Flood insurance schemes and climate adaptation in developing countries

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Abstract

Risk transfer, including insurance, is widely recognized as a tool for increasing financial resilience to severe weather events such as floods. The application of this mechanism varies widely across countries, with a range of different types and schemes in operation. While most of the analytical focus has so far been on those markets that have a long tradition of insurance, there is still a clear gap in our understanding of how this mechanism works in a developing country context. This paper assesses 27 insurance schemes that transfer the risk of economic losses arising from floods in low – and middle income countries, focusing on the linkages between financial risk transfer and risk reduction. This aspect is important to avoid the effect of moral hazard and has gained particular relevance in the context of the climate change adaptation discourse, where some scholars and practitioners view insurance as a potential tool not just for current risks, but also to address projected future impacts of a changing climate by incentivizing risk reduction. We therefore look beyond the pure financial risk transfer nature of those 27 insurance schemes and investigate any prevention and risk reduction elements. Our analysis suggests that the potential for utilizing risk transfer for risk reduction is far from exhausted, with only very few schemes showing an operational link between risk transfer and risk reduction, while the effectiveness and implementation on the ground remains unclear. The dearth of linkages between risk reduction and insurance is a missed opportunity in the efforts to address rising risk levels, particularly in the context of climate change. Rising risk levels pose a threat to the insurability of floods, and insurance without risk reduction elements could lead to moral hazard. Therefore a closer linkage between risk transfer and risk reduction could make this a more sustainable and robust tool.

Keywords: Risk transfer, climate adaptation, flood risk, insurance, risk reduction

1. Introduction

Floods can lead to widespread destruction and human tragedy – severely affecting communities, businesses, public services, ecosystems and individuals all around the globe. As seen with recent events in Thailand, which caused an estimated loss of USD45.7 billion (World Bank estimate according to [1]) the impacts can be felt near and far: on the ground, where the flooding occurs, and beyond, through business supply-chains and cascading effects, leading to high economic damages.

Climate change is likely to increase the frequency and severity of extreme weather events such as floods [2]. Statistics on the number of natural disasters world-wide between 1980 and 2011 show that floods are the most common hazard, and its annual frequency for this period has increased comparatively more than other climatic hazards including storms, droughts and extreme temperatures [3].

It is the interplay of hazard, exposure and vulnerability that determines the consequences of a flood. But despite a range of efforts at international level, for example through the UNISDR, or nationally by Governments and locally through NGOs, flood risk levels continue to rise in many areas and pose a threat to our society [4]. This is particularly true in the context of low-and middle income countries: While total economic losses from floods are higher in developed countries, the relative size of economic impacts (economic losses expressed as a proportion of Gross Domestic Product) and the number of fatalities are more significant in developing countries. Many developing countries are located in high risk areas – with regular floods already affecting large parts of the population. In addition to these geographic factors there are a range of other aspects that drive risk levels [5], such as high economic importance of agriculture (a sector highly vulnerable to floods) and population growth. Currently about 800 million people are living in flood prone areas, of which on average about 70 million people are experiencing floods each year [6]. Population growth, particularly in developing countries, is expected to increase the future exposure to floods significantly [7]. In addition, the lack of financial resources to prepare for and prevent floods can pose a key constraint for developing countries' efforts in increasing their climate resilience. Linked to this are gaps in technical know-how, skills and data, which all influence the way a country responds to natural disaster risks. Severe floods can put at risk past development gains by damaging natural capital and infrastructure, undermining economic development and setting back poverty reduction efforts [6]In response, a wide range of tools and mechanism have been developed to reduce and manage the risks of flooding. Traditionally, flood risk management has mainly focused on engineered responses, such as dykes and flood walls or ex-post on rebuilding and compensation. But over the last decades, there is evidence of a broader approach to flood risk management – sometimes referred to as 'holistic'– which also considers so-called 'soft measures' such as planning, building regulation, early warning schemes [8], as well as financial instruments, such as risk transfer.

Insurance is one tool that can assist with the ex-ante management of flood risk by removing or reducing the financial risks arising from flooding. This instrument can be aimed at individuals

such as home owners and farmers, or at entities such as companies, organizations and governments.

It is widely acknowledged that risk transfer can be a cost effective way of managing risks, including floods (see for example [9]). But less clear is how insurance can influence risk levels beyond the financial dimension by fostering risk reduction. This aspect is traceable back to the early days of insurance, when marine policies sold by Lloyd's of London were conditioned on the adherence to basic safety rules in order to reduce the risk of losing a ship or its cargo, or where the provision of fire insurance triggered the development of fire services.

In this paper we explore the insurance –risk reduction link for flood risk in developing countries. While not widely available and mostly offered in the context of multi-peril crop insurance, we note a range of new schemes and pilot projects that explore the option for rolling out flood insurance across low-income countries. [10] Recently, this aspect has gained renewed attention in the context of the climate change adaptation discourse, where some scholars and practitioners view insurance as a potential tool in response to not just current risks, but also to address the projected future impacts of a changing climate. Currently, policy makers within the UNFCCC's Loss and Damage programme are considering the potential of setting up so called 'climate insurance schemes' in highly vulnerable countries, that would transfer financial risk arising from floods and other climatic risks to increase those countries' climate resilience.

This discussion occurs against the backdrop of growing concerns about sustainability of flood insurance in many developed countries, triggered by increasing losses and rising risk levels, with fear of unaffordable premiums and decreasing commercial viability for private sector companies involved in the risk transfer provision. While some experts warn that risks might become uninsurable in the future (see [11, 12), others argue that there are some clear opportunities for the insurance sector to develop new products [13]. One key aspect emerging in this context is the importance of linking risk transfer to risk reduction, seen as an effort to address the insurability challenge of rising risk levels.

This principle is well established in the context of commercial insurance: the higher a company's health and safety standards are, the more attractive the risk becomes for private insurers. But to what extent is this applicable to the situation of flood insurance in developing countries? Is there any evidence of flood insurance and risk reduction linkages in those schemes that do offer flood insurance? These are the research questions that we want to explore in this paper. Our paper aims to contribute to the growing literature on flood insurance in two ways: through expansion of the empirical evidence base through the analysis of schemes in developing countries; and secondly through an assessment of how risk reduction is promoted or incentivized in those schemes.

Based on the premise that insurance can in theory incentivize and promote risk reduction beyond the pure financial risk transfer, we explore the current level of integration within existing flood insurance schemes. Our evidence is derived from the recently published Compendium of Disaster Risk Transfer Initiatives in the Developing World, published by ClimateWise [10]. While reporting on a broad range of natural perils, the Compendium contains 27 schemes that provide cover against flood risk. We conclude by discussing the

relevance of our findings for the current climate adaptation discourse, including the role of risk transfer in the context of overall climate resilience.

2. The theoretical context: Flood insurance and risk reduction

Insurance risk transfer has been used for centuries as a tool to manage the risk of uncertain losses. In its most basic form insurance is a mechanism where risks or part of a risk are transferred from the insured to the insurer in return for a premium payment. This reduction in uncertainty is widely seen as an important mechanism driving our economic systems: without insurance many activities and processes would be deemed too risky and would not be undertaken, and those affected by a loss might struggle to recover [14]. The main aim of this financial risk transfer is the compensation for damages and funding of recovery efforts, but it is widely understood that the role of insurance can go further: if correctly designed and implemented insurance can foster prevention efforts, thus leading to an overall reduction of physical risks[1].

It is often argued that insurance can offer a valid alternative to more stringent command and control measures by governments – highlighting the influence that insurers could have over individuals and organizational risk behavior. In this context insurance becomes an instrument to provide incentives and to steer behavior towards prevention. The foundation of this work is the recognition that insurance premiums can send risk price signals.

This item has received some scholarly attention in the context of moral hazard, particularly for environmental pollution insurance (for a good overview see [15]): providing pollution cover could be seen as a license to pollute or a license to operate in a way that is unnecessarily harmful to the environment, unless a direct link between the environmental efforts of the insured and the level of the premium is established. Here insurance, if designed properly, can offer an incentive for prevention and risk reduction, for example by imposing certain operational standards, which reduce pollution risks. Some commentators identify insurance as a ‘surrogate regulatory tool’, arguing that through their own risk assessment and the underwriting decisions insurers can drive the behavior of the insured. Yin et al. [16] provide empirical evidence, which suggests that insurers may effectively exercise a quasi regulatory capacity for potentially hazardous or polluting operations. Here, the main driver for deterrence is the risk of not gaining insurance cover if certain standards are not met.

In general terms insurance can trigger risk reduction activities if it is beneficial for both the insured and the insurer. In the context of environmental liability insurance the link between

[1] At this point it is important to reflect on terminologies: these measures to tackle risk levels are often labeled risk reduction, but also prevention, risk mitigation or in the context of climate change, adaptation. This is a key challenge for research in this area – despite very similar outcomes in terms of reducing risk levels, the concepts are often grounded in very different notions.

risk reduction and provision of cover is evident: the adherence to high standards, such as a company's environmental management system, can be a condition for the provision of insurance, or it may justify a lower premium compared to those risks where lower (or no) pollution standards are implemented. For insurers this is a direct way to reduce and control insured losses during the lifespan of an insurance policy (usually a year).

The discourse about risk reduction and risk transfer has recently gained more global attention:

Does the same apply to flood insurance? Some observers argue that for insurance against floods and other natural disasters 'the insurance industry can act as a bridge between the public and private sectors in addressing risk awareness, physical resilience and financial preparedness' [17]. We note a broad agreement in the literature about the theoretical potential for insurance to reduce flood risk – although different categorizations exist:

Crichton [18] suggests six ways of how insurance could lead to physical flood risk reduction:

- 'Assistance with identifying areas at risk;
- Catastrophe modelling;
- Economic incentives to discourage construction in the floodplain;
- Collection of data on the costs of flood damage to feed into benefit cost appraisals for flood management schemes;
- Promotion of resilient reinstatement techniques after a flood loss;
- Promotion of temporary defence solutions' [19].

Paudel [19] argues along the same lines – his categorization differentiates between '1) risk assessment and mapping; (2) policies and regulations that are integrated in the insurance system; and (3) (financial) incentives that the insurance provides to policyholders to invest in mitigation' [19].

Surminski and Oramas-Dorta [20] apply this to a developing country context: their analysis of disaster insurance in developing countries identified different levels or scales of direct links between risk transfer and risk reduction:

- risk awareness-raising initiatives, such as the provision of risk-relevant information and knowledge transfer to educate policy-holders and the public about preventive measures;
- capacity-building through knowledge transfer and educational elements;
- explicit incentive structures for risk reduction, such as risk based pricing, where premiums reflect risk such as charging according to local flood risk levels;
- compulsory risk reduction, such as requiring policy holders to take certain preventive measures as a condition for cover.

While in theory most observers agree that there is the potential to make insurance work for risk reduction, the evidence of how this is implemented and the effectiveness of these measures is very limited. The scholarly debate on this has mainly focused on insurance in

developed countries, for example in the context of the US National Flood Insurance Programme (see [21]), and in the context of countries such as UK and France, which has been discussed by Crichton [18] as regards to the role of the insurance industry in reducing flood risk, including the provision of economic incentives to discourage construction in floodplains. In the UK the so-called Statement of Principles between insurers and government spells out the need for better flood risk information, stricter planning policy and more investment in flood defences as a condition for flood insurance provision. This approach is currently under review, as risk levels continue to rise, despite these reduction efforts [22]. In Austria insurers are actively driving public flood risk awareness through the Hora-initiatives, but evidence of resulting physical risk reduction efforts is scarce [23].

As these examples show, measuring success, implementation and effectiveness of these remains a challenge. There appear to be a range of barriers and trade –offs for effectively utilizing the risk reduction potential of insurance: Picard [24] highlights the trade-off between the effectiveness of risk based pricing and equity – as those most vulnerable could possibly not be able to pay for risk-based premiums [24].
Some recent studies have explored the link between risk reduction measures and premium pricing, though methods such as interviews with the insured, hypothetical modeling and willingness to pay exercises: Thieken et al. [25] found that in Germany insured households are more likely to undertake risk reduction measures than uninsured, suggesting that flood insurance sets an incentive for policy holders to take action. For the Netherlands, Botzen [26] suggests that many homeowners would be willing to make investments in risk reduction if this would lead to an insurance premium reduction: 'In particular, approximately two-thirds are willing to invest in water barriers (…) and about a fifth are willing to replace floor types that are vulnerable to flooding with water resistant floor types. Furthermore, about a quarter are willing to move central heating installations to floors safe against flooding' [26].

While we know relatively little about how insurance contributes to risk reduction in the context of established insurance markets, we know even less about the situation in developing countries. One could speculate that these newly emerging insurance schemes have the advantage of learning from mistakes of more established systems, and that they are being designed with risk reduction in mind. Is this the case? Evidence remains very limited. Summarizing recent literature on this topic, the IPCC's report on managing the risk of extreme events [7]concludes that 'risk sharing (formal insurance, micro-insurance, crop insurance) can be a tool for risk reduction and for recovering livelihoods' in the face of extreme weather events, but warns that it could also provide disincentives, if not correctly structured [7]. Suarez and Linnerooth-Bayer [27] have investigated the suitability of insurance related instruments for disaster risk reduction in vulnerable countries and conclude that these tools can effectively spread losses spatially and temporally, as well as to other parties, thus reducing vulnerability and enhancing preparedness however, several obstacles to implementation remain that require support from international development communities for such risk reduction programs to progress [27]. Suarez and Linnerooth –Bayer [27] summarize the potential links between risk financing (including insurance) and risk reduction for developing countries, illustrating the wide range of ways in which insurance can influence behavior and physical risk reduction: either in a moral hazard context, where insurance can lead to a more risky behavior, or as an

incentive, where insurance can trigger risk reduction investments, or the implementation of prevention measures and improved building standards. The key message emerging from this literature is that the design and implementation of a risk transfer scheme will determine the promotion of risk reduction and the level or moral hazard [14].

In summary, we note a gap of exploring how risk reduction and risk transfer can work hand-in hand – this applies to developed markets, but even more to newly emerging markets, where policy makers have recently started to consider insurance as a tool to trigger broader climate adaptation. Our paper aims to address this gap by investigating the risk reduction elements of flood risk insurance schemes in developing countries.

3. Evidence base and methodology

Our empirical analysis assesses the current use of flood insurance in lower and middle income countries[2]. When analyzing coverage data for flood risk globally, a clear imbalance of insurance penetration across countries becomes evident: flood insurance is practically non-existent in least developed countries, like Sudan, where the victims absorbed over 80% of the losses from the severe flooding in 1998, and the state covered the rest with outside assistance [28]. This is in line with the overall picture for insurance across the world: The provision of risk transfer is still in its infancy in most developing countries, as shown by the distribution of insurance premiums: In 2010 Europe (37%) and North America (30%) were the largest insurance markets in terms of premium volume. Asia accounted for 27% of the global premium volume. In contrast Latin America and Africa/Oceania only made up a 6% share of the global insurance premiums (3% each) [29].

Estimates indicate that in developing countries only 3% of natural disaster losses are insured, compared to 40% in developed markets [30]. The reasons behind this 'insurance gap' are many: on the supply side significant technical challenges exist for the provision of flood insurance, such as high transaction costs and inadequate distribution channels, as well as limited availability of data and flood modeling tools. A range of aspects need to be considered when modeling flood risk, such as topography, hydrology, land use, infrastructure and location of assets. In long established insurance markets the private sector has been actively engaged in developing flood modeling tools. But for many developing countries the data needed is often not readily available, and there is no commercial case for private sector actors to develop such models. [31, 32]

On the demand side there are also a range of factors hampering uptake of flood insurance, such as high transaction costs , lack of financial literacy and lack of access to affordable products in remote rural areas. [33] Efforts to overcome these challenges are visible in many pilot schemes, but as the newly developed index-based insurance schemes show the debate

[2] The classification of income groups in the database is based on the World Bank's income group classification of economies (January 2011), based on 2009 gross national income (GNI) per capita, and calculated using the World Bank Atlas method.

about most suitable scheme design and type is still ongoing, and significant limitations remain. [34].

Beyond the global level, there are several multi-country overviews offering insight into national flood insurance provision, most notably the summaries of existing flood insurance schemes provided by Insurance Europe (formerly known as the CEA). While mainly descriptive and illustrative, they provide an outline of the wide range of different types in operation – ranging from private market solutions to publicly funded risk pools, including compulsory schemes and completely voluntary offerings [35, 36]. This information can prove useful for policy makers and insurers alike, particularly when regulatory changes or the introduction of new insurance schemes is considered. These global or multi-national overviews have focused on well-established insurance markets, mostly in developed countries. For low and medium income countries the evidence base is much more limited. While there are topical overviews which contain some data on flood insurance, such as the Worldbank's survey of agricultural insurance schemes [37] or the International Labor Organization's Microinsurance Compendium for several countries [38, 39, 40], there is still a limited understanding of the overall flood insurance status across the developing world. The recently published 'Compendium of disaster risk transfer in developing countries' [10] was developed to address the evidence gap for these new and emerging markets. While not exhaustive, it contains a total number of 123 risk transfer initiatives in middle-income and lower-income countries that involve the transfer of financial risk associated with the occurrence of natural hazards[3].

The Compendium captures:

- schemes that make use of ex-ante risk transfer instruments, including indemnity and index-based insurance and insurance-linked securities (e.g. catastrophe bonds, catastrophe swaps, and weather hedges);
- schemes in which the public sector, the private sector or both (as public-private partnerships) play a role in their set up and operation;
- schemes that have been implemented (fully operational or as pilots) and proposed schemes that are at a reasonably advanced conceptual stage.

Within this dataset we can identify 27 insurance schemes that transfer at least some of the risk of economic losses associated to floods. Within the dataset we find very few non-agricultural schemes covering flood. This is not surprising as the demand and supply side challenges are significant for providing property-based flood insurance.

Our analysis considers those schemes that are fully operational (22) or being run as pilot projects (5), but we do not consider discontinued or proposed schemes. The analysis first looks at generic characteristics of these schemes, by looking at their geographical distribution, size, type of insurance products offered and governance; and then focuses on the existing links between risk transfer and risk reduction (section 4) through a comparative analysis, please see the Appendix for a summary of the 27 schemes.

[3] For references to the literature behind the Compendium data please see Appendix 1.

Not surprisingly, the picture of flood risk insurance in low- and middle income countries can be described as very geographically diverse (see Figure 1). There appear to be regional differences, for example the lack of micro-insurance outside Asia. As expected, the majority of schemes covering flood are based on the concept of indemnity, where the insurance policy pays out after a loss. Index-based insurance schemes (payment is made upon the occurrence of a trigger event based on a pre-agreed parameter or index and is not dependent on an actual loss) are also relatively common in agriculture and for sovereign-level insurance. Latin America and the Caribbean region show the highest concentration of schemes providing flood cover; while the Sub-Saharan region has no recorded schemes providing flood cover.

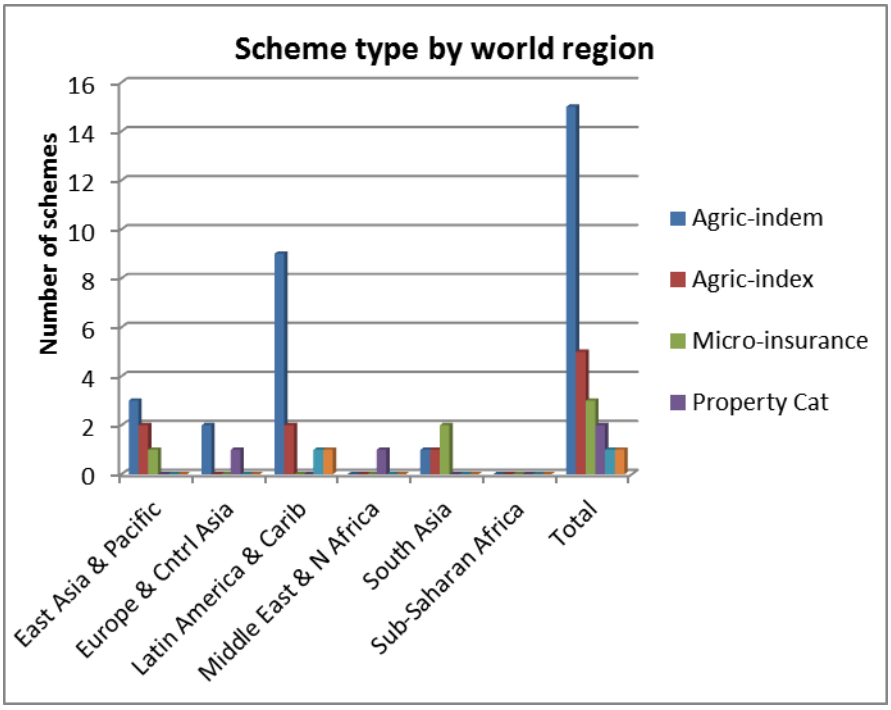

Figure 1: Number of schemes by scheme type and by world region. Legend indicates the broad scheme types/ categories considered. Applying the income-categories used by the World Bank we notice that the vast majority of schemes are in lower middle and upper middle income countries, with only one scheme in a low income country (Livestock insurance and crop pilot insurance programs in Nepal; #80).

The schemes differ also significantly in size and scale: There is a broad spread of scheme sizes, with the largest schemes (> 100,000 insured) being represented by large national agricultural insurance schemes providing flood cover (such as Agricultural insurance in China #84, National Agricultural Insurance Scheme (NAIS) in India #30, Index weather crop insurance in Mexico #110) and by national catastrophe insurance pools such as the Algerian Catastrophe Insurance Pool (ACIP) #105 and the Romanian Catastrophe Insurance Pool (PAID) # 103. The smaller schemes (< 20,000 insured) consist of both agricultural insurance schemes and disaster micro-insurance schemes covering flood. Only two of the considered schemes focus on just flood: the agricultural insurance scheme 'Flood index crop insurance in Vietnam' (#8) and the disaster micro-insurance scheme 'Index flood insurance in Indonesia' (# 87). The rest of the considered schemes are multi-peril, of which 6 schemes provide cover for weather events only (including

flood); and 19 provide cover for weather and non-weather events combined, such as pest or landslides. And the schemes are characterized by a range of different public/private roles: The majority of considered schemes (85%) include some form of public and private involvement. Two schemes do not refer to a direct public involvement, while two other schemes appear to be purely public. The roles taken by public and private sector vary between risk transfer and other support functions, such as providing technical assistance, promoting insurance, subsidizing premiums, or financing infrastructure such as weather stations. In 52% of the schemes the risk transfer is provided jointly by the public and private sector, with each sector taking varying risk levels and volumes of insurance and reinsurance layers. The private sector provides risk transfer in 41% of the cases; whereas the public sector does so in the remaining 7% of cases.

For our investigation of potential linkages between risk reduction and risk transfer we develop the following methodology:

1. We identify the degrees of linkages based on publicly available information by investigating if and how these flood insurance schemes recognize the concept of risk reduction. In the Compendium database we found evidence of three different degrees of linkages between risk transfer and risk reduction:

    -**no association**: this applies to schemes where there is no documented link to any risk reduction measures;

    -**indirect association**: where risk transfer is considered as one element within an overall policy framework or strategy for disaster risk reduction or adaptation;

    -**direct association**: where a risk transfer scheme explicitly supports risk reduction efforts as part of its operation;

2. We then conduct more in-depth analysis of those schemes where a linkage appears present by asking what the risk reduction measure is, the roles and responsibilities of those involved as well as their capacity to act.

Arguably this is a rather high-level assessment that should be complemented by on-the ground investigations. But we argue that this is a useful first step, to develop an evidence base and a better understanding of how risk reduction is currently being considered, similar to our knowledge in developed markets. This will then allow us to develop a more sophisticated framework to compare and measure the effectiveness of these linkages across countries, schemes, and markets.

4. Analysis of the linkages between risk transfer and risk reduction in flood risk insurance schemes in developing countries

The previous section has outlined our empirical evidence base for flood insurance in developing countries. From the data we learn that only a third of all schemes show signs of any formal association between risk reduction and risk transfer.

If applied to our 27 flood insurance schemes, it emerges that only very few schemes show any link between risk transfer and risk reduction, while the large majority (66.7%) appears not to formally or informally address risk reduction.

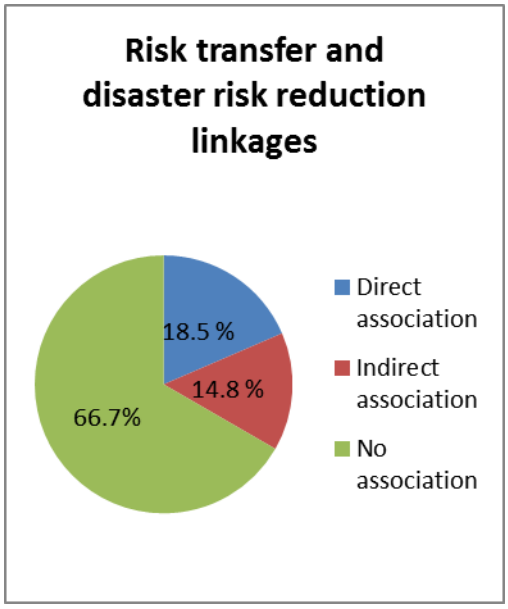

Figure 2: Proportion of schemes providing flood cover where risk transfer has some type of association (direct or indirect) to risk reduction measures; or has no association to risk reduction (as shown by the legend).

This is surprising, as it seems widely recognized that insurance is no silver bullet, and that integration with wider risk reduction efforts is important, particularly in the context of moral hazard: flood insurance without risk management implications may lead to complacency of government or those at risk. The importance of institutional frameworks and policies to integrate different disaster risk management tools is highlighted by the 'Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters' [41], adopted by the World Conference on Disaster Reduction in 2005, which sets out a comprehensive work plan to reduce global disaster losses. The Hyogo framework promotes and supports action in a range of areas, including efforts by countries to enhance their institutional capacity for dealing with disasters, for example by implementing national legislation to outline responsibilities for disaster risk reduction. UNISDR's Global Assessment

Report 2011 shows a certain degree of progress for institutionalizing and integrating overall disaster risk reduction policies at different governance levels across most countries, but it also confirms that progress is lacking particularly in least developed countries [27].
We suggest that this integration of different risk management approaches is likely to be more common in reality than shown by the Compendium data. We suspect some form of reporting bias is distorting the findings, as not all of the schemes in the Compendium would label themselves as part of a wider flood risk management portfolio, and not all would offer information about the wider framework that insurance is placed in. Further detailed analysis would be needed to investigate the relationship between government's wider DRM efforts, policy measures and the development of insurance. Surminski (2013) explores this in the context of China, and identifies public policy and insurance regulation as the key governance drivers for natural disaster insurance in China. [42].

We now look in greater detail at the schemes that show indirect and direct linkages. .

The 'indirect association' category includes four schemes (14.8 % of total) where risk transfer and risk reduction are not operationally linked, but where both feature as elements of an overall disaster risk reduction strategy or an adaptation plan:

#84: The National Agricultural Insurance Program in China is framed in the context of a wider policy framework and legislation on natural disaster prevention released by the Government of China in 2005, which identifies disaster preparedness and risk reduction as priorities for successful disaster risk management.
#90: The Afat Vimo disaster micro-insurance program in India provides multi-peril coverage for small-scale businesses. It is part of a wider program that promotes risk reduction measures such as fire safety in schools and capacity building inputs to clients.
#98: The Disaster Preparedness Program in India (Andhra Pradesh) includes disaster micro-insurance as one tool among a range of disaster management initiatives such as a local disaster preparedness fund managed by the community, housing, health awareness, drinking water, sanitation, and provision of capacity building for communities, government, civil society, and media organizations.
#110: The Index weather crop insurance in Mexico is part of a national institutional framework for disaster preparedness involving risk assessment, risk reduction, the promotion of a culture of prevention, and insurance.

The above examples show risk transfer as one tool amongst others, embedded within an overall flood risk management policy, but without any obvious consideration on how to utilize insurance for physical risk reduction. This 'operational risk reduction' link is evident in five insurance schemes (18.5 % of total):

Table 1

Scheme	Operational risk reduction element	Who is insured ?	Evidence of risk reduction?
Peru's Flood Index (ENSO) insurance (#123**)**	Risk awareness raising and capacity-building amongst farmers: the scheme offers technical advice. Use of insurance pay-out for preventive measures.	Local farmers	Clearage of draining systems
Philippines' Agricultural insurance scheme in the (#48)	Risk based pricing: Farmers pay a variable rate according to the risk zone.	Local farmers	-
Costa Rica's agricultural insurance scheme (#64)	Risk based pricing: Rates vary depending on the region, type of plantation. Protection measures and contingency plans implemented by the insured is reflected in premiums, deductibles, and indemnity limits.	Local farmers	-
Venezuela's agricultural insurance scheme (#76)	Risk based pricing: Rates vary depending on the crop, location, and coverage level.	Local farmers	-
India's National Agricultural Insurance Scheme (NAIS) and the modified NAIS (mNAIS) project (#30)	Risk based pricing: premiums consider risk mitigation measures	Local farmers	Adoption of water conservation and sustainable farming practices for better risk mitigation.

Table 2: Schemes that show operational risk reduction linkage.

The most basic mechanism observed is the creation of some level of risk awareness through 'risk based pricing', where the insurance rate is reflecting the underlying risk level.
This is applied in the agricultural insurance schemes in the Philippines (#48), Costa Rica (#64) and Venezuela (#76). In these cases farmers pay a variable rate according to the risk zone, which is usually based on crop type and location. In the Costa Rica example rates also specifically take into account protection measures and contingency plans implemented by the farmer. A similar approach is taken in the National Agricultural Insurance Scheme (NAIS) and

the modified NAIS (mNAIS) project in India (#30), where the premium structure is taking into account the adoption of better water conservation and sustainable farming practices.

This price signal could be the first step in taking risk reduction measures, but it does not imply that action will be taken. In fact those at risk may not have the capacity to act because they lack tools, methods or financial means. Particularly in the case of local farmers the options to respond to this 'price signal' of insurance seem very limited. While widely being considered as a key principle of disaster insurance, risk based pricing can pose a difficult choice between effectiveness and equity or fairness, as 'competitive insurance may be a too heavy burden for the ones who live and work in vulnerable situation without any possibility of reducing their risk exposure at a reasonable cost' [24]. This challenge is evident across most flood risk transfer schemes observed and in fact it also applies to developed markets, as highlighted by the current discussions about the future of flood insurance in the UK. The affordability of insurance is a cornerstone of introducing this tool and securing sufficient demand, but rising risk levels may make this an even harder challenge. In most cases this challenge is being addressed through government premium subsidies.

One scheme, Peru's Flood Index (ENSO) insurance (#123**)**, shows a commitment to risk awareness-raising and capacity building initiatives. In this example the educational efforts focus on helping the insured to understand how to mitigate risks through practical actions in their local community. A particular result has been new efforts by the farmers' associations in remote regions of Piura to clear drainage systems, funded by the pre-event pay-out of the ENSO insurance scheme. The basis for this linkage is an innovative concept of forecast insurance. This is an index-based insurance instrument (the pay-out trigger is not a loss, but a climatic event) linked to a forecast of imminent loss from El-Nino related flooding in Peru. This type of contingent insurance pays out on the basis of a seasonal forecast, giving policyholder the opportunity to use the pay-out for preventive measures, such as the purchase of drainage cleaning machinery or to improve transport infrastructure or adjust cash flows in anticipation of likely income reduction. The idea is that a well-prepared farmer, who takes preventive risk reduction steps could benefit from insurance pay-outs and from reduced crop losses [27].

While the ability to undertake risk reduction may be limited at individual or farmer level, there could be scope to tie in government efforts. This is particularly relevant for sovereign insurance schemes, which insure governments against fiscal shortfalls arising from disasters, government funded pools. The Compendium does not indicate specific risk reduction linkages for those schemes. This could be due to a data gap, or lack of reporting, and would need further investigation particularly as the risk of moral hazard from governments seems high if not addressed within the insurance scheme.

The Compendium does also not provide evidence of any compulsory links between flood risk transfer and risk reduction (i.e. provision of risk transfer contingent upon the adoption of specific risk reduction measures). This is being applied in some non-flood agricultural schemes, such as the CropCredit Insurance Guarantee Program for Small and Marginal Farmers (SEAF) in Brazil, where the farmer must commit to applying risk reduction methods and technology in order for the risk transfer to be valid. A similar approach is taken by the agricultural insurance scheme in Sudan, where farmers are also required to adopt more resilient farming practices

to gain access to the risk transfer scheme.

While our findings clearly point to a current gap in the linkage of risk reduction, we need to be careful not to promote the handful of case studies as best practice. Most of the schemes listed are relatively recent, often in the form of pilots, applied to specific local areas. This makes general conclusions about their effectiveness very difficult.

Finally, there is a word of caution: Reflecting on these findings one needs to be aware of a semantic challenge to the analysis of links between risk transfer and risk reduction: stakeholders do not always speak the same language and may use terms such as loss prevention, risk engineering, risk reduction, vulnerability reduction and climate adaptation, all in the same context. Without going into greater detail about the different concepts and definitions used, it is important to highlight that relevant activities may not be considered under the headings of risk reduction or adaptation.

5. Discussion

Assessing the exact contribution of flood insurance to increased resilience remains a challenge, particularly as most of the schemes in operation are still very young, only running for a few years and may not yet have been tested by big pay out events. Some studies are exploring this, for example in the context of microinsurance, where the effectiveness of insurance schemes have been investigated by Biener and Eling [43]through a data envelopment analysis of several indicators based on financial strength, underwriting success and a social function of the organisations involved. Risk reduction is not specifically considered –this would be an interesting area for further research.

Comparing those insurance schemes with risk reduction against those without would offer another way to detect any risk reduction signals. This would require an assessment in the context of the broader effectiveness of flood insurance, including economic cost-benefit analysis, as well as the recognition of the different stakeholder objectives such as vulnerability reduction, commercial viability, and affordability.

A full investigation of this topic would require two things: an analysis over time (some of these schemes have only been in operation for a short period); and detailed research on the ground to establish and verify the extent of action.

Lack of risk data is posing a general challenge to flood insurance in developing countries, particularly for the application of risk based pricing, as this relies on adequate risk modelling and exposure information [44]. Data in developing countries is often scarce and unreliable [27], with observation networks and data infrastructure often in need of modernization and upgrading [45]. This applies to both flood hazard data, but also the information on exposure and vulnerability. Government asset databases or sectoral disaster loss data is not available in all countries, or it may be very limited in scope [46]. The availability of current and historical hazard data and risk models can also be a limitation to the development and scaling up of

schemes - as reported in the case of the index weather crop insurance in Mexico (#110).

But even if data would be accessible and available there are some other barriers in place that make the implementation of physical risk reduction through insurance a challenge [10]: most schemes are heavily reliant on government subsidies and donor support; there is a lack of local distribution channels; overall local communities show limited demand for flood risk cover and lack of financial literacy. Other factors likely to influence the level of integration between risk reduction and risk transfer are: institutional capacity, weak regulatory systems and insufficient understanding of the instruments amongst stakeholders. More work to identify these is required. Unless this is explored in greater detail there is a clear danger of missing an opportunity here: new risk transfer schemes might come out that do not provide linkages to risk reduction – or, even worse, provide negative incentives.

Peru's ENSO scheme has been designed to overcome at least some of these issues and it will be interesting to see how it develops over time. It is also promising to see that most of the proposed schemes featured in the Compendium, which have not been part of our analysis, show signs of capturing the challenges of linking risk reduction and risk transfer. For example, the Munich Climate Insurance Initiative (MCII) is proposing a closer link between insurance and disaster risk reduction through building incentive structures and considering risk reduction activities as prerequisites for participation in climate risk insurance programmes [47].

Another example is the South East Europe and Caucasus Catastrophe Risk Insurance Facility (SEEC CRIF), which is supported by the Worldbank and aims at improving technical knowledge and expertise in dealing with climate risks, while offering risk-based priced catastrophe and weather risk cover [48].

The discussion of these aspects is likely to get greater recognition. Assisting developing countries in their efforts to become more resilient to extreme weather events is now an established part of the international climate negotiations under the UNFCCC. The Cancùn Adaptation Framework, an outcome of the 16th session of the Conference of Parties to the UNFCCC in 2010, highlights the need to strengthen international cooperation and expertise to understand and reduce loss and damage associated with the adverse effects of climate change and a new work programme on 'Loss and Damage' has been initiated under the UNFCCC. This considers a wide range of adaptation and risk management measures. One particular focus of this work stream is the proposal to create a climate insurance facility to provide cover against extreme weather events. In these current discussions insurance is often considered as a showcase for engaging the private sector in risk reduction and adaptation in developing countries. The key challenge is to implement this in practice by overcoming barriers, engaging stakeholders and creating a long-lasting solution. Our examples show that there is scope and potential, but more work is needed to understand the risk reduction effectiveness of risk transfer. Most fundamentally it is essential for all stakeholders to understand that insurance removes or reduces the risk of experiencing an uncertain financial loss. Any further risk reduction achievements need to be built into the risk transfer structure.

This is not just an important question for flood insurance in developing countries – it is also very relevant in more established markets. The availability and affordability of flood insurance

can become a highly political issue, often after an event has occurred, during the recovery process, when effectiveness, costs and future availability of cover come under public scrutiny. At the same time, insurance providers also revisit their flood insurance offerings, mainly driven by regulatory requirements on their solvency arrangement. Current discussions in Australia in the wake of the Queensland floods in 2011 and on-going debates at EU level sparked by the in-homogenous different of insurance cover available across the EU illustrate this [49]. In the UK, the existing private market solution, based on a 'Statement of Principles' between Government and insurance industry, is expiring in 2013 – with the design and scope of a new insurance scheme still under discussion [50, 51]. The National Flood Insurance Programme in the US has also been subject to intense political debate, revisions and restructuring over its lifetime. Growing risk and exposure levels, public finance constraint, the public perception of flood risk, and trust in insurance all play part in defining the national settings of flood insurance schemes. Making flood insurance work in developing countries may even offer some useful guidance for those long-existing schemes that are struggling with rising risk levels.

For the private insurers this may prove a valuable knowledge exchange, as they tend to operate across countries. Commercial viability of flood insurance is clearly an issue - and this has so far also hampered the development of higher resolution risk models and tools that could assist risk based pricing and risk reduction efforts.

6. Conclusions

Managing flood risk now and in the future is an imperative, particularly in low-and middle income countries, where recent development gains are under threat from the impacts of flooding. Against this backdrop flood risk transfer is receiving growing recognition amongst policy makers as one way to address these challenges. In this paper we have investigated the current status of flood insurance in developing countries and we have asked if there is any evidence of linkages between flood insurance and physical risk reduction in the schemes currently in operation.

Our analysis shows that the full potential for utilizing risk transfer for risk reduction is far from exhausted. In fact only very few schemes show a direct operational link or an indirect association between risk transfer and risk reduction, and where identified, the evidence for success and effectiveness is extremely limited. This is a main challenge and an area that will require further work to establish how behaviour, compliance and capacity at the insured level influence risk reduction.

We also establish that there are only very few property flood insurance schemes in operation in developing countries. They are significantly outweighed by agricultural insurance schemes. As outlined in our analysis, the potential for risk reduction undertaken by farmers in crop insurance schemes appears relatively low and may be much larger for property insurance. A look at more established insurance markets, such as the UK or the US , shows that evidence of

successful risk reduction incentivization through property insurance is also limited. Measurement of the risk reduction potentially achieved through the risk transfer schemes creates several challenges: success or failure often only become evident after another loss event, and it requires in-depth data collection on the ground. Such an assessment needs to be done over time, which is a clear challenge as most of the schemes are still relatively young or at a pilot stage. Surveys and on-the-ground verification activities, which would explore actual risk reduction activities, would be needed to assess this over time. Quantifying and verifying any increased climate resilience does require extensive data collection on the ground and sophisticated modelling. Monitoring the compliance with and implementation of risk reduction activities is necessary, but this can be very costly. New technologies such as remote sensing may help overcome some of the practical challenges. Given the variety of schemes and the range of risk reduction support measures, a case by case analysis appears to be the only valid approach to quantifying a scheme's actual contribution to adaptation and disaster risk reduction.

Above all, our findings underline how important a valid evidence base is. Exploring this further, particularly in the context of how best to evaluate the effectiveness of risk reduction efforts linked to insurance, could provide useful input for scholars as well as practitioners.

In conclusion, we recommend that the risk reduction dimension of flood insurance receives more attention in the design and implementation phase of new and existing schemes. This needs to be supported by further research into the effectiveness of risk reduction linkages – something that is still missing at this stage.

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Appendix

1. **List of the 27 flood risk transfer schemes in the Compendium of** Disaster Risk Transfer Initiatives in the Developing World

SCHEME ID #	SCHEME	TYPE OF SCHEME
8	Flood index crop insurance in Vietnam	Agricultural insurance (index-based)
9	Yield index crop insurance in Vietnam	Agricultural insurance (index-based)
17	Yield index crop insurance for cotton farmers in Peru	Agricultural insurance (index-based)
30	National Agricultural Insurance Scheme (NAIS) and the modified NAIS (mNAIS) project in India	Agricultural insurance (index-based)
48	Agricultural insurance in Philippines	Agriculture insurance (indemnity-based)

49	Subsidized agricultural insurance scheme in China (Beijing)	Agriculture insurance (indemnity-based)
50	Agricultural insurance in Bulgaria	Agriculture insurance (indemnity-based)
51	National agricultural insurance in Kazakhstan	Agriculture insurance (indemnity-based)
62	Subsidized agricultural insurance in Chile	Agriculture insurance (indemnity-based)
64	Agricultural insurance in Costa Rica	Agriculture insurance (indemnity-based)
65	Subsidized crop insurance in Dominican Republic	Agriculture insurance (index-based)
67	Agricultural insurance in El Salvador	Agriculture insurance (indemnity-based)
68	Agricultural insurance in Guatemala	Agriculture insurance (indemnity-based)
69	Agricultural insurance in Honduras	Agriculture insurance (indemnity-based)
72	Agricultural insurance in Panama	Agriculture insurance (indemnity-based)
74	Subsidized agricultural insurance in Peru (Agro Protege scheme)	Agriculture insurance (indemnity-based)
76	Agricultural insurance in Venezuela	Agriculture insurance (indemnity-based)
77	Catastrophe Aggregate Yield Shortfall Cover for Rural Communities in Peru	Agriculture insurance (indemnity-based)
80	Livestock insurance and crop pilot insurance programs in Nepal	Agriculture insurance (indemnity-based)
84	Agricultural insurance in China	Agriculture insurance (indemnity and index-based)

87	Index flood insurance in Indonesia	Disaster micro-insurance
90	Afat Vimo disaster micro-Insurance program in India	Disaster micro-insurance
98	Disaster Preparedness Program in India (Andhra Pradesh)	Disaster micro-insurance
103	Romanian Catastrophe Insurance Pool (PAID)	Property Catastrophe Risk Insurance Pool
105	Algerian Catastrophe Insurance Pool (ACIP)	Property Catastrophe Risk Insurance Pool
110	Index weather crop insurance in Mexico/ PACC (Programa de Atención a Contingencias Climatológicas)	Sovereign Disaster Risk Financing & Agricultural insurance (index-based)
123	Flood Index (ENSO) insurance in Peru	Business Interruption Insurance

Table A1: List of the 27 flood risk transfer schemes in the Compendium of Disaster Risk Transfer Initiatives in the Developing World

2. **Information sources used in the Compendium of** Disaster Risk Transfer Initiatives in the Developing World **– as per** http://www.climatewise.org.uk/climatewise-compendium

Information sources are primary (dedicated scheme websites, risk transfer web portals and information provided by specific insurers) and secondary (public sector and private sector reports, as well as reports by international research organizations and partnerships).