The second section includes the questions about local vulnerability and impacts due to floods, while the third section asks about local adaptation behaviours. The final section is uses pictograms presenting the attributes for the choice experiment.

The questionnaire was pre-tested with a test sample of over 30 households. The research team conducted the pilot survey to make sure that all the questions were answerable. During the focus group discussions and key information interviews, researchers also asked participants questions which were purposefully hard for local people to answer to confirm whether the information they were being given was accurate. The pilot enabled the research team to the finalise the questions for the final survey.

1 *Sawtooth is the software used to select choice sets to design insurance products by running a full factorial design.*

4 Findings and discussion

4.1 Characteristics of respondents

Of the 387 households living in the flood basin in Da Nang City involved in this study, 63 were respondents from Hoa Quy Ward in Ngu Hanh Son district; 53 respondents from Hoa Chau, 51 respondents from Hoa Tien, 53 respondents from Hoa Khuong, 57 respondents from Hoa Xuan, 54 respondents from Hoa Tho Dong and rest from Hoa Hiep Bac. Results in Table 6 highlight that most respondents in our sample were male and married (60 per cent). The average age of the respondents is around 50 years, with most respondents falling in the age groups between 45 and 55 years and 51 and 65 years (26 per cent). The share of respondents capable of reading and writing is high, at 97.6 per cent. Most respondents have a secondary education, accounting for 50.8 per cent, and about 2.4 per cent of respondents are unable to read and write.

With respect to the housing conditions (Table 7), each household has access to electricity, but only 27 per cent to piped drinking water. Many households involved in this study use well-water, especially households in Hoa Vang (accounting for 87 per cent) for their daily use. This means that in the context of floods and environmental pollution, households living in flooding areas are more exposed to the risks of floods, particularly health problems. In terms of housing types, the study shows that despite living in a flood-risk area, the number of semi-permanent houses is very high, accounting for 71 per cent of households involved in this study, while the rate of permanent houses is only 26 per cent. On the other hand, 29 per cent live in one-storey houses with about 64 per cent having an elevated ground floor.

Table 6. Characteristics of sample survey

Characteristics of respondents		**Frequency**	**Percentage**
Gender	Male	220	60.00
	Female	167	40.00
Age	< 35 years	19	4.80
	35 < 45 years	71	18.40
	45 < 55 years	197	50.80
	>= 55 years	101	26.00
Education level	None	9	2.40
	Primary	68	17.60
	Secondary	197	50.80
	High school	91	23.60
	College degree	22	5.60
By ward	Hoa Quy	63	16.3
	Hoa Chau	53	13.7
	Hoa Tien	51	13.2
	Hoa Khuong	53	13.7
	Hoa Xuan	57	14.7
	Hoa Tho Dong	54	14.0
	Hoa Hiep Bac	56	14.5

Source: 2013 household survey data

Table 7. Housing conditions of households

Target		**Percentage**	**Cumulative percentage**
Source of drinking water	Households using piped water	27.20	27.20
	Households using well water	72.80	100.00
House type	Permanent houses	26.40	26.40
	Semi-permanent houses	71.20	97.60
	Impermanent houses	2.40	100.00
Number of storeys	One storey	29.60	29.60
	One storey with elevated ground floor	64.40	94.00
	Two storeys	6.00	100.00

Source: 2013 household survey data

It is important to note that the average family size of participating households is relatively the same as the size of families living in rural areas of Vietnam. The average number of household members is almost five people, and over half of family members are of working age (Table 8). The other family members are dependants. However, it should be recognised that the average number of workers in each households is relative high – about 2.8, which is considered an important resource for households in adopting adaptive measures to mitigate the impact of floods.

Table 8. Household demographics and employment

Target	Minimum	Maximum	Mean	Std. Deviation
Number of household members	3	7	4.78	1.03
Number of employment members	1	5	2.83	1.02
Number of children below 15 years old	0	4	1.30	1.11
Number of members older than 60 years	0	3	0.65	0.85

(Source: Household survey data in 2013)

Regarding household income, Table 9 shows that on average, households' mixed income is VN$ 44.84 million per household, correlatively VN$ 9.38 million per person (equivalent to about US$5 00 per capita). Per capita income in the sample is considerably lower than the average per capita in Vietnam (about US$ 1000 per person), perhaps because respondents involved in this study live in high-risk areas with livelihoods which are vulnerable to disasters. Many of them are farmers without land and work as manual workers in the city, and with low levels of education. This finding is consistent with a World Bank report in 2010 stating that about 17 million workers and officers in Vietnam have a salary lower than the poverty line of US$ 2 per day. The study also found that most respondents' livelihoods are largely dependent on non-agriculture activities. The highest proportion of income (81.13 per cent) came from non-farming activities; 12.82 per cent from livestock farming; and about 6.04 per cent from growing crops. Results from the survey show that a large number of labourers left the agricultural sector in these districts to work in Da Nang City and southern industrial zones. Participants in FGDs reported that:

> *…agricultural land has been reduced significantly in last ten years due to rapid urbanisation, industrialisation and public infrastructure construction, thus farmers, especially young labourers living in rural areas have to deal with high rate of unemployment. We got compensation for land lost but we found it hard to seek new livelihoods. Young workers often migrate to southern cities to seek jobs. Workers aged between 40 and 50 could not go there as we have to take care of family. Thus, we find manual jobs in Da Nang City, such as motor repairs, local builders etc…*

Table 9. Surveyed household incomes by source (VN$ million)

Livelihood	Minimum	Maximum	Mean	Share (%)	Standard deviation
Raising crops	0	15	2.71	6.04	4.06
Livestock	0	120	5.75	12.82	16.87
Non-agricultural	0	150	36.38	81.13	32.75
Total income	0	150	44.84	100.00	33.73

Source: 2013 household survey data

It is important to note that respondents' incomes are both low and uncertain. This possibly affects their demand for flood insurance.

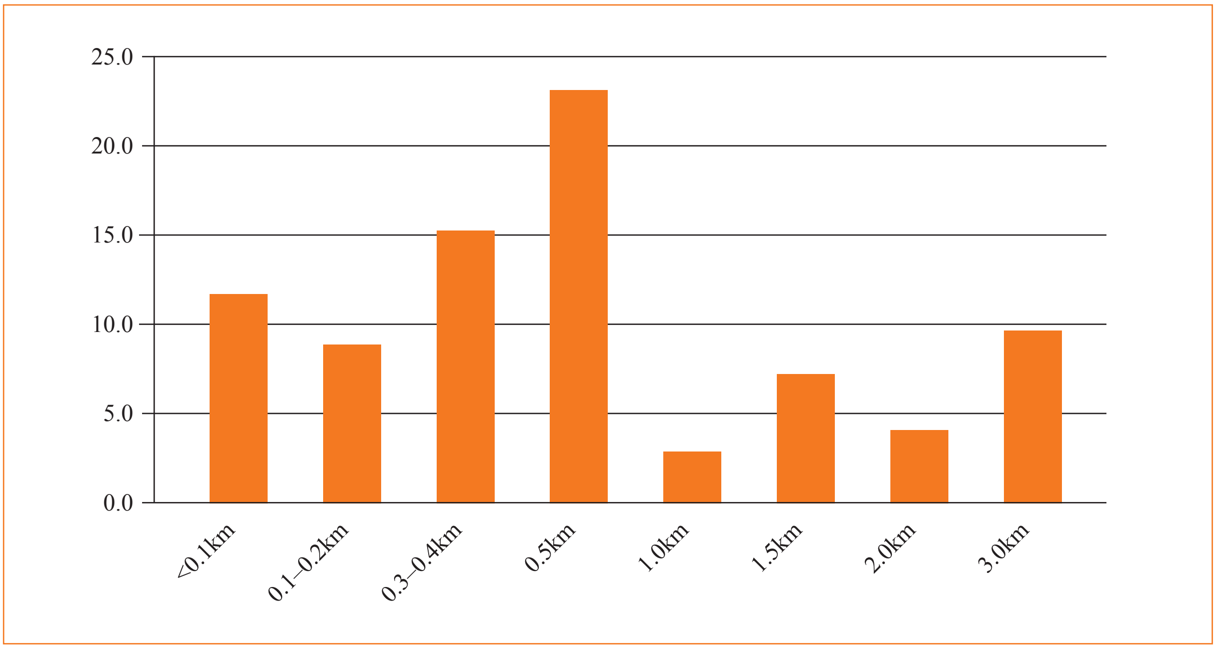
4.2 Respondents' exposure to and perceptions of flood risks

Figure 3 shows that most respondents' have houses located very close to the riverbank – over two thirds of respondents live less than one kilometre from a river. About a quarter of respondents (25 per cent) live roughly one to three kilometres away from the nearest river. Regarding flood evacuation centres, which are considered as safer shelters for households living in Da Nang city, the study found that the mean distance from house to safe shelter is 0.49km. According to respondents, there are no flood shelters in these districts, so schools are still used as flood shelters. However, participants in FGDs confirmed that

> *… we found it hard to evacuate to flood shelters such as schools, common houses, and government offices because they are located at a far distance. They are often built in the centre of the ward. We do not want to evacuate out of our houses in low severe floods as we have to protect our property, thus when floods increase flooding levels we cannot move [to the flood shelters] as we do not have transport.*

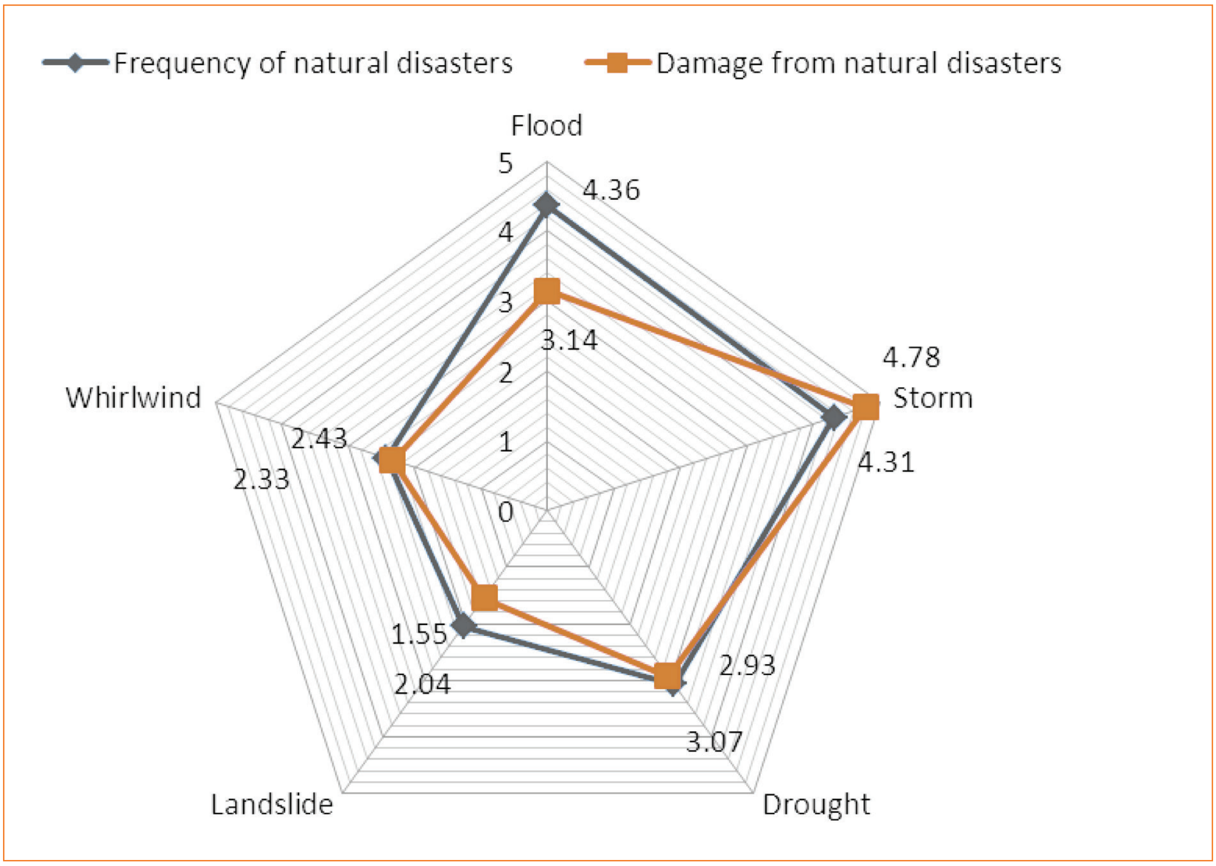
Participants strongly recommended that government should have a policy to construct public buildings with a combination of flood evacuation centres throughout the ward, not just in the centre of the ward.

Figure 3. Distances from households to nearest rivers



The study investigated local perceptions of flood risks by using a five-point Likert scale to understand how respondents assessed the frequency of natural disasters occurring and their subsequent damage. Figure 4 indicates that floods and storms are two types of disaster which occur regularly in Da Nang City, of which flooding occurs more regularly than storms, with a mean-assessed point of 4.36. According to respondents, storms cause the most damage to households is the highest compared to other natural disasters with a mean-assessed point of 4.78. In addition, some natural disasters are less likely to occur in Da Nang city, such as droughts, landslides or whirlwinds. This is consistent with disaster data recorded by the Da Nang Committee for Storm and Flood Control. Storms and floods often occur together and flooding also often occurs if there is heavy rain which lasts for two to three days without wind.

Figure 4. Frequency of and damage caused by natural disasters in Da Nang City: ratings by respondents



The increasing frequency of extreme flooding events in the past 10 to 20 years has caused significant damage to households. Table 10 shows that the average cost of damage is about VN$ 20 million per household during the most extreme flood such as those in 2007. The impact of floods on household property is the highest, about VN$ 14.60 million per household (accounting for 70.94 per cent of the total flood damage per household). Among the damages to household property, the most expensive damage (VN$ 12.96 million per household) was caused by housing damage, correlatively accounting for 88.77 per cent of total damage costs to properties, followed by damage to appliances (VN$ 1.26 million per household). The study also points to the fact that damage to agricultural production is less as farmers often harvest their crops before the flooding season, although floods often damage vegetable and fruit crops such as banana and papaya. On average, flood damage to agricultural production costs VN$ 5.41 million per household during the most extreme floods.

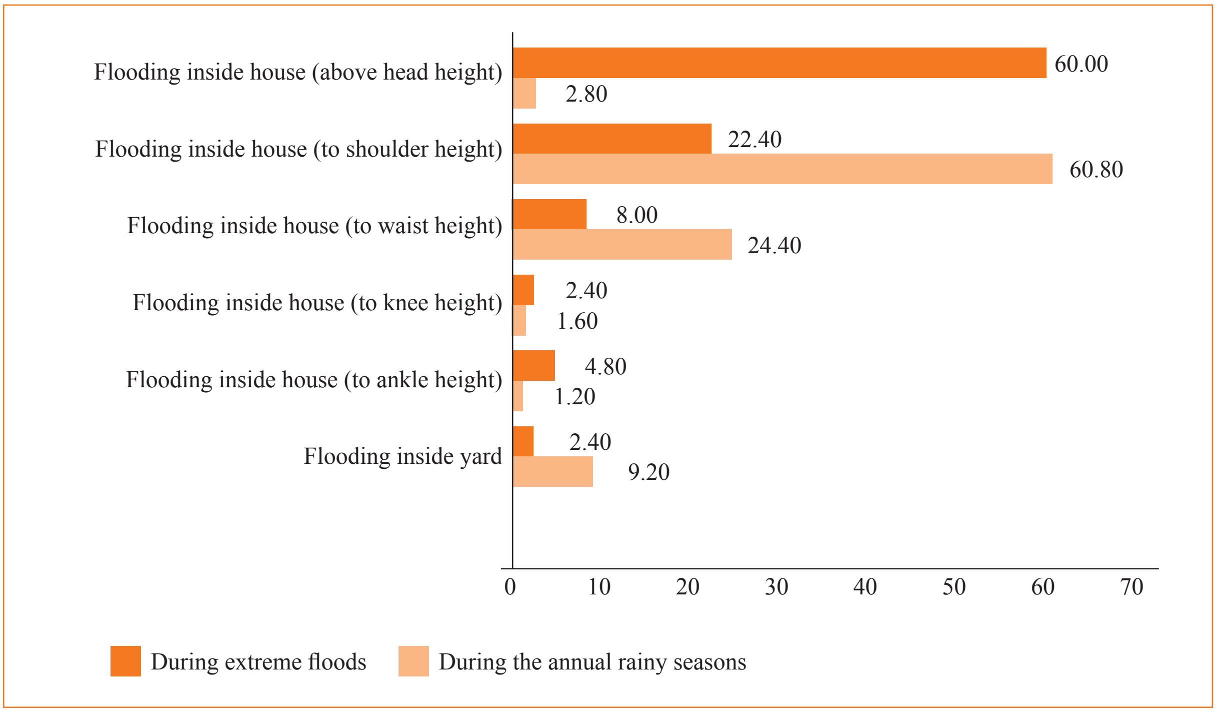
Regarding flooding water levels and inundation, Figure 5 shows flood inundation levels during both the annual floods and extreme floods over the last 10 years. About 60 per cent of respondents reported that flood inundation levels reached to shoulder height inside the house during the annual floods and 60 per cent confirmed that flood inundation levels came to above head height during extreme floods in the last ten years. Increasing inundation levels mean that most households are inundated from three to four days, especially in Hoa Vang District. In most cases, the floods did not last longer than one week.

Table 10. Estimate of damage to households caused by flooding (Unit: VN$ million per household)

Damage category	Extreme floods		Recent regular annual floods	
	Mean	Std. Dev	Mean	Std. Dev
1. Damage to household property	**14.60**	**14.53**	**4.41**	**4.42**
House	12.96	13.59	4.02	4.21
Household appliances	1.26	2.70	0.27	0.57
Vehicles	0.20	0.88	0.06	0.27
Amenities	0.19	0.22	0.07	0.08
2. Damage to household production	**5.85**	**5.48**	**3.85**	**3.41**
Loss of crops	3.33	2.31	2.37	1.64
Loss of livestock and poultry	2.08	4.24	1.10	2.25
Impacts on non-farming activities	0.44	1.95	0.38	1.68
3. Disease (medical costs)	**0.13**	**0.55**	**0.06**	**0.25**

Source: 2013 household survey data

Figure 5. Inundation levels during extreme floods and annual floods (% respondents)



In terms of adaptation to floods, the study revealed that households adopted various autonomous adaptation measures such as building houses with higher foundations, building a mezzanine level inside the house using reinforced concrete, strengthening homes with reinforced concrete or one room with a reinforced concreted roof, and storing food and necessities above expected flood levels. In terms of responses to floods, households often evacuate to a safer shelter, moving their possessions to a safer place. The participants in the FGD stated that reinforcing houses with reinforced concrete or building a mezzanine are effective measures to adapt to storms and floods. However, not many households were able to adopt these measures as they are expensive in relation to their incomes. Thirty per cent of households involved in this study were not satisfied with their current level of protection against catastrophic floods. Around 20 per cent of the sample stated that they were unable to cope with the impacts of flood disasters like the one in 2007. The reasons most frequently heard were that (i) they feel they live in an unstable house in a low-lying area close to the river; (ii) they are too old and weak to protect themselves and have no adult family member to help them; and (iii) they have insufficient resources to recover from a catastrophic flood. In the latter case, many respondents reported that they still have unrepaired damages from the flood in 2007. Moreover, the impact of the flood damage on households during the most extreme flood events, such as in 2007, forced some households to borrow money to repair their houses and recover production activities. Table 11 shows that 21 per cent of households borrowed money after the flood in 2007. About 70 per cent of respondents were satisfied with their current level of protection against annual flood events but not against extreme events. They are able to adopt adaptation measures such as moving their belongings to a safer place, reinforcing their houses or building houses with higher foundations, thus helping them to reduce the damage caused by annual floods, but not extreme ones.

Table 11. Flood-risk coping strategies and perceptions

Target	Frequency	Percentage
I. Risk coping strategies		
1. Number of households borrowing money after the 2007 flood	82	21.20
2. Number of households satisfied with current level of protection against annual flood events	271	70.00
3. Number of households that have had to evacuate due to flooding	144	37.20
II. Risk perception		
1. Number of households believing extreme floods have increased in the past 10 to 20 years	340	88.00
2. Number of households believing that extreme floods will increase in future	240	62.40

Source: 2013 household survey data

To support household flooding victims, there are often many social actors involved in charitable practices such as charity organisation, private companies, churches and government. A majority of respondents reported that they often received in-kind relief such as rice, instant noodles and crop seeds, estimating the value to be around VN$ 0.23 million per household. Moreover, based on the level of damage to houses, private companies and local government also provide financial support for repairing houses and building new ones. For instance, if selected during ward committee meetings, households can receive around VN$ 10 million from government if their houses have collapsed during floods or storms (see Table 12).

Table 12. Value of money or goods received from different sources after flooding (ĐVT: VN$ million/household)

Sources of money or goods	Maximum	Mean	Std. Deviation
Charitable organisations, associations or companies	1.20	0.23	0.27
Local government	0.61	0.12	0.14
Total	**1.81**	**0.35**	**0.41**

Source: 2013 household survey data

The majority of respondents in all study sites consider catastrophic flooding as the most important issue in their region. About 88 per cent believe that extreme events have increased in the past 10 to 20 years. About 62 per cent believe that flooding will increase in future and reported that floods have increased both in frequency and severity. Combined with water discharges from hydropower plants upstream, this has caused even more damage than before, pushing respondents beyond the limits of their adaptive capacity. This explains their high demand for flood index-based insurance schemes.

4.3 Modelling local demand for flood index-based insurance

Of the 387 respondents, about 66 per cent expressed an interest and willingness to pay for flood index-based insurance. Hence, WTP for flood insurance is positive in the majority of cases. Of the 130 respondents (about 34 per cent of the whole sample) who consistently chose neither of the two alternatives on the choice experiment cards, the majority of respondents (43 per cent) said that they were happy with their current situation; 34 per cent reported that they could not afford to pay for insurance or were unable to pay extra for flood insurance given their limited income; 20 per cent of respondents said that they weren't interested in buying index-based flood insurance; and approximately 3 per cent said that flood insurance was the responsibility of the government, not themselves (Figure 6).

Of the 257 respondents who chose index-based flood insurance, when asked the main reasons for their choice, the survey showed that the main reason for their choice was influenced by the 'flood return period' (32.53 per cent), 'insurance premium' (27.11 per cent), and 'insurance provider' (18.07 per cent), followed by 'fatality risk' (13.25 per cent) (see Figure 7). Most respondents were not influenced by the financial costs of flood damage because the costs were not considerable.

Figure 6. Reasons for not choosing index-based flood insurance

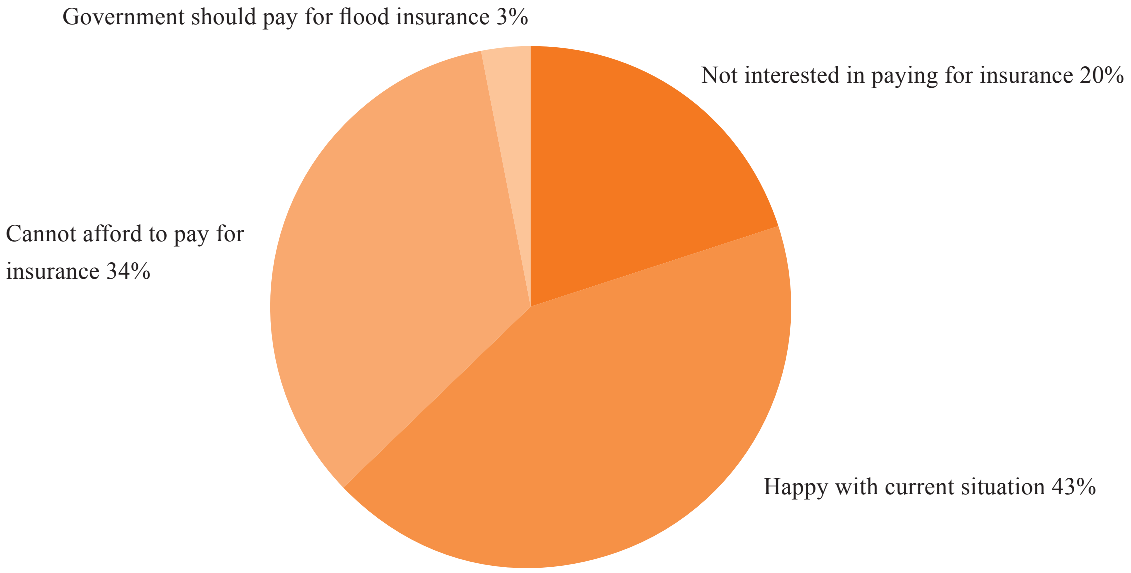
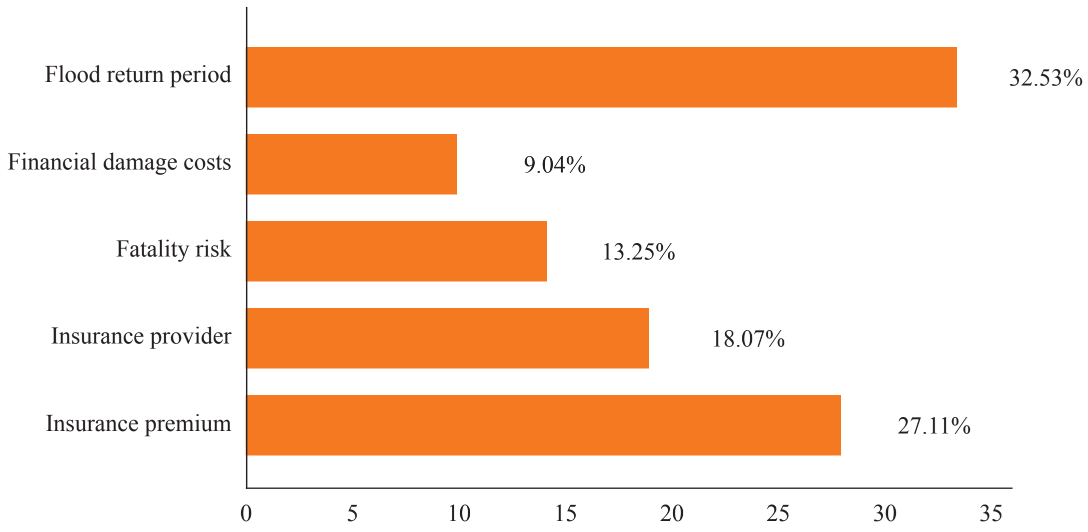


Figure 7. Reasons for choosing index-based flood insurance



Source: calculated by authors using 2013 household survey data

Before assessing household preferences for flood index-based insurance, the study will analyse the factors affecting household choices for flood insurance. A binary logistic model is used for estimating. The variables in this model include (i) ages of heads of household; (ii) total numbers of household members; (iii) distances from houses to nearest local rivers; (iv) income per household; (v) damage caused by floods; and (vi) flood zones (see Table 13).

Table 13. Description statistics in binary logistic model

Variables	Description			
I. Independent variables	**Minimum**	**Maximum**	**Mean**	**Std. Dev**
1. Age of head of household (years)	32.00	80.00	50.35	10.39
2. Total number of household members (people)	3.00	7.00	4.78	1.03
3. Distance to nearest local rivers (km)	0.01	3.00	0.54	0.61
4. Household income (million VN$)	12.00	150.00	44.84	33.73
5. Flood damage (million VN$)	2.00	50.00	14.43	13.07
6. Characteristics of flood zone	Dummy, 1= Heavy flood zone			
II. Dependent variable				
Y (Choice of index-based flood insurance)	Choice 1 = Choice; 0 = Not choice			

Source: 2013 household survey data

The results of the binary logistic regression (Table 14) shows that the estimated parameters are statistically significant, thus confirming that household demand for flood index-based insurance is affected by all factors. However, flood zone characteristic have the strongest influence on households' choice of flood insurance. If households live in a heavily flooded zone, the probability of demanding insurance is 69 per cent. The distance from the house to the nearest local river is also a factor that has a strong impact on households' demand for flood insurance. In addition, the number of household members also has an impact with a marginal effect of 9.6 per cent. Next is the marginal effect of the flood damage variable with 4.8 per cent, followed by the age of the household head at 3 per cent and household income at 0.6 per cent.

Table 14. Results of binary logistic regression

Variables	B	S.E.	Wald	Sig.	Marginal effects (x 100%)
1. Age of head of household (years)	0.119	0.033	13.242	0.000	0.030
2. Total number of household members (people)	0.382	0.209	3.359	0.067	0.096
3. Distance to nearest local rivers (km)	–0.903	0.351	6.601	0.010	–0.226
4. Household income (million VN$)	0.025	0.007	12.267	0.000	0.006
5. Flood damage (million VN$)	0.192	0.041	21.756	0.000	0.048
6. Characteristics of flood zone	2.789	0.541	26.546	0.000	0.697
Constant	–10.441	2.537	16.938	0.000	
2-log likelihood	169.611				
Cox and Snell R Square	0.450				
Nagelkerke R Square	0.624				

Source: 2013 household survey data

With the value of 2-log likelihood indicator in the binary logistic model reaching 169.611, it can be concluded that the likelihood of the model is significant and suitable for this study. The Nagelkerke R-Square correlation coefficient has a value of 0.624, meaning that about 62.4 per cent of the variance is explained by this model, and this is a relatively high correlation coefficient. Table 15 shows that the overall percentage of correct predictions in the model is quite high, accounting for 86 per cent, and it reveals that the binary logistic model used for this study is sufficiently reliable.

Table 15. Estimated correct percentage of model for respondents' flood insurance choice

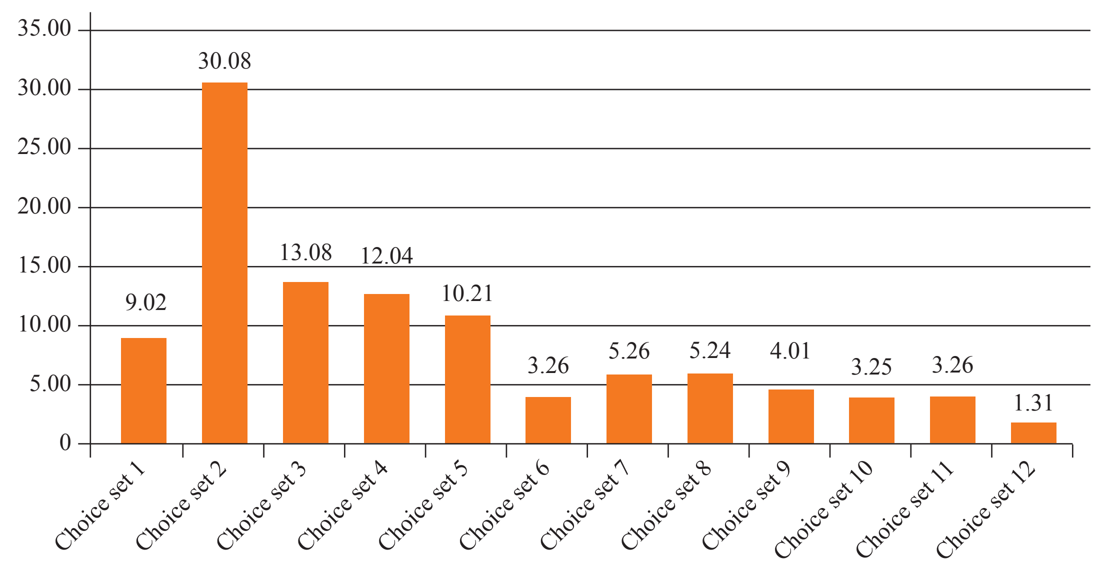
		Predicted		
		Choice flood insurance		
Observed		**Not choosing**	**Choosing**	**Estimated correct of model (%)**
Flood insurance choice	Not choosing to buy insurance	108	22	83.33
	Choosing to buy insurance	33	224	87.35
Overall percentage (%)				86.00

Source: 2013 household survey data

Table 15 summarises statistics from the choice experiment modelling of the 257 respondents. Eighty-seven per cent agreed with buying index-based flood insurance in principle while the rest of the respondents were not willing to pay. It is significant enough evidence to state that there is a high demand for catastrophe flood index-based insurance for households living in Da Nang City.

Although households are familiar with the annual floods, an increase in frequency and severity of extreme floods combined with the impacts caused by hydropower plants and urbanisation often causes huge damage to properties. Figure 8 reveals the details of choice sets (i.e. flood index-based insurance goods) selected by respondents, in which Choice Set 2 was the most popular. Choice Set 2 reflects the main features of catastrophe flood which occur most frequently in Da Nang City, including rainfall reaching 1000–1500mm, river-water levels reaching 4.5–4.75m, wind speeds reaching those of a tropical cyclone, a flood-return period of every 10 years, insurance premiums of VN$ 20,000, and a payout of VN$ 20 million. The insurance premium was also found to reasonable by households (see Appendix 2). The results of omnibus tests of model coefficients show that the indicator of log likelihood has a negative sign (-1,614.158) and the statistical value of Chi-square is 400.262 at a significant level of 1 per cent. The conclusion from this is the research model for this study is highly statistically significant.

Figure 8. Distribution of choice sets chosen by households



Results from the conditional logistic model regression are shown in Table 16. Almost all parameter levels have the expected signs and are statistically significant except for the flood damage insurance package 'Dam3' level of the 'Dam' attribute variable (see Tables 17 and 18). The non-significance of this level shows an insufficient contribution to respondents' utility function and reveals that this level does not affect respondents' demand for flood index-based insurance. The positive coefficient sign implies higher probability of a choice being associated with its corresponding attribute levels. Thus, as expected with higher weather indices, respondents' demand for flood insurance is greater. This originates in two main causes: (1) storms are usually accompanied by floods in Da Nang City, so when floods occur winds reach Level 9 and above; (2) River-water levels are always high during the annual rainy seasons due to water being discharged from hydropower dams in Quang Nam Province and the low drainage capacity of canals and lakes inside Da Nang City due to the lack of any well-designed urbanisation plan.

Table 16. Model statistics

Omnibus tests of model coefficients	
Number of respondents	387
–2 log likelihood	1614.158
Chi-square	400.262 (0.000)

Source: 2013 household survey data

The results of the conditional logit model estimated that the flood return period has a positive effect on the choices of this attribute. A lower probability of return period results, *ceteris-paribus*, in a lower probability of an alternative being chosen. The result is quite appropriate in the context of flooding in Da Nang City, where the probability of floods occurring has increased in the last 15 years. Catastrophic flooding has increased in both frequency and intensity, for example the catastrophic floods of 1999, 2006, 2007 and 2009 in Da Nang City. It explains why the respondents chose a high probability of flood-return. The FGD participants even suggested that

> *…we should increase the probability of catastrophic floods to that of the past. It is reasonable as annual floods combine with water discharge from hydropower plants in two main rivers in Da Nang, thus causing annual catastrophic floods, instead of based on rainfall index…*

For this reason, river-water levels have been used in different scenarios of weather indices (Table 17).

As the respondents were all households living in the regular flood zone, there was a high percentage of one-storied houses with an elevated ground floor where people can shelter during floods (accounting for 64.4 per cent). Moreover, a majority of households have experiences in preventing flood damage, with the most important measure before and during flood events being moving belongings to a safer place. It is also important to bear in mind that most households live in flooded areas with lower-income livelihood strategies. Their most valuable assets are their homes, usually covering an area of 4–5m in width and 15–20m in length. On average, damage caused by extreme floods cost around VN$ 20 million per household. As a result, respondents are willing to pay lower premiums for lower damage payouts in this study (i.e. choice sets 1 to 5). A large proportion of respondents preferred damage payouts of VN$ 25–50 million and relatively few chose damages of VN$ 50–100 million. Conversely, respondents preferred to choose attributes with a higher fatality probability, reflecting a higher WTP to avoid increasing mortality risks.

The results of this model highlight that local respondents involved in this study have indicated a high demand for index-based flood insurance. The results of this study are also relatively consistent with current literature (Brouwer and Akter 2010; and Akter *et al*. 2011). The results of the choice experiment model found that when the flood-return period (probability) and damage costs increased, this increased the willingness to pay for an insurance premium. However, respondents reduced their choice in accordance with the current context of a catastrophic flood-return period. This is consistent with the fact that respondents have indicated that they would prefer a higher probability of catastrophic flood-return period than that already included in existing insurance schemes. The results were similar for damage costs, with households preferring to have higher damage cover (Lindhjem *et al*. 2011). However, for higher damage costs of over VN$ 50 million (i.e. between VN$ 75 million and VN$ 100 million), index-based insurance was not preferred by respondents. This means that in reality, the index of damage costs used for insurance policy design should not be over VN$ 50 million. The damage costs covered by flood insurance should be between VN$ 10 and 30 million, which is feasible for households living in flood-prone areas.

Regarding the probability of fatality attribute, the results in the choice model reveal that respondents' willingness to pay for this attribute increased when the probability of fatality increased. The households were willing to pay for flood insurance to protect themselves from an increase in the probability of death in relation to an increase in the probability of catastrophic floods. However, this relationship is not non-linear where there is an increase between willingness to pay and probability of fatality and probability of floods.

Table 17. Estimated results for the basic CL model

Attributes	Variables	Parameter estimate	Standard error	P-value.
Rainfall: 1000–1500 mm; River level: 4.50–4.75m; Wind level: Tropical cyclone	W_index2	–0.423*	0.238	0.075
Rainfall: 1500–2000mm; River level: 4.75–5.00m; Wind level: Typhoon level 6–8	W_index3	0.727***	0.272	0.008
Rainfall: >2000mm; River level: > 5.00m; Wind level: Typhoon level >=9	W_index4	0.874***	0.231	0.000
Flood-return period (once every 10 years)	Fr peri2	0.516***	0.191	0.007
Flood-return period (once every 30 years)	Fr peri3	–0.476**	0.225	0.035
Flood-return period (once every 50 years)	Fr peri4	–0.673*	0.373	0.071
Flood damage (50 million VN$)	Dam2	0.279*	0.167	0.095
Flood damage (75 million VN$)	Dam3	–0.272^{ns}	0.212	0.201
Flood damage (100 million VN$)	Dam4	–0.905***	0.245	0.000
Fatality probability (1:5000)	FProb2	0.338*	0.196	0.085
Fatality probability (1:2000)	FProb3	0.360*	0.203	0.077
Fatality probability (1:1000)	FProb4	0.507**	0.249	0.042
Payout (20 million VN$)	Pay2	0.645***	0.172	0.000
Payout (30 million VN$)	Pay3	–0.735***	0.211	0.000
Payout (50 million VN$)	Pay4	–0.746***	0.197	0.000
Insurance premium (VN$/hh/month)	IP	–0.00008***	0.00001	0.00000

Note: W_index1, Fr peri1, Dam1, FProb1, Pay1, InCom1: base level; Significance levels: *** p<0.01, **p<0.05, * p< 0.10
(Source: Calculation by SPSS using 2013 household survey data)

Turning to insurance design characteristics, respondents showed a strong preference for government-supplied flood insurance (the dummy variable for insurance providers has the value 1 if the provider is a government insurance company). As expected, a higher insurance premium results in a lower likelihood that an alternative option is chosen. Government insurance is regarded as more reliable than private insurance in the context of climate change.

Table 18. Estimates of WTP (VN$/household/month)

Attributes	Variables	WTP
Rainfall: 600–1000mm; River level: <4.50m; Wind level: Tropical cyclone	W_index1	–14,156
Rainfall: 1000–1500mm; River level: 450–4.75m; Wind level: Tropical cyclone	W_index2	–5,089
Rainfall: 1500–2000mm; River level: 4.75–5.00m; Wind level: Typhoon level 6–8	W_index3	8,734
Rainfall: > 2000mm; River level: > 5.00m; Wind level: Typhoon level >= 9	W_index4	10,511
Flood-return period (once every 5 years)	Fr peri1	7,603
Flood-return period (once every 10 years)	Fr peri2	6,200
Flood-return period (once every 30 years)	Fr peri3	–5,716
Flood-return period (once every 50 years)	Fr peri4	–8,087
Flood damage (25 million VN$)	Dam1	10,792
Flood damage (50 million VN$)	Dam2	3,358
Flood damage (75 million VN$)	Dam3	–3,266
Flood damage (100 million VN$)	Dam4	–10,884
Fatality probability (1:10,000)	Fprob1	–6,355
Fatality probability (1:5000)	FProb2	–4,060
Fatality probability (1:2000)	FProb3	4,322
Fatality probability (1:1000)	FProb4	6,093
Payout (10 million VN$)	Pay1	10,050
Payout (20 million VN$)	Pay2	7,749
Payout (30 million VN$)	Pay3	–8,836
Payout (50 million VN$)	Pay4	–8,962
Private insurance company	Private	–4,938
Public insurance company	Public	4,938

Source: Calculation by SPSS using 2013 household survey data

Table 18 shows the willingness to pay for the insurance weather index attributes. Respondents requested a discount of VN$ 14,156/hh/month for the designed premium in order to accept the third weather index (Rainfall: 1500–2000 mm; River level: 4.75–5.00m; Wind level: Typhoon level 6–8). However, they were willing to pay VN$ 10,511/hh/month to ensure all weather scenarios (i.e. all weather indices) were offered by the insurance contract (about VN$ 127,000/hh/year, equivalent to US$ 6/hh/year). However, respondents were willing to pay VN$ 7603/hh/month to accept the lowest flood return period which is once every five years (about VN$ 90,000/hh/year or US$ 4.5/hh/year).

Respondents were willing to pay VN$ 6093/hh/month when the probability of dying was increased from one in every 10,000 people to one in every 1000 people. Willingness to pay was VN$ 10,050/hh/month only if the insurance company paid out VN$ 10 million per flood event for each household. Respondents preferred flood insurance offered by a public company and were willing to pay VN$ 4938/hh/month to a government insurance company.

Respondents exhibited a preference for lowering thresholds (for flood damage) for which they have the right to be compensated. The results of this study also show that they would accept an insurance contract with the fourth damage level (VN$ 100 million) to allow them to be compensated only if the package had a discount of VN$ 10,884/hh/month. This can be explained as the non-parametric Kruskal–Wallis test rejects the null hypothesis of equal mean WTP between three levels of flood damage. As Table 19 shows, there is no significant difference found for mean WTP between three levels of flood damage.

Table 19. Kruskal–Wallis Test of equal mean WTP between three levels of flood damage

	Flood damage	**N**	**Mean rank**
Mean WTP	≤ 25 million VN$	161	84.02
	25 < 50 million VN$	51	78.50
	≥ 50 million VN$	45	86.11
	Total	257	
2. Kruskal–Wallis Test			
Chi-Square	0.294		
Df	2		
Asymp. Sig.	0.863		

The results of the binary logistic model show that the household characteristics are considered to be factors that have a strong influence on decision making for buying flood insurance. This also means that WTP is impacted by these characteristics. Firstly, a significant difference is found for mean WTP between four age groups of heads of household at 1 per cent level (Table 20). The outcome of the non-parametric Kruskal–Wallis test shows that households in which the head is aged 55 or older have the highest mean rank, whereas households in which the head is aged less than 35 years old have the lowest mean rank. This means that the older the household head, the higher the mean WTP is.

Table 20. The Kruskal–Wallis Test of equal mean WTP between four age groups (heads of households)

1. Ranks	**Age group of head of household**	**N**	**Mean rank**
Mean WTP	< 35 years old	34	43.95
	35 < 44 years old	54	79.31
	45 < 54 years old	89	78.71
	>= 55 years old	80	98.09
	Total	257	
2. Kruskal–Wallis Test			
Chi-Square	13.490		
Df	3		
Asymp. Sig.	0.004		

Source: 2013 household survey

Secondly, household income also impacts on willingness to pay. According to the results of non-parametric Kruskal–Wallis test, a significant difference is found for mean WTP between five income groups of households at 1 per cent level. Table 21 shows that the highest mean rank belongs to households that have an annual income greater than or equal to VN$ 50 million. This confirms that the impact of household income on mean WTP is positive.

Table 21. The null hypothesis test of equal mean WTP between five levels of household income groups

1. Ranks	**Household Income**	**N**	**Mean Rank**
Mean WTP	< 20 million VN$	39	46.79
	20 < 29 million VN$	55	68.03
	30 < 39 million VN$	65	75.48
	40 < 49 million VN$	49	106.79
	≥ 50 million VN$	48	116.78
	Total	256	
2. Kruskal–Wallis Test			
Chi-Square	40.469		
Df	4.000		
Asymp. Sig.	0.000		

Source: 2013 household survey

Thirdly, the willingness to pay of respondents is affected by flood zone characteristics. Table 22 shows that the highest mean rank belongs to households living in heavily flooded zones. This implies that they are willing to pay a higher insurance premium than households living in less flooded zones.

Table 22. The null hypothesis test of equal mean WTP between two flood zones

1. Ranks	**Flood zone**	**N**	**Mean rank**	**Sum of ranks**
Mean WTP	Moderate flood zone	97	53.52	2729.50
	Heavy flood zone	160	96.80	11131.50
	Total	257		
2. Mann–Whitney Test				
Mann-Whitney U		1403.500		
Wilcoxon W		2729.500		
Z		–5.447		
Asymp. Sig. (2-tailed)		0.000		

Source: 2013 household survey

5 Conclusions and policy implications

Using a choice experiment model to estimate local demand for index-based flood insurance in the context of climate change and in a developing country like Vietnam can make a significant contribution to the understanding of choices around insurance, and consequent policy development. It is important to understand that climate change and its induced disasters, particularly floods, have increased sharply in frequency and intensity in last 15 years in Da Nang City. This has had severe impacts on socio-economic development, especially for households living in flood-prone areas. It is also important to consider that despite rapid growth and urbanisation, a large proportion of the population involved in this study are poor households living in semi-permanent and poorly constructed houses in flood-prone areas. For adaptation to floods, there are number of autonomous adaptation and response measures such as reinforcing houses, building mezzanine levels, moving possessions to safer places, and borrowing money to reduce the impacts of floods. The efficiency of these measures is limited in the context of catastrophic floods with the exception of housing reinforcement. However, the number of households for which this adaptation option is affordable is limited due to its high expense.

There is no existing flood insurance option in Da Nang City in particular and in Vietnam in general. This study has shown that there is a high demand for index-based flood insurance among local communities in flooded areas in Da Nang City. In the context of increases in the frequency and intensity of catastrophe floods and typhoons, the additional problem of water discharge from upstream hydropower plants causes more damage to property, especially houses. The situation is projected to be exacerbated when rapid urbanisation processes in this city further reduce the floodwater drainage capacity. The lakes and canals inside the city have been made more narrow so as to expand urban areas, and there are now more high buildings, urban housing areas and commercial centres, leading to more severe floods and more damage to household property.

The willingness to pay for flood insurance increases in accordance with an increase in weather indices, the probability of a shorter catastrophic flood-return period, increased flood damage costs, and probability. However this is not linear correlation. Households most preferred choice set 2, followed by choice sets 3, 4 and 5. These choice sets present the most common features of annual flooding and the economic conditions of households living in flood-prone areas of Da Nang City. The respondents seem to be risk neutral as they prefer reasonable insurance coverage related to reasonable damage costs. The study found that 100 per cent of respondents would choose index-based insurance provided by a government company.

The study found a significant difference in the demand for index-based flood insurance between respondents living in heavily flooded areas and less flood-prone areas in this study site. Households living in heavily flooded areas indicated a much higher demand for flood insurance than households lived in less flood-prone areas. It means that flood-risk perception is different among respondents in different contexts, thus leading to different choices when it comes to purchasing index-based flood insurance.

The income of households strongly affects their willingness to pay for index-based flood insurance in Da Nang City. As the income of respondents is quite low, this results in a lower willingness to pay for insurance than insurance premium design presented in the choice experiment, although respondents also showed that their demand for insurance was high.

This means that to develop index-based flood insurance, the government should provide subsidies for households who purchase the insurance, particularly for the poor living in flood-prone areas.

The validity and reliability of indices used for index-based insurance development is a very important factor contributing to the willingness to pay for flood insurance. The failure of previous disaster-risk insurance provided by the Ministry of Agriculture and Rural Development in the Northern Provinces and by Bao Viet insurance for coffee plantations in the Central Highlands was due to low penetration among households, which resulted in a reduction of reliability and validity of the indices. Thus, insurance companies and households found it hard to find a common agreement relating to estimating damage costs and coverage for insurance policies.

This study found that weather indices such as rainfall, river-water levels and wind speed are viewed as the most valid and reliable attributes for insurance companies, insurance buyers and government alike. Besides these, the probability of fatality, damage costs and cover are also considered valid and reliable by insurance companies and households. It is important to note that local demand for flood insurance increases when the probability of fatality, higher damage costs and probability of flood-return periods increase; however it is not linear correlation. It means that a reasonable level of damage costs, probability of floods and probability of flood-return periods will meet the local demand for flood insurance in this study. The impact of urbanisation and hydropower development are also factors contributing to the exacerbated situation of flood damage to houses and affecting the local demand for flood index-based insurance.

One hundred per cent of respondents involved in this study showed their preference for using a state-owned insurance company rather than a private one. It means that state-owned insurance companies such as Bao Viet one should play the most important role in developing flood index-based insurance schemes. They should provide households living flood-prone areas in Da Nang City with a demonstrated model for developing and establishing a flood index-based insurance market in Vietnam. In doing so, the government should provide financial support for Bao Viet Insurance Company using the annual budget subsidy, as well as providing relief for households whose property has been damaged by floods.

Central government should also develop policy encouraging both state-owned insurance companies as well as private ones to develop flood index-based insurance markets. A compensation mechanism should also be developed collaboratively with government, insurance companies and households. The findings of this study propose that the flood indices used for the compensation mechanism development should be selected for their publicity, validity and reliability among stakeholders.

Despite local high demand for flood index-based insurance, insurance premiums and insurance payouts should be of a reasonable rate. The insurance premium should be about or under VN$ 10,000/hh/month or about VN$ 120,000/hh/year (equivalent to about US$ 6/hh/year) as households living in flood-prone areas earn a low income, thus higher insurance premiums might result in low penetration among households.

There has been never been a flood index-based insurance scheme in Vietnam in general and in Da Nang City in particular. This means that households have a very limited awareness of flood index-based insurance schemes or of buying insurance for their properties as a means of enhancing their adaptation option to floods. It is important to raise awareness about flood index-based insurance schemes as an adaptation mechanism among local communities, particular for households living in flood-prone areas. Insurance companies should collaborate with local government to conduct campaigns about such schemes in village meetings and in the local public media. Priority should be given to older heads of households, better-off households and households living in severely flooded areas before scaling schemes up to whole communities.

It is clear that insurance can play an important role in reducing risks, not only by helping affected households to recover from catastrophes such as floods and typhoons through financial compensation, but also encouraging behaviour that reduces their exposure to disaster risks, especially as government often shoulders the financial burden to support local communities to recover from damages. While local communities have demonstrated a high demand for index-based flood insurance, their low incomes and the lower validity and reliability of the design of flood insurance products have constrained the success of disaster insurance in Vietnam. Index-based flood insurance can tackle such constraints, providing more validity and reliability for flood insurance schemes in the housing sector in the context of rapid urbanisation and climate change.

References

Akter, S., Brouwer, R., van Beukering, P., Silver, E., French, L., Choudhury, S. and Azis, S. 2011. Exploring the feasibility of private micro flood insurance provision in Bangladesh, *Disasters* 35(2): 287–307.

AM Best Company. 2011. Special report: Vietnam's insurance market awakening to further change. AM Best Company.

Ahmed, I. 2011. An overview of post-disaster permanent housing reconstruction in developing countries. International Journal of Disaster Resilience in the Built Environment 2, 148–164.

Birol, E. and Koundouri, P. (eds.) 2008. *Choice Experiments Informing Environmental Policy: A European perspective*. Edward Elgar Publishing, Cheltenham, UK.

Botzen, W. and van den Bergh, J. 2008. Insurance against climate change and flooding in the Netherlands: present, future and comparison with other countries. *Journal of Risk Analysis*, 28 (2): 413–426.

Botzen, W. and van den Bergh, J. 2009. Bounded rationality, climate risks and insurance: is there a market for natural disasters? *Journal of Land Economics* 85: 265–278.

Botzen, W., Aerts, J. and van den Bergh, J. 2009. Willingness of homeowners to mitigate climate risk through insurance, *Ecological Economics* 68(8–9), 2265–2277.

Brouwer, R. and Akter, S. 2010. Informing micro insurance contract design to mitigate climate change catastrophe risks using choice experiments, *Journal of Environmental Hazards* 9(1), 74–88.

Brouwer, R., Akter, S., Brander, L. and Haque, E. 2009. Economic valuation of flood risk exposure and reduction in a severely flood prone developing country, *Environment and Development Economics*, 14(3), 397–417.

Brouwer, R. and Schaafsma, M. 2009. Choice modelling of climate change flood risk mitigation and disaster management. Paper presented at the EAERE conference in Amsterdam, 24–28 June 2009.

Clark, D.E., Novotny, V., Grifin, R., Booth, D., Bartosova, A., Daun, M.C. and Hutchinson, M. 2002. Willingness to pay for flood and ecological risk reduction in an urban watershed, *Water Science and Technology* 45(9), 235–242.

Da Nang City People'S Committee 2011. Annual report on socio-economic development in 2010 and action plans for 2011. Da Nang City, Vietnam.

Da Nang CSFC. 2011. Annual report on disasters and its damages, and disaster response action plans. Da Nang City Committee for Storm and Flood Control (CSFC), Vietnam.

Da Nang CSFC 2012. Annual report on disasters and its damages, and disaster response action plans. Da Nang City Committee for Storm and Flood Control (CSFC), Vietnam.

Da Nang Office of Statistics. 2011. Statistical yearbook 2011. Da Nang Office of Statistics, Da Nang City. Vietnam.

Dang, N.M., Babel, M.S. and Luong, H.T. 2011. Evaluation of food risk parameters in the Day River Flood Diversion Area, Red River Delta, Vietnam, *Natural Hazards* 56: 169–194.

Dlugolecki, A. 2008. Climate change and the insurance sector. *The Geneva Papers* 33 (1), 71–90.

Dworkin, R. 2000. *Sovereign Virtue: The theory and practice of equality*. Cambridge, MA: Harvard University Press.

Greene, W.H. 1997. *Econometrics Analysis*, 3rd Edition, New York, US: Macmillan.

How Quy Commune People's Committee. 2009. Hoa Quy Commune's annual report on hazard damages. Hoa Quy Commune, Hoa Vang District, Da Nang City.

Ho, T.K.L and Umitsu, M. 2011. Micro-landform classification and flood hazard assessment of the Thu Bon alluvial plain, central Vietnam via an integrated method utilizing remotely sensed data. *Applied Geography* 31 (3): 1082–1093.

ISET. 2011. Da Nang Climate Change Resilience Strategy Action Plan 2011–2020, Vietnam.

Kunreuther, H.C. and Pauly, M. 2006. Rules rather than discretion: lessons from Hurricane Katrina. *Journal of Risk and Uncertainty* 33 (1–2), 101–116.

Lancaster, K. 1966. A new approach to consumer theory. *Journal of Political Economy* 74, 132–57.

Lindhjem, H., Navrud, S., Braathen, N.A., and Biausque, V. 2011. Valuing lives saved from environment, transport and health policies: a meta-analysis, *Risk Analysis* 31(9), 1381–1407.

Louviere, J. and Hensher, D. 1982. On the design and analysis of simulated choice or allocation experiments in travel choice modelling. *Transportation Research Record* 890, 11–17.

Louviere, J. and Woodworth, G. 1983. Design and analysis of simulated consumer choice or allocation experiments: an approach based aggregate data. *Journal of Marketing Research*, 20, 350–367.

Luce, R.D. 1959. *Individual Choice Behavior: A theoretical analysis*, John Wiley and Sons: New York.

Mai, C.V., Stive, M.J. and van Gelder, P.H. 2009. Coastal protection strategies for the Red River Delta, *Journal of Coastal Research* 25(1), 105–116.

McFadden, D. 1973. Conditional logit analysis of qualitative choice behavior. In: Zarembka P. (Ed.), *Frontiers in Econometrics*, Academic Press: New York.

McElwee, P. 2010. *The Social Dimensions of Adaption to Climate Change in Vietnam*. Discussion Paper 12. The World Bank: Washington D.C.

Michel-Kerjan, E. and Kousky, C. 2008. Come rain or shine: evidence on flood insurance purchases in Florida. *Journal of Risk and Insurance* 77(2), 369–397.

Mills, E. 2005. Insurance in a climate of change. *Science* 309, 1040–1044.

MoF. 2009. *Natural Disaster Insurance in Vietnam: Current situation, solution and development trend*. Department of Insurance, Ministry of Finance (MoF), Hanoi, Vietnam.

MoNRE. 2009. *Guiding framework for formation of climate change response and action plans of ministries, sectors and localities.* Ministry of Natural Resources and Environment, Hanoi, Vietnam.

Navrud, S., Tuan, T.H. and Tinh, B.D. 2012. Estimating the welfare loss to households from natural disasters in developing countries: a contingent valuation study of flooding in Vietnam, *Global Health Action* 5, 17609, http://dx.doi.org/10.3402/gha.v5i0.17609.

Neelke, D. 2013. Rationality in flood risk management: the limitation of probabilistic risk assessment in the design and selection of flood protection strategies. *Journal of Flood Risk Management* 10, 45–78.

Nguyen, V.T. 2013. *Insurability of Catastrophe Risks and Government Participation in Insurance Solutions.* Background paper prepared for the Global Assessment Report on Disaster Risk Reduction 2013.

Parry, M.L., Canziani, O.F., Palutikof, J.P., van der Linden P.J. and Hanson C.E. (eds.) 2007. *Climate Change 2007: Impacts, adaptation and vulnerability.* Contribution of Working Group II to the fourth assessment report of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press: Cambridge.

Petrolia, D., Landry, C.E. and Coble, K.H. 2011. Risk preferences, risk perceptions, and demand for flood insurance, *Land Economics* 89(2).

Pilarczyk, K.W and Nuoi, N.S. 2005. Experience and practices on flood control in Vietnam, *Water International* (30)1, 114–122.

Rao, N.K. 2010. Index Based Crop Insurance. *Journal of Agriculture and Agricultural Science Procedia* 1, 193–203.

Reynaud, A., Aubert, C. and Hung, N.M. 2012. Living with floods: protective behaviours and risk perception of Vietnamese households, *The Geneva Papers* 38, 547–579.

Schiller. 2003. 'The impact of insurance fraud detection systems,' *Journal of Risk and Insurance*, The American Risk and Insurance Association, 73(3), 421–438.

Selamet, Y. Undated. The Turkish Catastrophe Insurance Pool (TCIP) and the Compulsory Earthquake Insurance Scheme. See http://info.worldbank.org/etools/docs/library/114715/istanbul03/docs/istanbul03/11yazici3-n%5B1%5D.pdf.

Shaw. R. 2006. Community-based climate change adaptation in Vietnam: inter-linkages of environment, disaster, and human security. In: S. Sonak (Ed.) *Multiple Dimension of Global Environmental Changes*, TERI, 521–547.

Skees, J., Hartell, J. and Murphy, A.G. 2007. *Using Index-Based Risk Transfer Products to Facilitate Micro Lending in Peru and Vietnam.* GlobalAgRisk Inc. Unpublished working paper.

Suarez, P. and Linnerooth-Bayer, J. 2011. *Insurance-related instruments for disaster risk reduction*. Submitted to the International Strategy for Disaster Reduction (UNISDR) in the context of The 2011 Global Assessment Report on Disaster Risk Reduction.

Tu, T.T and Nitivattananon, V. 2011. Adaptation to flood risks in Ho Chi Minh City, Vietnam, *International Journal of Climate Change Strategies and Management* (3)1, 26–42.

Warner, K. 2010. Economics and social vulnerability: dynamics of entitlement and access. In: Brauch, H.G., Oswald Spring, U., Mesjasz, C., Grin, J., Kameri-Mbote, P., Chourou, B., Dunay, P. and Birkmann, J. (eds): *Coping with Global Environmental Change, Disasters and Security Threat:, Challenges, Vulnerabilities and Risks*. Hexagon Series on Human and Environmental Security and Peace, volume 5.

World Bank. 2012. *ASEAN: Advancing Disaster Risk Financing and Insurance in Asean Member States: Framework and Options for Implementation*. Volume 1: Main report. World Bank: Washington DC.

World Bank. 2010. *Weathering the Storm: Options for disaster risk financing in Vietnam*. World Bank: Washington DC.

Yusuf, A.A. and Francisco, H. 2009. *Climate Change Vulnerability Mapping for South East Asia*, International Development Research Centre (IDRC).

Zhai, G., Sato, T. Fukuzono, T., Ikeda, S. and Yoshida, K. 2006. Willingness to pay for flood risk reduction and its determinant in Japan, *Journal of the American Water Resources Association* 42(4), 927–940.

Appendix 1: Questionnaire for household survey

Code of household:

Interviewer:

Date of interview:

I: Household information

1 Address:

Commune/Ward:

District:

2 Gender of respondents:

☐ 1. Male

☐ 2. Female

3 Age: (years)

4 What level of education have you completed?

☐ 1. None ☐ 2. Primary ☐ 3. Secondary

☐ 4. High school ☐ 5. College degree ☐ 6. Graduate

6 Are you the head of household? (interview the head or his/her spouse only)

☐ 1. Yes ☐ 2. No, spouse

7 How long has your family lived here? (not your ancestors) (years)

8 Number of household members

No	Description	No. people
1	Total number of household members	
Of which…		
A	Number of family members who are working	
B	Number of children less than 15 years of age	
C	Number of family members older than 60 years of age	

9 What type of house do you live in?

9.1 Degree of permanence

Residential housing type	
1. Permanent (e.g. all walls are made of brick and concrete)	☐
2. Semi-permanent (e.g. wall is brick but roof is made of tiles and metal)	☐
3. Not permanent (e.g. not made of brick, only wood, bamboo or other materials)	☐
4. Other (please specify)	☐

9.2 Number of storeys

☐ 1. One storey ☐ 2. One storey with an elevated ground floor

☐ 3. Two storeys ☐ 4. Other (please specify)

10 Does your household have access to electricity? ☐ Yes ☐ No

11 How do you source drinking water in your household?

☐ 1. Piped water/community tap ☐ 2. Well/tube-well/hand pump

☐ 3. From rivers/ponds ☐ 4. Buying

☐ 5. Other (please specify)

12 What distance is your house from the nearest local rivers? (km)

13 What distance is your house from the nearest flood shelter where your family can evacuate to during the flooding season? (km)

14 What are the sources of income inyour household?

No.	Livelihood practices	Current amount (VN$ thousands)
1	Growing crops	
2	Raising livestock	
3	Aquaculture	
4	Non-farming/self-employment	
5	Waged labour and pension	
6	Remittance from family members or relatives	
7	Daily work	
8	Self-employed services	
9	Other (specify)	

II: Vulnerability assessment–flood exposure, risk perception and experience

1. Which type of area does your family live in?

   ☐ 1. Heavy flood zone ☐ 2. Moderate flood zone ☐ 3. No flooding at all

2. Has your house been inundated by floods in the last five years?

   ☐ Yes ☐ No

3. Has your household suffered any damage due to an extreme flood in the last 15 years?

   ☐ Yes ☐ No

   Please specify the most recent serious damage:

   Cost of damage (in VN$ thousands):

   Year:

4. Did you receive relief/compensation from the government for your family's losses due to flooding?

   ☐ Yes ☐ No

5. Please rank which disasters have been most frequent in your area during the last 15 years

   (1 = lowest, 5 = highest)

	Ranking				
Hazards	**1**	**2**	**3**	**4**	**5**
Floods					
Storm					
Drought					
Landslide					
Whirlwind					
Other					

6. Please rank which disasters have caused the most damage in your area during the last 15 years

   (1 = least serious, 5 = most serious)

	Ranking				
Hazards	**1**	**2**	**3**	**4**	**5**
Floods					
Storm					
Drought					
Landslide					
Whirlwind					
Other					

7. Do you think it is likely that you will experience floods which will cause damage to your family?

- ☐ 0. It will not happen to me
- ☐ 1. Very unlikely
- ☐ 2. Unlikely
- ☐ 3. Neutral
- ☐ 4. Likely
- ☐ 5. Very likely
- ☐ 6. Do not know

8. If your house is damaged by flooding, what do you expect the consequences will be?

- ☐ 0. No consequences at all
- ☐ 1. Very small consequences
- ☐ 2. Small consequences
- ☐ 3. Neutral
- ☐ 4. Severe consequences
- ☐ 5. Very severe consequences
- ☐ 6. Extremely severe consequences

9. How important is it for you to prevent or reduce these negative consequences?

- ☐ 0. Not important at all
- ☐ 1. Almost no importance
- ☐ 2. Little importance
- ☐ 3. Neutral
- ☐ 4. Somewhat important
- ☐ 5. Very important
- ☐ 6. Extremely important

10. How do you judge your own ability to protect yourself from floods that might cause damage to your family?

- ☐ 0. I cannot protect myself at all
- ☐ 1. I can hardly protect myself
- ☐ 2. I can somewhat protect myself
- ☐ 3. Neutral
- ☐ 4. I can protect myself well
- ☐ 5. I can protect myself very well
- ☐ 6. I can protect myself completely

11. Do you think you are more or less vulnerable to floods than other households?

- ☐ 1. Less vulnerable
- ☐ 2. As vulnerable as others
- ☐ 3. More vulnerable

12. In the future, do you think that the threat of flooding to your house will occur:

☐ 1. Less frequently than present

☐ 2. As frequently as present

☐ 3. More frequently than present

13. Compare with other households in your area, is your house:

☐ 1. Less at risk than others

☐ 2. As much at risk than others

☐ 3. More at risk than others

14. Does your house get inundated during the rainy season every year?

☐ Yes ☐ No

15. How high does the floodwater reach during the annual rainy seasons?

☐ 0. Flooding inside yard

☐ 1. Flooding inside house (to ankle height)

☐ 2. Flooding inside house (to knee height)

☐ 3. Flooding inside house (to waist height)

☐ 4. Flooding inside house (to shoulder height)

☐ 5. Flooding inside house (above head height)

16 How high did the water reach during the extreme floods in the last 10 years?

☐ 0. Flooding inside yard

☐ 1. Flooding inside house (to ankle height)

☐ 2. Flooding inside house (to knee height)

☐ 3. Flooding inside house (to waist height)

☐ 4. Flooding inside house (to shoulder height)

☐ 5. Flooding inside house (above head height)

17. For how many days did this inundation in and around your house last?

☐ 0. 1–2 days

☐ 1. 3–4 days

☐ 2. 5–7 days

☐ 3. Between 1 and 2 weeks

☐ 4. Between 2 and 4 weeks

☐ 5. Between 1 and 2 months

☐ 6. More than 2 months

18. Did you receive a flood warning before the extreme flooding event of 2007?

☐ Yes ☐ No

19. How were you informed (through which media)?

☐ 1. Relative/friend/neighbour

☐ 2. Local government

☐ 3. Radio

☐ 4. TV

☐ 5. Other (please specify)

20. Have you ever been evacuated due to the threat of extreme flooding?

☐ Yes (please provide year) ☐ No

21. Do you think that the frequency of extreme floods like the flood in 2007 has increased, decreased or stayed the same over the past 10–20 years?

☐ 0. Stayed the same ☐ 2. Decreased

☐ 1. Increased ☐ 3. I don't know

22. What damage/losses to your household were caused by the annual floods in recent years? What damage/losses to your household were caused by the most extreme flood events?

	Damage category	**Most extreme floods (VN$ thousands)**	**Recent annual floods (VN$ thousands)**
1	**Damage/losses to household property**		
	House		
	Household appliances		
	Vehicles/boats		
	Amenities (water supply, electricity, communications)		
	Others (please specify)		
2	**Damage/losses to household production**		
	Crops		
	Livestock and poultry		
	Aquaculture farming		
	Household-based industries		
	Household commercial activities		
	Other economic activities(please specify)		
3	**Forgone income**		
	Loss of income/wages (daily labour)		
	Loss of business		
	Other (please specify)		
4	**Loss of life, diseases, loss of school days**		
	Deaths in family		
	Injuries (specify medical costs)		
	Disease/illness (specify medical costs)		
	Loss of school days (specify number of days)		
	Other (please specify)		
5	**Other damage costs or problems** (please specify)		

23. How long did it take your household to recover after the flood?

☐ For the most extreme flood: days/weeks/months /years (please circle the appropriate unit)

24. Does your household borrow money to aid recovery from damage caused by regular or extreme flood events like the one in 2007?

- ☐ 0. No
- ☐ 1. Yes, I regularly borrow money after the annual flooding
- ☐ 2. Yes, I borrow money after extreme flood events like the one in 2007

25. If you borrow money to recover from flood damage, can you indicate from whom?

- ☐ 1. Formal loan from bank
- ☐ 2. Informal loan (please specify e.g. relatives/friends/neighbours/community fund etc.

26 Are you satisfied with your current level of protection against extreme flood events?

☐ Yes (GO TO Q.11) ☐ No

27. If not, can you specify why not?

....

....

28. In your opinion, who is responsible for providing flood protection for you and your family in your region?

- ☐ 0. I am responsible
- ☐ 1. Local government (municipality)
- ☐ 2. Regional government
- ☐ 3. Central (national) government
- ☐ 4. Community
- ☐ 5. Other (please specify)

29. What does your household need to be better prepared against extreme flood events like the one in 2007? (MULTIPLE ANSWERS POSSIBLE)

- ☐ 1. Financial assistance for flood protection measures
- ☐ 2. Building (infra) structures to prevent flooding
- ☐ 3. Provision of index-based insurance against the cost of damage caused by extreme floods
- ☐ 4. Improved knowledge and information about how to cope with extreme floods
- ☐ 5. Other (please specify)

IV: Choice experiment

I'd now like to inform you about the possibility of extreme flood events occurring in the future. In the future, the frequency of extreme flooding events like the ones in 1999, 2007 or 2009 are likely to increase due to climate change. Also, the damage associated with these events is expected to increase due to population growth and economic development. In order to anticipate these future flood risks, we would like to ask you to consider a number of descriptions of possible future situations and measures to mitigate the negative impacts of the increasing risks of flooding. We are interested to find out which of these measures you prefer given the expected future situation. All we ask you to do is to look at the presented situation and tell us which situation you prefer, given the expected increase in catastrophic flood risk and the proposed measures to mitigate these risks. I will present you with an example card first to explain to you what the situations represent. Following this, I will show you 6m ore of these cards and for each of these cards you will be asked to indicate which situation you prefer.

[SHOW OVERVIEW CARD AND EXPLAIN CARD WITH THE TEXT BELOW]

Weather index	**Rainfall: 600–1000mm** **River level: <4.50m** **Wind level: Tropical cyclone**	**Rainfall: 1000–1500mm** **River level: 4.50 –4.75m** **Wind level: Tropical cyclone**	**Rainfall: 1500–2000mm** **River level: 4.75–5.00m** **Wind level: Typhoon Level 6–8**	**Rainfall: > 2000mm** **River level: >5.00m** **Wind level: Typhoon Level 9 and above**
Flood-return period	Once every 5 years	Once every 10 years	Once every 30 years	Once every 50 years
Damage (VN$ millions)	25	50	75	100
Fatality probability	1:1000	1:2000	1: 5000	1: 10,000
Payout(VN$ millions)	10	20	30	50
Insurance premium (VN$/hh/month)	10,000	20,000	30,000	50,000

In each future situation,the frequency of extreme flood events is expected to change, from currently once every 50 years to once every 5 years. Also the financial damage to assets as a result of these extreme events will increase, from VN$ 25 to 100 million per extreme flood event. The probability that someone will die as a result of an extreme flood event ranges from between 1 in 10,000 people to 1in 1000 people. This means that if an extreme flood event occurs, 1 in 10,000 people to 1 in 1000 people, possibly including one of your family members, faces the risk of dying.

In order to deal with these increased flood risks in the future, an insurance scheme will be introduced to mitigate the consequences of extreme flood events in your region. The insurance will cover the financial costs of any damages as a result of future extreme flood events like the ones in 1999, 2007 or 2009. Having an insurance scheme hence reduces the financial burden your family faces should a catastrophic flood event occur. You have the option to choose from whom you wish to buy the insurance, either the central government ora private insurance company. The standard insurance policy on offer includes home insurance to cover any damage to your family home, crop insurance to cover any damage to your crops, and life insurance in case you or one of your family members dies as a result of catastrophic flooding.

In order to obtain the insurance, your household will either have to pay a fixed insurance premium every month to the private insurance company or an extra earmarked tax to the central government. The premium amount or earmarked tax is the same–the only difference is that the insurance is private if concluded with the private insurance company, or public if concluded with the central government. The prices of the standard insurance policy vary between VN$ 10,000 and 50,000 per household per month.

The insurance policy applies to catastrophic flooding only. This means that a flood event has to be officially categorised as catastrophic by an independent assessor. Also, the damage claim after the catastrophe and the indemnity paid will be evaluated and estimated by an independent assessing committee with the involvement of government, insurance companies and community representatives.

1. Please look at the following cards and tell me which situation you prefer?

		Situation A		Situation B	Neither
Example card		□		□	□
a. Card 1		□		□	□
b. Card 2		□		□	□
c. Card 3		□		□	□
d. Card 4		□		□	□
e. Card 5		□		□	□
f. Card 6		□		□	□

[BELOW IS A LIST OF CARDS THAT WILL BE SHOWN TO THE RESPONDENT]

CARD 1

Situation	A	B	
Weather index	Rainfall: 600–1000 mm River level: <4.50 m Wind level: Tropical cyclone	Rainfall: 1000–1500 mm River level: 4.50–4.75 m Wind level: Tropical cyclone	
Flood-return period	Once every 5 years	Once every 10 years	
Damage (VN$ millions)	25	50	
Fatality probability	1:10,000	1:5000	
Payout(VN$ millions)	10	20	
Insurance premium (VN$/hh/month)	10,000	20,000	
I prefer (tick)			Neither

CARD 2

Situation	A	B	
Weather index	Rainfall: 600–1000 mm River level: <4.50 m Wind level: Tropical cyclone	Rainfall: 1500–2000mm River level: 4.75–5.00m Wind level: Typhoon level 6–8	
Flood-return period	Once every 5 years	Once every 20 years	
Damage (VN$ millions)	25	75	
Fatality probability	1:10,000	1:5000	
Payout(VN$ millions)	10	30	
Insurance premium (VN$/hh/month)	10,000	30,000	Neither
I prefer (tick)			

CARD 3

Situation	A	B	
Weather index	Rainfall: 600–1000 mm River level: <4.50 m Wind level: Tropical cyclone	Rainfall: > 2000 mm River level: >5.00 m Wind level: Typhoon level 9 and above	
Flood-return period	Once every 5 years	Once every 50 years	
Damage (VN$ millions)	25	100	
Fatality probability	1:10,000	1:1000	
Payout (VN$ millions)	10	50	
Insurance premium (VN$/hh/month)	10,000	50,000	
I prefer			Neither

CARD 4

Situation	A	B	
Weather index	Rainfall: 1000–1500 mm River level: 4.50–4.75 m Wind level: Tropical cyclone	Rainfall: 1500–2000 mm River level: 4.75–5.00 m Wind level: Typhoon level 6–8	
Flood-return period	Once every 10 years	Once every 30 years	
Damage (VN$ millions)	50	75	
Length social disruption	4 days	6 days	
Fatality probability	1:5000	1:2000	
Payout(VN$ millions)	20	30	
Insurance premium (VN$/hh/month)	20,000	30,000	
I prefer (tick)			Neither

CARD 5

Situation	A	B	
Weather index	Rainfall: 1000–1500 mm River level: 4.50–4.75 m Wind level: Tropical cyclone	Rainfall: > 2000 mm River level: >5.00 m Wind level: Typhoon level 9 and above	
Flood-return period	Once every 30 years	Once every 5 years	
Damage (VN$ millions)	50	100	
Length social disruption	4 days	One week	
Fatality probability	1:2000	1:1000	
Payout(VN$ millions)	20	50	
Insurance premium (VN$/hh/month)	30,000	50,000	
I prefer			Neither

CARD 6

Situation	A	B	
Weather index	Rainfall: 1500–2000mm River level: 4.75–5.00 m Wind level: Typhoon level 6–8	Rainfall: >2000 mm River level: >5.00 m Wind level: Typhoon level 9 and above	
Flood-return period	Once every 30 years	Once every 50 years	
Damage (VN$ millions)	75	100	
Fatality probability	1:5000	1:1000	
Payout(VN$ millions)	30	50	
Insurance premium (VN$/hh/month)	30,000	50,000	
I prefer			Neither

INSTRUCTIONS:

TO TEST STABILITY AND CONSISTANCY, REPEAT QUESTIONS ON CARD 1.

IF THE RESPONDENT CHOSE‘NEITHER’ 4 TIMES, GO TO Q.2, OTHERWISE GO TO Q.4

2. From your choice of insurance premium above, from which insurance company would you prefer to buy it?

☐ 1. Government ☐ 2. Private sector ☐ 3. Public–private partnership

3. Can you explain why you chose 'Neither' 4 times?
   - ☐ 1. I'm not interested in buying insurance
   - ☐ 2. My current situation is good enough
   - ☐ 3. I cannot afford to pay for insurance
   - ☐ 4. Flood insurance is the responsibility of the government, notmine
   - ☐ 5. Other (please specify)
4. Can you briefly explain what the main reason was for your choices?

   Please only circle the most important reason:
   - ☐ 1. Flood-return period
   - ☐ 2. Financial damage costs
   - ☐ 3. Social disruption
   - ☐ 4. Fatality risk
   - ☐ 5. Insurance provider
   - ☐ 6. Insurance premium/tax
   - ☐ 7. Other (please specify)
5. How credible do you consider the alternative situations that were presented to you?
   - ☐ 0. Not at all credible
   - ☐ 1. Not credible
   - ☐ 2. Somewhat credible
   - ☐ 3. Credible
   - ☐ 4. Verycredible
   - ☐ 5. I don't know

V. Household's risk-sharing activities

1. Has anyone in your family received money or goods from the following sources?

	Sources for receiving money or goods	Before the flood (VN$ thousands)	After the flood (VN$ thousands)
1	Remittances and in-kind gifts from people overseas such as your relatives, friends and neighbors		
2	Domestic remittances and in-kind gifts from people such as your relatives, friends and neighbors		
3	Insurance payments and pension		
4	Income and support from charity organizations, associations or private companies		
5	Money and in-kind gifts from local government at different levels		
6	Other (please specify)		

(Note: If your family received any in-kind gifts, please estimate the current value in cash).

2. Have any members of your family been involved in post-flooding risk-sharing activities?

	Sources of money or goods received	Before 2007/2009 flood (VN$ thousands)	After 2007/2009 flood (VN$ thousands)
1	Selling production means (e.g. machines, tools)		
2	Selling working cattle and other animals		
3	Selling fields or residential land		
4	Selling gold, silver, precious stones, jewellery		
5	Withdrawals from savings, stocks, calling indebts...		
6	Borrowing money and in-kind items from local government		
7	Receiving tax/fees reduction by government		
8	Borrowing money and in-kind items from relatives, neighbours and friends		
9	Saving money with banks		
10	Lending money to neighbours, friends or relatives		
12	Supporting neighbours, friends or relatives		
11	Other (please specify)		

3. Before the 2007/2009 floods, had your household taken out any loan/credit/micro-credit?

☐ 1. Yes ☐ 2. No

4. Has your household taken taken out any loan/credit/micro-credit after the flood?

☐ 1. Yes ☐ 2. No

5. Have you taken out any type of insurance before?

☐ 1. Yes ☐ 2. No

6. If yes, please describe your choice:

Type of insurance	Premium (VN$)			
	Monthly	Quarterly	Six monthly	Yearly
Life				
Health				
House				
Motorbike				
Car				
Other household assets				
Agricultural crops				
Agricultural implements				
Machinery				
Other (please specify)				

7. Do you have any disaster-related insurance policies?

☐ 1. Yes ☐ 2. No

8. Has anyone in your house beenevacuated to another place due to floods?

☐ 1. Yes ☐ 2. No

9. If yes, will he/she desire to return home?

☐ 1. Yes ☐ 2. No

10. Is he/she working as a daily labourer aftermigration?

☐ 1. Yes ☐ 2. No

Thank you for taking the time to help us.

Appendix 2: Attributes of choice sets designed for flood index-based insurance

Situation	Choice set 1	Choice set 2	Choice set 3	Choice set 4	Choice set 5	Choice set 6	Choice set 7	Choice set 8	Choice set 9	Choice set 10	Choice set 11	Choice set 12
Weather index	Rainfall: 600–1000 m m; River level: <4.50 m ; Wind level: Tropical cyclone	Rainfall: 1000–1500mm River level: 4.50–4.75m Wind level: Tropical cyclone	Rainfall: 600–1000 mm River level: <4.50 m Wind level: Tropical cyclone	Rainfall: 1500–2000 mm River level: 4.75–5.00 m Wind level: Typhoon level 6 - 8	Rainfall: 600–1000 mm River level: <4.50 m Wind level: Tropical cyclone	Rainfall: >2000 mm River level: >5.00 m Wind level: Typhoon level 9 and above	Rainfall: 1000–1500 mm River level: 4.50–4.75 m Wind level: Tropical cyclone	Rainfall: 1500–2000 mm River level: 4.75–5.00 m Wind level: Typhoon level 6 - 8	Rainfall: 1000–1500mm River level: 4.50–4.75 m Wind level: Tropical cyclone	Rainfall: >2000 mm River level: >5.00 m Wind level: Typhoon level 9 and above	Rainfall: 1500–2000 mm River level: 4.75–5.00 m Wind level: Typhoon level 6 - 8	Rainfall: >2000 mm River level: >5.00 m Wind level: Typhoon level 9 and above
Flood-return period	Once every 5 years	Once every 10 years	Once every 5 years	Once every 20 years	Once every 5 years	Once every 50 years	Once every 10 years	Once every 30 years	Once every 30 years	Once every 5 years	Once every 30 years	Once every 50 years
Damage (VN$ millions)	25	50	25	75	25	100	50	75	50	100	75	100
Fatality probability	1:10,000	1:5000	1:10,000	1:5000	1:10,000	1:1000	1:5000	1:2000	1:2000	1:1000	1:5000	1:1000
Payout(VN$ millions)	10	20	10	30	10	50	20	30	20	50	30	50
Insurance premium (VN$/hh/ month)	10,000	20,000	10,000	30,000	10,000	50,000	20,000	30,000	30,000	50,000	30,000	50,000

Acronyms

AADMER	ASEAN Agreement on Disaster Management and Emergency Response
ASEAN	Association of Southeast Asian Nations
CE	Choice experiments
FGD	Focus group discussions
WTP	Willingness to pay

Modelling demand for catastrophic flood index-based insurance in Da Nang City, Vietnam: Using choice experiments

Asian Cities Climate Resilience Working Paper Series

This working paper series aims to present research outputs around the common theme of urban climate resilience in Asia. It serves as a forum for dialogue and to encourage strong intellectual debate over concepts relating to urban resilience, results from the ground, and future directions. The series is also intended to encourage the development of local research capacity and to ensure local ownership of outputs.

The series has arisen out of the Asian Cities Climate Change Resilience Network (ACCCRN, www.acccrn.org), an initiative funded by the Rockefeller Foundation.

The series is intended to present research in a preliminary form for feedback and discussion. Readers are encouraged to provide comments to the authors whose contact details are included in each publication.

Published by IIED, 2014

IIED order no: 10706
http://pubs.iied.org/10706IIED.html
ISBN 978-1-78431-061-5

80-86 Gray's Inn Road, London WC1X 8NH, UK
Tel: +44 (0)20 3463 7399
Fax: +44 (0)20 3514 9055
email: humans@iied.org
www.iied.org