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The roles of public and private actors in the governance of adaptation: the case of agricultural insurance in India

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Abstract

Climate change adaptation is an increasingly important field and will involve a range of actors from national governments to private companies, communities and households. There is a growing policy discourse supporting the involvement of the private sector in adaptation, however there is little empirical examination to show how the sector might be involved and how adaptation might be governed. This paper uses evidence from the field of risk governance and insurance and analytical frameworks from the wider governance literature to draw important findings for the governance of adaptation. We use the recently published Compendium of Disaster Risk Initiatives in the Developing World and a case study of agricultural insurance in India to argue that the role of the private sector is increasing but so far within a particular model of engagement. In the context of climate change, how the public-private relationships are constructed is key to how adaptation can be leveraged from such an arrangement. The evidence in this paper suggests that due to commercial viability and other concerns there will continue to be a role for the public sector alongside the private sector to ensure adaptation measures address vulnerability. In conclusion we argue that the type of relationship between the public and the private actors has a significant influence on the adaptation outcomes. The question is not purely about involving the private sector which is how this is currently framed within policy and academic work on adaptation, but *how* the private actors are engaged. . Governments seeking to engage private actors need to build those relationships with the desired adaptation outcomes in mind.

1. Introduction

Climate change adaptation is now an accepted part of climate policy along with mitigation, and the engagement of the private sector in adaptation has become a growing policy paradigm. Unlike the rhetoric of climate change mitigation, which is highly centralised and government-driven, it is known that the governance of adaptation will be more decentralised and much will take place beyond the official 'adaptation decisions' of the nation-state or the UNFCCC (Agrawala and Fankhauser, 2008). Decisions will be taken by a variety of private actors from individuals to households and firms that will impact on societal exposure to risk. Despite the widespread acknowledgement of the diversity of

governance arrangements that will be needed in adaptation, there has so far been little empirical examination of the emerging role of the private sector in the area.

To address this gap, this paper borrows evidence from a related field: we ask how the roles of the public and private sector have changed over time in the governance of natural disasters and insurance and what we can learn from this for climate change adaptation. This field shares common goals with climate adaptation, such as reducing vulnerability and increasing resilience to extreme weatherGovernance of natural hazards risk has a long history and involves a similar mix of public and private players. We therefore take the example of an industry that has been involved in this area for several decades, the insurance industry, to explore what can be learned for climate change adaptation from this example. 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. In this paper, we review the current governance literature on adaptation and from this suggest two strategies for addressing our research question: using insights from natural hazard governance and insurance, and adopting analytical frameworks from the broader governance literature. We then go on to outline our methods and findings using the example of one type of insurance (crop) in one country (India). Finally, in the analysis and conclusions we explore how the relationships between public and private actors have changed over time and what this adds to an understanding of the governance of climate adaptation.

2. The governance of adaptation and risk

Theories of governance have been applied to global climate politics in an attempt to explain the multiple new relationships and modes of governing that were emerging around this issue. As noted by many of the governance scholars, arrangements are rarely composed of just one type of actor and public-private or hybrid partnerships have been emerging as an important area of future research in climate governance, creating "new niches in the multilateral system" (Andonova and Mitchell, 2010; Backstrand et al., 2010). Whilst these arguments are increasingly well rehearsed in the context of mitigation (see for example Backstrand, 2008), there are still significant gaps in our understanding of adaptation governance.

2.1 Governance of adaptation

The governance of adaptation is fundamentally different to the challenges of the governance of mitigation. Firstly, adaptation policies do not require collective action and therefore are not reliant on national government agreements and international frameworks (apart from the need for extra financing). Secondly, local adaptation can potentially make a significant difference to household and community outcomes whereas a small quantity of

mitigation will not have local or global effects. Therefore, since its inception adaptation has involved a wide range of actors and processes including individuals and households, communities, firms and governments. Adaptation can be both reactive to an unexpected hazard or planned in preparation for a hazard or changing environment and again this may involve a different range of actors. The role of governments in adaptation planning is to provide political leadership, provide and protect public goods such as research, infrastructure and cultural sites, and provide support for local adaptation infrastructure (Fankhauser and Fisher, forthcoming). Communities, households and individuals all have a role to play in adaptation measures, as do local governments. Governments and other actors help to create the enabling structures around households and communities that structure local adaptation choices. As adaptation involves a much wider range of actors than simply the national government it also involves more diffuse modes of governing and authority. As well as policy programmes and state authority actors need to use softer modes of governing such as information dissemination or using best practice examples to set social and cultural norms. Determining which actors at which scales should engage in adaptive action is a significant question for the future (Adger et al., 2005). The assessment of governance in the context of climate change adaptation is a relatively new area, and there are still some significant gaps in analysis.

Firstly, despite a normative international policy position supporting their involvement very little is known about the potential role of the private sector in adaptation governance (Agrawala et al., 2011; Agrawala and Fankhauser, 2008; PWC, 2010). Initial research in this area has focused on identifying and classifying the different actors currently involved (see Agrawala et al., 2011; Berrang-Ford et al., 2011; PWC, 2010; Tompkins et al., 2010) or analysing the theoretical roles for different actors (Agrawala and Fankhauser, 2008). This is partly due to a scarcity of examples, most of the adaptation measures in developed countries have been proactive measures taken by government at national, regional or local level (Berrang-Ford et al., 2011; Tompkins et al., 2010). In least developed countries governments have been responsible for developing the National Adaptation Plans (NAPAs) and are the main receivers of climate finance directed from the UNFCCC and other adaptation funds. However, there is an increasing focus on the potential role of organisations in the private sector as implementers of climate change adaptation policies within the climate policy discourse. The Nairobi work programme of the UNFCCC on private sector engagement stresses “the unique expertise of the private sector, its capacity to innovate and produce new technologies for adaptation, and its financial leverage can form an important part of the multi-sectoral partnership that is required between governmental, private and non-governmental actors” (UNFCCC, 2012). The private sector will have a role to play in the adaptation of climate change both through managing their own exposure to risks and using the opportunity of opening markets for adaptation projects and products.

Secondly, there has been an emergence of conceptual frameworks put forward to understand what is good adaptation (Adger et al., 2005; Tompkins et al., 2010), what

underlying factors support adaptation (Jones et al., 2010; WRI, 2010), and how to evaluate adaptation measures (Brooks et al., 2011; PPCRWorkingGroup, 2010-11). Whilst these have provided a wealth of ways to think about adaptive capacity, vulnerability and resilience this has not provided many conceptual frameworks to consider the *governance* of adaptation. We suggest that the actors involved and how they interact is an increasingly important factor in building successful adaptation policies. Many adaptation policies or programmes contain implicit assumptions of the role of the national government and the private sector for example, but these are rarely explicitly justified or explained and research on adaptation has not yet provided conceptual frameworks to consider the governance structures within the field. In this paper we seek to address these gaps by underpinning our work with empirical evidence from the field of risk governance and applying existing analytical tools for assessing public-private roles from the wider sphere of governance. These tools offer a new perspective on adaptation governance that contributes to a development in the field.

2.2 Governance of risk: the example of insurance

In our search for empirical evidence and historical context we turn to the area of natural disaster governance and insurance. Emerging from the field of risk governance, research in this area explores the management of natural hazards and disasters by public and private actors at local, national and multi-national levels (see Kuhlicke et al. 2011; Ahrens and Rudolph 2006). The most notable recent effort to draw out the synergies between adaptation and natural disaster risk reduction is the IPCC's Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (Field et al., 2012), which brought together experts in both fields. The report notes the small but increasingly important role the private sector is playing in disaster risk reduction but highlights the uncertainty of this under future climatic conditions and the need for "innovative private-public sector partnerships … to better estimate and price risk as well as to develop robust insurance related products" (p347). Drawing on this work, we identify two areas significant to an analysis of the governance of adaptation. These are: the range of relationships between public and private actors and the varying roles for each, as well as the importance of risk transfer and risk reduction in adaptation risk responses.

The empirical evidence of natural hazard governance is relatively rich, with some examples such as building of dykes dating back far into human history. Walker et al. (2010) explore natural hazard governance in Europe and conclude that governance of natural disasters has seen similar shifts to governance overall: more engagement of multiple actors, networks and partnerships, the appearance of multilevel governance and shifts of responsibility away from the state. But they also point out that the approaches to natural hazard governance vary significantly across countries. Insurance, as a sector with a history of involvement in natural disaster risk management, is often referenced by the literature to illustrate the multi-actor nature of this area and to explore the roles of these different actors, and in particular, the private sector (Walker et.al 2010).

But the application of insurance to manage the impacts of natural disasters is unevenly applied across the world, with the extent and scope of risk transfer varying from country to country. In general terms the penetration of insurance cover is mainly determined by income levels – with insurance in most low-income and middle-income countries still in its infancy. Insurance risk transfer can take many different forms and shapes, ranging from micro-insurance to sovereign disaster risk pools, with various degrees of public and private engagement. The technical aspects of these different types and their economic effectiveness have been explored in the literature (see Cummins and Mahul 2009) and there are suggestions that some of the schemes are more suited for private sector engagement than others (see for example Paudel 2012). While this is an important aspect when investigating public and private roles, a detailed analysis of this is beyond the scope of this paper. The key point to draw from this is the fact that public and private actors are engaged in natural disaster governance and insurance in a wide range of forms.

Considering natural disaster governance and insurance in the context of climate change brings up another important issue: the question of insurability. Some experts warn that risks might become uninsurable in the future (see Charpentier 2008; Herweijer et al. 2009), others argue that there are some clear opportunities for the insurance sector to develop new products (Mills 2009). One key aspect emerging in this context is the importance of linking risk transfer to risk reduction, which could be seen as an effort to address the insurability challenge of rising risk levels (Ward et al. 2008). Fundamentally, insurance removes or reduces the risk of experiencing an uncertain financial loss, but it is widely recognised that it can also play a role in physical risk reduction and adaptation. The IPCC's SREX concludes that "risk sharing (formal insurance, micro-insurance, crop insurance) can be a tool for risk reduction and for recovering livelihoods" but also warns that it could also provide disincentives, if not correctly structured (Cutter et al. 2012, p.294/5).

Suarez and Linneroth-Bayer (2011) investigate the suitability of insurance related instruments for disaster risk reduction in vulnerable developing countries and conclude that they "can increase disaster resilience, not only as an ex post complement to pre-disaster risk reduction but also as an ex ante vehicle to promote vulnerability reduction, hazard management and disaster preparedness", while outlining a range of barriers and challenges for the successful application of insurance in developing countries. Studies on the role of insurance in supporting climate change adaptation come to a similar conclusion. While risk transfer is no magic solution for all climate risks, there is evidence that, if applied correctly, it can play a cost-effective role in a country's efforts to increase its climate resilience. (Warner et al. 2009). Surminski (2010) provides an illustration of how some insurers are engaged in adaptation activities in developed markets – with those initiatives identified ranging from raising awareness of climate risks, promoting action by Government, and supporting action of individuals through incentives, information and financial means.

Clearly the above points are not the only drivers influencing the use of insurance risk transfer for disaster governance and adaptation. There are a range of other factors, such as financial literacy, risk awareness, distribution channels, regulatory frameworks and enforcement of property rights that can all influence the development and suitability of this specific tool. An assessment of these drivers is beyond the scope of this paper (see Feyen et al.2011 and Hussels et al.2005 for reviews).

For our analysis of risk and adaptation governance the wide variety of private-public- role combinations and the broad range of different approaches to insurance and adaptation are important and demand more in-depth analysis of existing examples of insurance.

2.3 Analytical tools for analysis

To deepen our engagement with the governance of adaptation we turn to the broader field of governance analysis. Theorists have explored how governance moves across scales in theories of multi-level governance (Hooghe and Marks, 2003) as well as the implications for the role of the state and other actors (Arts et al., 2001; Dingwerth and Pattberg, 2006; Jagers and Stripple, 2003). Whilst governance theories are diverse, one of the unifying analytical points lies in the ability "to move beyond state-centric analyses to include a focus on the processes of governance, to highlight the power of non-state actors, and to identify and theorize about the changing forms and institutionalization of political authority" (Sending and Neumann 2006 p651).

We use the work of Borsel and Risse (2005) to explore the nature of the relationship between the public and the private actors in governance and combine this with an analysis of modes of governing, developed by Andonova et al. (2010), to extend the analysis to consider new forms of governance and authority beyond traditional public-private relationships. It is quite common in the literature to describe the relationship between public and private actors in the context of public private partnerships (PPP) and this is the terminology employed by Borsel and Risse. However, the connotation of PPP has become quite diffuse, ranging from well-defined private infrastructure financing schemes to more loosely connected forms of collaboration between public and private sectors. We therefore refrain from using the term PPP and adapt the Borsel and Risse framework accordingly, by using their typology to explore the details of the relationships between public and private actors whilst not labelling these as partnerships per se. Whilst Borsel and Risse describe their framework in terms of governance (see 2010) they use a particular terminology of regulation. Again, we find that in the context of insurance these terms have particular usages and to avoid confusion we use the broader term of 'governance' where they use 'regulation'. Borsel and Risse (2005) provide a typology of these relationships ranging from "private self-governance in the shadow of hierarchy", to "delegation to private actors", to "co-governance of public and private actors" and "consultation and co-option of private actors". We also consider in this context that as well as the "shadow of hierarchy" there is also the "shadow of opportunity" that can motivate private actors to self-govern in order to

ready themselves for new market opportunities. This is particularly true in the context of climate change. Either side of these mixed arrangements are public governance and private self-governance. We summarise each category in the table below.

Table 1: Borsel and Risse (2005) amended typology of public-private relationships

Increasing autonomy of private actors ⟷ Increasing autonomy of public actors					
Private self-governance	*Private self-governance in the shadow of hierarchy (or opportunity)*	*Delegation to private actors.*	*Co-governance of public and private actors*	*Consultation and co-option of private actors*	*Public governance*
No public involvement.	Private actors fearing punitive legislation act to self-regulate. Could also apply in case of anticipating new business opportunities.	Delegation of specific functions such as outsourcing of public services. Involves varying levels of autonomy.	Joint decision-making over an issue.	Using expertise of private sector.	No private involvement.

This paper also applies the analytical framework of Andonova et al (2009) to analyse how actors might govern (defined as "steering towards public goals") without state authority. The framework was developed to explore transnational governance through non-state actors in climate change. Whilst some of the risk governance discussed in this paper is national, as will be shown later there are transnational elements and the framework helps elucidate the modes of governing between non-state actors even within a nation-state. Andonova et al. (2009) identify three core governance functions that help understand how steering takes place, these are: information sharing; capacity building and implementation; and rule-setting. We now turn to the empirical findings of the paper, before going on to analyse the significance of these findings for the literature on adaptation.

3. The Compendium of Disaster Risk Transfer Initiatives and a case study analysis of crop insurance in India

To analyse the role of the private sector in the governance of adaptation we use the *Compendium of Disaster Risk Transfer Initiatives in the Developing World (ClimateWise 2011)* and a case study of agricultural insurance schemes in India from the 1970s to 2012.

Most of the schemes in developing countries are relatively new and still being tested as pilot projects and estimating the resilience and sustainability of these schemes is very difficult. The Compendium offers an original analysis of the breadth of the sector whilst India's agricultural crop insurance as one of the longest-running schemes in operation for weather and climate risks offers an in-depth angle to explore the role of private actors over time. Schemes have been in operation in some form since the 1970s, and currently covering over 25 million farmers. Since 2007 they are being provided by a mix of public-and private players. The data collection and analysis has been done in four parts. Firstly, we used the Compendium to analyse the broader roles of public and private actors in insurance schemes in low and middle-income countries. Secondly, we conducted a review of policy documents and secondary literature about the crop insurance schemes in India analysing the role of different actors over time and the potential for adaptation. This was supplemented with an analysis of India's climate policies and the role of insurance and the private sector in such policies. Thirdly, we conducted stakeholder interviews between November 2011 and February 2012 with key actors in the public and private companies currently involved in delivering agricultural crop insurance schemes. Interviewees were selected as being in a senior role managing the agricultural insurance portfolio of the company. Questions were asked about the company involvement with the sector, relationships between the private and the public insurers, the challenges and barriers, and the changing risks associated with climate change. This included a representative from the AIC and private insurers providing the WBCIS and mNAIS as well as their own private schemes[1]. Lastly, we analysed the climate policies and policy signals around insurance and climate change in the Indian context.

3.1 *The Compendium: linking risk transfer and risk reduction*

The *Compendium of Disaster Risk Transfer Initiatives in the Developing Worl, recently published by ClimateWise,* offers a snapshot of current risk transfer activities in low- and middle-income countries. The Compendium documents 123 existing initiatives in middle-income and lower-income countries that involve the transfer of financial risk associated with the occurrence of natural hazards. This presents a diverse picture, with schemes often created to meet very specific needs in a particular community, with a wide range of stakeholders being involved, and differing levels of risk transfer being provided. The Compendium offers an opportunity to explore the extent to which risk transfer and risk reduction/adaptation are linked, a crucial factor in determining whether insurance and the private sector can play a role in not just transferring risk but also reducing it. In an analysis of the Compendium, Surminski and Oramas–Dorta (2011) show that the full potential for utilizing risk transfer for adaptation is far from exhausted: very few schemes show a direct operational link between risk transfer and risk reduction, and only one to have explicitly

[1] Interviewees were from the following companies: AIC, ICICI Lombard, IDFCC-Tokyo, HDFC Ergo and brokers, BASIX and Microensure.

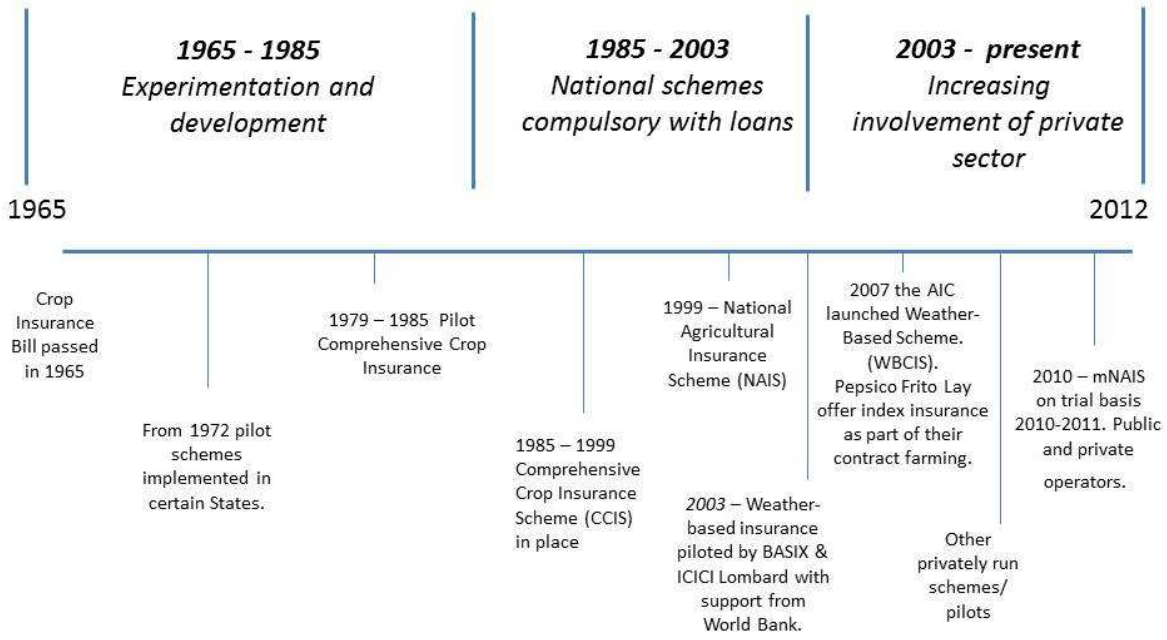
taken into account the impact of climate change on risk levels. The Compendium also documents the relative roles of the public and private sector. For those schemes where a direct link between risk transfer and risk reduction is recorded, the authors notice that the public sector plays a larger role than in those schemes without risk reduction linkage: in these cases the public is involved in the provision of risk transfer (55%), which compares to the 40% based on the whole Compendium (Surminski and Oramas-Dorta 2011). Insurance risk transfer comes in a variety of forms and shapes. The Compendium highlights the range of different roles that public, private and third sector actors play in the provision of risk transfer. Beyond the core underwriting function, which is being done by private sector in 89% of cases, there are a wide range of support functions for the implementation and operation of these risk transfer schemes, such as funding of technical assistance projects, financing of scheme feasibility studies, education and capacity building or development of data infrastructure, (Surminski and Oramas-Dorta 2011) which appear to be receiving public funding in 68% of all cases in the Compendium.

The evidence from the Compendium shows that the role of the private sector is growing but the relationship between risk transfer and risk reduction is often linked with the involvement of the public sector, as are a wide range of support functions. This evidence suggests that the governance of risk in the context of adaptation, may not be purely about a public or private actor but a combination or actors working in different forms of governance.

3.2 The case study: Agricultural insurance in India

Two thirds of the Indian population is dependent on agriculture as their main source of livelihood with 70% of the farming community described as small and marginal farmers. This explains why agriculture risk management including crop insurance has received relatively high political attention and support. In the future, the risk of climate change could become another driver impacting the system. Insurance schemes were introduced in India during the colonial period by the British Government as part of the social protection for colonial officials. After independence in 1947, the life insurance industry was nationalised but in the 1990s as part of a wider set of liberalisation and financial reforms, private insurance companies were again allowed to operate in India. Today there are 24 general insurance companies and 23 life insurance companies operating in the country (IRDA, 2012). This trend in general insurance has also influenced the development of agricultural insurance in India. A timeline of the developments of agricultural insurance in India is shown below (more detail is included in Appendix 1).

Figure 1: Timeline of India's crop insurance schemes



After a period of experimentation and development from 1965 – 1985, the first national compulsory schemes for farmers taking loans where introduced in 1985 and run till 2003, when a major revision of the insurance approach to crop risks took place. The main public schemes running today are the National Agricultural Scheme (NAIS) the modified NAIS, and Weather-Based Crop Insurance Scheme (WBCIS). The NAIS is the largest crop insurance scheme in the world with 25 million farmers insured (Mahul et al. 2012). However, it has not been without its critics. Several authors suggest the government scheme has very long claim times, is not trusted amongst farmers who have not seen payouts and pays out disproportionately to certain States such as Gujarat (Mahul and Verma, 2010; Manuamorn, 2007; Veron and Majumdar, 2011). It also exposes the government to an open-ended liability due to the ex-post funding arrangement and variable annual contributions that are difficult to predict in advance of the harvest. Recognising the challenges with the existing national scheme, the Ministries for Finance and Agriculture and the AIC formed a joint task-force to address the shortcomings and extend coverage. The report released in 2004 suggested a review of the underwriting methodology, an actuarially sound methodology and pricing methodology acting as the basis for a move to ex-ante funded, market-based crop insurance and cost-effective catastrophe risk financing solutions for the public crop insurance company. The World Bank has been working with the Government of India (GoI) to develop an actuarially sound scheme and has helped develop a modified form of the NAIS.

The timeline shows that since 2003 private insurance companies have played an increasing role in the agricultural insurance market, this is shortly after the insurance sector re-opened to private companies. Two publicly run schemes (the WBCIS and the mNAIS) have for the first time opened up to private operators who can bid to the State governments to run the schemes in different districts. As well as participation of the private sector in publicly run

schemes, private insurers also produce their own agricultural insurance products. Weather-based index insurance for example was first piloted by ICICI Lombard and the NGO, BASIX. A form of weather insurance was then proposed in 2007 as a national government scheme that States can choose instead of the NAIS or mNAIS. Other companies have also developed their own products. For example, IFFCO Tokyo has a weather-index product *Barish Bima Yojana*. This sold 1200 policies across 7 States in the financial year 2011-12. The problem with these however is they do not attract government subsidy and so the premiums are much higher than government ones. In some cases the insurance may be subsidised by a company as in case of Pepsico Frito-Lay potato farmers. Pepsico uses contract framing to source potatoes from India. As part of this farmers can purchase index insurance and are incentivised to do so buy a slight increase in payment from Pepsico if they do so. The insurance produce is offered by ICICI Lombard. Farmers taking loans must take insurance. 95% of Pepsico farmers choose to buy index insurance, this is an extremely high percentage given national uptake of agricultural insurance in general.

There are several different functions that public and private actors can offer. Since 2003 the private sector has played a role in underwriting the risk, developing new products and gathering technical information and skills (such as weather data and developing indices). The overall rule-setting in terms of insurance law and regulation remains with governments (State and national) and applies to all schemes, but with different degrees of private autonomy and public involvement. The decision over entrance to the market rests to a large degree with government, in the form of insurance regulation. At the same time, there is also the decision by the private insurer to apply for a licence and enter a market. This highlights the relevance of commercial viability – which governs the private sector's decision making. Beyond the entrance to the market the most important criteria is the rules and standards that govern products and operative issues. As crop insurance in India shows, there exist a wide variety of arrangements. There appears to be a trend towards more actuarial pricing, rather than a flat premium structure. This would signal an important change in the risk governance approach, by attaching a price that signals risk levels.

3.3 Challenges and barriers to private sector involvement

A number of barriers to private sector involvement were identified by stakeholders. Several of these echo the findings of literature elsewhere on challenges to this field including limited demand, difficulty in distributing products and uncertainties in index products such as weather. Of particular interest to this paper however, is how these barriers might constrain adaptation.

Firstly, the relationship with multiple tiers of government was complex and acted as barrier in some cases. The private insurers had to negotiate with the various State governments in gaining access to new markets due to licencing arrangements and overall insurance regulation and a lack of transparency over the political and regulatory decision-making

process was perceived as another barrier to further market and product development. One stakeholder talked about the inertia of the State to implement new schemes and prejudices against private companies. He also commented on the lack of technical expertise within State governments that constrained approval and acceptance of technical innovation of the products. Stakeholders commented that it was difficult to incorporate risk reduction measures due to the requirements and restrictions of the tendering process. This point was emphasised by other providers (including the AIC), arguing that despite the large amounts of public funds being spent on scheme subsidies there was very little public capacity to allow product differentiation or to evaluate the effectiveness of the schemes.

Limited demand for insurance solutions was a widespread concern amongst stakeholders. This well-known challenge, which is common in most low-income and emerging economies, is impacted by a range of factors, such as affordability of cover, desirability of products and financial literacy of the farmers. The public insurance schemes try to overcome this challenge by making cover mandatory, linking it to loans and subsidizing premiums. The majority of current crop insurance products are linked to loans and so are sold in bulk to the bank or state government rather than directly to the farmer. There is therefore no insurer/farmer interface and little demand or understanding of the product. Several insurers felt that until the demand was driven by farmers there would be little incentive to improve the products or innovate to provide what the farmers really wanted. This lack of proximity between farmers and insurers almost made incorporating risk reduction methods difficult and product development is driven by the selection procedure of the State governments. On the other hand loan products are commercially attractive to the insurers as they create the needed market volume.

The opening towards the private sector has introduced a degree of competition to the crop insurance system, amongst private insurers and between public and private providers. But there are concerns about imbalance between public and private providers. A number of insurers said that the capacity to take on risks rather than the degree of competition were the biggest challenge to growing the market, and therefore competition did not act as a spur to develop and improve on products. As prices are mainly regulated by the government, there is not a competition over the price of the product. Insurers also talked about a range of technical barriers, such as lack of risk data.

In addition to these barriers it is also important to understand the motivation and drivers for the engagement of private actors. The model of a corporation like Pepsico that has had a product designed for their farmers and effectively subsidises its purchase with a higher buy-back rate relies on the advantages to the company in long-standing relationships with farmers and a high quality, high yield product. Other motivations for private sector involvement in the schemes vary from a business commitment to farmer's welfare (IFFCO-Tokyo is an alliance between the Indian Farmer's Fertilisers Cooperative and a Japanese insurance company), a long-standing interest in particular schemes (such as ICICI Lombard

working in index insurance since 2003), the need to fulfil rural quotas set by the regulator and a desire to build expertise and capacity in an area which is seen to be growing. Involvement is very new in this area in India, and it remains to be seen whether these motivations will continue to be sufficient to increase private sector involvement as envisaged in the Indian national strategy for climate change, the National Action Plan on Climate Change released in June 2008 (see Fisher 2012 for an overview of Indian climate policies).

3.4 Agricultural insurance and climate change: a changing governance picture?

Finally, we consider our findings in the context of climate change. Agricultural insurance schemes have been managing risk in India under current climatic conditions however some aspects of this risk governance may change under worsening climatic conditions. Under climate change, India is likely to experience greater variability of precipitation with less certainty over the arrival of the South-West monsoon and its duration. Agriculture is the most vulnerable sector to climate change in India. Increases in mean surface temperatures have been linked to decreased crop yields and duration in India and the latest IPCC assessment report predicts a 2.5-10% decline in crop yields in Asia in the 2020s and 5-30% decrease in the 2050s (Solomon et al., 2007). As climate change starts to introduce greater uncertainty into growing seasons and precipitation, insurance could become an important mechanism to transfer and mitigate risks. There is evidence that concerns about climate change are driving changes in policy frameworks and public regulation due to international agreements or national strategies which could affect governance structures; this could also influence the crop insurance schemes.

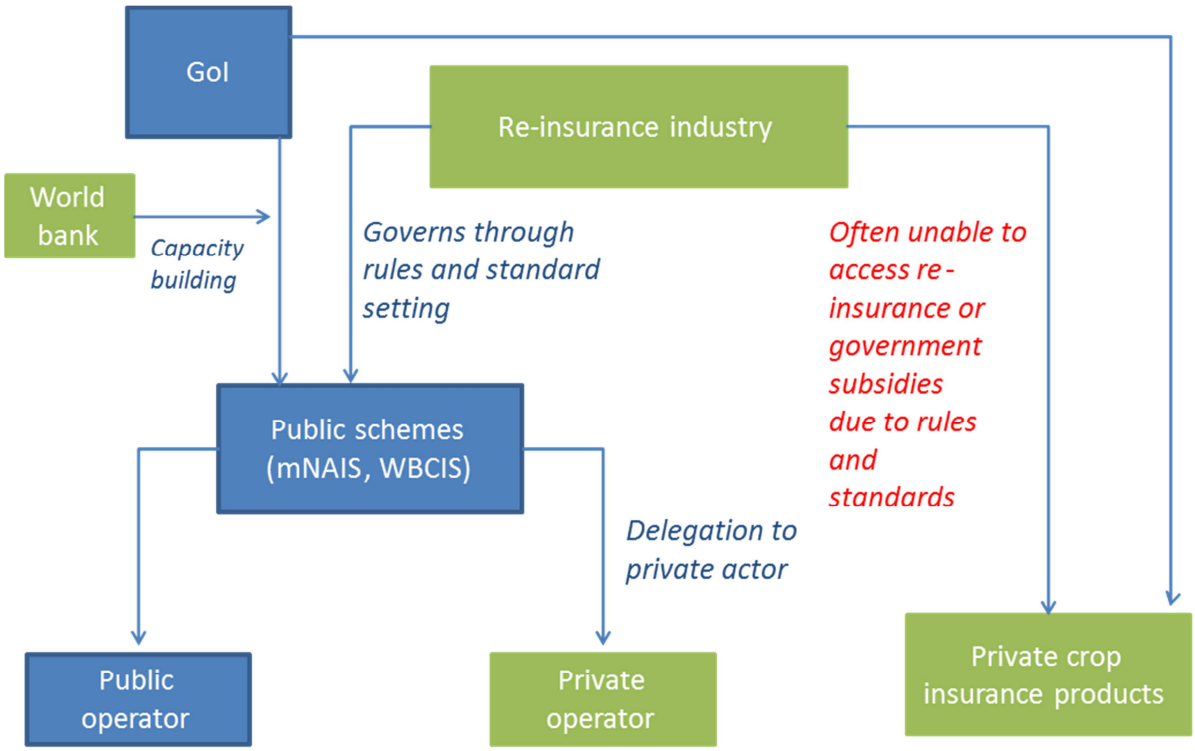
India released its National Action Plan on Climate Change (NAPCC) in June 2008 with 8 National Missions addressing mitigation and adaptation. The Mission for Sustainable Agriculture includes agricultural insurance as one of its ten interventions. Others include water efficiency, pest management and improved farming practices. The current intervention is illustrative of potential strategies and suggests a number of policies in the four areas of: research and development; technologies and practices; infrastructure and capacity building. The intervention suggests developing further insurance products and strategies to address emerging climate risks as well as extensive capacity building with farmers to increase demand and coverage of the products. Finally, the intervention also contains a commitment to the involvement of the private sector through public-private partnerships to increase aggregate insurance cover and "improve viability of the insurance schemes over time" (GoI, 2008 p49). It is clear then, that the Indian government foresees an important role for crop insurance in future adaptation strategies, and particularly the role of the private insurers. However, as noted at the beginning of the paper the model of engagement with private insurers as well as the costs and benefits to such actors of greater involvement in such schemes is left unexplored.

4. Analysis

The previous section has outlined the broad relationship between risk transfer and risk reduction in insurance schemes in low and middle-income countries, and given a detailed analysis of agricultural insurance schemes in India. We now use these findings to make two arguments important to the governance of adaptation: First, our example suggests that there is an opening of risk governance and adaptation to private actors but this is occurring within a particular model of engagement between public and private actors that has restricted the role private players can play. Secondly, in the context of climate change, how the public-private relationships are constructed is key to how adaptation can be leveraged from such an arrangement. *4.1 The increasing role of the private sector through delegation*

Firstly, we argue that there has been an increasing role for the private sector within risk governance but this has been within very particular model of engagement usually delegating services to the private sector. In line with the overall trend of deregulation and liberalisation of insurance in India the purely public schemes have been opening to private actors, in addition to the emergence of purely private schemes. Faced with growing problems in the public schemes and supported by the recognition of the importance of insurance as a risk management tool there appears to be a government commitment to expand the schemes and make them more effective. However, the relationships between public and private actors have changed over time, with different degrees of involvement and roles emerging. Figure 2 shows the main institutions of the public schemes and the private actors after 2003.

Figure 2: The changing relationships post 2003 (blue actors – public, green – private)



Beyond the national dynamics of the relationships, there are also transnational dimensions to the governance of risk in this context. Firstly, there are some multinational companies involved in the provision of crop insurance, for example in the IFFCO-Tokyo example or via reinsurance arrangements that both the public and the private actors need to gain access to if they wish to operate a large-scale scheme. Furthermore, the World Bank has been a key actor in reforming the national schemes, and as such has played a role in steering new arrangements through capacity building.

As well as the increasing role of private actors in the governance of agricultural risk, applying the above findings to the framework of Borsel and Risse (2005) shows how the public-private arrangements are emerging in particular forms in India as shown in Table 2.

Table 2: Schemes applied to Borsel and Risse framework

Increasing autonomy of private actors ⟷ Increasing autonomy of public actors					
Private self-governance within the boundaries of insurance law	*Private self-governance in the shadow of hierarchy (or opportunity)*	*Delegation to private actors.*	*Co-governance of public and private actors*	*Consultation and co-option of private actors*	*Public governance*
Pepsico NGO-schemes	BASIX/WB/ICICI Lombard pilot	mNAIS WBCIS (private actors underwrite risk, but operate within rules of the scheme set by government)			Experimental schemes CCIS NAIS

The private sector has mainly become involved through a delegation of services from the public sector, although there is also some evidence of private governance in the shadow of hierarchy/opportunity. Differentiating between delegation and private self-governance one could say that delegation might just be replicating what used to be done by the public sector before – possibly with different outcomes in terms of effectiveness and efficiency, but similar in terms of scale and scope. For private self-governance one could say that something new and additional has emerged – created by business interest (Pepsico's supply chain), but with potential implications beyond the core self-interest group (such as village or community spill over). The majority of the risk governance in this example is still a public issue. Within the current landscape of agricultural insurance in India there appears to be little scope for what has been termed "private governance" of adaptation. This is the management of climate risks through an entirely private and voluntary enterprise. The one

example of this, the Pepsico scheme, is currently very small scale but gives an indication of the kind of innovation that could result from companies protecting their own supply systems.

4.2 The role of the public-private relationships in supporting adaptation outcomes

Secondly, the empirical evidence of the Compendium and the India agriculture insurance case study suggest that the relationship between different actors and the nature of governance arrangements are important for determining the degree of adaptation and risk reduction triggered through insurance, as well as the potential for the theoretical advantages of private sector involvement. Our findings suggest the type of relationship and enabling environment created by the State is crucial for not only if, but also how, private actors can contribute to climate change adaptation. Stakeholder interviews suggest that the current model of engagement with private actors is not yet harnessing the theoretical advantages of private involvement beyond transferring financial liability (see section 3.3). Government rules and standards have created barriers to risk based pricing and product innovation. This suggests that governments need to reassess why they wish to involve the private sector. If, as widely suggested in policy discussions, it is to harness expertise and capacity as well as financial resources, then the enabling environment of the state must allow actors to develop these areas, to innovate and compete in order to deliver better adaptation measures. But one also needs to ask to what extent private actor involvement in adaptation is compatible with commercial viability. The Pepsico example tells a positive story here, but at the same time commercial viability is often stated as a key barrier to further scaling up pilot projects.

This aspect of innovation is important when considering the adaptation dimension of existing risk governance schemes. Our stakeholder interviews have highlighted further challenges and barriers for innovating insurance procedures and integrating risk reduction. Stakeholders suggest for example that they cannot currently develop better innovative products that incorporated risk mitigation as well as risk transfer or reduce the vulnerability of farmers. The highly technical nature of the product, the multi-levelled interactions with the State and the lack of transparency of product selection all form barriers to developing better products (see section 3.3). This is supported by a recent World Bank paper that also commented on the decreasing innovation in the index-scheme (Clarke et al., 2012).

The Indian example shows that some public and private insurance schemes have incorporated risk reduction measures but stakeholders suggested these were difficult to monitor, and did not play a significant role in altering farmer's behaviour. A key aspect for making insurance work in the context of adaptation is the ability to link the financial risk transfer to physical risk reduction. There is the potential for insurance to trigger behaviour change and increase resilience by putting a price on risk. So called 'risk-based pricing' can send a signal about the underlying exposure and create risk awareness as well as provide incentives for risk reduction. This principle of pricing according to risk often clashes with the

concept of maintaining affordability and increasing uptake of insurance. Subsidies and price caps can distort this signal and limit the risk reduction potential of insurance, while at the same time supporting growth of the schemes. How risk reduction can be more effectively built into private insurer schemes relates back to the question of how the relationship between the public and the private actor is constructed.

The private scheme discussed in this paper (Pepsico) incorporated several risk reduction measures, perhaps due to the motivation of the company to reduce risks to their high-quality supply chain. The Pepsico scheme requires farmers to use certain high quality seeds and gives them access to technical knowledge which may help build adaptive capacity. The mNAIS calculation of premium involves discounts to farmers with better water conservation practices and sustainable farming practices. Certain risky behaviours and crops may become un-insurable and this might encourage shifts into other sectors, although the penetration of crop insurance at the moment does not suggest it would act as a significant driver to alter farmer growing choices. If such schemes are to be used as part of adaptation to climate change measures it will be important to know how they reduce actual vulnerability compared to direct investments of a similar magnitude by the government. These considerations about linking risk transfer and risk reduction are also important in the context of ensuring future availability and affordability of insurance. The risk reduction will not only increase overall resilience, it will also help to maintain insurance as a viable option in the wake of rising future risk levels.

As well as the national policy signal that suggests there could be some change under future climate change, the wider literature on climate change governance also suggests that new transnational partnerships, international funds (such as the Adaptation Fund, PPCRs), international agreements (such as the UNFCCC's Loss and Damage proposals), and research bodies may all alter the context of adaptation governance through information, rule-setting, capacity building and implementation. It is not yet clear how these actors might affect the governance of risk in this context, but for example international adaptation funds could alter the incentives for private actors to get involved in the sector through additional funding sources for premium subsidies, transnational networks could change ideas of best practice and effectiveness for adaptation through information dissemination, and national climate policies could provide strong drivers for growth in particular products and regions.

5. Conclusions

In conclusion, this paper has argued that using evidence from risk governance and analytical frameworks from the wider governance literature it is possible to draw important findings for the governance of adaptation. Policy discourse on adaptation has tended to hold a normative stance on the role of the private sector, whilst academic research has not yet explored how the roles of public and private actors might inter-relate, focusing instead on

more simplistic divisions between either public or private actors, national governments or communities (Berrang-Ford et al., 2011; Tompkins et al., 2010) Our research brings several important findings to the governance of adaptation. In contrast to work in the field that identifies the theoretical roles of different actors (Agrawala and Fankhauser, 2008; Fankhauser and Burton, 2011) or capacities of national governments to respond (Brooks et al., 2005; Nathan L, 2011; Tol and Yohe, 2007), we argue that what is of crucial importance, is the relationships *between* such actors.

The evidence in this paper suggests that due to commercial viability and other concerns there will continue to be a role for the public sector alongside the private sector to ensure adaptation measures address vulnerability. Secondly, we argue that the question is not purely about involving the private sector which is how this is currently framed within policy and academic work on adaptation, but *how* the private actors are engaged. How can the private sector be engaged in a way that allows the innovation and flexibility needed to build adaptive responses as well as ensuring that underlying social needs are met? We have shown in this paper how the type of relationship between the public and the private actors also has a significant influence on the adaptation outcomes or potential for responses, and governments seeking to engage private actors need to build those relationships with the desired adaptation outcomes in mind.

As well as these initial conclusions, many questions remain about the role of the private sector in adaptation. One of these is how to design for adaptation effectiveness. We know from the Compendium that it is extremely challenging to assess the effectiveness of such measures in the context of climate change. Characteristics of what makes effective insurance for adaptation are still not well defined and the measurement of risk reduction has several methodological challenges (see Surminski and Oramas-Dorta 2011). Given this lack of certainty on how such initiatives contribute to risk reduction, it is extremely challenging for governments to create the terms of engagement with private sector involvement that will maximise this reduction in vulnerability. Whilst the Indian government has included crop insurance as part of its climate change plan and aims at increasing the level of including private sector involvement, without an understanding of how to make schemes work for adaptation this may not be effective. In an environment where farmers will be facing increasing, unknown risks, such protection may not be sufficient. Therefore advancing an understanding of the characteristics of effectiveness of insurance and other measures would be a significant step towards a more productive relationship between public and private actors in the context of adaptation.

These findings have broader implications than the insurance industry. Other sectors such as utilities and transportation are involved in public-private relationships which could be used for climate change adaptation. The findings of the paper suggest that such relationships need to be built with adaptation *outcomes* in mind and designed specifically for adaptation effectiveness. Specific acknowledgement of the relative strengths of the private and the

public sectors is important for commercial viability as well as allowing an adaptive response that is innovative and flexible to respond to changing risks and growing uncertainties.

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References

Adger, N., Arnell, N.W., Tompkins, E.L. (2005) Successful adaptation to climate change across scales. Global Environmental Change 15, 77-86.

Agrawala, S., Carraro, M., Kingsmill, N., Lanzi, E., Mullan, M., Prudent-Richard, G. (2011) Private Sector Engagement in Adaptation to Climate Change: Approaches to Managing Climate Risks. OECD Environment Working Papers 39.

Agrawala, S., Fankhauser, S., (2008) Economic aspects of adaptation to climate change: costs, benefits and policy instruments, in: OECD (Ed.), Paris.

Andonova, L., Mitchell, R. (2010) The Rescaling of Global Environmental Politics. Annual Review of Environmental Resources 35, 255-282.

Arts, B., Noortmann, M., Reinalda, B., (2001) Non-State Actors in International Relations, Non-State Actors in International Law, Politics and Governance. Ashgate.

Ayers, J., Dodman, D. (2010) Climate change adaptation and development I. Progress in Development Studies 10, 161-168.

Backstrand, K. (2008) Accountability of Networked Climate Governance: The rise of transnational climate partnerships. Global Environmental Politics 8, 74-102.

Backstrand, K., Khan, J., Kronsell, A., Lovbrand, E. (2010) Environmental Politics and Deliberative Democracy: Examining the promise of new modes of governance. Edward Elgar, Cheltenham.
Berrang-Ford, L., Ford, J.D., Paterson, J. (2011) Are we adapting to climate change? Global Environmental Change 21, 25-33.

Borzel, T., Risse, T., (2005) Public-Private Partnerships: effective and legitimate tools of international governance?, in: Grande, E., Pauly, L. (Eds.), Complex Sovereignty: On the Reconstitution of Political Authority in the 21st Century. University of Toronto Press, Toronto, pp. 195-216.

Brooks, N., Adger, N., (2005) Assessing and enhancing adaptive capacity., in: Lim, B., Spanger-Siegfried (Eds.), Adaptation Policy Frameworks for Climate Change: Developing Strategies, Policies and Measures. Cambridge University Press., UNDPGEF. , pp. pp 165-181.

Brooks, N., Anderson, J., Ayers, J., Burton, I., Tellam, I. (2011) Tracking adaptation and measuring development. IIED Working Paper 1.

Brooks, N., Neil Adger, W., Mick Kelly, P. (2005) The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation. Global Environmental Change 15, 151-163.

Charpentier, A. (2008) Insurability of Climate Risks, The Geneva Papers, 33, (91–109)

Clarke, D., Mahul, O., Rao, K., Verma, N., (2012) Weather based crop insurance in India, Policy Research Working Paper Series, World Bank, Washington DC.

ClimateWise (2011) Compendium of Disaster Risk Transfer Initiatives in the Developing World, available online http://www.climatewise.org.uk/climatewise-compendium/ [accessed 13.06.2012].

Cummins, J.D. and Mahul, O. (2009) Catastrophe Risk Financing in Developing Countries: principles for public intervention. The International Bank for Reconstruction and Development/ The World Bank. Washington, DC.

Cutter, S., B. Osman-Elasha, J. Campbell, S.-M. Cheong, S. McCormick, R. Pulwarty, S. Supratid, and G. Ziervogel, (2012) Managing the risks from climate extremes at the local level. In: Field, C., Barros, V., Stocker, T., Qin, D., Dokken, D., Ebi, K., Mastrandrea, M., Mach, K., Plattner, G., Allen, S., Tignor, M., and P Midgley (Eds) 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 (IPCC). Cambridge University Press, Cambridge, UK, and New York, NY, USA, 291-338

Dingwerth, K., Pattberg, P. (2006) Global governance as a perspective on world politics. Global governance 12, 185-203.

Fankhauser, S., Burton, I. (2011) Spending adaptation money wisely. Climate Policy 11, 1037-1049.
Fankhauser, S., Fisher, S., (forthcoming) Adaptation measures, in: Noguer, M. (Ed.), How to avoid dangerous climate change. Springer.

Feyen, E., Lester, R. and Rocha, R. (2011) What Drives the Development of the Insurance Sector? An Empirical Analysis Based on a Panel of Developed and Developing Countries. World Bank, Working Paper S5572.

Field, C., Barros, V., Stocker, T., Qin, D., Dokken, D., Ebi, K., Mastrandrea, M., Mach, K., Plattner, G., Allen, S., Tignor, M., and P Midgley (2012) (Eds) 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 (IPCC). Cambridge University Press, Cambridge, UK, and New York, NY, USA

Fisher, S., (2012) India and climate change: equity, energy and development, in Bailey, I., and Compston, H., Feeling the Heat: the politics of climate policy in rapidly industrialising countries Eds (Palgrave Macmillan, Basingstoke)

Füssel, H.M. (2007) Adaptation planning for climate change: concepts, assessment approaches, and key lessons. Sustainability Science 2, 265-275.

GoI, (2008) National Action Plan on Climate Change: Prime Minister's Council on Climate Change, Delhi.

Gupta, J., Termeer, C., Klostermann, J., Meijerink, S., van den Brink, M., Jong, P., Nooteboom, S., Bergsma, E. (2010) The Adaptive Capacity Wheel: a method to assess the inherent characteristics of institutions to enable the adaptive capacity of society. Environmental Science & Policy 13, 459-471.

Herweijer, C., Ranger, N.and Ward, R.E.T. (2009) Adaptation to climate change: threats and opportunities for the insurance industry, The Geneva Papers, 34, pp.360-380

Hussels, S., Ward, D. and Zurbruegg, R. (2005) Stimulating the Demand for Insurance. Risk Management and Insurance Review, 8(2), pp. 257-278.

Hooghe, L., Marks, G. (2003) Unraveling the Central State but How? Types of multilevel governance. American Political Science Review 97, 233-243.
IRDA, (2012) History of the Insurance Industry in India, http://www.irda.gov.in/ADMINCMS/cms/NormalData_Layout.aspx?page=PageNo4&mid=2 [accessed 13.06.2012].

Jagers, S., Stripple, J. (2003) Climate governance beyond the State. Global governance 9, 385-399.
Jones, L., Boyd, E. (2011) Exploring social barriers to adaptation: Insights from Western Nepal. Global Environmental Change 21, 1262-1274.

Jones, L., Ludi, E., Levine, S., (2010) Towards a characterisation of local adaptive capacity, ODI Background Notes. Overseas Development Institute, London.

Lonsdale, K., Gawith, M.J., Johnstone, K., R, S., West, C., Brown, A., (2010) Attributes of well-adapting organisations, Report prepared by UK Impacts Programme for the Adaptation Sub-Committee, London.

Mahul, O., Verma, N., (2010) Making markets work for farmers in India, in: WorldBank (Ed.), Smart Solutions, Washington DC.

Manuamorn, O., (2007) Scaling up micro-insurance: the case of weather insurance for smallholders in India, in: WorldBank (Ed.), Agriculture and Rural Development Discussion Paper 36, Washington DC.

Martin, D., Belanger, D., Gosselin, P., Brazeau, J., Furgal, C., Dery, S. (2007) Drinking water and potential threats to human health in Nunavik: Adaptation strategies under climate change conditions. Arctic 60, 195-202.

Mills, E. (2009) From Risk to Opportunity: Insurer Responses to Climate Change 2008. CERES Report. www.ceres.org.

Nathan L, E. (2011) Adaptive capacity and its assessment. Global Environmental Change 21, 647-656.

Paudel, Y. (2012) Comparative Study of Public—Private Catastrophe Insurance Systems: Lessons from Current Practices, The Geneva Papers on Risk and Insurance - Issues and Practice, Volume 37, Number 2, 257-285

PPCRWorkingGroup, (2010-11) PPCR Results Framework: Meeting of the PPCR Sub-committee. Agenda Item 6, Washington DC.

Prin, G., Rayner, S., (2007) The wrong trousers: radically rethinking climate policy, Joint Discussion Paper. James Martin Institute for Science and Civilisation, Oxford and MacKinder Centre for Study of Long-Wave events, LSE.

PWC, (2010) Business leadership on climate change adaptation: Encouraging engagement and action, in: PWC (Ed.), http://www.pwc.co.uk/sustainability-climate-change/publications/adapting-to-climate-change.jhtml.

Reid, H., Mozaharul, A., Berger, R., Cannon, T., Huq, S., Milligan, A. (2009) Community based adaptation to climate change: an overview. Participatory Learning and Action, 11-38.

Solomon, S., Qin, D., Manning, M., Chen, Z., Marquis, K., Averryt, M., Tignor, M., Miller, H., (2007) Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007. Cambridge University Press, Cambridge and New York.

Surminski, S., (2010) Adapting to the extreme weather impacts of climate change – how can the insurance industry help?, http://www.climatewise.org.uk/the-role-of-insurers-in-adapta/ [accessed 13.06.2012].

Surminski, S., Williamson, A., (forthcoming) Comparing political, regulatory and legal drivers of insurance development across countries, Centre for Climate Change Economics and Policy, Working Paper, London and Leeds.

Tol, R.S.J., Yohe, G.W. (2007) The weakest link hypothesis for adaptive capacity: An empirical test. Global Environmental Change 17, 218-227.

Tompkins, E.L., Adger, W.N., Boyd, E., Nicholson-Cole, S., Weatherhead, K., Arnell, N. (2010) Observed adaptation to climate change: UK evidence of transition to a well-adapting society. Global Environmental Change 20, 627-635.

UNFCCC, (2012) Nairobi work programme on impacts, vulnerability and adaptation to climate change http://unfccc.int/adaptation/nairobi_work_programme/items/3633.php [accessed 13.06.2012].

Veron, R., Majumdar, A. (2011) Micro-insurance through corporate-NGO partnerships in West Bengal: opportunities and constraints. Development in Practice 21.

Walker, G, Whittle, R, Medd, W and Watson, N., (2010) Risk Governance and Natural Hazards. CapHaz-Net WP2 Report, Lancaster Environment Centre, Lancaster University: Lancaster (available at: http://caphaz-net.org/outcomes-results/CapHaz-Net_WP2_Risk-Governance.pdf).

Ward, R., Herweijer, C., Patmore, N. and Muir-Wood, R., (2008) The role of insurers in promoting adaptation to the impacts of climate change, The Geneva Papers on Risk and Insurance – Issues and Practice, 33, p.133-139.

WRI, (2010) World Resources Report 2010-11: Decision-making in a changing climate. World Resources Institute, Washington.

Yohe, G., Tol, R.S.J. (2002) Indicators for social and economic coping capacity—moving toward a working definition of adaptive capacity. Global Environmental Change 12, 25-40.