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What is This?

From knowledge to action: Bridging gaps in disaster risk reduction

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Abstract
A large amount of studies have been produced on disaster-related issues over the last century of research, yet there continues to be gaps in translating knowledge into action. This paper discusses the battlefield of knowledge and action for disaster risk reduction (DRR), outlining the need for a more integrative process consisting of bottom-up and top-down actions, local and scientific knowledge, and a vast array of stakeholders. The challenges in addressing the need for an integrated process are outlined alongside a potential road map for bridging gaps in DRR. The final section addresses issues to be overcome in order to implement the aforementioned road map. Future ways to bridge gaps in DRR between bottom-up and top-down actions, and local and scientific knowledge are proposed.

I A battlefield of knowledge and action

A large number of studies have been published on disaster-related issues over the last century. Among social sciences, and particularly within geography, two major paradigms have emerged and followed different paths. On one side, the proponents of the dominant, so-called hazard paradigm, which largely drew from the behavioural geography movement, assert that disasters result from extreme and rare natural hazards, and that affected people fail to 'adjust' because their perception of risk associated to these natural events is insufficient (Burton et al., 1978; Kates, 1971). On the other hand, the more recent vulnerability paradigm, in line with the political ecology tradition of geography, asserts that disasters primarily affect those who are marginalized in everyday life and who lack access to resources and means of protection which are available to others with more power (Hewitt, 1983; Wisner et al., 2004).

In parallel, policy-makers have given primary attention to the outcomes and suggestions

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of the hazard paradigm (Gaillard, 2010). Most national risk reduction policies still rely on command-and-control and top-down frameworks, which emphasize scientific knowledge and national government intervention at the detriment of local actions (GNDR, 2011; IFRC, 2011). Only within the international arena have policy-makers considered ideas from the vulnerability paradigm. This led to the development of international policy documents, such as the Hyogo Framework for Action (HFA). However, such a non-binding treaty with no concrete targets remains too vague to entail concrete outcomes at the national level (UNISDR, 2005).

In reaction to these dominant technocratic policies, practitioners in the field, especially those working for Non-Government Organizations (NGOs), have been advocating for increased involvement of those affected by disasters in policy and actions towards disaster risk reduction (DRR). This necessitates recognizing that local people and communities (for definitions of communities in the context of DRR, see Delica-Willison and Gaillard, 2012; Marsh and Buckle, 2001) are not helpless in facing natural hazards and that local knowledge is a valuable resource (Anderson and Woodrow, 1989; Maskrey, 1984, 1989). Practitioners have thus pushed for community-based disaster risk reduction (CBDRR), a practice which has gained considerable attention throughout the world over the last two decades (e.g. Heijmans, 2009; Pelling, 2007).

To use the words of Long and Long (1992), the field of DRR is a battlefield of knowledge and action, which often results in poor outcomes in terms of actual reduction of disaster risk for those most vulnerable. Indeed, disasters, both small-scale and high-profile events, seem to be on the rise worldwide (Center for Research on the Epidemiology of Disasters, 2011; Wisner and Gaillard, 2009). On the one hand, this trend reflects an increasing vulnerabilization of the world, a subject of significant studies in the

geographical and larger social science literature (e.g. Hewitt, 2007; Lewis, 1999; Oliver-Smith, 1994; Wisner et al., 2004), while, on the other hand, it is our assumption that the escalating occurrence of disasters also reflects an inability to bridge the gap between local and scientific knowledge, and bottom-up and top-down actions in DRR.

This battlefield of knowledge and actions in DRR reflects a larger debate in the geography literature, that of scale and the so-called 'politics of scale' (Cox, 1998; Smith, 1990, 1992; Swyngedouw, 1997). Indeed, the increased importance of international treaties, such as the HFA, but also of international institutions, like the United Nations International Strategy for Disaster Reduction (UNISDR) or the World Bank Global Facility for Disaster Reduction and Recovery (GFDRR), and global NGOs, as well as the parallel growing emphasis given to community-based and local actions, somehow reflects the 'hollowing out of the state' (Jessop, 2000) and a sort of 'glocalization' (Swyngedouw, 1997) of DRR. In the context of disaster science, policy and practice, the local and global are largely disconnected and stretched apart by this process of glocalization. This is clearly evident in the dominant top-down, homogenizing DRR strategies utilizing global scientific knowledge on hazards and vulnerability, on the one hand, and the context-specific nature of local knowledge and community-based actions on the other hand (Wisner et al., 2012). Such a gap in the scale of actions and knowledge is considered a major obstacle for reducing disaster risk in a sustainable manner and on a large scale (Wisner, 1995).

In this article we tackle this gap, investigating this geography of stakeholders and space of actions in DRR. We suggest reconciling the role of different forms of knowledge and actions from a large array of stakeholders at several scales and towards different directions, from the top down and from the bottom up. In so doing, the term 'knowledge' is used in a
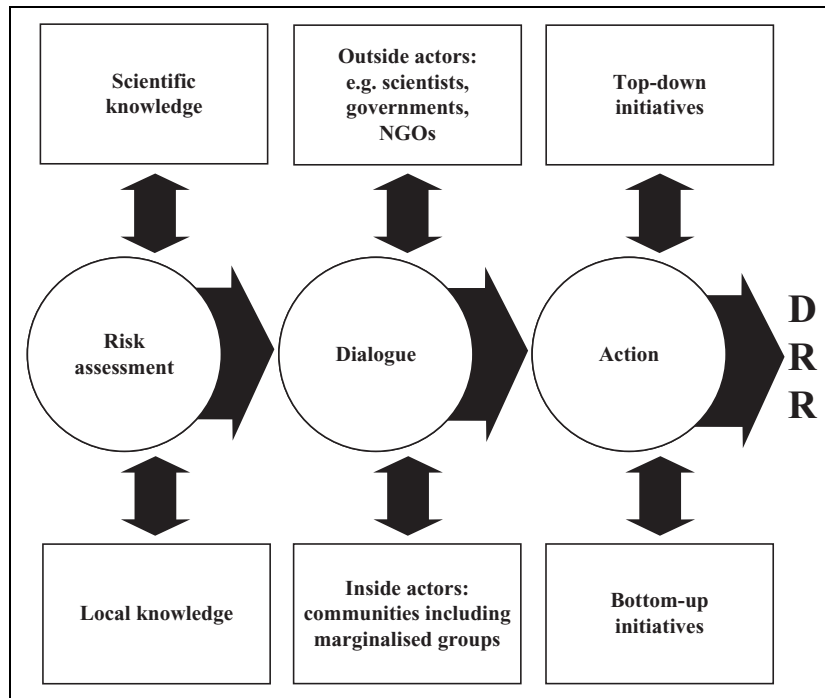
Figure 1. Road map for integrating knowledge, actions and stakeholders for disaster risk reduction.

broad sense to include information and/or skills acquired through education and experiences. We then narrow this term down further, utilizing 'local knowledge' to refer to knowledge often gained through experiences and 'scientific knowledge' to refer to knowledge gained through more formal methods of education (for further definitions, see Mercer, 2012; Polanyi, 1958).

With that goal in mind, we set a 'road map' for integrating knowledge and actions in DRR. In the first section below, we justify why local and scientific knowledge, and bottom-up and top-down actions are all valuable and compulsory to sustainable DRR. The second section reviews the reasons for our present inability to bridge the gap. In a third section, we suggest three key areas for improvement towards integrating knowledge and actions in DRR. The fourth section finally addresses issues to be overcome in order to implement the suggested road map.

II Disaster risk reduction as an integrative process: a road map

We hereby suggest that DRR should be inclusive rather than exclusive. Here 'inclusive' means (1) recognizing that different forms of knowledge are valuable in addressing disaster risk, (2) that actions at different scales, from the top down and from the bottom up, are necessary to reduce the risk of disaster in a sustainable manner, and (3) that both previous points require a large array of stakeholders operating across different scales to collaborate. Figure 1 outlines a road map for integrating knowledge, actions and stakeholders for DRR. This road map emphasizes a horizontal process starting with an integrated assessment of disaster risk based on different knowledge forms, then establishing multi-stakeholder dialogue on issues and potential solutions, to lead finally to actions which combine top-down and bottom-up

initiatives. The following subsections provide the rationale for the proposed road map.

1 On the importance of integrating local and scientific knowledge

Scientists, including geographers, have long dismissed local (or 'inside') knowledge as inferior and insignificant, in comparison to scientific (or 'outside') knowledge which is officially developed and verified within the scientific community (Mercer, 2012; Wisner, 1995). The label 'expert' given to scientists symbolizes authority and prestige, as opposed to locally generated knowledge, often embedded within a community and given no particular label (Agrawal, 1995). Although scientific knowledge reflects the place(s) from where it emerges, it is eventually verified and validated by the global community (Livingstone, 2003). On the other hand, local knowledge continually evolves through internal creativity, experimentation and contact with external systems and knowledge (Flavier et al., 1995). Such a gap in dynamics and forms of validation contributes to pulling apart global science and local knowledge within the geography of knowledge. Local knowledge is, however, increasingly recognized for its contribution to development, with many arguing that development strategies can only be successful upon recognition and incorporation of local knowledge (Agrawal, 1995). However, given the increased connectivity and globalization of the world today some local knowledge may no longer be viable, while some could exacerbate vulnerability (Mercer, 2012). Local knowledge should be assessed carefully to ensure its applicability and effectiveness in addressing disaster risk (e.g. Tibby et al., 2008).

Today there is an increased focus upon use of local knowledge for DRR (e.g. Shaw et al., 2008, 2009). This represents a movement away from top-down technological focused solutions to the more context specific 'local' solution (Agrawal, 1995). While it is clearly accepted

that 'science' saves lives, local knowledge too has demonstrated this capacity. Recent high-profile cases include the 2004 Indian Ocean tsunami (e.g. Arunotai, 2008; Baumwoll, 2008; Gaillard et al., 2008b) and Cyclone Zoe which hit the Solomon Islands in 2002 (e.g. Anderson-Berry et al., 2003; Kelman, 2005; Vettori and Stuart, 2004; Yates and Anderson-Berry, 2004). However, in the contemporary globalized space of DRR, too often local and scientific knowledge are considered in isolation, with neither recognizing the potential strengths of the other (Schmuck-Widmann, 2001). In addition, it cannot be assumed that either science or local knowledge alone will provide answers to development challenges within communities (Briggs, 2005; Tibby et al., 2008). In many cases there is a danger of over-romanticizing knowledge, especially local knowledge, yet, as Anstiss (2001) and Dods (2004) identify, there is a need to 'bridge the gap' and 'reconcile science and tradition' or the global and the local. For example, solutions offered by a DRR effort based on solid scientific parameters may fail for not fitting within local wisdoms, whereas solutions based on contextual specific local knowledge may fail in light of the increased pace of change experienced today. Hence there is an obvious need to combine the most effective and applicable local and scientific knowledge. A technical know-how adapted to local wise practices could greatly enhance DRR strategies (Dekens, 2007a, 2007b).

It is therefore imperative that scientists work in collaboration with local communities. This is to link local knowledge and management systems with appropriate scientific technology where necessary, i.e. that knowledge which is most beneficial in a particular context (Mercer et al., 2009, 2010). Scientific knowledge can no longer be seen as superior to local knowledge, or vice versa; rather the two areas of knowledge need to converge to provide sustainable assessment and solutions to disaster risk

(Figure 1). Local communities in hazard-prone areas often develop their own distinct way of addressing disaster risk which upon further analysis may or may not be beneficial for DRR (e.g. Shaw et al., 2008, 2009). However, local knowledge is a precious resource that can facilitate the process of DRR in cost-effective, participatory and sustainable ways (Howell, 2003). Beneficial local knowledge when combined with relevant scientific approaches offers a blend of effective and applicable knowledge which could open avenues for DRR. This approach was advocated during the International Decade for Natural Disaster Reduction. The resolution of the United Nations (UN) General Assembly called for a concerted worldwide effort to utilize existing scientific, technical and local knowledge in each country, adding new knowledge as needed in order to underpin the adoption and implementation of a public policy for disaster prevention (UNIDNDR, 1994). However, this is yet to be evidenced in practice and requires both top-down and bottom-up actions.

2 Actions from the top down and initiatives from the bottom up

Top-down and bottom-up frameworks for action have long been considered as opposite and irreconcilable doctrines not only for DRR but for development and environmental management at large as emphasized in the geography and cognate literatures (e.g. Batterbury et al., 1997; Easterly, 2008; Gray and Moseley, 2005; Robinson and Berkes, 2011). In line with the so-called hazard paradigm, it is no surprise that dominant DRR policies draw upon specific and *extra*-ordinary measures fostered by institutions framed to face the sole threat of natural hazards (Gaillard, 2010; Hewitt, 1983). Most often these actions, designed at a global scale, include specific, technocratic, command-and-control measures such as engineering structures to control natural hazards, technology-based

monitoring and warning systems to anticipate the occurrence of hazardous events, hazard-based land-use planning and unilateral risk awareness campaigns. Such frameworks further rely on top-down transfers of knowledge, technology and experience from the industrialized regions of the world, supposed to be safer because of their technological and economic 'advancement', towards the poorest ones, considered more vulnerable, thus drawing upon an abrupt and overgeneralizing geography of risk opposing the safe North to the dangerous South (Hewitt, 1995; de Waal, 1997). Throughout history, richer countries have thus developed policies, including disaster policies, to assist so-called poorer countries in addressing poverty-related issues due to their alleged inability to cope alone (Bankoff, 2001; Escobar, 1994).

Top-down policies have largely failed to prevent the occurrence of disasters, thus prompting practitioners supported by some social scientists to suggest an alternative, bottom-up framework for reducing disaster risk. CBDRR fosters the participation of vulnerable communities in both the evaluation of risk and in ways to reduce it. CBDRR empowers communities with self-developed and culturally, socially and economically acceptable ways of coping with natural hazards (Anderson and Woodrow, 1989; Maskrey, 1984, 1989). CBDRR thus gives prime importance to local resources. In extreme cases, the proponents of CBDRR have rejected all support from the outside/top down to local communities (Broekhuijsen, 2009). This proves problematic when it comes to embedding CBDRR within the long-term strengthening of people's livelihoods and local development processes (Cannon et al., 2003; Twigg, 2004). Indeed, the accessibility of necessary resources to those most vulnerable is often dependent on actors and forces which lie outside a community.

The inside/outside dichotomy is crucial to understanding why both frameworks if isolated

will never succeed in reducing the risk of disaster in the long run. The space of actions for DRR requires both initiatives from the top down and initiatives from the bottom up (Figure 1). Reinforcing the ability of people to face natural hazards necessitates reducing their vulnerability, which requires intervention from the top, and strengthening their capacities, which draws upon actions from the bottom up (Gaillard, 2010). People's vulnerability in facing hazardous events largely, not exclusively, results from structural forces which are exogenous to local communities and often of national or global origin, e.g. unequal access to resources, poverty, gender and ethnic discrimination, and poor governance, among other structural cultural, social, economic and political constraints (Watts and Bohle, 1993; Wisner et al., 2004). Therefore, reducing vulnerability seems to be a task of prime, not sole, responsibility for those with power to better share resources. Yet, local communities are not helpless and always display capacities in some form. This has sometimes been termed disaster subculture by authors including Anderson (1965) and Wenger (1978). This disaster subculture ensures communities largely, but not exclusively, draw upon resources which are endogenous to them including local knowledge, skills and technologies, and solidarity networks.

Unfortunately the gap between both frameworks is wide, and attempts to integrate global top-down and local bottom-up strategies for DRR have so far been sparse (Gaillard, 2010; Wisner, 1995). In fact, the larger field of geography has been similarly struggling to provide strong alternatives to bridge the gap, although some authors have provided stimulating ideas (e.g. Rauch, 1993). Few frameworks, however, exist to emphasize roles and responsibilities of different stakeholders within and across different scales, and to suggest ways forward to go beyond the dichotomy between actions from the top and initiatives from the bottom.

3 Involving a large array of stakeholders

Integrating knowledge and actions in DRR at the two ends of the road map entails that different stakeholders partake and dialogue in the process. The geography of stakeholders for DRR should therefore be multiscalar from the very local through to national and international levels (Figure 1). This is in order to simultaneously reduce the vulnerability of people and strengthen their capacities to face natural hazards.

Disasters are local events which first and foremost affect local communities. No one is therefore more interested in reducing disaster risk than those whose survival and well-being is at stake. Furthermore, since local people are those immediately affected when disasters occur, they become the first responders to the event (e.g. Delica-Willison and Willison, 2004; Quarantelli and Dynes, 1972). In times of disaster, outside assistance arrives at best hours or at least days after the event even though it is well known that the initial few hours are crucial to save lives and livelihoods (e.g. Alexander, 2002a). Evidence from the field suggests that 85% of post-disaster survivors are rescued by their friends, kin or neighbours who are on the spot at the time of an event (Quarantelli, 1986–1987). It therefore makes sense that local communities should be the prime stakeholders of DRR.

Nonetheless, if people and communities are able to handle many tasks in responding to disasters, thanks to their endogenous capacities, they often need external assistance too. Local communities are unable to undertake timely, long-range massive evacuation, clean very heavy debris, or undertake complex medical operations without assistance. In that context, people and local communities usually partner with local institutions, which know better their needs and resources. These include local government authorities, NGOs, schools, faith groups and local private businesses. When not

impacted by the disaster themselves, these local institutions are frequently better able to channel assistance as their spatial proximity ensures they are more reactive. When resources are lacking among local institutions, national government agencies or international institutions are usually required to fill in the gaps.

Despite the contemporary 'hollowing out of the state' emphasized in the introduction and a movement towards 'denationalization' of DRR, governments and government institutions are actually instrumental to sustainable DRR (Lavell et al., 2012; O'Brien et al., 2012). In most cases, disasters result from the non-application of existing laws, whether for enforcing construction codes or the protection of natural resources, and from the unequal distribution of resources within society (Hewitt, 2007). Disasters thus reflect social injustice and poor governance which prevail in most affected countries (UNISDR, 2011). Governance here goes beyond the sole democratic and free election process, decentralization and people's consultation. It refers to the larger relationships between the state and the people, or the ideology, values and authority imposed on the latter, the distribution of power within the society, and the level of priority given to DRR (Wisner et al., 2004). Governance further applies to private stakeholders, such as insurance companies, the media and international organizations whose policies and action may hinder or facilitate access to resources at the local level.

Finally, scientists, both social and physical, are clearly important actors of DRR. Beyond providing additional knowledge, as emphasized in the foregoing section, they are those best able to collaborate with local communities and other local stakeholders such as NGOs towards monitoring, forecasting and warning of the pending occurrence of natural hazards. Social scientists further assist in identifying the best potential options for planning for DRR.

A requirement for action at local, national and international levels from the bottom up and from the top down results in DRR becoming a multiscalar and multidimensional process involving a large array of stakeholders. Emphasizing the role and importance of different forms of knowledge, actions and stakeholders at different scales and towards multiple directions is not a difficult task given the wealth of studies and feedback from the field accumulated over the last century of research. Making DRR integrative in policy and practice is a much more complicated assignment as a significant number of obstacles arise.

III Why is it so difficult to integrate knowledge and actions in DRR?

Integrating knowledge, actions and stakeholders in DRR turns out to be difficult in policy and practice essentially because of the lack of trust that prevails between stakeholders which interact, often in autonomy, at different scales. As observed by geographers in the larger fields of political ecology and urban and regional development, such dissociation between stakeholders creates a sort of hierarchy of distinct scales (Brenner, 2001; Neumann, 2009). Governments and scientists still often dismiss the contribution of local communities, while communities and NGOs are frequently suspicious about governments and scientists' intentions. The bottom-line issue for this distrust between stakeholders seems to lie in the absence of space for dialogue, i.e. the central and key component of the proposed road map (Figure 1). However, the absence of space for dialogue across the hierarchy of scales is also compounded by the low priority often accorded to DRR by those most at risk due to other pressing concerns, the limited time, resources and space afforded DRR by local actors, and 'participation fatigue' or competition from other key issues which local actors face (GNDR, 2011; UNISDR, 2011).

1 Challenges identified for integrating knowledge

The importance of integrating the most beneficial local ('inside') and global scientific ('outside') knowledge for DRR at a practical level has been demonstrated within some studies (e.g. Cronin et al., 2004a, 2004b; Daly et al., 2010). However, the importance of integrating different knowledge types for DRR while visibly obvious is rarely, if ever, achieved and in some cases local and/or scientific knowledge could be detrimental to reducing disaster risk (Mercer, 2012; Mercer et al., 2007). UNISDR (2009) have moved towards highlighting the value of local knowledge for DRR, yet their recent reports reviewing progress towards the HFA outline national-level progress failing to transform into local-level action (UNISDR 2009, 2011). In many cases, effective local strategies continue to be overlooked in favour of scientific knowledge, which is not necessarily appropriate or applicable to the context in which it is applied. This results in the gradual loss of local knowledge as communities perceive global science as 'superior'.

Uneven power dynamics between those most at risk and decision-makers outside a community contributes to difficulties in integrating local and scientific knowledge. It is often argued that there is an uneven distribution of power between the 'researcher', in this case 'the scientist', and the 'researched' or community at risk (Moss, 1995). However, it has also been argued that 'outsiders' have the power to 'hand over the stick', giving power to the 'researched' (Chambers, 1994a, 1994b; Nast, 1994). As identified in a recent report, 'Views from the frontline' (GNDR, 2011), produced in parallel to UNISDR's (2011) report to measure progress towards the HFA at the local level, it is the communities most at risk who know their situation best. More often than not strategies developed are far removed from the reality of the community concerned and doomed to failure through lack of consideration of the local context. Communities should be the centre point of engagement, without which there will continue to be gaps in integrating knowledge, with science viewed as far superior due to its more global nature.

An additional obstacle to effectively integrating local and scientific knowledge lies in the context-specific and embedded nature of local knowledge. Strategies which are applicable to DRR may not be identified as such by community members, as they are embedded within community life and therefore not tangible to outside stakeholders. Cultural and language difficulties compound these problems of access and present difficulties in attempts to integrate the two knowledge types (Mercer, 2012; Mercer and Kelman, 2009). For example, traditional folk tales are often part of a community's risk reduction strategy and have contributed to saving lives, as in the case of the 2004 tsunami (Gaillard et al., 2008a). However, these tales, while often correlating with scientific observations, are difficult to quantify and therefore integrate with scientific risk reduction strategies. In addition, other stories or actions may in themselves be inadequate risk reduction strategies but might be a precursor to other more satisfactory strategies (Wisner, 2009). Dangerous dismissal of such strategies and folk tales by the scientific community could perpetuate and widen the already existing gap between scientific and local knowledge.

2 Technocratic institutional frameworks

Integrating bottom-up and top-down initiatives across different scales within the space of actions for DRR is as difficult as it is for bridging the gap between local and scientific knowledge. The most significant impediment lies within the technocratic nature of institutional frameworks geared towards reducing the risk of disaster. As mentioned in the previous section, most DRR policies throughout the world are shaped in order to face the alleged

extra-ordinary dimension of natural hazards and disasters (Gaillard, 2010). They often reflect frameworks established prior to international organizations, on the one hand, and community-based initiatives, on the other hand, having taken over most DRR initiatives (Lavell et al., 2012). Existing policies thus often reflect the 'hollowing out of the state' in facing the risk of disaster. Outdated state policies very much resemble strategies and structures developed in times of war (Gilbert, 1995). Indeed, in many countries DRR policies are handled by the army or civil protection institutions which rely on military chains of command, treating natural hazards as enemies which should be fought against (Alexander, 2002b; Delfin and Gaillard, 2008). In facing disasters there are, however, three major issues which arise with such frameworks.

First, the underlying social, cultural, economic and political causes of vulnerability are not usually viewed as military or civil-defence matters (Wisner et al., 2004). Reducing vulnerability is thus off the radar of DRR policies which often continue to focus on preparedness and response to disastrous events. This is particularly evident in the allocation of financial resources for reducing the risk of disaster. In many countries, DRR relies on large but sporadic and event-related release of emergency funds which prove inadequate to address the quotidian dimension of vulnerability (e.g. Delfin and Gaillard, 2008; Oxley, 2010). Granting access to resources and means of protection in facing natural hazards rather requires regular support from the government and anchoring in everyday life.

Second, civil defence and military organizations and institutions are usually highly hierarchical and run well on a top-down chain-of-command (Arbuthnot, 2008; Jeggle, 2001). DRR policies are therefore often crafted at the national level and eventually implemented at lower levels by local government institutions which are only tasked to relay actions from the top down. This orientation may assist in countering large-scale events which largely overcome the ability of local communities to respond on their own. However, such frameworks give little space for integrating local community capacities and fostering decision-making at the community level. It is further poorly fitted for harnessing local knowledge and addressing the root causes of vulnerability which are highly contextual (Wisner et al., 2004).

Finally, the lingering distrust with the military which prevails in many countries frequently affected by disasters makes it difficult to build trust between institutions in charge of DRR and local communities and their partner NGOs (Anderson, 1970; Dynes and Quarantelli, 1975; Gaillard et al., 2008a). Since decision-making and implementation are externalized such frameworks are often tagged for their lack of transparency, and sometimes corrupt nature, by those whose prime concern is the disaster(s), i.e. local communities.

In that context DRR policies are most often funnelled within narrow frameworks disconnected from everyday development policy and practice. For this reason they not only fail both to address the underlying causes of disasters and to recognize the capacities of local communities, but also continue to support a paradigm which further distracts our attention from recognizing the importance of vulnerability and capacities. These existing frameworks if continued to be utilized need to be supported to embed local voices and connect local knowledge to outside expertise.

3 Lack of tools to enable the dialogue

The lack of trust between stakeholders not only results from institutional frameworks poorly fitted to address disaster risk. It also pertains to our inability to bring all actors, usually working at different scales and in dissimilar directions, together around the same table of

discussion. There is indeed little experience in the literature of truly multi-stakeholder projects which involved collaboration between local communities, scientists, local and national governments and NGOs to only consider the most important actors of DRR. Although promising, those few projects which worked in this direction seem to have encountered serious difficulties in levelling power relationships between local people, government officials, scientists and NGO workers (e.g. Cronin et al., 2004a, 2004b; Daly et al., 2010; Fazey et al., 2010). Such difficulties largely result from the absence of tools mutually trusted by all stakeholders and which make all forms of knowledge tangible to all, thus fostering dialogue between different actors of DRR.

Most tools used by scientists and government officials to assess hazards and vulnerability (here capacities are hardly considered) and to foster DRR fall within the category that Chambers (2007) coins as economic reductionism. These tools are geared towards appraising the alleged *extra*-ordinary dimension of hazards and disasters. Hazard assessment particularly focuses on reducing the uncertainty pertaining to the occurrence of natural events, thus relying on the latest available technological devices, e.g. probabilistic models, seismographs, extensometers, radars, GPS, and remote sensing (Saito et al., 2012). In parallel, social scientists provide evaluations of vulnerability and risk perception based on tools and methods such as questionnaire-based survey and Geographic Information Systems analysis. All these tools are quantitative and non-contextual as well as selected and designed by outsiders for local communities to fit the global standards of science.

In parallel, there are a lot of tools which are used by NGOs for facilitating the participation of local communities for CBDRR. These are developed from the usual participatory learning and action (PLA) toolkits and refer to ranking, scoring, calendars and timelines, problem trees,

Venn diagrams, transect walks, participatory mapping, etc. Practitioners have also developed more specific tools and toolkits such as the Vulnerability and Capacity Analysis (VCA) matrixes which have become widespread (e.g. Anderson and Woodrow, 1989; CARE, 2009; Davis et al., 2004). Unfortunately, if these tools prove very useful for achieving their primary goal, i.e. identifying local knowledge and issues, and planning actions at the community level, they remain insufficient to integrate stakeholders from beyond local communities and NGO partners. Local government institutions and scientists have indeed been reluctant to seriously consider both the tools themselves and the knowledge they produce for improving policies. This is because participatory tools are not primarily geared towards producing quantitative data which are of primary importance for government decision-makers and scientists.

Maps and mapping provide a very good geographic example of such a gap when it comes to the tools most often used for emphasizing knowledge and fostering DRR. Maps constitute a powerful tool which gives visual expression to realities which are perceived, desired or considered to be useful, thus often providing means for conveying ideas beyond the realms of those who produce maps (Chambers, 2008). However, for communicating with outsiders, maps need to be intelligible to all stakeholders, which is seldom the case for DRR. In that sense maps often reflect unequal power relationships and different access to knowledge between stakeholders (Crampton, 2001). On the one hand, scientists supported by governments and sometimes international organizations usually provide very useful, highly detailed and scientifically accurate hazard maps. Unfortunately, these maps often require particular skill to decipher. Hazard maps are crafted after western guidelines and semiologies (e.g. language, technical jargon, colour coding of the legend, orientation towards the North), which frequently make little sense to people threatened by the same hazards. On the

other hand, local communities assisted by NGOs are able to draw very insightful sketch maps of their territory which feature people's perception of natural hazards and their vulnerability and capacities. These maps are usually culturally embedded and thus reflect local needs and resources. Unfortunately they are seldom scaled and georeferenced. Their value is therefore most often dismissed by local government institutions and scientists which challenge the veracity of the data. In the end, we are left with two sets of stakeholders working in parallel, producing very insightful knowledge and planning very valuable actions but who seldom meet and collaborate towards the same goal, i.e. integrating local and scientific knowledge and bottom-up and top-down actions into DRR.

This section has highlighted that the reasons for which it proves difficult to integrate knowledge and actions in DRR pertain to the very nature of knowledge, power relationships, institutional structures and methodological pitfalls. These constitute a complex and intricate set of factors which no single, miracle solution will be able to overcome. However, it is our contention that there exist some potential ways forward to bridge the gap between local and scientific knowledge and bottom-up and top-down actions for sustainably reducing the risk of disaster.

IV How to bridge the gap between local and scientific knowledge and bottom-up and top-down actions in DRR?

There is an obvious need to bridge the gap across the geography of stakeholders and space of actions in DRR. However, it is less clear as to how to achieve this. This section addresses the urgent need for consensual tools, practical frameworks and national policy changes which could be used to bridge this gap. This is in order to empower those most 'at risk' to identify appropriate DRR strategies utilizing their own knowledge alongside up-to-date scientific knowledge. Without communication and coordination between those most 'at risk' and associated stakeholders, any DRR effort based solely on top-down, scientific knowledge or bottom-up, local knowledge is tantamount to failure (Weichselgartner and Obersteiner, 2002).

1 In search of consensual tools for integrating knowledge and actions

Searching for tools trusted by all stakeholders of DRR and which would help in integrating knowledge and actions from different directions and levels does not mean that these tools need necessarily be new and original. Many existing tools may actually be refined or redesigned to provide all actors with opportunity to dialogue on a trusted basis.

One of the major issues is to make local knowledge tangible and credible to both community members and their NGO partner on one side, and scientists and government officials on the other hand (Mayoux and Chambers, 2005; Mercer, 2012). This is of particular importance for identifying vulnerability and capacities, which are abstract concepts that materialize only when hazards strike and wreak damages. Making local knowledge tangible allows for its valorization beyond the scope of local communities in the context of top-down actions. It further opens grounds for discussion within a community and between the community and outside stakeholders. DRR should indeed rely on the sharing of knowledge and the search for consensus around the identification of the issues to be addressed and the design of remedial actions (Mercer, 2012).

To foster the dialogue required to exchange knowledge and discuss consensual actions there should be tools that allow all stakeholders to participate in the same activity, around the same table and at the same time. These tools should enable an assessment of the needs and capacities

of local communities and to plan from the inside what can and should be done at the community level. They should also provide space for NGOs and local government officials to plan and plot, in collaboration with local people, top-down actions intended to sustain local needs. Such common tools and collaboration are essential to integrate bottom-up and top-down initiatives for DRR. Measures and actions developed and adopted in such a way are obviously more credible and more easily endorsed by all stakeholders who have collaborated in the same activity to produce them.

For these tools to allow the participation of and dialogue between stakeholders of DRR, they should be trusted by all parties. The most marginalized and vulnerable people, including the illiterate who may have limited knowledge of scientific concepts, should be able to discuss DRR with scientists and government officials, who on the other hand may have a poorer understanding of the local context. Such tools should contribute to empowering the most marginalized by granting them access to scientific knowledge and by rendering credible their own knowledge to the eyes of scientists. They should henceforth balance power relationships between local people and scientists. This therefore unlocks one of the crucial problems identified in the previous sections for integrating effective and applicable local and scientific knowledge.

Some tools of that kind already exist or are in the process of being improved to better bridge the gap as emphasized in this paper (e.g. Mayoux and Chambers, 2005). In the particular case of maps and mapping taken as an example in the foregoing section, such tools include scaled participatory mapping (Gaillard and Pangilinan, 2010) and participatory three-dimensional mapping (Cadag and Gaillard, 2012; Gaillard and Maceda, 2009). These forms of participatory mapping allow both local communities and scientists to plot hazard-prone areas, vulnerable assets and resources which

support local capacities using the same tool. They are credible to local communities who draw the maps and plot most of the information and to scientists and local government representatives who can easily overlap their own data and plans. They therefore provide the common, trusted ground which enables all stakeholders to collaborate for DRR.

Such innovative tools cannot, however, be designed in isolation. They need to be integrated within larger practical frameworks which provide the road map for integrating science (assessing disaster risk), policy (planning remedial actions) and practice (implementing, monitoring and adjusting actions) in DRR.

2 Towards practical frameworks for integrating knowledge and action in DRR

Geographers have shown that communities around the world have long experienced the challenges and opportunities of adjusting to social and environmental change (e.g. Nunn and Britton, 2001). While today we may be experiencing an unprecedented rate of change, we need to learn from past events in identifying and establishing effective, appropriate DRR strategies (Bankoff et al., 2004; Pelling and Dill, 2010). As outlined above, there is a need to develop specific tools and approaches which enable the integration of both bottom-up and top-down actions, and local and scientific knowledge. As with the identification of appropriate tools for integrating knowledge and actions, some practical frameworks already exist which go some way towards the integration of bottom-up and top-down actions and local and scientific knowledge. One such framework was developed by Mercer et al. (2010) for DRR in Small Island Developing States (SIDS; http://www.sidsnet.org) and subsequently revised by Kelman et al. (2009) for community-based climate change adaptation.

The 'Process Framework' consists of four clear and progressive, yet flexible, steps.

Communities are guided through an in-depth exploration of factors contributing to their vulnerability before identifying local and scientific knowledge used past and present which could be used to address this (for detailed information on each of the four steps, see Mercer et al., 2009, 2010). Feedback from community members where this approach was trialled indicated that they felt able to integrate relevant and applicable local and scientific strategies which they felt were achievable utilizing existing knowledge (Mercer et al., 2009). The process helped community members identify and relate to changing vulnerability patterns over time and how their activities or existing knowledge could have contributed to this. It also encourages a proactive response among community members to address their own vulnerability (Mercer et al., 2009). However, while this process was developed and initiated at the community level, it is essential that other stakeholders are involved in the process. This is in order for communities to access other relevant and applicable scientific knowledge. This may further enable community members to address their vulnerability, in the context not only of internal factors but also of external ones (Kelman et al., 2009). However, this requires a need for change within national DRR policies and ultimately international development policy.

3 Need for changes in national policies

While the tools and practical frameworks identified above clearly demonstrate the need for processes by which local and scientific knowledge and top-down and bottom-up actions could be integrated for DRR, this is not sustainable without supportive national institutions and policy. As clearly demonstrated within this article a paternalistic viewpoint in which local knowledge is often ignored in favour of the more scientific approach is often taken (Weichselgartner and Obersteiner, 2002; White et al., 2001). This continued disengagement between policy

(science) and practical action (at risk communities) can only contribute to increased, rather than reduced vulnerability (GNDR, 2011). It further participates in glocalizing the geography of DRR through hollowing out the responsibility of the state in preventing the occurrence of disasters, while reinforcing the role of local communities, at the local level, and international organizations, supported by scientific knowledge, at the global scale.

In that context, it seems essential to reaffirm the role of the state and national policies for reducing disaster risk as has been observed by geographers in the case of urban and regional development (e.g. Cox, 1998; MacLeod and Goodwin, 1999). A few governments (e.g. Colombia, Jamaica, Cuba, South Africa, Mozambique, India, Indonesia, the Philippines) are moving in this direction and undertaking such actions to reduce risk, especially in light of new pressures such as climate change (Lavell et al., 2012; UNISDR, 2011). However, many of these actions involve the development of policy documents at national government level, actions of which are not trickling down to those most at risk (GNDR, 2011). In addition, the development of national DRR policies does not often involve consultation with those most at risk. This puts the policies themselves 'at risk' of being ignored through lack of ownership by the communities concerned. Utilizing such tools and frameworks as those outlined above gives 'voice' to and empowers communities, enabling them to identify with their pre-existing capacities and to recognize how local knowledge plays an important part within DRR. It ensures 'local knowledge' becomes tangible, therefore paving the way for an integrated bottom-up and top-down approach to DRR.

Too often, national policies are developed in isolation from each other, thereby ignoring the interlinkages between social, cultural, physical, political, economical and environmental factors, which all contribute to vulnerability in the face of natural hazards (Lavell et al., 2012;

Wisner et al., 2004). This is as opposed to a more holistic approach which is taken at the community level. For example, while climate change is a major international concern, at the community level it may be equal to, less or more than other contributory factors (Mercer, 2010). Yet disasters are viewed as the result of a complex interplay of cause and effect, where it is not sufficient to concentrate on one factor at the expense of others; rather, all factors need to be addressed in a holistic approach to reducing risk (Wisner et al., 2012). Many in the international development community have been campaigning for a holistic response to sustainable development for decades, but this has yet to be evidenced in practice (e.g. Hewitt, 1983, 2007; Torry, 1979; UNDP, 2004).

National policies need to change to put those most at risk at the forefront of any strategy developed to reduce their risk (Weichselgartner and Obersteiner, 2002; White et al., 2001). Local knowledge at the community level needs to be listened to, with the most effective knowledge incorporated with appropriate scientific knowledge for relevant and applicable DRR policy. The continued top-down policy approach for DRR risks the development of poorly thought through and irrelevant policy for the given context, ignoring the professionalism of local actors (Chambers, 1980; Dahl, 1989). The difficulties of integrating top-down and bottom-up approaches and local and scientific knowledge are acknowledged but the approaches outlined above go some way towards achieving this goal. Changes in national policy in turn need to support such initiatives. The institutionalization of good practices in terms of reducing risk at the community level and utilizing local and scientific knowledge is the only way to achieve large-scale results. NGOs go some way towards this, but in many respects produce results which have impact only in small areas. There are currently limited opportunities to scale up these results through institutionalizing practices. In some cases, this is the fault of a highly, competitive, donor-led aid industry which results in NGOs operating in isolation, rather than in coordination with each other. However, without such a process vulnerability will not be reduced as those at risk are not made visible, are not reached or are not included in or in control of decision-making processes (Weichselgartner and Obersteiner, 2002; Wisner et al., 2012).

This section reviewed ways to bridge the gap within and across different scales between top-down and bottom-up approaches and local and scientific knowledge for DRR. It is clear that there are potential tools to linking communities with associated stakeholders or clear, practical frameworks to integrate both sets of knowledge. However, without the incorporation of such tools and approaches within national development policy, thereby simultaneously reaffirming the role of the state and giving voice to those most at risk, we are in danger of under-utilizing the wealth of local knowledge available and engaging in unproductive DRR strategies which contribute to enhancing vulnerability rather than reducing it.

V What is presently preventing bridging the gap?

To pave the way for the implementation of the foregoing road map a number of impediments need to be overcome.

First, there needs to be a strong political will on the side of all stakeholders involved to collaborate towards DRR. In 2009, only 77 out of 168 countries which signed the HFA submitted a report to the UN assessing progress made since 2005. In fact a number of disaster-prone countries such as Kenya, Uganda, Vietnam and Cambodia still lack legal and institutional frameworks to develop DRR (IFRC, 2011). In that context, Wisner et al. (2011) emphasize the importance of political, economic, legal and moral incentives for such states to commit to reducing the risk of disaster. These incentives

should cater to meet international standards as set by international institutions. Such standards already exist in the context of humanitarian interventions (including post-disaster situations) and have proved useful in ensuring the needs of affected people and communities are met (HAP, 2010; The Sphere Project, 2011). Commitment to these standards should be strictly monitored by all stakeholders involved in DRR, including local communities who should be able to claim for any shortcomings on the side of the state and other actors.

Second, stakeholders should go beyond rhetoric and commit to actual results, especially in terms of people's participation in DRR. Too often, the core principles of CBDRR are overlooked to serve the needs of donors and implementing agencies for which 'participation' has become a buzz word (e.g. Blaikie, 2006; Cooke and Kothari, 2001). Gray and Moseley (2005) further assert that community-based activities have actually been captured by neoliberal policies as part of their privatization and decentralization campaigns. Such inept approaches of participation often result in further disempowerment of local communities and in resources being siphoned off by local elites, thus leading to further distrust between stakeholders and an increase in the vulnerability of people most threatened by natural hazards. Inappropriate involvement and participation of local communities is also a result of donor-led, result-based practices. This is where international organizations and NGOs inundate local partners, NGOs or community-based organizations with huge financial support, expecting short-term, concrete outcomes, without for example building preliminary capacities in facilitating multi-stakeholder CBDRR (Heijmans, 2009). Yet building trust between stakeholders requires time and is first and foremost a matter of process. There cannot be significant outcomes, especially in the short term, without a thoughtful process based on a trusted dialogue between stakeholders within and across different scales.

Third, policies and actions should be flexible and context-specific. No single, miracle, 'one size fits all' solution is appropriate. DRR policies and practice should be embedded in local culture and social and economic contexts. Local needs, resources and power relationships indeed vary from one place and one community to another (Wisner et al., 2004, 2012). This requires that legal and institutional frameworks developed at the national level need to be flexible enough to adapt to specific contexts when decentralized to the local level. Too often national level policies for DRR are rolled out at the local level without a clear understanding of the local context or how such policies and processes would fit within it (GNDR, 2011). There needs to be a clear assessment of specific divisions within a country e.g. districts or provinces and their local culture, social and economic context. This would allow for the development of appropriate policy which could then be embedded within an overall umbrella framework, i.e. the national policy, but which is more specific to the local context in which it is to be applied, rather than being one step removed and out of context at the national level.

Funding is obviously another important obstacle, although not the most significant. Indeed, changing national policies, fostering dialogue and building trust between stakeholders are not expensive tasks. Yet they require resources to be dispatched to projects whose success will be assessed on the basis of a lack of evidence, i.e. the disaster that did not happen (Paul, 2009), and on a regular, everyday basis. Although many political figures such as the UN General Secretary Ban Ki-Moon often outline the benefits of DRR and that it is better and less costly than disaster response (Ki-Moon, 2011), many policy-makers still hesitate to invest in actions which will provide little political outcomes for their administration. Alongside the issue of funding, an often heavy reliance within poor countries upon consultancies outsourced to fill in capacity gaps at the

local level is another issue to be considered. This results in volatile knowledge flow in and out of local places where actual needs include a long-term integration of local and scientific knowledge and resources. Furthermore, media and international organizations continue to encourage large-scale event-based donation and funding at the detriment of small-scale, neglected disasters. This is despite the knowledge that the cumulative impact of the later exceeds that of high-profile disasters both in terms of lives and livelihoods (Lavell, 2000; Lewis, 1984; Wisner and Gaillard, 2009).

All four previous points call for greater transparency and accountability on the side of all stakeholders (Twigg, 1999–2000). Accountability is, however, more than an upward trend where implementing agencies justify to donors how money and other resources have been utilized. Policy-makers and local practitioners should also be accountable to local communities whose plight they articulated in the design of their proposals submitted to funding agencies (Delica-Willison and Gaillard, 2012). Downward accountability should go beyond financial transparency and include reflections on actual empowerment of local people and how much dialogue and trust have been built with outside stakeholders. Accountability here reflects governance at large.

VI Conclusion

The continued rhetoric surrounding the need for bottom-up and top-down actions and an integration of local and scientific expertise is no longer adequate. Similarly, to the larger scalar debate within geography this now needs to be translated into policy and action at all levels to reduce disaster risk within society. This paper has set a road map for integrating knowledge and actions in DRR (Figure 1) and identified three key areas for improvement. These include the need for consensual tools, practical frameworks and change in national policies.

This implies that there needs to be a reassessment of DRR among 'at risk' communities ensuring a truly participatory process in which communities themselves are active decision-makers. There is an important need to address power relations within and across scales in order to reduce the manifestation of hierarchies of scale, and the focus upon global at the detriment of national and local (Marston et al., 2005; Neumann, 2009). Ultimately, to bridge the gap between local and scientific knowledge, and bottom-up and top-down actions there needs to be a strengthening of communication and coordination mechanisms between communities and relevant stakeholders including scientists, civil society and government agencies (GNDR, 2011). Without this level of communication and coordination, local knowledge and action will continue to be intangible and communities may not fully understand or accept the science proposed.

Networks of stakeholders should provide a basis for progressive action and change which builds upon local and scientific knowledge. This is as opposed to waiting for top-down DRR policy and action to trickle down to those at the local level (Robbins, 2004). It is therefore time to step back and reflect upon the vast amount of research undertaken in the last century on disaster-related issues within both geographical literature and other academic disciplines. Use of this material is required in order to develop new paradigms for DRR which bring the 'battlefield of knowledge and actions' under control, and ensure concrete outcomes are achieved at international, national and local levels. This is in order to adequately address, through agreed-upon, systematic and applied policy and action, the integration of bottom-up and top-down actions, and local and scientific expertise within and across different scales.

For the road map identified in this article to be adequately resourced and transformed into policy and action, appropriate codes and standards need to be developed. Learning from the

humanitarian sector where internationally accepted standards have been established (e.g. HAP, 2010; The Sphere Project, 2011), appropriate standards developed for DRR could greatly contribute to adequately ensuring the integration of local and scientific knowledge, and bottom-up and top-down actions. Without such standards there will continue to be resource and capacity gaps at the local level, and poor or inappropriate participation, thereby contributing to an ever-increasing gap between policy development at the national level and practice at the local level. The issues of scale and especially hierarchies of scale continue to be a hindrance in linking the global/local binary (Brenner, 2001; Neumann, 2009). It is therefore essential that such codes and standards recognize the diversity in existence within and between countries, thereby allowing for flexibility in terms of the transference and implementation of international and national standards at the local level. This article calls for the use of existing knowledge and resources to identify appropriate tools and frameworks for integrating local and scientific expertise, and bottom-up and top-down actions, alongside appropriate changes in national policy which enable this to occur. This is in order to set a strong road map for action at international, national and local levels for DRR. Divergence from such a road map will contribute to further gaps in DRR within and between local, national and international levels.

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