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Analysis

Estimating the value of economic benefits associated with adaptation to climate change in a developing country: A case study of improvements in tropical cyclone warning services

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ABSTRACT

Linking tropical cyclone activity with anthropogenic climate change is subject to on-going debate. However, modelling studies consistently have projected that climate change is likely to increase the intensity of cyclones and the related rainfall rates in the future. A precautionary approach to this possibility is to adapt to the adverse effects of the changing climate by improving early warning services for cyclones as a 'no or low-regrets' option. Given limited funding resources, assessments of economic efficiency will be necessary, and values for benefits are an essential input. This paper aims to estimate the benefits to households of an improved cyclone warning service in Vietnam. Choice experiment surveys with 1014 respondents were designed and conducted to inform this paper. The benefit estimates of the maximal improvements in a number of attributes of cyclone warning services (i.e. forecasting accuracy, frequency of update, and mobile phone based warnings) are approximately USD7.1–8.1 per household, which would be an upper bound estimate. Results from the marginal willingness to pay for the attributes suggest that investments should be dedicated to improvements in the accuracy of warning information and a warning service based on mobile phone short message.

1. Introduction

Our climate is changing and impacting the world around us. The global average temperature has risen by about 0.74 °C for the period of 1906–2005 and the warming trend over the last 50 years is nearly twice that for the previous 50 years (Trenberth et al., 2007). As the global climate has warmed, tropical cyclone intensity has increased, at least in some ocean basins (i.e. North Atlantic and western North Pacific) (Elsner et al., 2008; Emanuel, 2005; Emanuel et al., 2008; Hoyos et al., 2006; Webster et al., 2005). However, other studies argue that the evidence is thin since this recent upward trend is still within natural variability and longer-term records do not reveal changes in underlying intensity (Donnelly and Woodruff, 2007; Klotzbach, 2006; Landsea et al., 2006). The low confidence for attributing detectable changes in tropical cyclone activity to anthropogenic climate change may be due to uncertainties in the historical data and incomplete understanding of the physical mechanisms linking tropical cyclone metrics to climate change (Kossin et al., 2007; Seneviratne et al., 2012; WMO, 2006). Given the limitations of data and interpretations of the data, the debate about whether tropical cyclone activity is globally changing in a warming climate will likely continue in the foreseeable future.

However, modelling studies consistently have projected that greenhouse warming is likely to cause increases in the global average intensity of tropical cyclones and the related rainfall rates (Hill and Lackmann, 2011; Knutson et al., 2010; Seneviratne et al., 2012). Under this scenario, cyclone losses would become significant. Mendelsohn et al. (2012) forecast that climate change would be responsible for a doubling of cyclone losses, from US$26 billion per year at present to $53 billion by 2100; and that the damage would be concentrated in North America, East Asia and Central America–Caribbean due to the increased intensity of North Atlantic and western North Pacific cyclones.

The progression of climate change cannot be halted in the short run; society, therefore, needs to adapt to the adverse effects of the changing climate. Adaptation to climate change will require substantial monetary investment (Fankhauser, 2010; Narain et al., 2011;

Abbreviations: CE, Choice experiment; NCHMF, National Centre for Hydro-meteorological Forecasting; NHMS, National Hydro-Meteorological Service; MIC, Ministry of Information and Communication; MONRE, Ministry of Natural Resources and Environment; VND, Vietnamese dong; WTP, Willingness to pay.

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World Bank, 2010). As climate change is likely to impact poorer countries more than developed countries, it is anticipated that within a few decades substantial financial resources will be needed for adaptation in developing countries. However, these developing countries have relatively limited resources to reduce the impacts of climate change through adaptation. External funding is an important additional resource (Dellink et al., 2009; Hartzell-Nichols, 2011; Paavola and Adger, 2006). Developed countries have agreed, as part of the United Nations Framework Convention on Climate Change (UNFCCC), to assist developing countries in meeting the costs of adaptation. In the Cancun Agreements of 2010, climate and weather-related disaster risk reduction has been included in commitments to provide additional finance for adaptation to climate change. Unfortunately, the funds available are limited relative to the need (Herminia, 2008; Krysanova et al., 2010). To ensure the best use of funding resources, evaluation of the economic efficiency of adaptation programs using cost-benefit analysis is needed (Haites, 2011; Stern, 2008). Information on benefits associated with adaptation measures would play an important role in a cost-benefit analysis, which in turn would assist international negotiations for adaptation funding.

Improving early warning services for cyclones is a 'no or low-regrets' option for adaptation to climate change, which would provide benefits under any range of climate change scenarios and cope with high levels of uncertainties over future climate change directions and impacts (Hallegatte, 2009; Lal et al., 2012). Improvements in early warning services, hence, are recommended to reduce the level of vulnerability to future cyclone events (Grossmann and Morgan, 2011; Lal et al., 2012; Sovacool et al., 2012). Although climate change is at the top of the international development agenda, it is only one factor among many contributing to cyclone related vulnerability (Mercer, 2010; UNISDR, 2009). Investments in early warning services as the option for adaptation to changing climate, therefore, should be integrated with current disaster risk reduction and other development strategies (i.e. poverty reduction and education) to improve the effectiveness of national systems for managing disaster risk (Fankhauser and Burton, 2011; Lal et al., 2012; Schipper, 2009; UNISDR, 2009). In order to align the adaptation option of improving cyclone warning services with disaster risk management, the efficiency of the option should be also assessed based on an economic assessment framework (Lal et al., 2012). Benefits of improved cyclone warning services are essential components of the assessment.

There are a variety of benefits from improved cyclone warning services to potential beneficiaries: households, businesses, and governments. Cyclone forecasting information allows people to make preparations to reduce or prevent damage from cyclones. Examples of potential benefits to households can be reduced cost of unnecessary evacuations, reduced avoidable property damage, avoided loss of vacation or leisure time, reduced morbidity and mortality, increased sense of security, and altruistic concern for family or community (Letson et al., 2007; Suchman et al., 1979). Benefits to businesses could include reduced property damage and reduction in business losses. Governmental benefits would largely result from reduced public expenditures on unnecessary evacuations and avoided damage to public infrastructure (Letson et al., 2007).

This paper presents a case study from Vietnam that determines economic benefits to households. To the best of our knowledge, the values provided in this paper are the first estimates of the economic benefits associated with improvements to a cyclone warning service at a household level in a developing country. Improvements in cyclone warning services may include improvements in not only meteorological forecasting, but also forecast communication, comprehension, and response (Letson et al., 2007). In order to be comparable with available previous study in developed countries, e.g. Lazo et al. (2010), only improvements in a number of attributes of cyclone warning services (i.e. forecasting accuracy, frequency of update, and mobile phone based warnings) were covered in this research.

To estimate the economic benefits, we apply a choice experiment (CE) approach, which captures the total economic value of an improved cyclone warning service. The benefits of an improved warning service include not only the expected reduction in the present cyclone-related fatalities and property damage, but also the peace of mind resulting from the increase in safety for both present and future generations. In addition, CE is argued to be a useful tool for valuing a multi-attribute public good or service, which includes cyclone warning services (Hanley et al., 2001). The application of CE provides not only the average value of willingness to pay (WTP) by householders, but also the marginal values for improving the attributes of cyclone warning services. These marginal values could be used to derive values for specific improvement programs that best meet the needs of households in Vietnam as well as communities in other developing countries. In this paper, we also examine factors that affect the values for improvements in cyclone warning services. A discussion of heterogeneous preferences is extended with a comparison of mixed logit and latent class models.

2. Materials and Methods

2.1. Tropical Cyclone Risk and Early Warning Service in Vietnam

Situated close to the tropical cyclone centre of the western North Pacific, Vietnam is one of the most cyclone-prone countries in the Mekong region. Vietnam's coastal areas have been affected at an average of seven cyclones each year (ISPONRE, 2009). About 70% of Vietnam's population lives in cyclone-prone areas, with the majority of the most vulnerable located in the Central region (IEDM, 2008; Shaw, 2006). Fig. 1 shows that about 60% of cyclones affecting Vietnam made landfall in the Central region from 1961 to 2009. Vietnam is among the top 20 countries in term of cyclone fatal risk (Mosquera-Machado and Dilley, 2009; Peduzzi et al., 2012). Imamura and Dang (1997) have observed that the damage from cyclones in Vietnam is surprisingly large being more than 70% of the total damage from all natural disasters.

In Vietnam, the major source of meteorological services is the National Hydro-Meteorological Service (NHMS), which is an operational unit under the Ministry of Natural Resources and Environment (MONRE). Within the organizational framework of NHMS, the National Centre for Hydro-meteorological Forecasting (NCHMF) is responsible for providing hydro-meteorological and marine forecasts across the whole country to meet the growing requirements of socio-economic activities and natural disaster reduction.

Cyclone warnings issued by the NCHMF are provided free and are the primary source of information for the public, particularly in rural coastal areas, to assess the risk of and to decide how to respond to threats from cyclones. Cyclone warnings are often 24–72 h ahead of the expected occurrence of a cyclone, allowing adequate time for response activities. There are several ways for the public to access the cyclone warnings. Television and radio remain as the primary means for the public to access cyclone forecasts (Huy, 2009; Nhan et al., 2007). Local warning disseminating platforms such as fixed and portable loudspeakers or door-to-door visits by the local Committee for Flood and Storm Control officials and volunteers are effectively used to alert the public. For offshore communication, well-equipped fishing boats are warned of an impending cyclone through high frequency radio telephone. Traditional methods, such as signals using long bamboo poles or big fires, are used to give a danger signal to those who are in small fishing boats near shore without communication equipment. In the case of nearby or rapidly forming cyclones, the border police search for small boats to warn them personally.

However, the capacity of the NCHMF may not meet the demands of the more complex fluctuations of tropical cyclones due to climate change. According to a NCHMF report (2009), its monitoring network has a small number of stations, most of which are not on continuous