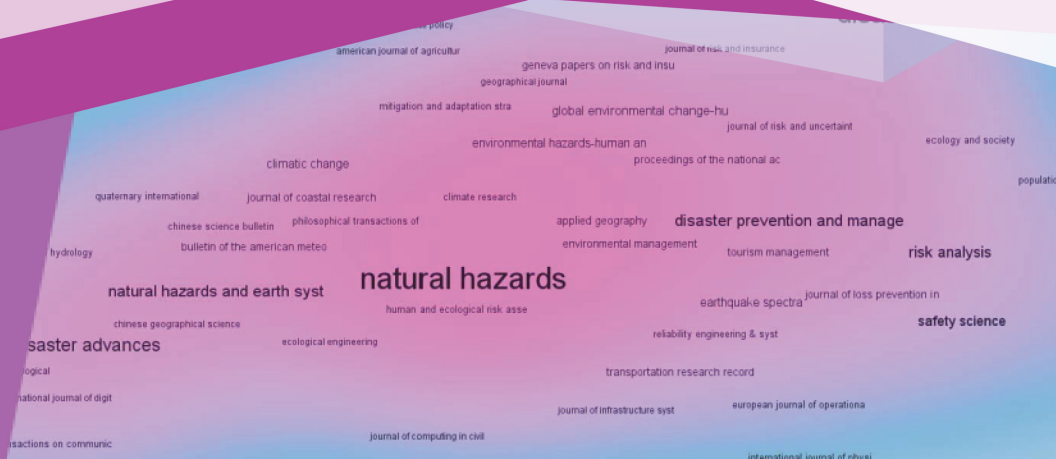
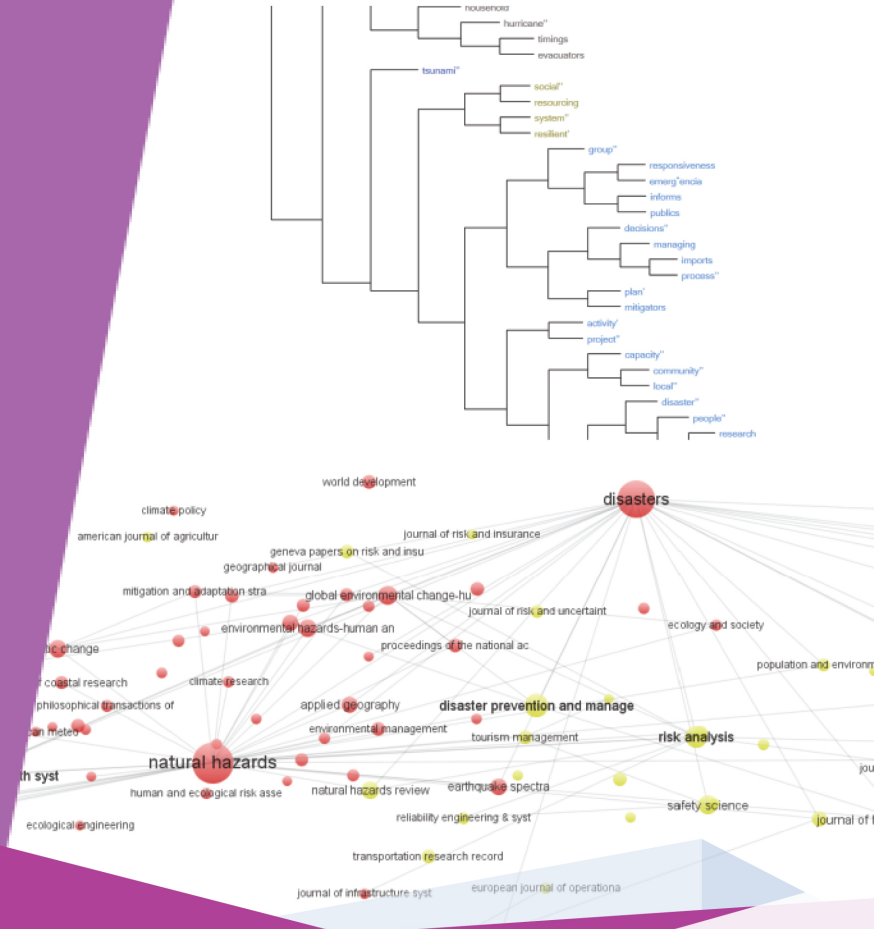


Integrated Research on Disaster Risk (IRDR)

Incentives for Disaster Risk Management

AIRDR Project Report No. 2



IRDR

IRDR was established by the International Council for Science (ICSU) in 2010, in co-operation with the International Social Science Council (ISSC) and the United Nations International Strategy for Disaster Reduction (UNISDR). IRDR's main legacy will be an enhanced capacity around the world to address hazards and make informed decisions on actions to reduce their impacts. This will include a shift in focus from response–recovery towards prevention–mitigation strategies, and the building of resilience and reduction of risk through learning from experience and the avoidance of past mistakes.

This report was commissioned by UNISDR to inform the 2015 Global Assessment Report on Disaster Risk Reduction, section on the Future of Disaster Risk Management. It builds on work conducted for the IRDR Assessment of Integrated Research on Disaster Risk (IRDR AIRDR Publication No. 1).

Suggested citation: Gall, M., S. L. Cutter, and K. Nguyen (2014). *Incentives for Disaster Risk Management* (IRDR AIRDR Publication No. 2). Beijing: Integrated Research on Disaster Risk.

Incentives for Disaster Risk Management

May 2014

Contents

	Page
1. Introduction	4
2. Methods	5
3. Results	6
Knowledge Clusters	6
• Cost-Effectiveness of Investments	6
• Risk Perception and Heuristics	7
• Community-Based Disaster Risk Management	8
• Climate Adaptation through Disaster Risk Management	10
• Disaster Risk Management in Developing Countries	10
4. Knowledge Gaps	12
• Integrated Disaster Risk Management	12
• Beyond Techno-Centric Solutions	12
• Behavioural Economics	13
• Monitoring Systems	13
• Development and Climate Change Adaptation	13
• Systemic Shortcomings in Incentives Research	14
5. Conclusion	16
References	17
Annex	21

1. Introduction

In 2005, 168 countries signed the Hyogo Framework for Action (HFA), which laid out a road map for disaster risk reduction over the next 10 years (UNISDR 2005). Subsequently, international frameworks, political statements, and programmatic strategies continued to profess recognition of the central role of disaster risk management (DRM) for sustainable investment and development (IPCC 2012). A number of international processes, including the recent Rio+20 meeting, the review of the Millennium Development Goals (MDGs), the development of the Sustainable Development Goals (SDGs) and consultations for the successor of the Hyogo Framework for Action (HFA) all argue for disaster risk reduction and increased investment in the management of disaster risk (Cutter 2014). But a consistent and even growing gap remains between the proclamations and actual implementation and progress towards risk reduction as underscored by the occurrence of some of the most catastrophic disasters during recent years (e.g., 2010 Haiti earthquake, 2011 Tohoku earthquake/tsunami, 2012 Sahel drought, 2013 Typhoon Haiyan/Yolanda).

This literature review summarises our current scientific knowledge on incentives for disaster risk management: how it has evolved over the past decades, what we know about incentives, their influence on disaster risk reduction, and where the research gaps are in our present knowledge. This overview builds on the efforts by the IRDR working group on the Assessment of Integrated Research on Disaster Risk (AIRDR) to provide the science-based evidence for the development of the post-2015 Hyogo Framework for Disaster Risk Reduction (IRDR 2013).

Three key policy questions are addressed in this review:

- Are disaster risk mitigation and prevention still seen primarily as a cost and not an investment?
- Are the corrective, prospective, and compensatory aspects of disaster risk management not well understood and as a result emphasis is still placed on high-cost, corrective and compensatory schemes and approaches as opposed to proactive, lower cost actions thus the cost-benefit calculation more difficult to bear?
- Can incentives be identified that may constitute tipping points for behavioural change towards prospective disaster risk management and risk-sensitive choices at a significant scale thereby increasing the political, social and economic saliency of disaster risk management?

2. Methods

This literature review summarises the current state of research based on original research published in peer-reviewed journals. This methodology replicates the approach developed by the IRDR AIRDR project working group (Gall et al. 2014). The original AIRDR database contains 1,069 peer-reviewed, academic, English-language journal articles culled from 39 journals published between 1999 and 2013. For the purpose of this review, a subset of 65 incentive-related articles of the AIRDR database were supplemented with 67 additional articles based on a keyword search (disaster AND incentive) utilising the academic citation indexing and search service *Web of Science*. See the *Annex* for a complete listing of all reviewed publications.

By using this combined approach it was possible to minimise two biases: focusing solely on indexed journals and analysing only journals that publish specifically on disaster risk. Some challenges remain and could not be overcome. Those are the exclusion of monographs, edited books, grey literature and non-English language publications. Books, reports, and so forth were excluded because a) the quality of the peer-review process is not transparent, and b) the review and classification criteria (see below) could not be transferred. Furthermore, research on war or civil unrest, technological hazards (e.g., oil spills, nuclear accidents), climate (e.g., carbon dioxide concentration, El Niño), and diseases (e.g., HIV/AIDS, malaria) were also excluded to keep the focus on natural hazards.

The methodology and literature analytics involved content and cluster analysis. The goal was to identify key topics, study areas, methodological approaches, authorship, and changes in publication output over time. To do so, each article was reviewed and classified based on: study area, number of authors, authors' disciplinary backgrounds, number of disciplines, authors' countries of affiliation, and the type of research partnership (e.g., academic, academic-governmental). Information on disciplinary background and type of partnership was confirmed through internet research. In addition, publication content was reviewed and classified using keywords capturing research topic, hazard type, major disasters, and methodology. A publication's original keywords were dismissed to ensure uniform classification across all works by the research team.

A word count analysis (including stemmed words, e.g. insurance, insured, insurable) was performed on the full texts of all 132 publications to identify central themes in incentives research. To group and classify similar research, publications were coded using 49 keywords derived from the initial content analysis as well as the word count analysis. Subsequent cluster analyses on these coded publications provided the quantitative results (Pearson correlation coefficient) resulting in grouping the publications into prevalent knowledge domains on incentives in disaster risk management discussed in the results section. Similar publications have a Pearson correlation coefficient close to 1 whereas less similar publications have a coefficient close to 0. All content analysis was performed in EndNote X5 and NVivo 10.

It is important to reiterate that the results of this literature review are based on original research in peer-reviewed, English-language journal publications (see *Annex*). To set the findings into a broader context, additional literature such as reports and books are cited throughout this background paper although they did not undergo the methodological steps outlined above. All citations throughout this paper are listed in the reference section. Again, all reviewed publications are listed separately in the *Annex* section though only a select number are cited to ensure readability.

The following *Results* section is divided into five central research themes that emerged over the past years and are drawn from the reviewed literature. Each research theme—called knowledge cluster—starts out with a brief summary of the current state of knowledge and then touches on remaining challenges within the specific research area. Larger gaps in incentives research and research needs are discussed in more detail in the *Knowledge Gaps* section.

3. Results

Incentives-related research has steadily increased nearly tripling in the past years (Figure 1). The primary focus of the scientific literature is on the costs and impacts associated with disasters, with a geographic concentration on developed nations, especially the United States. Risk reduction strategies are predominantly associated with risk transfer (i.e. insurance) and seen as a function of government responsibility. The topic of climate change and its accelerating effect on losses and costs from natural hazards has entered the incentives debate beginning in the mid-2000s.

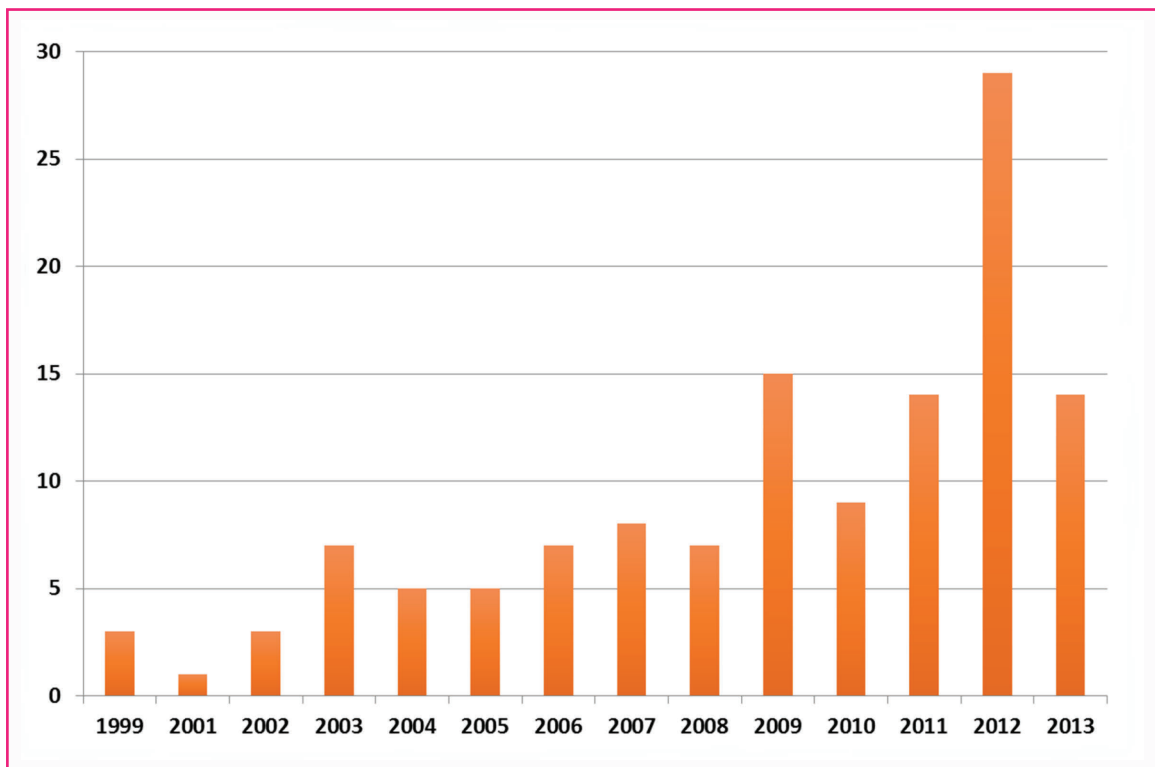


Figure 1: Number of incentives-related publications per year shows a significant upward trend.

Broadly speaking, there are five research clusters constituting the current knowledge on incentives: 1) cost-effectiveness of investments; 2) risk perception and heuristics; 3) community-based disaster risk management; 4) climate adaptation through disaster risk management; and 5) disaster risk management in developing countries. These will be explained in more detail in the following sections.

Knowledge Clusters

1. Cost-effectiveness of Investments

The majority of the research literature examines the cost-effectiveness of investments. Is it worth investing in loss-reducing measures? This is generally the underlying but hidden question behind the term *incentive*. The justification for investing in ex-ante loss reducing measures is often evaluated based on economic analyses and approaches such as cost-benefit analysis, which compares avoided losses (benefits) from a natural disaster with the costs of protective actions (Whalen et al. 2004; Young et al. 2012; Michel-Kerjan et al. 2012).

What is Known

Economists in particular have generated evidence showing that investing in risk-reducing efforts is a fiscal incentive because:

- a) Ex-ante investments are more cost effective than ex-post spending as long as they incentivise protection of existing development rather than subsidising new development (de Hoop and Ruben 2010; Johnston 2012; Donahue and Joyce 2001; World Bank 2010);
- b) Ex-post response and recovery spending creates welfare economics and a moral hazards/Samaritan's dilemma (Jaffee and Russell 2013);
- c) (Micro-)Insurance products that reward hazard mitigation and disaster risk reduction are effective in reducing losses and/or transferring risk (Clarke and Grenham 2013; Kleindorfer and Kunreuther 1999; Kreibich et al. 2011);
- d) Insurance must be priced based on risk (Picard 2008; World Bank 2010);
- e) Transferring risks to capital markets through catastrophe bonds (CAT bonds) and reserve funds provides avenues for the insurance industry to balance their financial risks (Smolka 2006; Kunreuther and Linnerooth-Bayer 2003);
- f) Improved building codes and other structural improvements, particularly with regard to wind and earthquake hazards, reduce losses when enforced (Spence 2004; Young et al. 2012); and
- g) Advanced probabilistic loss assessment models generate better information hereby improving risk evaluation and cost-benefit analyses (Cardona et al. 2008; Smolka 2006; Whalen et al. 2004).

Remaining Challenges

The quality of the cost-benefit analysis and other economic modeling approaches depend heavily on the quality of loss data as well as on the methodology of how to monetise avoided losses and the incorporation of uncertainties regarding climate change. How much is a saved life worth? What is the monetary value and loss avoidance potential of maintaining mangroves? What if the frequency of rainfall changes over the next 50 years? While the method of cost-benefit analysis is standard in business decisions, the data needed to determine the benefits of risk-reducing investments remains a challenge. For example, disaster losses tend to be notoriously underestimated because there is either 1) inadequate loss information or 2) the absence of full loss accounting that considers direct as well as indirect losses to individuals, communities, and countries as a whole (Gall et al. 2009). As such, losses (or benefits) appear artificially low making it difficult to justify from a cost-benefit point of view any investments in ex-ante risk reducing efforts.

In addition, planning departments at local, state or national governments where risk-reducing investment decisions compete with other community development projects usually require cost-benefit analyses. This competition pivots ex-ante risk-reducing measures, which unfold their benefit only during low probability/high impact emergencies against community projects that deliver immediate benefits. The consequence of this dilemma is that non-disaster related projects often trump improvements in resilience and even worse, ex-post investments appear to be more cost-effective given certain economic and political environments. Furthermore, reconstruction costs after an event are largely borne by individuals and private businesses making it “unnecessary” for local government to invest in public goods such as flood protection (Burby 2006).

2. Risk Perception and Heuristics

At the individual level, cost-benefit analyses are also performed though not in a quantitative mode. Instead decisions on investing in protective measures fall into the realm of risk perception and heuristics. If a person perceives a risk for adverse effects to be high, he or she is more likely to expend money on protective measures.

What is Known

There are a number of consistent findings in the literature on risk perception and heuristics. Research on behavioural incentives indicate that:

- a) Risk education and awareness is essential to motivate people to voluntarily take action (Bateman and Edwards 2002; Gigerenzer 2014; Slovic et al. 2002) otherwise they underprepare and are largely unaware of the risk they face and, consequently, underinsure (Clarke and Grenham 2013);
- b) Community-based and participatory efforts (e.g., participatory risk assessments) are among the most effective methods for promoting protective actions (Pelling 2007);
- c) Local capacity building is key to not only understand risk but also mitigate them and adapt to new conditions; and
- d) Mandatory participation may be necessary when incentives and voluntary actions are insufficient (Paudel 2012).

Remaining Challenges

Triggering behavioural change through incentives is among the most difficult undertakings because individuals:

- a) Are myopic, plan only for the immediate future, and are reluctant to engage in risk reduction efforts (Kleindorfer and Kunreuther 1999; Healy and Malhotra 2009);
- b) Overestimate their ability to cope with a disaster including the protection offered by their residence (NRC 2006);
- c) Rely heavily on emergency relief and humanitarian aid after a disaster (Mileti and Peek-Gottschlich 2001); and
- d) Suffer disproportionately due to varying levels of vulnerability (Cutter 2005; Adger 2006).

There is a paucity of empirically-based studies on which incentives lead to behavioural changes and their effectiveness. We know that experiencing a disaster is an effective way of raising awareness and that it generally motivates people to be more proactive; but only for a period of time (Michel-Kerjan and Kousky 2010; NRC 2006). Post-disaster payments and governmental aid are detrimental to stimulating risk reduction because they create welfare economics and moral hazards. The unanswered question is how best to balance or tie humanitarian aid after a catastrophic event to pre-event risk reduction efforts.

3. Community-based Disaster Risk Management

Organisations, particularly governmental entities, can respond to incentives (e.g., fiscal incentives) as well as create incentives for their constituents. As a result, organisational research studies both the drivers behind establishing risk management policies, programmes, and projects as well as responses to external or top-down incentives.

What is Known

There is a wide array of structural (e.g., flood protection system) and non-structural measures (Table 1) available to governments to reduce disaster risk. Legislation that regulates building codes and land use ranks among the most common tools, with broad implications for communities, private sector and local residents (Burby et al. 2000; Spence 2004). As Smolka (2006, 2147) states: “A main responsibility of governments is to formulate regulations for building construction and land use” to curb losses and make insurance a sustainable risk transfer strategy.”

Table 1: Non-structural measures and powers to reduce or transfer risk.

From \ To	Local Governments	Communities	Private Sector	Households/ Individuals
National Government	Policy Legislation Spending/Investment	Legislation Spending/Investment	Insurance Taxation Impact Fees	Insurance
Local Government		Regulation Ordinances Planning Spending/investment	Zoning Building codes Ordinances Taxation Education	Zoning Building codes Ordinances Taxation Acquisition Education
Private Sector			Lending Insurance Construction practices	Lending Insurance Construction practices

The willingness to adopt and implement disaster risk reduction measures is increased when:

- a) The public participates and engages in group decision-making rather than individual normative thinking (Cox 2012; Shaw and Goda 2004; NRC 2006);
- b) Cultural values are understood and integrated (Douglas et al. 2012);
- c) Organisational capacity for implementation, coordination and cooperation exists locally (Brody et al. 2010); and
- d) Local authority, individual rights, procedures and boundaries as well as monitoring and accountability are clear (Saldaña-Zorrilla 2008).

Remaining Challenges

The importance of risk perception and heuristics is not only of central importance to decision-making at the individual and household levels, but also in regard to public and political investment decisions (Bonstrom et al. 2012). Myopic voters may reward politicians for ex-post disaster relief spending rather than ex-ante investments (Healy and Malhotra 2009), whereas other studies show that governments that let preparedness programmes lapse, for example, become unpopular (Cox 2012). Thus, there is no “standard” public preference for community risk management decisions. Instead it varies depending on locality and risk culture. “The success of any government action depends equally on the development in society of a ‘safety culture’ in which citizens both understand the risks they face and are prepared to participate in the management of them” (Spence 2004, 391).

Furthermore, structural and non-structural risk reduction measures can when applied inconsistently or with contradictory goals, disincentivise and even undermine sustainable disaster risk management (Bagstad et al. 2007; Burby 2006). Local policies designed for economic growth (e.g., tax incentives) are often in direct opposition to risk reduction and, in fact, often directly contribute to increasing losses and reliance on ex-post disaster aid (Stehr 2006). For example, flood control structures such as levees promote new development placing more people and assets at risk (IPCC 2012). Although land use planning is one of the most effective tools for risk reduction it also tends to be among the most difficult to implement and align with, for example, economic development (Berke et al. 2014; Burby et al. 1999).

Similar to the design of insurance products, inadequately designed community-based programmes can disincentivise risk-reducing efforts. An example is the U.S. Community Rating System intended to mitigate flood impacts, which has a non-linear performance rewards scheme that results in municipalities essentially gaming the system by engaging in marginal efforts and neglecting more difficult to implement risk reducing measures (Zahran et al. 2010).

4. Climate Adaptation through Disaster Risk Management

With climate change altering the frequency and magnitude of severe weather events, disaster risk management figures prominently as a component of climate change adaptation (IPCC 2012). Climate change adaptation, however, is more complex than disaster risk management given the intricate system of international parties, treaties, and negotiations as well as the interplay with climate mitigation (Schipper 2009). Due to political inaction on climate mitigation and the recognition of limits to adaptation (Dow et al. 2013), the expectations on the effectiveness of disaster risk management continue to grow.

What is Known

The financial, behavioural and political incentives discussed above therefore apply not only to reducing disaster risk but also to adapting to climate change. As a result, much of the literature on climate change adaptation promotes similar ideas such as more effective land use planning, (micro)insurance, crop insurance, etc. (Linnerooth-Bayer et al. 2009; Smit and Skinner 2002).

Remaining Challenges

The uncertainty associated with climate impacts remains a major obstacle for transforming disaster risk management into an effective climate adaptation strategy. The inability to downscale changes in rainfall patterns, sea level rise, and temperature to local areas constrains disaster risk management alternatives. It also appears that risk perception and heuristics play an even more critical role in climate adaptation than in conventional disaster risk management, again due to the uncertainties associated with today's climate impact models (IPCC 2012).

The effects of climate change will be most notable in the fishing and agricultural sector particularly in developing countries. Sea-level rise, coastal erosion, water scarcity as well as water excess will affect the quality of arable land, agricultural yields and challenge established farming techniques such as irrigation, crop selection, crop rotation, and more (Smit and Skinner 2002). On the other hand, the agricultural sector tends to be very responsive to incentives such as government policies, crop insurance, price support and international trade agreements. However, limited research exists on how these traditional risk buffers in the agricultural sector actually become "perverse" incentives and prolong business as usual rather than fostering climate adaptation.

5. Disaster Risk Management in Developing Countries

The low priority of disaster risk management or climate adaptation in developing countries is not surprising given the more immediate needs associated with livelihoods, social inequality as well as low economic and institutional development, of which economic development and disaster prevention are often perceived as conflicting goals (World Bank 2010). Despite their economic fragility and set-backs suffered by disasters, political incentives to invest scarce resources are virtually non-existent.

What is Known

Much of the literature on climate change adaptation and disaster risk management in the developing world tends to limit incentives to financial incentives such as emergency loans/microcredits and micro-insurance for households and individuals (Linnerooth-Bayer et al. 2009) or hedging instruments such as catastrophe bonds for governments (Kunreuther and Linnerooth-Bayer 2003). This focus is problematic given the unaffordability of insurance by many citizens and because any activities (subsidies) to stimulate the insurance market and insurance penetration can quickly create inefficiencies and a moral hazard as seen in the case of agricultural

insurance in China (Wang et al. 2012). They suggest that “without strong incentives and governmental support, a shrinking natural disaster insurance market is inevitable” (Wang et al. 2012, 1719), especially in developing countries. Thus, financial incentives have a high likelihood for transferring disaster risk while at the same time creating economic costs elsewhere. Overall, our current knowledge on the benefits and drawbacks regarding the use of financial instruments in developing countries is largely incomplete and in its infancy with case studies and pilot programmes providing contradictory evidence (Linnerooth-Bayer et al. 2009).

Motivating people to take up insurance in developing countries is particularly challenging given widespread expectations for government and humanitarian aid post-disaster (Ikeme 2003). Some argue that promoting the reduction of physical (exposure) and social vulnerability through political and behavioural incentives and integrated strategies offer the most significant benefits since less vulnerable infrastructure and reductions in social vulnerability improve societal resilience to external shocks in general (Cutter 2014).

Remaining Challenges

The “lack of recognition of the need to adapt, poor incentive to adapt and low capacity to adapt” (Ikeme 2003, 29) makes progress in risk reduction extremely challenging. The focus on incentives aimed at individuals ignores the important lessons learned from community-based disaster risk management: institutional development and raising awareness among the general public and public officials are essential.

To build capacity and acquire financial resources, developing countries facing adverse effects from climate change are currently promoting a compensation mechanism for the loss and damage they are (or will be) suffering (Huq et al. 2013). While these countries are in desperate need of financial resources and capacity building to implement climate adaptation strategies, ex-post finance has the potential to create new “perverse” incentives for developing countries to increase development rather than promoting and fortifying existing infrastructure.

4. Knowledge Gaps

1. Integrated Disaster Risk Management

Although it is clear that risk reduction and fewer losses foster sustainable development, it appears that the integration of disaster risk management into sustainable development policies and programmes has either failed or failed to reach its full potential. Long-term strategic disaster risk management is necessary at all levels of government and society. Some researchers even call for entirely new institutional structures including public-private partnerships to manage disaster risk (Gopalakrishnan and Okada 2007; Biagini and Miller 2013).

Without a radical rethinking of institutional structures, integrated disaster risk management could be achieved through community-based disaster risk management implementing the lessons learned surrounding behavioural and political incentives. The management of disaster risk has to move from an “add-on” mandate (Wisner 2011) to comprehensive integration into policies, programmes, and decision-making. This can, however, only be accomplished when citizens reward public safety and pre-event protection over post-disaster welfare. In addition, national and local governments need to harmonise and streamline compartmentalised policies that pursue conflicting goals both within and between administrative levels. As Bals et al. (2006, 640) put it: a discussion on “risk transparency, communication about acceptable risks, and possible actions to limit exposure to risk” must emerge.

In sum, there is a need for more research on effective public policy and public administration that reduces losses and increase resilience. While a large body of research evaluating failed policies such as the U.S. National Flood Insurance Program (Thomas and Leichenko 2011) exists, there is very little evidence on whether and how research findings have been used to inform policy revisions or course corrections. Is it possible to undo unintended consequences or maladaptation caused by misguided or inadequately designed policies, financial tools, etc.? And if so, what were the incentives (e.g., economic growth) and trigger mechanisms (e.g., tipping points, civil unrest, leadership, etc.) for these system corrections to take place?

2. Beyond Techno-centric Solutions

Changing behaviour and decision-making at all levels of society is far more challenging than implementing early warning systems or building flood protection systems. After years of investing in structural solutions such as dams, levees, or tsunami walls, designed to prevent losses and provide land for agricultural use and development, it turns out that these “protective” measures have, in fact, placed more people and assets at risk than ever before (Mileti and Peek-Gottschlich 2001). In addition, lack of infrastructure maintenance over time and poor design or construction practices often led to failure before these investments reached the end of their designed life. Impacts from a changed climate will further diminish the designed life of many structural investments or require substantial financial investments in order to retrofit and maintain the expected protection levels (Jonkman et al. 2013).

What is unclear at this point is, if structural measures, once implemented, lived up to their benefit assessment or if the (external) costs they generated were actually higher. Research shows that structural measures have the tendency to foster development, place more people and assets at risk and promote “business as usual” (IPCC 2012). Is it therefore imperative to assess if structural measures contributed to increasing losses and start factoring this information into cost-benefit analyses? Follow-up assessments on the realisation of the anticipated benefits and costs are essential to distinguish between effective incentives and “perverse” incentives. Which structural measures work and which do not? What are the circumstances or conditions under which they are most effective (cost) and when does their impact turn detrimental to the overall system? This

is a noticeable gap in the scientific literature.

3. Behavioural Economics

The call for increased access to insurance and micro-insurance as a risk-reducing strategy largely ignores the psychological and sociological findings on heuristics and human decision-making. Insurance companies control their financial risk by encouraging the insured to participate in loss mitigation actions. In fact, they can also promote their financial risk by raising insurance premiums, increasing the self-participation of the insured party in the loss (so-called deductibles), setting liability limits, and excluding high-risk areas or certain hazards (Smolka 2006). Research shows that these strategies, while essential for the bottom-line and survival of insurance companies, leaves either national governments to step in as insurer of last resort (Botzen and van den Bergh 2008) or leads people to drop insurance altogether (Michel-Kerjan and Kousky 2010). As a result, it exposes countries and people to more—not less—unforeseen financial risks. While theoretically and conceptually important, there is a lack of empirically-based studies that demonstrates these effects.

Risk transfer is not the same as risk reduction. There are too many examples of insurance schemes being misused or triggering unwanted behaviour rather than reducing risk. Additional research is needed on incentivising risk transfer strategies that have truly risk reducing capacities. When designing insurance products, concerns about affordability and equity are important though they should not trump or ignore the evidentiary value of behavioural economics and heuristics.

4. Monitoring Systems

Although many countries have established loss-monitoring systems in the past years, largely with the help of external support through the United Nations Development Programme (UNDP), there are significant concerns regarding the reliability and sustainability of these efforts. In many instances, data coverage is sporadic—meaning loss estimates are missing, data quality is questionable, and operators lack financial resources to maintain loss databases (UNDP/BCPR 2013). On the other hand, equally important data on vulnerability and resilience is largely missing making it difficult to track loss reduction progress in conjunction with resilience.

Better data on losses, both historic and current, are also essential for the attribution of extreme weather impacts to climate change (Basher 1999; Jagger et al. 2011). Being able to recognise that weather patterns and their impacts have changed is crucial for establishing the need for climate adaptation rather than conventional disaster risk management. Consequently, losses (or avoided losses) should be considered a performance measure of risk management, as should resilience. Thus, more research is needed on outcome measures of risk management, which ultimately aids in the evaluation of the effectiveness of incentives.

5. Development and Climate Change Adaptation

Establishing a safety or risk culture poses a major challenge in developing countries (Wisner et al. 2003) where institutional resources and capacities for land use planning, regulation enforcement and public safety are limited and building practices as well as materials are often of substandard quality (Spence 2004). In addition, qualified personnel at municipal levels or legal systems holding negligent builders and engineers liable are lacking while corruption is rampant. Therefore matching incentives, policies and practices to local circumstances, for example, simplifying building codes such as limiting floor height must become a guiding principle.

This is particularly important in the debate surrounding developing countries and climate change adaptation (Schipper and Pelling 2006) where researchers are all too often attempting to transfer

knowledge or tools gleaned from their experience in developed countries to less developed countries. This is neither a sustainable nor suitable approach. It is imperative to produce innovative research fitting the context of developing countries (Onyekuru and Marchant 2012); but also to build research capacity within those countries.

Some researchers are therefore calling for new and innovative financing mechanisms as well as more public-private partnerships (Wang et al. 2012; Linnerooth-Bayer et al. 2009; Biagini and Miller 2013) because “helping poor countries to afford these pre-disaster protective measures may not only be desirable on equity grounds, but would avoid having investors depicted as capitalising on the potential catastrophic losses facing poor countries from future natural disasters” (Kunreuther and Linnerooth-Bayer 2003, 638).

Thus, incentives research should more strongly elicit the differences and opportunities between and among developed and developing countries in regard to economic, behavioural, and political incentives. Again, measuring their effectiveness and impacts is equally important meaning research needs to generate more case studies and evidence-based research for developing countries in order to identify best practices and locally-informed incentives. There are untapped possibilities for climate change adaptation in developing countries that require creative thinking and novel research such as a stronger involvement of the public sector (Biagini and Miller 2013) and the development of policies or “optimal strategies” that integrate different needs to generate “adaptation co-benefits” (Hoffmaister and Román 2012, 243; Goklany 2007, 782).

6. Systemic Shortcomings in Incentives Research

The economic-centric perspective in incentives research is mirrored in the authorship of the 132 analysed journal articles (Appendix). Out of 227 authors, more than half of the authors come from six disciplines (Figure 2): economics, geography, engineering, planning and development, environmental studies, and natural resource management with the latter three and geography being somewhat related. These disciplines engage predominately in research on insurance as well as improvements in building codes, land use planning, and measurements of losses and vulnerabilities. Organisational research, mostly on governmental organisations, is conducted in the fields of political science, public administration, sociology, and emergency management. Their focus lies on early warning and emergency management systems and organisational structures. Disciplines that could contribute knowledge on incentives for businesses, communities and households such as anthropology, public health, psychology and business administration are far less involved. However, engaging these disciplines and especially striking collaborations between, for example economics and psychology, is critical if behavioural economics and heuristics are to be recognised across the various focal areas of incentives research.

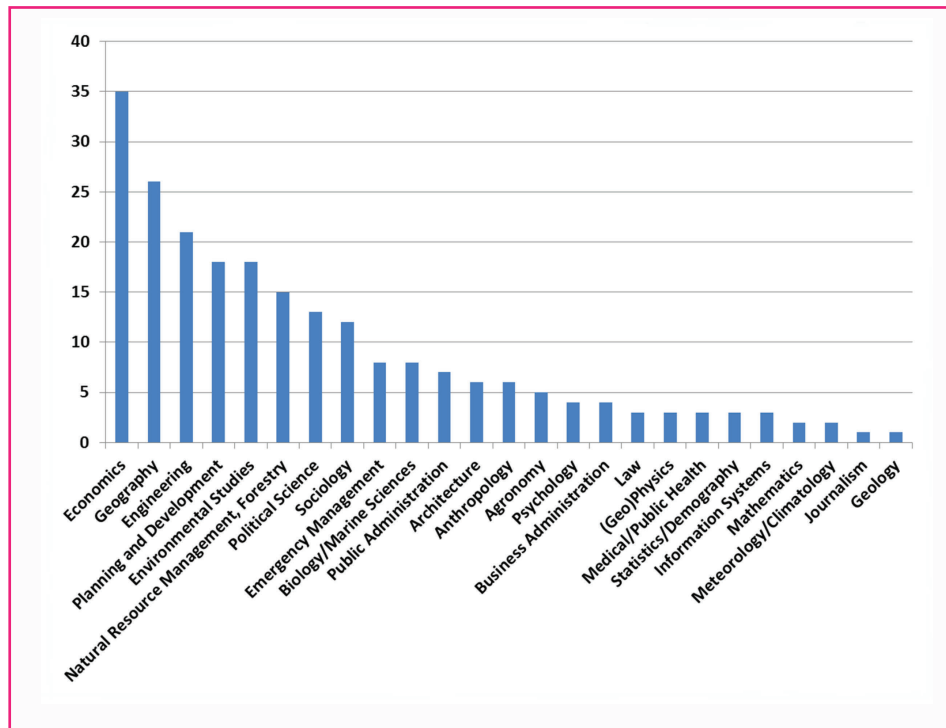


Figure 2: Disciplinary engagement in research on incentives.

In addition, out of the 132 analysed publications, the majority of the research was either theoretical/conceptual in nature (n=30) or focuses on developed countries, primarily the USA (Figure 3). Again, this speaks to the biased research orientation towards economic incentives and the insurance markets.

Research on risk reduction incentives in Asia, Africa, Latin America, and small island nations is spotty. Frequently, research focuses on maladaptation and “perverse incentives.” Thus, evidence on what incentives are effective is very limited, if not unavailable entirely. It is therefore imperative to create research capacity as well as research partnerships within and beyond developing countries to fill these knowledge gaps.

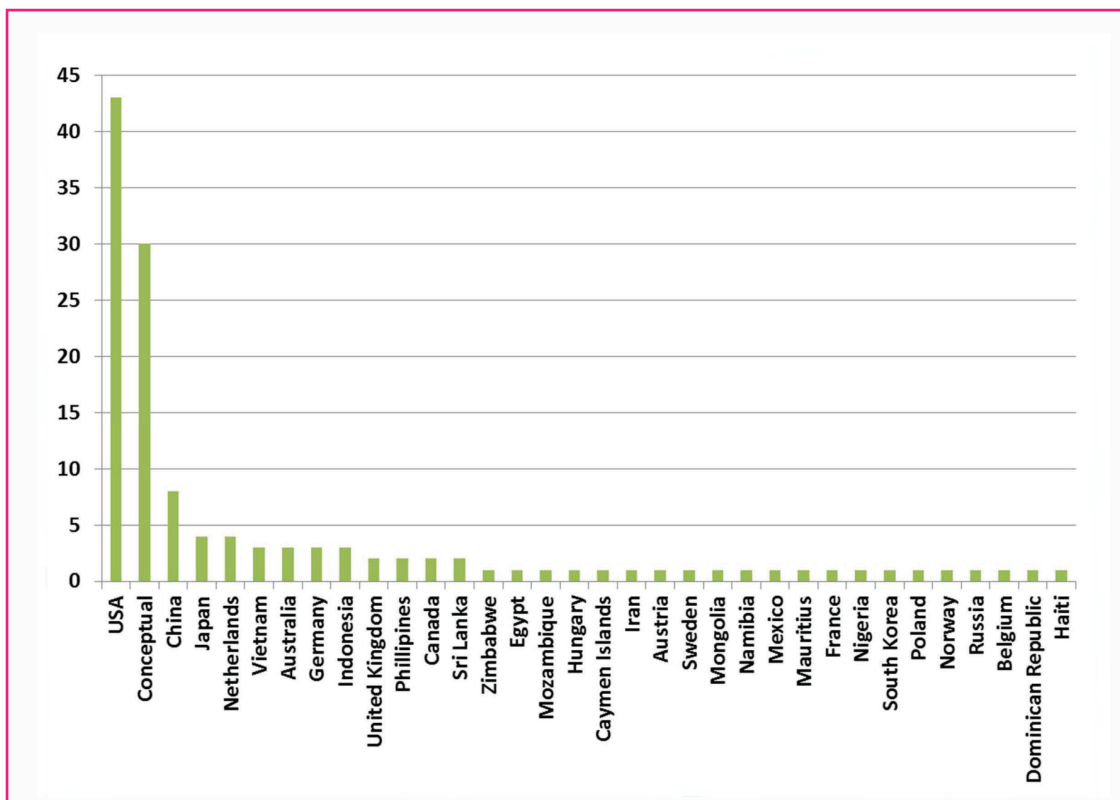


Figure 3: Incentives research is largely conceptual in nature or focuses on developed countries.

5. Conclusion

Numerous intra- and inter-country studies demonstrated the weakness of disaster risk management and seeming inability to curb losses and protect residents from disasters. Conflicts in policies and legislation pit economic development and myopic politics against comprehensive and integrated disaster risk management strategies. This results in the continued and dominant support for disaster response and recovery (the status quo) over prevention despite proven ineffectiveness particularly in inefficient and corrupt bureaucratic environments. Thus, the current incentive structure is largely ineffective and, in fact, promotes risk-seeking behaviour by individuals, private businesses and municipalities as well as local and national governments.

The gap between knowledge and action remains resulting in few success stories. Land use decisions frequently ignore risk assessments despite significant advances in methodology and reliability (Burby 2006). There is also sound evaluative research on existing policies and programmes, little of which has resulted in programme adjustments or improvements. Furthermore, sufficient research exists on how to coerce stakeholders into better decision-making but disaster risk management remains under-prioritised as it is still considered on its own rather than integrated into economic and social decision-making. In sum, governments and decision-makers are not making more informed decisions despite the abundance of better information.

The added expectations on disaster risk management to facilitate climate adaptation has the potential to foster maladaptation by continuing failed policies, designing inadequate financial products, and focusing on structural solutions. The inability to implement community-based risk management strategies reduces adaptive solutions to discussions about micro-insurance, land use planning, etc. rather than leading towards transformative, long-term risk strategies.

It appears that the lack of political repercussions and economic accountability for failed policies is an incentive to forgo disaster risk management. Even in societies that have a strong safety culture such as in Europe, thresholds or tipping points capable of undermining gains in economic development, environmental protection, and public health have seemingly not (yet) been reached. The social, economic and political saliency of disaster risk management still must be argued more clearly. What are the politically salient themes and problems to which disaster risk management can successfully be linked in a manner that would propel it to the same level of political interest and urgency as, for example, fiscal stability, unemployment or national security? How can we move from conceptual “good practices” to evidence-based practice with real success stories?

References

- Adger, W. Neil. 2006. "Vulnerability." *Global Environmental Change* 16 (3): 268–281. doi: 10.1016/j.gloenvcha.2006.02.006.
- Bagstad, Kenneth J, Kevin Stapleton, and John R D'Agostino. 2007. "Taxes, Subsidies, and Insurance as Drivers of United States Coastal Development." *Ecological Economics* 63 (2-3): 285–298. doi: 10.1016/j.ecolecon.2006.09.019.
- Bals, C, K Warner, and S Butzengeiger. 2006. "Insuring the Uninsurable: Design Options for a Climate Change Funding Mechanism." *Climate Policy* 6 (6): 637–647.
- Basher, Reid E. 1999. "Data Requirements for Developing Adaptations to Climate Variability and Change." *Mitigation and Adaptation Strategies for Global Change* 4 (3-4): 227–237. doi: 10.1023/A:1009668902876.
- Bateman, J, and B Edwards. 2002. "Gender and Evacuation: A Closer Look at Why Women Are More Likely to Evacuate for Hurricanes." *Natural Hazards Review* 3 (3): 107–117. doi: 10.1061/(ASCE)1527-6988(2002)3:3(107).
- Berke, P R, W Lyles, and G Smith. 2014. "Impacts of Federal and State Hazard Mitigation Policies on Local Land Use Policy." *Journal of Planning Education and Research* 34 (1): 60–76. doi: 10.1177/0739456x13517004.
- Biagini, Bonizella, and Alan Miller. 2013. "Engaging the Private Sector in Adaptation to Climate Change in Developing Countries: Importance, Status, and Challenges." *Climate and Development* 5 (3): 242–252. doi: 10.1080/17565529.2013.821053.
- Bonstrom, Holly, Ross B. Corotis, and Keith Porter. 2012. "Overcoming Public and Political Challenges for Natural Hazard Risk Investment Decisions." *Journal of Integrated Disaster Risk Management* 1 (1). doi: 10.5595/idrim.2012.0030
- Botzen, W. J. Wouter, and J. C. J. M. van den Bergh. 2008. "Insurance against Climate Change and Flooding in The Netherlands: Present, Future, and Comparison with Other Countries." *Risk Analysis: An Official Publication of the Society for Risk Analysis* 28 (2): 413–426. doi: 10.1111/j.1539-6924.2008.01035.x.
- Brody, Samuel, Jung Kang, and Sarah Bernhardt. 2010. "Identifying Factors Influencing Flood Mitigation at the Local Level in Texas and Florida: The Role of Organizational Capacity." *Natural Hazards* 52 (1): 167–184. doi: 10.1007/s11069-009-9364-5.
- Burby, Raymond J, T Beatley, P R Berke, R E Deyle, S P French, D R Godschalk, E J Kaiser, et al. 1999. "Unleashing the Power of Planning to Create Disaster-Resistant Communities." *Journal of the American Planning Association* 65 (3): 247–258. doi: 10.1080/01944369908976055.
- Burby, Raymond J, Robert E Deyle, David R Godschalk, and Robert B Olshansky. 2000. "Creating Hazard Resilient Communities through Land-Use Planning." *Natural Hazards Review* 1 (2): 99–106
- Burby, Raymond J. 2006. "Hurricane Katrina and the Paradoxes of Government Disaster Policy: Bringing About Wise Governmental Decisions for Hazardous Areas." *The Annals of the American Academy of Political and Social Science* 604 (1): 171–91. doi: 10.1177/0002716205284676.
- Cardona, O D, M G Ordaz, L E Yamin, M C Marulanda, and A H Barbat. 2008. "Earthquake Loss Assessment for Integrated Disaster Risk Management." *Journal of Earthquake Engineering* 12: 48–59. doi: 10.1080/13632460802013495.
- Clarke, D J, and D Grenham. 2013. "Microinsurance and Natural Disasters: Challenges and Options." *Environmental Science & Policy* 27: S89–S98. doi: 10.1016/j.envsci.2012.06.005.
- Cox, Louis Anthony. 2012. "Community Resilience and Decision Theory Challenges for Catastrophic Events." *Risk Analysis: An Official Publication of the Society for Risk Analysis* 32 (11): 1919–34. doi: 10.1111/j.1539-6924.2012.01881.x.
- Cutter, Susan L. 2005. "The Geography of Social Vulnerability: Race, Class and Catastrophe." *Understanding Katrina: Perspectives from the Social Sciences*. Social Science Research Council. <http://understandingkatrina.ssrc.org/Cutter/>.

- Cutter, Susan L. 2014. "Building Disaster Resilience: Steps toward Sustainability." *Challenges in Sustainability*. Vol. 1. doi: 10.12924/cis2013.01020072.
<http://www.librelloph.com/challengesinsustainability/article/view/cis-1-2-72>.
- De Hoop, T, and R Ruben. 2010. "Insuring against Earthquakes: Simulating the Cost-Effectiveness of Disaster Preparedness." *Disasters* 34 (2): 509–523. doi: 10.1111/j.0361-3666.2009.01140.x.
- Donahue, A K, and P G Joyce. 2001. "A Framework for Analyzing Emergency Management with an Application to Federal Budgeting." *Public Administration Review* 61 (6): 728–740.
 doi: 10.1111/0033-3352.00143.
- Douglas, E M, P H Kirshen, M Paolisso, C Watson, J Wiggin, A Enrici, and M Ruth. 2012. "Coastal Flooding, Climate Change and Environmental Justice: Identifying Obstacles and Incentives for Adaptation in Two Metropolitan Boston Massachusetts Communities." *Mitigation and Adaptation Strategies for Global Change* 17 (5): 537–562. doi: 10.1007/s11027-011-9340-8.
- Dow, Kirstin, Frans Berkhout, and Benjamin L Preston. 2013. "Limits to Adaptation to Climate Change: A Risk Approach." *Current Opinion in Environmental Sustainability* 5 (3-4): 384–391.
 doi: 10.1016/j.cosust.2013.07.005.
- Gall, Melanie, Kevin A Borden, and Susan L Cutter. 2009. "When Do Losses Count? Six Fallacies of Natural Hazards Loss Data." *Bulletin of the American Meteorological Society* 90 (6): 799–809.
 doi: 10.1175/2008BAMS2721.1.
- Gall, Melanie, Khai Nguyen, and Susan L. Cutter. 2014. "Integrated Research on Disaster Risk: Is It Really Integrated?" *International Journal of Disaster Risk Reduction*, in review.
- Gigerenzer, Gerd. 2014. *Risk Savvy: How to Make Good Decisions*. New York, NY: Viking Adult.
- Goklany, IndurM. 2007. "Integrated Strategies to Reduce Vulnerability and Advance Adaptation, Mitigation, and Sustainable Development." *Mitigation and Adaptation Strategies for Global Change* 12 (5): 755–786. doi: 10.1007/s11027-007-9098-1.
- Gopalakrishnan, Chennat, and Norio Okada. 2007. "Designing New Institutions for Implementing Integrated Disaster Risk Management: Key Elements and Future Directions." *Disasters* 31 (4): 353–372. doi: 10.1111/j.1467-7717.2007.01013.x.
- Healy, Andrew, and Neil Malhotra. 2009. "Myopic Voters and Natural Disaster Policy." *American Political Science Review* 103 (3): 387–406. doi: 10.1017/S0003055409990104.
- Hoffmaister, Juan P, and Mikael Román. 2012. "Pursuing the Link between Development and Climate Change Adaptation: The Case of Rice Production in Mozambique." *Climate and Development* 4 (3): 234–248. doi: 10.1080/17565529.2012.698591.
- Huq, Saleemul, Erin Roberts, and Adrian Fenton. 2013. "Loss and Damage." *Nature Publishing Group* 3 (11): 947–949. doi: 10.1038/nclimate2026.
- Ikeme, Jekwu. 2003. "Climate Change Adaptational Deficiencies in Developing Countries: The Case of Sub-Saharan Africa." *Mitigation and Adaptation Strategies for Global Change* 8 (1): 29–52.
 doi: 10.1023/a:1025838610473.
- IPCC. 2012. *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change*. Edited by C B Field, V Barros, T F Stocker, D Qin, D J Dokken, K L Ebi, M D Mastrandrea, et al. New York: Cambridge University Press.
- IRD. 2013. "Welcome to the AIRDR Community of Practice."
<http://www.irdrinternational.org/projects/airdr/>.
- Jaffee, D, and T Russell. 2013. "The Welfare Economics of Catastrophe Losses and Insurance." *Geneva Papers on Risk and Insurance-Issues and Practice* 38 (3): 469–94.
 doi: 10.1057/gpp.2013.17.
- Jagger, Thomas H., James B. Elsner, and R. King Burch. 2011. "Climate and Solar Signals in Property Damage Losses from Hurricanes Affecting the United States." *Natural Hazards* 58 (1): 541–557.
 doi: 10.1007/s11069-010-9685-4.
- Johnston, J S. 2012. "Disasters and Decentralisation." *Geneva Papers on Risk and Insurance-Issues and Practice* 37 (2): 228–256. doi: 10.1057/gpp.2012.13.
- Jonkman, Sebastiaan N., Marten M. Hillen, Robert J. Nicholls, Wim Kanning, and Mathijs van Ledden. 2013. "Costs of Adapting Coastal Defences to Sea-Level Rise - New Estimates and Their Implications." *Journal of Coastal Research* 290: 1212–1226. doi: 10.2112/JCOASTRES-D-12-00230.1.
- Kleindorfer, P R, and H Kunreuther. 1999. "The Complementary Roles of Mitigation and Insurance in Managing Catastrophic Risks." *Risk Analysis* 19 (4): 727–738. doi: 10.1023/A:1007097906602.

- Kreibich, H, S Christenberger, and R Schwarze. 2011. "Economic Motivation of Households to Undertake Private Precautionary Measures against Floods." *Natural Hazards and Earth System Sciences* 11 (2): 309–321. doi: 10.5194/nhess-11-309-2011.
- Kunreuther, H C, and J Linnerooth-Bayer. 2003. "The Financial Management of Catastrophic Flood Risks in Emerging-Economy Countries." *Risk Analysis* 23 (3): 627–639. doi: 10.1111/1539-6924.00342.
- Linnerooth-Bayer, J, K Warner, C Bals, P Hoppe, I Burton, T Loster, and A Haas. 2009. "Insurance, Developing Countries and Climate Change." *Geneva Papers on Risk and Insurance-Issues and Practice* 34 (3): 381–400. doi: 10.1057/gpp.2009.15.
- Michel-Kerjan, Erwann O., S Hochrainer-Stigler, Howard C. Kunreuther, Joanne Linnerooth-Bayer, Reinhard Mechler, R Muir-Wood, N Ranger, P Vaziri, and M Young. 2012. "Catastrophe Risk Models for Evaluating Disaster Risk Reduction Investments in Developing Countries." *Risk Analysis* 33 (6): 984-999. doi: <http://doi.wiley.com/10.1111/j.1539-6924.2012.01928.x>.
- Michel-Kerjan, Erwann O., and Carolyn Kousky. 2010. "Come Rain or Shine: Evidence on Flood Insurance Purchases in Florida." *Journal of Risk and Insurance* 77 (2): 369–397. doi: 10.1111/j.1539-6975.2009.01349.x.
- Mileti, Dennis S, and Lori Peek-Gottschlich. 2001. "Hazards and Sustainable Development in the United States." *Risk Management* 3 (1): 61–70. doi: 10.2307/3867745.
- NRC. 2006. *Facing Hazards and Disasters: Understanding Human Dimensions*. Washington, D.C.: The National Academies Press. http://www.nap.edu/catalog.php?record_id=13457
- Onyekuru, N A, and R Marchant. 2012. "Nigeria's Response to the Impacts of Climate Change: Developing Resilient and Ethical Adaptation Options." *Journal of Agricultural & Environmental Ethics* 25 (4): 585–595. doi: 10.1007/s10806-011-9336-0.
- Paudel, Y. 2012. "A Comparative Study of Public-Private Catastrophe Insurance Systems: Lessons from Current Practices." *Geneva Papers on Risk and Insurance-Issues and Practice* 37 (2): 257–285. doi: 10.1057/gpp.2012.16.
- Pelling, Mark. 2007. "Learning from Others: The Scope and Challenges for Participatory Disaster Risk Assessment." *Disasters* 31 (4): 373–385. doi: 10.1111/j.1467-7717.2007.01014.x.
- Picard, P. 2008. "Natural Disaster Insurance and the Equity-Efficiency Trade-Off." *Journal of Risk and Insurance* 75 (1): 17–38. doi: 10.1111/j.1539-6975.2007.00246.x.
- Saldaña-Zorrilla, Sergio O. 2008. "Stakeholders' Views in Reducing Rural Vulnerability to Natural Disasters in Southern Mexico: Hazard Exposure and Coping and Adaptive Capacity." *Global Environmental Change* 18 (4): 583–597. doi: 10.1016/j.gloenvcha.2008.09.004.
- Schipper, E. Lisa F. 2009. "Meeting at the Crossroads?: Exploring the Linkages between Climate Change Adaptation and Disaster Risk Reduction." *Climate and Development* 1 (1): 16–30. doi: 10.3763/cdev.2009.0004.
- Schipper, E. Lisa F., and Mark Pelling. 2006. "Disaster Risk, Climate Change and International Development: Scope For, and Challenges To, Integration." *Disasters* 30 (1): 19–38. doi: 10.1111/j.1467-9523.2006.00304.x.
- Shaw, R, and K Goda. 2004. "From Disaster to Sustainable Civil Society: The Kobe Experience." *Disasters* 28 (1): 16–40. doi: 10.1111/j.0361-3666.2004.00241.x.
- Slovic, Paul, Melissa Finucane, Ellen Peters, and Donald G MacGregor. 2002. "The Affect Heuristic." *In Heuristics and Biases: The Psychology of Intuitive Judgment*, edited by T Gilovich, D Griffin, and D Kahneman, 397–420. New York, NY: Cambridge University Press.
- Smit, Barry, and Mark W Skinner. 2002. "Adaptation Options in Agriculture to Climate Change: A Typology." *Mitigation and Adaptation Strategies for Global Change* 7 (1): 85–114. doi: 10.1023/a:1015862228270.
- Smolka, A. 2006. "Natural Disasters and the Challenge of Extreme Events: Risk Management from an Insurance Perspective." *Philosophical Transactions of the Royal Society a-Mathematical Physical and Engineering Sciences* 364 (1845): 2147–2165. doi: 10.1098/rsta.2006.1818.
- Spence, R. 2004. "Risk and Regulation: Can Improved Government Action Reduce the Impacts of Natural Disasters?" *Building Research and Information* 32 (5): 391–402. doi: 10.1080/0961321042000221043.
- Stehr, S D. 2006. "The Political Economy of Urban Disaster Assistance." *Urban Affairs Review* 41 (4): 492–500. doi: 10.1177/1078087405284887.

- Thomas, Adelle, and Robin Leichenko. 2011. "Adaptation through Insurance: Lessons from the NFIP." *International Journal of Climate Change Strategies and Management* 3 (3): 250-263.
- UNDP/BCPR. 2013. "A Comparative Review of Country-Level and Regional Disaster Loss and Damage Databases" New York, NY.
<http://www.undp.org/content/undp/en/home/librarypage/crisis-prevention-and-recovery/loss-and-damage-database/>.
- UNISDR. 2005. "World Conference on Disaster Reduction, 18-22 January 2005, Kobe, Hyogo, Japan." Geneva: United Nations.
- Wang, M, C Liao, S N Yang, W T Zhao, M Liu, and P J Shi. 2012. "Are People Willing to Buy Natural Disaster Insurance in China? Risk Awareness, Insurance Acceptance, and Willingness to Pay." *Risk Analysis* 32 (10): 1717–1740. doi: 10.1111/j.1539-6924.2012.01797.x.
- Whalen, T M, S Gopal, and D M Abraham. 2004. "Cost-Benefit Model for the Construction of Tornado Shelters." *Journal of Construction Engineering and Management* 130 (6): 772–779. doi: 10.1061/(asce)0733-9364(2004)130:6(772).
- Wisner, Ben. 2011. "Are We There Yet? Reflections on Integrated Disaster Risk Management after Ten Years." *IDRiM Journal* 1 (1): 1-14.
- Wisner, Ben, Piers Blaikie, Terry Cannon, and Ian Davis. 2003. *At Risk: Natural Hazards, People's Vulnerability, and Disasters*. 2nd ed. London: Routledge.
- World Bank. 2010. *Natural Hazards, UnNatural Disasters: The Economics of Effective Prevention*. Washington, DC: World Bank.
http://www.gfdrr.org/sites/gfdrr.org/files/nhud/files/NHUD-Report_Full.pdf
- Young, M, K Cleary, B Ricker, J Taylor, and P Vaziri. 2012. "Promoting Mitigation in Existing Building Populations Using Risk Assessment Models." *Journal of Wind Engineering and Industrial Aerodynamics* 104: 285–292. doi: 10.1016/j.jweia.2012.05.001.
- Zahran, Sammy, Samuel D Brody, Wesley E Highfield, and Arnold Vedlitz. 2010. "Non-Linear Incentives, Plan Design, and Flood Mitigation: The Case of the Federal Emergency Management Agency's Community Rating System." *Journal of Environmental Planning and Management* 53 (2): 219–239.

Annex: Research Literature Reviewed

- Adida, E., P.C.C. DeLaurentis, and M.A. Lawley. 2011. "Hospital Stockpiling for Disaster Planning." *IIE Transactions* 43 (5): 348-362.
- Aerts, J.C.J.H., and W.J.W. Botzen. 2011. "Climate Change Impacts on Pricing Long-Term Flood Insurance: A Comprehensive Study for the Netherlands." *Global Environmental Change-Human and Policy Dimensions* 21 (3): 1045-1060.
- Alexander, B., C. Chan-Halbrecht, and W. Salim. 2006. "Sustainable Livelihood Considerations for Disaster Risk Management: Implications for Implementation of the Government of Indonesia Tsunami Recovery Plan." *Disaster Prevention and Management* 15 (1): 31-50.
- Alscher, S. 2011. "Environmental Degradation and Migration on Hispaniola Island." *International Migration* 49: e164-e188.
- Aoki, M., and G. Rothwell. 2013. "A Comparative Institutional Analysis of the Fukushima Nuclear Disaster: Lessons and Policy Implications." *Energy Policy* 53: 240-247.
- Bagstad, K.J., K. Stapleton, and J.R. D'Agostino. 2007. "Taxes, Subsidies, and Insurance as Drivers of United States Coastal Development." *Ecological Economics* 63 (2-3): 285-298.
- Bals, C., K. Warner, and S. Butzengeiger. 2006. "Insuring the Uninsurable: Design Options for a Climate Change Funding Mechanism." *Climate Policy* 6 (6): 637-647.
- Barnett, B. J. 1999. "US Government Natural Disaster Assistance: Historical Analysis and a Proposal for the Future." *Disasters* 23 (2): 139-155.
- Bateman, J., and B. Edwards. 2002. "Gender and Evacuation: A Closer Look at Why Women Are More Likely to Evacuate for Hurricanes." *Natural Hazards Review* 3 (3): 107-117.
- Beardsley, K., and B. McQuinn. 2009. "Rebel Groups as Predatory Organizations: The Political Effects of the 2004 Tsunami in Indonesia and Sri Lanka." *Journal of Conflict Resolution* 53 (4): 624-645.
- Berke, P.R., W. Lyles, and G. Smith. 2014. "Impacts of Federal and State Hazard Mitigation Policies on Local Land Use Policy." *Journal of Planning Education and Research* 34 (1): 60-76.
- Bharosa, N., J. Lee, and M. Janssen. 2010. "Challenges and Obstacles in Sharing and Coordinating Information During Multi-Agency Disaster Response: Propositions from Field Exercises." *Information Systems Frontiers* 12 (1): 49-65.
- Biagini, B., and A. Miller. 2013. "Engaging the Private Sector in Adaptation to Climate Change in Developing Countries: Importance, Status, and Challenges." *Climate and Development* 5 (3): 242-252.
- Birkland, T., R. Burby, D. Conrad, H. Cortner, and W. Michener. 2003. "River Ecology and Flood Hazard Mitigation." *Natural Hazards Review* 4 (1): 46-54.
- Blanchard-Boehm, R.D., K.A. Berry, and P.S. Showalter. 2001. "Should Flood Insurance Be Mandatory? Insights in the Wake of the 1997 New Year's Day Flood in Reno-Sparks, Nevada." *Applied Geography* 21 (3): 199-221.
- Bonstrom, H., R.B. Corotis, and K. Porter. 2012. "Overcoming Public and Political Challenges for Natural Hazard Risk Investment Decisions." *Journal of Integrated Disaster Risk Management* 2 (1). doi: 10.5595/idrim.2012.0030.
- Botzen, W.J.W., and J.C.J.M. van den Bergh. 2008. "Insurance against Climate Change and Flooding in the Netherlands: Present, Future, and Comparison with Other Countries." *Risk Analysis* 28 (2): 413-426.
- . 2009. "Managing Natural Disaster Risks in a Changing Climate." *Environmental Hazards* 8 (3): 209-225.
- Brody, S.D., J.E. Kang, and S. Bernhardt. 2009. "Identifying Factors Influencing Flood Mitigation at the Local Level in Texas and Florida: The Role of Organizational Capacity." *Natural Hazards* 52: 167-184.
- Brody, S.D., S. Zahran, W.E. Highfield, S.P. Bernhardt, and A. Vedlitz. 2009. "Policy Learning for Flood Mitigation: A Longitudinal Assessment of the Community Rating System in Florida." *Risk Analysis* 29(6): 912-929.
- Brown, P.H., and J.H. Minty. 2008. "Media Coverage and Charitable Giving after the 2004 Tsunami." *Southern Economic Journal* 75 (1): 9-25.

- Brown, S., M.N. Harris, and K. Taylor. 2012. "Modelling Charitable Donations to an Unexpected Natural Disaster: Evidence from the Us Panel Study of Income Dynamics." *Journal of Economic Behavior & Organization* 84 (1): 97-110.
- Bruggeman, V., M. Faure, and M. Haritz. 2011. "Remodelling Reparation: Changes in the Compensation of Victims of Natural Catastrophes in Belgium and the Netherlands." *Disasters* 35 (4): 766-788.
- Brzoska, M. 2012. "Climate Change and the Military in China, Russia, the United Kingdom, and the United States." *Bulletin of the Atomic Scientists* 68 (2): 43-54.
- Bunce, M., L. Mee, L.D. Rodwell, and R. Gibb. 2009. "Collapse and Recovery in a Remote Small Island - a Tale of Adaptive Cycles or Downward Spirals?" *Global Environmental Change* 19 (2): 213-226.
- Burby, R., R. Deyle, D. Godschalk, and R. Olshansky. 2000. "Creating Hazard Resilient Communities through Land-Use Planning." *Natural Hazards Review* 1 (2): 99-106.
- Burby, R.J. 2006. "Hurricane Katrina and the Paradoxes of Government Disaster Policy: Bringing About Wise Governmental Decisions for Hazardous Areas." *Annals of the American Academy of Political and Social Science* 604: 171-191.
- Cai, X.M., D.C. McKinney, and M.W. Rosegrant. 2003. "Sustainability Analysis for Irrigation Water Management in the Aral Sea Region." *Agricultural Systems* 76 (3): 1043-1066.
- Cardona, O.D., M.G. Ordaz, L.E. Yamin, M.C. Marulanda, and A.H. Barbat. 2008. "Earthquake Loss Assessment for Integrated Disaster Risk Management." *Journal of Earthquake Engineering* 12: 48-59.
- Carpenter, S., K. Arrow, S. Barrett, R. Biggs, W. Brock, A.-S. Crépin, G. Engström, C. Folke, T. Hughes, N. Kautsky, L. Chuan-Zhong, G. McCarney, K. Meng, K.-G. Mäler, S. Polasky, M. Scheffer, J. Shogren, T. Sterner, J. Vincent, B. Walker, A. Xepapadeas, and A. Zeeuw., 2012. "General Resilience to Cope with Extreme Events." *Sustainability* 4 (12): 3248-3259.
- Casari, M., and S. J. Wilkie. 2005. "Sequencing Lifeline Repairs after an Earthquake: An Economic Approach." *Journal of Regulatory Economics* 27 (1): 47-65.
- Chang-Richards, Y., S. Wilkinson, R. Potangaroa, and E. Seville. 2013. "Resource Challenges for Housing Reconstruction: A Longitudinal Study of the Australian Bushfires." *Disaster Prevention and Management* 22 (2): 172-181.
- Cheong, S. M. 2011. "Policy Solutions in the U.S." *Climatic Change* 106 (1): 57-70.
- Clarke, D. J., and D. Grenham. 2013. "Microinsurance and Natural Disasters: Challenges and Options." *Environmental Science & Policy* 27: S89-S98.
- Collier, P., and B. Goderis. 2009. "Structural Policies for Shock-Prone Developing Countries." *Oxford Economic Papers-New Series* 61 (4): 703-726.
- Collins, T.W., and B. Bolin. 2009. "Situating Hazard Vulnerability: People's Negotiations with Wildfire Environments in the Us Southwest." *Environmental Management* 44 (3): 441-455.
- Comerio, M.C. 2004. "Public Policy for Reducing Earthquake Risks: A Us Perspective." *Building Research and Information* 32 (5): 403-413.
- Cox, L. A. 2011. "Community Resilience and Decision Theory Challenges for Catastrophic Events." *Risk Analysis* 32 (11): 1919-1934.
- Croson, D., and A. Richter. 2003. "Sovereign Cat Bonds and Infrastructure Project Financing." *Risk Analysis* 23 (3): 611-626.
- Das Gupta, M. 2014. "Population, Poverty, and Climate Change." *World Bank Research Observer* 29 (1): 83-108.
- de Hoop, T., and R. Ruben. 2010. "Insuring against Earthquakes: Simulating the Cost-Effectiveness of Disaster Preparedness." *Disasters* 34 (2): 509-523.
- Dennis, R., J. Mayer, G. Applegate, U. Chokkalingam, C.P. Colfer, I. Kurniawan, H. Lachowski, P. Maus, R. Permana, Y. Ruchiat, F. Stolle, Suyanto, and T. Tomich. 2005. "Fire, People and Pixels: Linking Social Science and Remote Sensing to Understand Underlying Causes and Impacts of Fires in Indonesia." *Human Ecology* 33 (4): 465-504.
- Dessai, S., and C. Sims. 2010. "Public Perception of Drought and Climate Change in Southeast England." *Environmental Hazards* 9 (4): 340-357.
- Donahue, A.K., and P.G. Joyce. 2001. "A Framework for Analyzing Emergency Management with an Application to Federal Budgeting." *Public Administration Review* 61 (6): 728-740.

- Douglas, E.M., P.H. Kirshen, M. Paolisso, C. Watson, J. Wiggin, A. Enrici, and M. Ruth. 2012. "Coastal Flooding, Climate Change and Environmental Justice: Identifying Obstacles and Incentives for Adaptation in Two Metropolitan Boston Massachusetts Communities." *Mitigation and Adaptation Strategies for Global Change* 17 (5): 537-562.
- Eakin, H., V. Magaña, J. Smith, J.L. Moreno, J.M. Martínez, and O. Landavazo. 2007 "A Stakeholder Driven Process to Reduce Vulnerability to Climate Change in Hermosillo, Sonora, Mexico." *Mitigation and Adaptation Strategies for Global Change* 12 (5): 935-955.
- Enia, J. 2013. "The Spotty Record of the Hyogo Framework for Action: Understanding the Incentives of Natural Disaster Politics and Policy Making." *Social Science Journal* 50 (2): 213-224.
- Fan, S.G., and A. Ramirez. 2012. "Achieving Food Security While Switching to Low Carbon Agriculture." *Journal of Renewable and Sustainable Energy* 4(4): 041405-1- 041405-13.
- Fara, K.. 2001. "How Natural Are `Natural Disasters'? Vulnerability to Drought of Communal Farmers in Southern Namibia." *Risk Management* 3 (3): 47-63.
- Fernández-Giménez, M.E., B. Batkishig, and B. Batbuyan. 2012. "Cross-Boundary and Cross-Level Dynamics Increase Vulnerability to Severe Winter Disasters (Dzud) in Mongolia." *Global Environmental Change* 22 (4): 836-851.
- Frazier, T.G., M.H. Walker, A. Kumari, and C.M. Thompson. 2013. "Opportunities and Constraints to Hazard Mitigation Planning." *Applied Geography* 40: 52-60.
- Gaillard, J.C., and J. Mercer. 2013. "From Knowledge to Action: Bridging Gaps in Disaster Risk Reduction." *Progress in Human Geography* 37 (1): 93-114.
- Ge, Y., Y. Gu, and W. Deng. 2010. "Evaluating China's National Post-Disaster Plans: The 2008 Wenchuan Earthquake's Recovery and Reconstruction Planning." [In English]. *International Journal of Disaster Risk Science* 1 (2): 17-27.
- Ge, Y., W.G. Peacock, and M.K. Lindell. 2011. "Florida Households' Expected Responses to Hurricane Hazard Mitigation Incentives." *Risk Analysis* 31 (10): 1676-1691.
- Giuliani, G., and P. Peduzzi. 2011. "The Preview Global Risk Data Platform: A Geoportal to Serve and Share Global Data on Risk to Natural Hazards." *Natural Hazards and Earth System Science* 11 (1): 53-66.
- Goklany, I.M. 2007. "Integrated Strategies to Reduce Vulnerability and Advance Adaptation, Mitigation, and Sustainable Development." *Mitigation and Adaptation Strategies for Global Change* 12 (5): 755-786.
- Goodspeed, T.J., and A.F. Haughwout. 2012. "On the Optimal Design of Disaster Insurance in a Federation." *Economics of Governance* 13 (1): 1-27.
- Gopalakrishnan, C., and N. Okada. 2007. "Designing New Institutions for Implementing Integrated Disaster Risk Management: Key Elements and Future Directions." *Disasters* 31 (4): 353-372.
- Gotham, K.F. 2013. "Dilemmas of Disaster Zones: Tax Incentives and Business Reinvestment in the Gulf Coast after Hurricanes Katrina and Rita." *City & Community* 12 (4): 291-308.
- Green, C. 2010. "Towards Sustainable Flood Risk Management." *International Journal of Disaster Risk Science* 1 (1): 33-43.
- Grothmann, T., and A. Patt. 2005. "Adaptive Capacity and Human Cognition: The Process of Individual Adaptation to Climate Change." *Global Environmental Change* 15 (3): 199-213.
- Hao, L., G. Joyeeta, and V.M. Pieter. 2012. "China's Governance Structure on Drought Disaster in Rural Areas." *Disaster Advances* 5(4): 976-980.
- Hausner, V.H., P. Fauchald, T. Tveraa, E. Pedersen, J.L. Jernsletten, B. Ulvevadet, R.A. Ims, N.G. Yoccoz, and K.A. Brathen. 2011. "The Ghost of Development Past: The Impact of Economic Security Policies on Saami Pastoral Ecosystems." *Ecology and Society* 16 (3): 4.
- Hawker, M. 2007. "Climate Change and the Global Insurance Industry." *Geneva Papers on Risk and Insurance-Issues and Practice* 32 (1): 22-28.
- Healy, A., and N. Malhotra. 2009. "Myopic Voters and Natural Disaster Policy." *American Political Science Review* 103 (3): 387-406.
- Hjerpe, M., and E. Glaas. 2012. "Evolving Local Climate Adaptation Strategies: Incorporating Influences of Socio-Economic Stress." *Mitigation and Adaptation Strategies for Global Change* 17 (5): 471-486.

- Hoffmaister, J.P., and M. Román. 2012. "Pursuing the Link between Development and Climate Change Adaptation: The Case of Rice Production in Mozambique." *Climate and Development* 4 (3): 234-248.
- Holub, M., and S. Fuchs. 2009 "Mitigating Mountain Hazards in Austria - Legislation, Risk Transfer, and Awareness Building." *Natural Hazards and Earth System Sciences* 9 (2): 523-537.
- Holub, M., and J. Hubl. 2008. "Local Protection against Mountain Hazards - State of the Art and Future Needs." *Natural Hazards and Earth System Sciences* 8 (1): 81-99.
- Hu, W. 1997. "Household Land Tenure Reform in China: Its Impact on Farming Land Use and Agro-Environment." *Land Use Policy* 14 (3): 175-186.
- Hwacha, V.. 2005. "Canada's Experience in Developing a National Disaster Mitigation Strategy: A Deliberative Dialogue Approach." *Mitigation and Adaptation Strategies for Global Change* 10(3): 507-23.
- Ikeme, J. 2003. "Climate Change Adaptational Deficiencies in Developing Countries: The Case of Sub-Saharan Africa." *Mitigation and Adaptation Strategies for Global Change* 8(1): 29-52.
- Innes, R. 2003. "Crop Insurance in a Political Economy: An Alternative Perspective on Agricultural Policy." *American Journal of Agricultural Economics* 85 (2): 318-335.
- Jaffee, D., and T. Russell. 2013. "The Welfare Economics of Catastrophe Losses and Insurance." *Geneva Papers on Risk and Insurance-Issues and Practice* 38 (3): 469-494.
- Jahangiri, K., Y.O. Izadkhah, and S.J. Tabibi. 2011. "A Comparative Study on Community-Based Disaster Management in Selected Countries and Designing a Model for Iran." *Disaster Prevention and Management* 20 (1): 82-94.
- Johnston, J.S. 2012. "Disasters and Decentralisation." *Geneva Papers on Risk and Insurance-Issues and Practice* 37 (2): 228-256.
- Jonientz-Trisler, C., R.S. Simmons, B.S. Yanagi, G.L. Crawford, M. Darienzo, R.K. Eisner, E. Petty, and G.R. Priest. 2005. "Planning for Tsunami-Resilient Communities." *Natural Hazards* 35: 121-39.
- Kamel, N. 2012. "The Actualization of Neoliberal Space and the Loss of Housing Affordability in Santa Monica, California." *Geoforum* 43 (3): 453-463.
- Kang, S.J., S.J. Lee, and H. Lee. 2009. "A Study on the Implementation of Non-Structural Measures to Reduce Urban Flood Damage-Focused on the Survey Results of the Experts." *Journal of Asian Architecture and Building Engineering* 8 (2): 385-392.
- Keefer, P., E. Neumayer, and T. Plumper. 2011. "Earthquake Propensity and the Politics of Mortality Prevention." *World Development* 39 (9): 1530-1541.
- Kick, E.L., J.C. Fraser, G.M. Fulkerson, L.A. McKinney, and D.H. De Vries. 2011. "Repetitive Flood Victims and Acceptance of Fema Mitigation Offers: An Analysis with Community-System Policy Implications." *Disasters* 35 (3): 510-539.
- Kim, S.H., M.A. Cohen, S. Netessine, and S. Veeraraghavan. 2010. "Contracting for Infrequent Restoration and Recovery of Mission-Critical Systems." *Management Science* 56(9): 1551-67.
- Kleindorfer, P.R., and H. Kunreuther. 1999. "The Complementary Roles of Mitigation and Insurance in Managing Catastrophic Risks." *Risk Analysis* 19 (4): 727-738.
- Kreibich, H., S. Christenberger, and R. Schwarze. 2012. "Economic Motivation of Households to Undertake Private Precautionary Measures against Floods." *Natural Hazards and Earth System Sciences* 12 (2): 391-392.
- Krysanova, V., H. Buiteveld, D. Haase, F.F. Hattermann, K. van Niekerk, K. Roest, P. Martínez-Santos, and M. Schlüter. 2008. "Practices and Lessons Learned in Coping with Climatic Hazards at the River-Basin Scale: Floods and Droughts." *Ecology and Society* 13 (2): 32.
- Kunreuther, H.C., and J. Linnerooth-Bayer. 2003. "The Financial Management of Catastrophic Flood Risks in Emerging-Economy Countries." *Risk Analysis* 23 (3): 627-639.
- Li, H., J. Gupta, and M.P. Van Dijk. 2013. "China's Drought Strategies in Rural Areas Along the Lancang River." *Water Policy* 15 (1): 1-18.
- Linnerooth-Bayer, J., and R. Mechler. 2006. "Insurance for Assisting Adaptation to Climate Change in Developing Countries: A Proposed Strategy." *Climate Policy* 6 (6): 621-636.
- Linnerooth-Bayer, J., K. Warner, C. Bals, P. Hoppe, I. Burton, T. Loster, and A. Haas. 2009. "Insurance, Developing Countries and Climate Change." *Geneva Papers on Risk and Insurance - Issues and Practice* 34 (3): 381-400.

- McLeman, R., D. Mayo, E. Strebeck, and B. Smit. 2008. "Drought Adaptation in Rural Eastern Oklahoma in the 1930s: Lessons for Climate Change Adaptation Research." *Mitigation and Adaptation Strategies for Global Change* 13 (4): 379-400.
- Meyer, R. J. 2012. "Failing to Learn from Experience About Catastrophes: The Case of Hurricane Preparedness." *Journal of Risk and Uncertainty* 45 (1): 25-50.
- Mileti, D.S., and L. Peek-Gottschlich. 2001. "Hazards and Sustainable Development in the United States." *Risk Management* 3(1): 61-70.
- Mozumder, P., R. Helton, and R.P. Berrens. 2009. "Provision of a Wildfire Risk Map: Informing Residents in the Wildland Urban Interface." *Risk Analysis* 29 (11): 1588-1600.
- Murdiyarmo, D., and L. Lebel. 2007. "Local to Global Perspectives on Forest and Land Fires in South East Asia." *Mitigation and Adaptation Strategies for Global Change* 12 (1): 3-11.
- Oki, S., and K. Nakayachi. 2012. "Paradoxical Effects of the Record-High Tsunamis Caused by the 2011 Tohoku Earthquake on Public Judgments of Danger." *International Journal of Disaster Risk Reduction* 2: 37-45.
- Onyekuru, N.A., and R. Marchant. 2012. "Nigeria's Response to the Impacts of Climate Change: Developing Resilient and Ethical Adaptation Options." *Journal of Agricultural & Environmental Ethics* 25 (4): 585-95.
- Orencio, P.M., and M. Fujii. 2013. "A Localized Disaster-Resilience Index to Assess Coastal Communities Based on an Analytic Hierarchy Process (Ahp)." *International Journal of Disaster Risk Reduction* 3: 62-75.
- Paudel, Y. 2012. "A Comparative Study of Public-Private Catastrophe Insurance Systems: Lessons from Current Practices." *Geneva Papers on Risk and Insurance-Issues and Practice* 37(2): 257-85.
- Pauw, P., and . Pegels. 2013. "Private Sector Engagement in Climate Change Adaptation in Least Developed Countries: An Exploration." *Climate and Development* 5 (4): 257-67.
- Picard, P. 2008. "Natural Disaster Insurance and the Equity-Efficiency Trade-Off." *Journal of Risk and Insurance* 75 1): 17-38.
- Poussin, J. ., W.J.W. Botzen, and J.C.J.H. 2013. Aerts. "Stimulating Flood Damage Mitigation through Insurance: An Assessment of the French Catnat System." *Environmental Hazards-Human and Policy Dimensions* 12 (3-4): 258-277.
- Pryce, G., and Y. Chen. 2011. "Flood Risk and the Consequences for Housing of a Changing Climate: An International Perspective." *Risk Management-an International Journal* 13(4): 228-46.
- Rhinard, M. 2009. "European Cooperation on Future Crises: Toward a Public Good?". *Review of Policy Research* 26 (4): 439-455.
- Risbey, J., M. Kandlikar, H. Dowlatabadi, and D. Graetz. 1999. "Scale, Context, and Decision Making in Agricultural Adaptation to Climate Variability and Change." *Mitigation and Adaptation Strategies for Global Change* 4 (2): 137-165.
- Samaratunge, R., K. Coghill, and H.M.A. Herath. 2012. "Governance in Sri Lanka: Lessons from Post-Tsunami Rebuilding." *South Asia-Journal of South Asian Studies* 35 (2): 381-407.
- Schad, I., P. Schmitter, C. Saint-Macary, A. Neef, M. Lamers, L. Nguyen, T. Hilger, and V. Hoffmann. 2012. "Why Do People Not Learn from Flood Disasters? Evidence from Vietnam's Northwestern Mountains." *Natural Hazards* 62 (2): 221-241.
- Schwarze, R., and G.G. Wagner. 2004. "In the Aftermath of Dresden: New Directions in German Flood Insurance." *Geneva Papers on Risk and Insurance-Issues and Practice* 29(2): 154-68.
- Seng, D.. 2012. "A Conceptual Framework for Early Warning System Governance: Towards Effective and Sustainable Resilience." *Journal of Integrated Disaster Risk Management* 2 (1)
- Shaw, R., and K. Goda. 2004. "From Disaster to Sustainable Civil Society: The Kobe Experience." *Disasters* 28 (1): 16-40.
- Smit, B., and M.W. Skinner. 2002. "Adaptation Options in Agriculture to Climate Change: A Typology." *Mitigation and Adaptation Strategies for Global Change* 7 (1): 85-114.
- Smith, V.H., and M. Watts. 2010. "The New Standing Disaster Program: A Sure Invitation to Moral Hazard Behavior." *Applied Economic Perspectives and Policy* 32 (1): 154-169.
- Smolka, A. 2006. "Natural Disasters and the Challenge of Extreme Events: Risk Management from an Insurance Perspective." *Philosophical Transactions of the Royal Society a-Mathematical Physical and Engineering Sciences* 364 (1845): 2147-2165.
- Spence, R. 2004. "Risk and Regulation: Can Improved Government Action Reduce the Impacts of Natural Disasters?". *Building Research and Information* 32 (5): 391-402.

- Stead, M.M. 2006. "Implementing Disaster Relief through Tax Expenditures: An Assessment of the Katrina Emergency Tax Relief Measures." *New York University Law Review* 81 (6): 2158-2191.
- Stehr, S.D. 2006. "The Political Economy of Urban Disaster Assistance." *Urban Affairs Review* 41 (4): 492-500.
- Tierney, K.. 2012. "Disaster Governance: Social, Political, and Economic Dimensions." *Annual Review of Environment and Resources* 37: 341-363.
- Tierney, K.J. 2007. "From the Margins to the Mainstream? Disaster Research at the Crossroads." *Annual Review of Sociology* 33: 503-525.
- Tompkins, E.L., L.-A. Hurlston, and W. Poortinga. 2009. "Foreignness as a Constraint on Learning: The Impact of Migrants on Disaster Resilience in Small Islands." *Environmental Hazards* 8 (4): 263-277.
- Tran, P., and R. Shaw. 2007. "Towards an Integrated Approach of Disaster and Environment Management: A Case Study of Thua Thien Hue Province, Central Viet Nam." *Environmental Hazards* 7 (4): 271-282.
- Uddin, N., and D. Engi. 2002. "Disaster Management System for Southwestern Indiana." *Natural Hazards Review* 3 (1): 19-30.
- Uy, N., Y. Takeuchi, and R. Shaw. 2010. "An Ecosystem-Based Resilience Analysis of Infanta, Philippines." *Environmental Hazards* 11 (4): 266-282.
- Vari, A., J. Linnerooth-Bayer, and Z. Ferencz. 2003. "Stakeholder Views on Flood Risk Management in Hungary's Upper Tisza Basin." *Risk Analysis* 23 (3): 585-600.
- Vina, A., X.D. Chen, W.J. McConnell, W. Liu, W.H. Xu, Z.Y. Ouyang, H.M. Zhang, and J.G. Liu. 2011. "Effects of Natural Disasters on Conservation Policies: The Case of the 2008 Wenchuan Earthquake, China." *Ambio* 40 (3): 274-284.
- Wang, M., C. Liao, S.N. Yang, W.T. Zhao, M. Liu, and P.J. Shi. 2012. "Are People Willing to Buy Natural Disaster Insurance in China? Risk Awareness, Insurance Acceptance, and Willingness to Pay." *Risk Analysis* 32 (10): 1717-1740.
- Warner, K., M. Hamza, A. Oliver-Smith, F. Renaud, and A. Julca. 2009. "Climate Change, Environmental Degradation and Migration." *Natural Hazards* 55: 689-715.
- Weichselgartner, J., and R. Kasperson. 2010. "Barriers in the Science-Policy-Practice Interface: Toward a Knowledge-Action-System in Global Environmental Change Research." *Global Environmental Change* 20 (2): 266-277.
- Wellstead, A.M., M. Howlett, and J. Rayner. 2013. "The Neglect of Governance in Forest Sector Vulnerability Assessments: Structural-Functionalism and 'Black Box' Problems in Climate Change Adaptation Planning." *Ecology and Society* 18 (3): 423-437.
- Whalen, T.M., S. Gopal, and D.M. Abraham. 2004. "Cost-Benefit Model for the Construction of Tornado Shelters." *Journal of Construction Engineering and Management* 130 (6): 772-779.
- Wilby, R.L., and R. Keenan. 2012. "Adapting to Flood Risk under Climate Change." *Progress in Physical Geography* 36 (3): 348-378.
- Ye, T., P. Shi, J. Wang, L. Liu, Y. Fan, and J. Hu. 2012. "China's Drought Disaster Risk Management: Perspective of Severe Droughts in 2009-2010." [In English]. *International Journal of Disaster Risk Science* 3 (2): 84-97.
- Young, M., K. Cleary, B. Ricker, J. Taylor, and P. Vaziri. 2012. "Promoting Mitigation in Existing Building Populations Using Risk Assessment Models." *Journal of Wind Engineering and Industrial Aerodynamics* 104: 285-292.
- Zahran, S., S.D. Brody, W.E. Highfield, and A. Vedlitz. 2010. "Non-Linear Incentives, Plan Design, and Flood Mitigation: The Case of the Federal Emergency Management Agency's Community Rating System." *Journal of Environmental Planning and Management* 53 (2): 219-239.

About IRDR

Over recent decades, our knowledge and understanding of natural hazards has grown rapidly. Scientists can now characterise more accurately the possible magnitude of hazard events and can better estimate their probability; and forecasting capacity has significantly improved especially for weather-related events. Far more is now also known about the socio-economic dimensions of disasters, such as exposure and vulnerability, conditions for resilience, and the causal links between disasters, development paths and other factors that determine the scope and distribution of losses.

Despite this growth in knowledge, losses associated with environmental hazards have risen dramatically with hundreds of thousands of people killed and millions injured, affected or displaced each year because of disasters. Also the value of property damage has been doubling about every seven years over the past 40 years, with spectacular increases witnessed in the 2000s.

Recognising the related science needs, the International Council for Science (ICSU), the International Social Science Council (ISSC), and the United Nations International Strategy for Disaster Reduction (UNISDR)—the programme’s Co-Sponsors—created “Integrated Research on Disaster Risk” (IRDR) as a global, trans-disciplinary and intersectoral research programme to address the major challenges of natural and human-induced environmental hazards. The complexity of the task is such that it requires the full integration of research expertise from the natural, socio-economic, health, engineering and cultural sciences, encompassing also areas of inquiry and practice such as policy-making, the role of communications, and public and political perceptions of and responses to risk.

Three research and action objectives have been suggested for the programme:

1. Characterising hazards, vulnerability and risk.
2. Understanding decision-making in complex and changing risk contexts.
3. Reducing risk and curbing losses through knowledge-based actions.

Three cross-cutting themes support IRDR’s work towards these objectives:

1. Building capacity, including mapping capacity distribution, for disaster risk reduction at different levels and across multiple hazards.
2. Development and compilation of case studies and demonstration projects.
3. Advancing assessment, data, and monitoring tools of hazards, risks and disasters

It is envisaged that a successful programme will lead to a better understanding of hazards, vulnerability and risk; an enhanced capacity to interpret and deal with disaster risk; improved insights into decision-making that may increase risk exposure, as well as how such choices may be influenced; and proposals for how new knowledge can more effectively guide disaster risk reduction efforts at all levels.

Members of the IRDR AIRDR Project Working Group

- Susan L. Cutter (Co-Chair), University of South Carolina, USA
- Allan Lavell (Co-Chair), Faculty of Social Sciences (FLACSO), Costa Rica
- Ian Burton, Professor Emeritus, University of Toronto, Canada
- Anthony Oliver-Smith, Professor Emeritus, University of Florida, USA

Integrated Research on Disaster Risk (IRDR) IPO
c/o RAD/Chinese Academy of Sciences (CAS)
Room B713, No 9 Dengzhuang Nanlu
Haidian District, Beijing, China 100094
Tel.: +86 10 8217 8917 and +86 10 8217 8913
Fax: +86 10 8217 8913
Email: connect@irdrinternational.org
Website: www.irdrinternational.org