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Coastal disasters from the perspective of ecological economics

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ABSTRACT

Natural hazards are recurrent events that frequently result in high death tolls and large economic losses. Because of their large impact, they have concerned the international community for a long time. In spite of the efforts, the impact of natural hazards has increased. Oftentimes, the role of natural ecosystems and the ecosystem services they provide to human societies are not considered in risk reduction programs. How relevant are ecosystems? What are the consequences of the depletion of natural ecosystems and the loss of ecosystem services provided by them? Would the alternative vision of ecological economics, in which development and economy are seen as the Whole – the ecosystem – (Daly, H.E. and Farley, J., 2004. *Ecological Economics: principles and applications*. Island Press, Washington, DC., 454 pp.), be helpful in reducing disaster risk? In this paper we are set to test whether a holistic approach from the perspective of ecological economics is helpful to clarify and reduce the impact of natural hazards. We focused on hurricanes because they are the most frequently reported events of all natural disasters (Hewitt, K., 1997. *Regions of Risk*. Longman, Edinburgh Gate, 389 pp.). We analyze the relationship between the components of Human, Built, Social and Natural capitals with the damage caused by hurricanes in terms of mortality rate. We then generate a conceptual model to help envision the complexity of the system. A stepwise (back and forth steps) linear regression analysis revealed that mortality rate was significantly and positively affected by hurricane frequency ($P < 0.01$) while area covered by semi-altered ecosystems (a mosaic of natural and human-altered ecosystems) ($P < 0.01$) and GDP ($P < 0.05$) negatively affected mortality rate ($R^2 = 0.81$). The proportion of natural/altered ecosystems yielding the best protection results needs to be determined yet. Natural capital alone does not decrease number of deaths. Rather, its complex interactions with the other capitals and the many feedback loops that are involved need to be considered to achieve effective disaster risk reduction. No single capital is enough to reduce the impact and intensity of natural hazard. A balance between Human, Built, Social and Natural capitals and an increasing awareness of the consequences of different development decisions, will help human societies to *live with* rather than *cope with* coastal hazards.

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1. Introduction

Natural hazards such as earthquakes, tropical cyclones, floods and droughts are common features of our dynamic planet, and humans have been exposed to them since their very origins. However, we have not fully learned yet, how to cope with these recurrent natural events. Oftentimes, natural hazards create such economic damage and the loss of so many human lives that they become disasters (UNDP/BCPR, 2004). Globally, natural disasters exert an enormous toll on development with ever-increasing annual economic losses: in the 1960s the average economic loss associated with natural disasters was US\$ 75.5 billion; in the 1970s this damage added to US\$ 138.4; it almost doubled in the 1980s (US \$ 213.9 billion) and by the 1990s economic damage owing to natural disasters had risen to US\$ 659.9 billion. Furthermore, in the last two decades, more than 1.5 million people have been killed by natural disasters (UNDP/BCPR, 2004; EM-DAT, 2005). Today, 26.7% of the countries of the world are exposed to earthquakes, 17.6% to tropical cyclones, 65.2% to floods and 12.8% to droughts (UNDP/BCPR, 2004). Of these, earthquakes, tropical storms and flooding caused by storms in coastal areas are the events with the highest death tolls and economic damage (Hewitt, 1997). In spite of their relatively high frequency, the high economic costs as well as the loss of human lives that are involved, disasters are still usually perceived as “exceptional natural events that interrupt normal human development and require humanitarian actions to mitigate loss” (UNDP/BCPR, 2004). Certainly, they are not exceptional events.

Because of their impact on human societies, natural disasters have concerned the international community for a long time. Almost twenty years ago, serious international efforts were aimed at developing policies to better deal with these recurrent events. On December 11, 1987, the United Nations General Assembly passed the resolution 42/169 to designate the 1990s as the decade of natural disaster reduction (<http://www.un.org/documents/ga/res/42/a42r169.htm>). The Economic and Social Council recommended that the General Assembly take actions on developing an appropriate framework toward international cooperation in a risk reduction program. The objective of the International Decade for Natural Disaster Reduction was to reduce the loss of life, property damage and social and economic disruption caused by natural disasters. The impact of natural disasters was not ameliorated after this well-intentioned decade. In fact, after 19 years of growing international awareness, there has nevertheless been a significant increase in loss of life and economic damage due to natural catastrophes (Pielke, 2005). For example, in China the Yangtze River flood in 1998 caused more than 30 billion US dollars in damage, 2000 deaths, and the relocation of 13.8 million people from their destroyed homes (Brown and Halweil, 1998). Hurricane Brendan struck the Chittagong region of Bangladesh in 1991, causing more than 138,000 deaths and 1.5 billion dollars in economic losses (<http://www.noaawebs.noaa.gov/stories/s334b.htm>). Hurricane Mitch swept through Honduras and Nicaragua in late October 1998 with an estimated death toll of more than 10,000 and economic losses of 8.5 billion US dollars (Pielke et al., 2003). And the most recent 2005 US hurricane series, Katrina, Rita, Stan and Wilma, imposed great damage to the US and Central America. Katrina alone caused over a million people

displaced, 1383 deaths and damage from \$100 to \$200 billions, making it the most expensive natural disaster in US history. Thus, it is obvious that current policies have not been enough to reduce the impact of natural hazards. Why? What is missing?

1.1. Natural coastal disasters from the perspective of ecological economics

What are the appropriate development policies and practices that contribute to the reduction of disaster risks? There are many interesting and potentially useful ideas. Dealing with hazard–risk issues entails the understanding of geographical as well as sociological matters. It covers interdisciplinary interaction pertinent to risk mitigation, preparedness, response, and recovery issues. Traditionally, hazard–risk analysis and risk reduction programs tend to be reactive and deal more with preparedness measures for disaster response, with the common variables of identifying the dangerous locations, and improving warning systems. Frequently, risk reduction of the impact of natural catastrophes focuses on issues like a) the analyses of social processes and underlying causes which may ultimately be quite remote from the disaster event itself (Blaikie, 1994, Alexander, 2000; Holzmann and Jørgensen 2004; b) the economics of catastrophe risk insurance and strategies for financing post-disaster infrastructure rehabilitation (Kunreuther, 1996, 2001; Andersen, 2002; Ermolieva et al., 2003; Freeman and Pflug, 2003; Berz, 2004; Gollier, 2005; c) the role of the Government, private sector, and NGOs for disaster preparedness and risk prevention (Benson et al., 2001; Daniels et al., 2006); or on d) a modeling approach to analyze the interplay between investment in mitigation and risk-sharing measures (Amendola et al., 2000). Occasionally, the role of natural ecosystems and the ecosystem services they provide to human societies are considered in development and risk reduction programs. For instance, the ecosystem service of protection provided by natural ecosystems such as forests, coastal mangroves, coral reefs, riparian habitats has been identified as a priority for hazard mitigation and risk reduction (Hook, 2000; Kreimer and Arnold, 2000; Bronstert, 2003). However, it is recognized that “the interaction of wild and managed ecosystems with extreme events and their changed vulnerability as a result of human interference remain largely uninvestigated and unknown” (Hook, 2000). Some studies have shown that Natural capital plays an important role on damage reduction. Hiraiishi and Harada (2003) used fluid modeling to determine that 30 trees per 100 m² in a 100-m wide belt would reduce by 90% of the flow pressure on the coastline. Danielsen et al. (2005) also found that areas covered by mangroves as well as tree shelterbelts were significantly less damaged from the Tsunami wave that hit the Cuddalore District, India in 2004. Certainly, risks can be reduced but natural hazards cannot. Risk reduction requires a deeper understanding of cultural, political, social, economic, psychological, technological, physical and natural conditions (McEntire, 2004) because a single perspective is limited. No doubt, the number of interactions and feedbacks between natural and socioeconomic variables demand a systemic vision of the problem.

Here we are set to test whether a holistic approach from the perspective of ecological economics is helpful to understand and generate new ideas to reduce the impact of natural hazards. Ecological economics recognizes that human societies are

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