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# Understanding the sociomaterial boundary qualities of livelihood resilience to climate change: Toward a methodological framework for more systematic social analysis

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## Abstract

This paper focuses on the status of resilience as a candidate ‘boundary object’ for facilitating communication and interaction on climate change between actors possessing differing social standpoints and worldviews. The paper argues that resilience possesses two differing properties, while resilience can be regarded as a boundary object, it may also come about through the emergence of boundary objects and related entities. In considering various forms of ‘boundary work’, the paper addresses limitations among current literature which have approached climate change issues using boundary studies. A series of structural factors are introduced, namely power, reflexivity, institutions and scale, which make a number of potential variables and themes visible. These can assist in moving boundary studies beyond narrow and localized empirical foci. The framework outlined here provides a methodological resource to facilitate the design of boundary studies of climate change which are more systematic, scalable and comparable.

## A. Introduction

This paper addresses the issue of articulating and mobilizing livelihood resilience in relation to climate change. With the deadline for a successive climate change treaty to Kyoto looming, livelihood resilience could provide a means of merging interests and discourses around the possibility of a climate change and development policy attuned to the needs of vulnerable communities. It has been proposed that livelihood resilience could be mobilized to coordinate the views of a wide array of stakeholders, ranging from policymakers and experts at the international level, to affected communities (Resilience Academy, 2014).

Resilience has become increasingly prominent in discussions around climate change (Adger et al., 2011). However, the ubiquity of the term has led some to question its usefulness. The notion of resilience in a climate change context has

been interpreted in a variety of sometimes contested ways (Brown, 2014).

Policymakers have been particularly keen to embrace the notion of resilience (Adger et al., 2011). This however has raised concerns about whether resilience is simply a fashionable term which has merely been substituted for other discourses (e.g. adaptation). More seriously, concerns have been expressed that resilience is susceptible to being politically exploited (Welsh, 2014). Resilience discourses have been critiqued for potentially justifying vested policy interests or the political status quo. For example, associating resilience with the ability to ‘bounce back’ suggests a politically conservative orientation. Alternatively, associating resilience with individual capacity to respond to climate change events, could reflect a neoliberal discourse used to justify the abrogation of responsibilities by the State (Welsh 2014).

Brand and Jax (2007) have posited the “increased vagueness and malleability” of resilience, as a possible advantage which may “foster communication across disciplines and between science and practice” (Brand and Jax, 2007, p. 23). As other commentators have more recently observed, meanings and framings of resilience vary considerably among different policy and academic fields (Brown, 2014, p. 108). These may reflect different concepts or emphases, such as adaptation, vulnerability, security or critical infrastructures. Framings of resilience may reflect different assumptions in scale and variably at the level of the individual, household, community, nation etc. Given the diversity of interpretations of resilience, one must question if the lack of fixed meaning has hindered rather than facilitated communication.

Interpretations of climate change resilience have also tended to reflect a more technical or scientific approach (Brown, 2014), possibly overlooking issues of a more social nature. The impact of climate change on the livelihoods of vulnerable communities is one significant concern. Livelihood systems involve a range of interlinked activities vital to communities, encompassing socio-economic activity; food and water supplies; environmental and cultural heritage; and the maintenance of kinship networks.

Livelihood approaches can encompass a wide variety of themes which cut across scientific research, policy and practice. They can relate to *local economies*, identifying threats to supply chains and networks; and the risks of tipping points, cascading effects and poverty traps. They also highlight the *habitability* and *productivity* of spaces which may be drivers of geographic and social mobility.

They can also emphasize *identity and attachment to place* and the possibility that individuals may not wish to leave a place, even one threatened by climate change due to a historical or cultural attachment to land. Livelihood approaches also encompass other social-structural dimensions, including political economy: power and institutions; and the law, for example, issues of sovereignty, the role of nation States and evolving social contracts (Resilience Academy, 2014, p. 12). These issues (which are not necessarily exhaustive) highlight the challenges in shaping prevention, response and planning frameworks to address climate change. New initiatives for policy and practice may require new data sources and novel methodologies. The challenge is two-fold: to explore how livelihood perspectives can encourage interventions to facilitate the social dimensions of resilience and to also understand the nature of livelihood resilience as a concept, given the interpretive flexibility of the term resilience across various academic and policy domains. These two challenges are linked by the issue of how resilience discourses are articulated and mobilized between policymaking spaces and vulnerable regions.

It has been suggested that livelihood resilience could be considered as a ‘boundary object’ (Star and Griesemer, 1989) to make connections between scientific communities, the policy community and vulnerable people. Boundary objects and related concepts, have been used to describe how actors may transcend epistemic and social distinctions between the worlds of science, politics, law, and economics. Other research has focused on how the boundaries between these social worlds may become drawn in different ways through their interaction

with each other. (Gieryn, 1983; Jasanoff, 1998; Lynch and McNally; 2003).

While it is possible to frame livelihood resilience as a boundary object, successful mobilization also requires a consideration of intended aims and consequences. Thinking of livelihood resilience as a potentially desirable quality raises a series of further questions, particularly that of resilience for whom, and in what form? Shaping the possibilities for facilitating resilience among vulnerable populations highlights the need for scientists, policymakers, practitioners and communities to work together. In this sense, resilience becomes an issue which underscores the problem of epistemic and social boundaries. Therefore, promoting livelihood resilience in the field can also be construed as the possible outcome of interactions between varied arrays of actors. Efforts toward mobilizing resilience approaches must address the Janus-faced quality which resilience exhibits – resilience *as* a boundary object, and resilience *through* boundary objects (or related entities).

This paper introduces a methodological framework to facilitate systematic comparisons of the boundary qualities of livelihood resilience. It highlights structural factors in shaping livelihood resilience which could complement more localized interactional studies. This framework reflects the position that any mobilization of livelihood resilience as a boundary object must pay careful attention to the relationship between discourses of livelihood resilience and consequent social and material manifestations. In highlighting this, the paper shows how livelihood resilience can make meaningful links between social research, policy and practice. The next section introduces literature from Science and Technology

Studies (STS) which explores the relationship between language, and socialmaterial relations.

## **B. Language and sociomaterial relations**

The possibility of articulating and mobilizing livelihood resilience invites consideration of the relationship between discourse and representation on one hand, and social and material orderings on the other. STS has drawn attention to the way in which realities are not merely ‘read off’, (in the sense of a pre-existing, objective ‘reality’) but are actively *created* through representative practices, bringing particular realities into being. This latter argument is also reflected in the concept of performativity.<sup>1</sup> Performativity illuminates how language helps create new realities through pronouncements, which may create new relations between people and material objects. The social shaping of relations between discourses, knowledge and materiality has received growing attention within STS (Faulkner and Lawless, 2012; Pinch and Swedberg, 2008) and the work of many STS authors emphasizes linkages between material practices and collectivizes perceptions, attitudes and ideas.

Similarly, socio-ecological systems (SES) literature has for some time explored the relationship between ideas, institutions and the material conditions of existence (Folke, 2007; Jamieson and Lovelace, 1985). As Folke et al. (2007, p. 49) assert for example:

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<sup>1</sup> The performativity thesis is itself predicated on ‘speech act’ theory, originally proposed by the philosopher J.L. Austin (Austin, 1962). Austin observed that words do not merely describe events (e.g. ‘the cat sat on the mat’), but that they can also bring certain social realities into being (‘I pronounce you man and wife’, ‘I sentence you to ten years in prison’ etc.).

“We abandon simple ideas of environmental or social determinism, and of human/nature independence, in favour of a co-evolutionary view of the origin and maintenance of ideas, institutions, resources, and societies. The biophysical world is not seen as a single strong determinant of social mechanisms, but neither is it passively moulded by human ideas and actions, nor is it simply a backdrop against which the human drama unfolds.”

The assertions of Folke et al. (2007) suggest a revisiting of the relationship between human society and ecology, open to the notion that humanity’s perception of, and interaction with the environment, shapes decision-making processes and the epistemologies which underpin them. STS literature on ‘co-production’ (Jasanoff, 2004) investigates how scientific knowledge and social institutions are co-dependent and mutually shaped. This vein of research explores relationships between science, governance and the environment. It has shown that the creation of scientific knowledge can directly shape political order (including the creation of political institutions) and can challenge or even redefine relationships between science, politics, law, economy etc. Jasanoff and others echo the sentiments of Folke et al. (2007), indicating that the environment and knowledge about it, actively shape human discourses and decisions on related issues such as climate change (see also Miller, 2004). Coproduction studies also emphasize how communities’ relations to their environments may alter, due to scientific developments, political movements and/or the effects of environmental change.

STS research has shown that scientific knowledge is incorporated into social systems where differing but equally authoritative epistemologies exist. Research has demonstrated how scientific knowledge is created and embedded within arrays of ethical, legal, economic, cultural and other social norms (Faulkner et al., 2012). Law, for example, is predicated on a markedly different set of epistemological practices (precedent and procedure rather than theory and experiment), yet has been shown to play a key role in shaping understandings of science in deliberative and regulatory arenas (Irwin et al., 1997; Jasanoff, 1987; 1998; Lawless, 2013; Lynch and McNally, 2003). These kinds of studies show how what is perceived to count as valid ‘scientific’ knowledge can vary from case to case. The boundaries between scientific knowledge and other forms of decision-making, have been demonstrated to be highly contingent and fluid. STS research has explored the ways in which actors negotiate, shape or seek to transcend boundaries between science, politics and law, each of which can be regarded as distinct social worlds (Gieryn, 1983). The practice through which actors navigate or redraw distinctions between these fields is termed ‘boundary work’. The next section reflects on the origins and development of the boundary work concept in more detail. Attempts to transcend or negotiate between these divisions have sometimes been perceived by researchers to involve the emergence of so-called boundary objects, boundary infrastructures, or boundary organizations. These concepts will be introduced and reviewed in the following sections.

### **C. Forms of boundary work**

The concept of ‘boundary work’, as introduced via the work of Gieryn (1983;

1999), has found significant import in sociological studies of science. It was originally proposed as a sociological response to the so-called 'demarcation problem' facing philosophers of science, namely the issue of normatively defining science from non-science (Kuhn, 1962; Popper, 1963). In Gieryn's (1983) original study, 'boundary work' was used to describe the practices through which scientists demarcate 'scientific' work from 'non-scientific', or 'pseudoscientific' pursuits. Using a variety of historical examples, Gieryn (1983) demonstrated that these practices may vary from case to case, showing how ideas about science may themselves be highly contingent.

Boundary work has since been well-developed in social studies of science and technology (Gieryn, 1999; Guston 1999; 2001), and has been shown to take a variety of forms (Clark et al., 2011). Some research, in the vein of Gieryn's (1983) original studies, has emphasized the epistemological dimensions of boundary work, investigating how 'science' is demarcated from 'non-science' in a variety of social contexts. Lynch and McNally (2003) for example, studied the ways in which English law courts contingently distinguished 'scientific' statistical methods from 'non-scientific' forms of reasoning. Epistemological issues also relate to defining relevant expertise in specific contexts. In their study of environmental non-governmental organizations (NGOs), Eden et al. (2006) found that these groups, while acknowledging the epistemic authority of science, were versatile and pragmatic in the way in which they legitimated knowledge from various sources, to allow them to further their aims. Research on environmental risk regulation has found that traditional scientific disciplines may only partially provide the knowledge to

address policy questions. Literature on 'regulatory science' (Irwin et al., 1997; Jasanoff 1987; 1993) has described how new scientific practices may emerge to bring together various forms of expertise in order to address policy-relevant concerns.

Boundary work has framed the emergence of specific scientific disciplines as a social achievement. Studies of boundary work may also exhibit an ontological dimension, pointing toward deeper issues of demarcation, for example between the 'natural' and the 'social'. Gaziano's (1996) history of the emergence of human ecology in the twentieth century interwar period argues that the formation of scientific communities and of individuals identifying as scientists, reflects the ability to negotiate the boundaries of the 'natural' and the 'social'. Gaziano (1996) argues that human ecology emerged from the development of sociology in academic institutions. Human ecology emerged from a desire to show how bridges between sociology and biology could be built. Sociology gained greater scientific authority from this association through distancing the discipline from the religiously motivated character of social work at the time.

The boundary work concept has been fruitful for illuminating the challenges faced in negotiating the boundary between science and politics. This kind of boundary work may involve defining priority issues; making strategic divisions of responsibility between science and politics in regulatory decision-making (Jasanoff, 1990); and separating scientists' research from their employer's politics (Clark et al., 2011). Differences in ideas about what constitutes acceptable scientific practice in specific polities also reflects contingent scientific boundaries. For example, in one study of

science and risk regulation, Jasanoff (1993) found that UK regulators preferred empirical data upon which to make decisions compared to US regulators who favoured theoretical models of risk.

While boundary work originally focused on the redrawing of distinctions, subsequent research has highlighted how existing boundaries are negotiated. A rich vein of research has explored how actors are able to communicate and co-operate while they continue to inhabit different socialized worldviews, from these studies a number of concepts have emerged. Some notable examples include boundary objects, boundary infrastructures and boundary organizations, which could be regarded as being involved in some instances of boundary work, these are introduced briefly below.

### **1. Boundary objects**

Star and Griesemer's (1989) historical ethnographic study of Berkeley's Museum of Vertebrate Zoology (MVZ) is generally credited with introducing the concept of the 'boundary object' in STS. They describe boundary objects as those which exist where different social worlds or interests intersect; they see boundary objects as being produced when varied arrays of stakeholders "collaborate to produce representations of nature" (Star and Griesemer, 1989, p. 408). In their example they describe the Museum of Vertebrate Zoology as a boundary object which co-ordinated the activities of academic zoologists, university administrators, amateur wildlife enthusiasts, hunters and others. The MVZ was perceived in different ways, as a way of preserving California's natural history by amateur enthusiasts; a material asset by university administrators; and as a site of research work by academic zoologists.

In a more recent review, Trompette and Vinck (2009, p. 5) summarize boundary objects thus:

"The notion is used to describe how actors maintain their differences and their cooperation, how they manage and restrict variety, how they coordinate in space and time. It qualifies the way in which actors establish and maintain coherence between interacting social worlds, without making them uniform or transparent from one to the other. Actors in these social worlds can, thanks to the boundary object, negotiate their differences and establish agreement on their respective points of view."

Star and Griesemer (1989) suggested that boundary objects can function in different ways. They may be: repositories (e.g. spaces where things can be ordered and indexed); ideal types (e.g. an idealized model or a concept); they may possess coincident boundaries (e.g. objects which have the same boundaries but which can be internally differentiated in different ways – a representation of California could show its political boundaries, while another map might demonstrate physical features); or be standardized forms (e.g. modes of data collection such as questionnaires, surveys etc.). Wenger (2000) has suggested that the notion of the boundary object can be separated into four dimensions: (1) abstraction, facilitating dialogue between different social worlds; (2) multi-tasking, making several activities or practices possible; (3) modularity, where different parts of the object can serve as a basis for dialogue between actors; and (4) standardization of information contained in the object, rendering the information interpretable.



Boundary objects have been described as possessing a range of properties and taking a variety of possible forms. They may be physical spaces, as in the case of the MVZ, or take more directly material-representational forms, as in the case of charts, documents or models (Cash et al., 2006; Dodgson et al., 2007; Sundberg, 2007). Boundary objects can also be nonmaterial, functioning as loose signifiers. Words like 'resilience' may function as boundary objects, despite having no essential material referent and may be open to interpretive flexibility.

Great emphasis is placed on the practices which boundary objects facilitate. Carlile (2002; 2004), suggests that the production of knowledge via boundary objects may entail: transfer (where there are stable relationships between actors and more compatible worldviews), translation (where there is joint activity between social worlds but uncertainty and/or divergence over specific meanings) or transformation. The latter may involve situations where actor's interests may diverge and where compromises between knowledge and interests may be needed. At this point boundary objects may be shaped by power and allegiances as much as the desire to share outcomes.

The boundary object concept has inspired a considerable amount of literature (Star, 2010; Trompette and Vinck, 2009). Further conceptual development has considered other boundary entities in which boundary objects may be embedded or nested. These insights have emerged partly through an interest in scaling up the boundary object concept to consider how information is shared and comprehended among actors who may not only share different (or partially overlapping) social worldviews, but who may also be separated in time and space. The concept

of boundary infrastructures has emerged from this interest (Bowker and Star, 2000).

## **2. Boundary infrastructures**

As Trompette and Vinck (2009, p. 5) observe, the boundary object quickly became "annexed to the initial, major issue of the role of infrastructures in communities of practices and in coordination between heterogeneous worlds." The construction and maintenance of information infrastructures and knowledge management is a notable theme of subsequent work by Star and colleagues, who introduced the notion of boundary infrastructures (Bowker and Star, 2000; Star, 2010; Star and Ruhleder, 1996). The boundary infrastructure concept helps describe "the institutionalization of categorical work across multiple communities of practice, over time" (Bowker and Star, 2000, p. 287). Bowker and Star (2000) argue that boundary infrastructures are those assemblages of actors and things which structure knowledge and understanding, they span "larger levels of scale than boundary objects" (p.287). Boundary infrastructures can be seen to stabilize the production and management of information, which may involve practices of classification, categorization etc., "including the activity's material basis as the central mediation in the construction of knowledge" (Trompette and Vinck, 2009, p. 5).

Boundary infrastructures can simultaneously shape cognitive and social orderings in processes of co-production. They may involve: the production of taxonomies or classification systems (Bowker and Star, 1998); professional identities being shaped through the (re)embedding of work activities such as nursing in hospital information management systems (Berg, 1997); or the redistribution of information flows across organizations and the production of management tools (Gerson and Star,

1986). Boundary infrastructures may arise with a particular vision in mind (Park, 2010), or they may emerge more responsively, as in the identification of mobile phone data as a means to understand patterns of communication and social networks following acute events or disasters (Flowminder, 2014).

Of further significance is the balance between intended aims and subsequent consequences. The concept of 'sociotechnical imaginaries' (Jasanoff and Kim, 2009) describes the way in which visions of future technological solutions may be mobilized to try and realize political aims as opposed to more general concepts of social good. Technologies which may be construed as boundary infrastructures may uphold or possibly challenge political orders. The latter could occur through changes to worldviews and new knowledge practices. Future technologies may require the projection of visions to persuade actors to invest in them, a process which may involve rhetoric and political persuasion (Sovacool and Brossman, 2013). This could include a more conscious degree of performativity, bringing sociotechnical realities into being through a combination of 'bricolage' (arrays of heterogeneous material objects) and political will (Hughes, 1983).

Boundary infrastructures represent new opportunities for reconciling social worlds and for reshaping ontology, but they also open up new practical challenges (Star and Ruhleder, 1996). Boundary infrastructure research has drawn attention to a host of potential technical, practical, communicative and logistical problems which might emerge in the course of their implementation. Star and Ruhleder (1996) studied one of the first efforts to develop a web-based 'collaboratory' to allow scientists to share data and communicate findings. However, they found that the use of the collaboratory was hindered by problems including, an inability to train

users, compatibility issues (e.g. between UNIX and Mac systems) and a lack of sufficient local IT capacity which was exacerbated by resource constraints and bureaucratic sluggishness in academic institutions (i.e. the slowness of university IT departments to respond to scientist's requests to upgrade the systems).

These findings alert us to the issue that if a livelihood resilience discourse is to be facilitated via technological means, it is dependent on a host of complex interactions between people and objects, which themselves are shaped by local organizational and cultural contexts. Such issues may only come to light when attempts to introduce a new boundary infrastructure are made (Bowker and Star, 2000). The attempted creation of new boundary infrastructures may reveal knowledge gaps. In the course of their emergence, boundary infrastructures may also create new problems which need to be resolved. The creation of these problems and their resolution could constitute a shared learning process. These processes should be viewed as both a topic and a resource, where detailed study provides lessons for future interventions.

### **3. Boundary organizations**

Entities such as boundary objects and boundary infrastructures are viewed as stabilizing relations between different actors (Guston, 2001). The successful functioning of these entities requires organized activity to bring about certain conditions. Such activity might promote opportunities to shape and use boundary objects, or to bring about incentives to promote them. Concerted activity might also be needed to bring together different actors and encourage participation in boundary work. Certain fora may function

to draw lines of accountability and responsibility between different actors brought together to work on specific policy issues.

Boundary organizations are those bodies which:

“Mediate between different social worlds and communities to bring people on either side of a boundary together to increase mutual understanding of one another's perspectives, capacities and needs while allowing individuals within the organization to remain within their respective professional boundaries and to maintain their responsibility to their different constituencies” (Franks, 2010, p. 286).

Boundary organizations can also therefore facilitate the coproduction of knowledge and social relations (Jasanoff, 2004). They allow the boundaries around an issue to be identified (Cash, 2001, p. 450), which might involve defining the issue under consideration (i.e. a working definition of resilience), determining which actors are deemed relevant to the issue and the means by which the issue is discussed. The negotiation of such boundaries also shapes the identity and practices of the organization in return (Bartel, 2001; Lorenzoni, 2007, p. 68). Boundary organizations could also themselves be construed, at least in certain situations, as boundary objects (Moore, 1996), this might facilitate further linkages between organizations and institutions.

Study of science-policy boundary work often points to the need for boundary objects, organizations, or other such practices to allow science-politics interactions to proceed in a meaningful way. Particularly when politics or policy is broken down to reflect issues of significance to populations such as,

matters of economics, justice, security etc. These issues crosscut through science-policy interactions over climate change.

In some cases, boundary practices emerge as a response to a recognised issue, whereas in other cases boundary work may reoccur with relatively little conscious reflection on the part of actors representing differing institutions (Edmond, 2000). This distinction has been largely overlooked so far, yet it raises important issues relating to the identification or non-identification of specific problems and/or the perceptions of opportunities for boundaries to be transcended. It also relates to the possibility of institutional transformation and the consequences thereof. This in turn highlights the influence of wider institutional barriers and drivers in shaping or hindering interactions. However, these may not be captured in ethnographic studies, which emphasize localized practice but which pay less attention to values, interests or institutions.

Some research has portrayed pre-existing objects or organizations as facilitating boundary work (Dodgson et al., 2007; Franks, 2010). This raises methodological concerns over whether boundary concepts are merely being used to repackage trivial descriptive accounts and is a common concern for other concepts developed from STS research (Hardie and Mackenzie, 2006). Such accounts may fail to consider other sociological explanations and simply reflect a confirmation bias where available data is shoe-horned into frameworks for the sake of convenience over analytical rigour.

A great deal of research on boundary work relating to climate change has focused on boundary objects, organizations or other similar practices and orderings. However, less consideration has been devoted to the question of why certain forms of boundary

work emerge as responses to specific boundary problems. Considering these issues, key questions are at risk of being overlooked. What choices or strategies were actors presented with in responding to boundary issues and why did they choose specific boundary solutions over others? How were boundary problems acknowledged (or not)? How were boundary solutions identified and why might other possibilities not have been acknowledged?

Context is therefore significant when considering boundary work but has been neglected in studies which have tested boundary concepts against specific empirical examples, or those which have taken a grounded theory approach to develop new boundary concepts in case studies. While these studies have added variety and richness to boundary studies and reflect the diversity of issues relating to climate change policy, they have also produced various concepts and framings which often only partially overlap. Concepts such as boundary objects, boundary organizations and boundary infrastructures have also been used and combined in an interchangeable fashion. In addition to constraining opportunities for scaling up comparative studies, it is difficult to identify lessons learnt which may translate across cases.

#### **D. Toward more systematic boundary work analysis in a climate change context: A methodological framework**

This section outlines a methodological approach to facilitate more scalable, comparative and generalizable boundary work studies. It identifies four overarching factors: power, reflexivity, institutions and scale. Together these

factors constitute a methodological framework which acknowledges the existence of varying epistemic, social, political and relational contexts in which boundary issues occur. The presented framework seeks to break down structural factors in terms of variables and themes to provide a pathway toward more comparative studies. These factors and related variables and themes, are introduced in turn. Following this section, the possible implications for understanding climate change resilience through this approach are considered.

#### **1. Power**

The role of power in boundary work has received varying degrees of attention and has been understood in different ways, which reflects the differing sociological positions concerning the nature and exercise of power (Carlile, 2002; 2004; Gieryn, 1983). Some boundary studies have shown that complex power relations may be an outcome of boundary work (Lawless, 2013). In other studies power has been placed in the background, implicit in discussions of institutional obduracy (Lynch and McNally, 2003). Some attention has focused on the role of power in the negotiation of boundary objects (Carlile, 2004). However, the exercise of authority, in the form of calls to law, regulations etc., has been less directly addressed and the influence of preexisting sanctions and/or incentives in shaping boundary work has been largely overlooked. Boundary work may lead to new sanctions or incentives, or new understandings of pre-existing ones (Franks 2010; Guston, 2001). Linking to matters of reflexivity and interests, power could be more or less consciously accrued to boundary organizations, infrastructures, objects etc.

Key variables relating to power also include the relational status of individuals participating in boundary work. The social status of, and potential inequalities between individuals, (in terms of gender, ethnic, social class differences or access to education) involved in boundary work has been so far under-explored. Boundary studies could also consider the role of social, human, financial, environmental and physical capitals (Mayunga, 2007) in shaping conditions under which boundary work occurs across spaces (Keck and Sakdapolrak, 2013). While some individuals actively participate in boundary work, others find the outcomes of boundary work impact upon them without their agreement or approval. Studies have tended to focus on legitimized forms of boundary work, yet the possibility remains that boundary work could involve illicit or illegal activities and possibly also corruption, favouritism etc. While this presents methodological issues in terms of access and ethics, it may have implications for climate change resilience (McSweeney et al., 2014).

## **2. Reflexivity**

The extent to which boundary work is consciously performed by actors directs the analytical gaze to questions of design, intentionality and standpoint. Boundary work varies in terms of expectations on the part of actors. Actors may be more or less conscious of a particular issue as they participate in boundary work. Successful boundary work may involve one or more participants acting in an entrepreneurial or brokering fashion, as in the case of Star and Griesemer's (1989) original example, where two individuals were instrumental in shaping the MVZ. While they enlisted the assistance of other actors, the latter

were not as well-placed to understand how the MVZ was to emerge.

While actors may be conscious of particular institutional regimes (e.g. rules or procedures), they may exhibit less awareness of the incommensurability between institutions, as in the case of making decisions regarding the status of scientific evidence within legal or policy contexts. Boundary issues may be routinely experienced with or without the conscious move toward a solution in the form of a boundary object or organization. This has been shown to be the case in studies of science-law interactions (Edmond, 2000). Appeals to a priori authority may replace any sense of individual responsibility, if actors prefer to follow procedure rigidly rather than looking for areas of flexibility.

Boundary work may involve the emergence of boundary objects, infrastructures or organizations with a sense of intentional design. The presence or absence of systems for reflection or collective learning may also be significant. The development of learning systems may comprise boundary work itself, but there may also be systems in place within existing organizations or structures (Bartel, 2001), these systems could influence the progress of future boundary work.

The presence or absence of envisaged aims is also relevant, as boundary work may reflect competing interests. The extent to which actors understand their own interests and how the aims and potential consequences of achieving them (or not), are understood, may vary from case to case. The way in which a priori interests are understood and articulated can have a key bearing on the outcome of boundary work (Carlile, 2004). The extent to which actors understand the interests of others may also vary (Fischer, 2001).

### 3. Institutions

Interactions between institutions are a core theme of boundary studies (Gieryn, 1983; Guston, 1999; Kaufmann and Todtling, 2001; Lynch and McNally, 2003; Lawless, 2013). Each institution exhibits heterogeneity, which could hinder comparative studies of specific types of institutional interaction (e.g. between law and science, policy and science etc.). However, there is scope to compare the role of certain normative structures in specific ways, for example, examining legislation between jurisdictions.

Despite allowing for heterogeneity, there remains the possibility to consider instances of specific types of institutional interaction. Different types of institution exhibit different ways of knowing, yet these institutional epistemologies can create tensions and uncertainties when they come into contact (Jasanoff, 1995). For example law, at least in the Anglo-American tradition, is associated with procedure and process, whereas science is commonly associated with hypothesis, numerical reasoning and progress (Goldberg, 1994; Schuck, 1993). Less formalized institutional epistemologies could also be considered, such as the implicit norm of interpretive flexibility which characterizes international political agreement. Institutional epistemologies represent important framings which may influence the way in which power is exercised. They may be formally stated, or be more implicit or tacit, only identifiable through initial ethnographic research.

Institutional context may influence the extent to which actors are reflexive in specific cases. Rather than new boundary objects or organizations emerging to address boundary issues, institutions might try and change from within by re-interpreting existing rules or procedures.

### 4. Scale

Issues of scale are reflected to an extent in the boundary infrastructures literature, showing how information circulates between actors separated across space and time (Bowker and Star, 2000). However, scale has not been researched in a systematic or comparative manner, nevertheless, a number of variables lend themselves to study when considering boundary work. The extent to which boundary work extends over geographic space relevant to climate change resilience, given the possibility of livelihood resilience to link actors together as a boundary object but also to manifest itself as a property across space. The population of actors engaged in boundary work influences possible outcomes through the emergence and/or maintenance of boundary organizations, infrastructures, objects etc. Linked to power, matters of scale could also relate to levels of human, social, environmental, financial and physical capital. The heterogeneity of actors can be measured in terms of the social worlds they inhabit, their capacities and status, which could include questions of inequality and exclusion. Finally, the temporal dimension of boundary work is significant given the inevitable anticipatory orientation of climate change effects.

#### E. Framing and addressing key issues

In a recent review, Weichselgartner and Kelman (2014) recommend empirical studies on:

“how people and communities connote resilience with different definitions and responses to allegedly positive or allegedly negative framings...not relabeling but reframing resilience allows values to be identified, choices to

be made, and political pathways to be identified” (Weichselgartner and Kelman, 2014, p. 11).

The framework introduced here is intended to provide a means for empirical researchers to better understand how resilience is framed in specific ways, why these framings become circulated in the ways they are and to help understand the consequences of these framings. It also aids understanding of how resilience can be construed as a performative phenomenon. These notions of the ‘resilient household’, or ‘resilient communities’ may potentially project political assumptions which may have tangible consequences for affected peoples. While field studies illuminate the fine-grained practices through which discourse relates to sociomaterial realities, it is important not to lose sight of wider structural determinants which may constrain or enable action on climate change and social justice. For example, negotiations on loss and damage reflect a certain power differential between developed and developing economies. These structures shape particular manifestations of resilience and may impede the shaping of more desirable framings. Understanding the nature of these structural determinants and how they impact upon the boundary qualities of resilience, is a vital first step in possibly overcoming them. Investigating the role of power is particularly important in studying the mobilization of resilience as both boundary object and the product of boundary work, as it alerts us to issues of possible incentivization and duress in shaping resilient communities.

Systematic study of the boundary qualities of livelihood resilience is important for facilitating learning of how the term may be mobilized and implemented. While failure may provide useful lessons, it may be not be an option for policymakers or practitioners under pressure, this aversion

to risk can lead to suboptimal outcomes or no progress at all. However, comparative studies of learning and problem resolution among heterogeneous actors, through the lens of boundary work, can help make sociocognitive barriers visible and identify practices of inclusion and exclusion in deliberations over issues of resilience, adaptation, loss and damage etc.

The framework can be considered as (partially) reflecting the social construction of knowledge tradition. However, it could also assist with understanding the converse, namely the social construction of ignorance, or agnatology (Proctor, 1995). This is an emerging field (McGooley, 2012) which explores how ‘uncertainty’ is constructed in policy areas such as climate change (Rayner, 2012). It draws attention to the role of power and interests such as ‘big business’, in framing issues such as climate change and its effects as ‘uncertain’. An agnatological focus is compatible with the framework discussed here and could provide vital insights in studying relations between expert and lay populations over climate change issues.

## **F. Conclusions**

The factors outlined in this paper are intended as a guide for further methodological design to study the boundary qualities of resilience. Figure 1 summarizes key variables encompassed by each factor, however, these should not be regarded as definitive; empirical work may identify further variables or new relationships between them. Together they constitute a series of possible variables, discrete and continuous, which could be used to compare different instances of the mobilization of climate change resilience. Single case studies alone may only be of limited usefulness. The framework is intended to guide researchers to design more systematic and comparative studies. Focusing on the factors of power,

reflexivity, institutions and scales enables social structure and agency to be reintroduced, with less concern on the precise relations between boundary work, objects, organizations, infrastructures which may hinder meaningful field research. The framework outlined here is also intended to indicate possible areas of reconciliation between qualitative and quantitative social research on climate change.

The framework nonetheless acknowledges the diversity and variance of boundary entities, with their own boundaries and interconnectivities as emergent things. It also accounts for the positional and relational variability that actors involved in boundary practices exhibit. The factors introduced in this paper should not be

regarded as replacing interactional research. Instead, they should be conceived as a means of complementing interactional studies by providing a methodological resource which can allow the former to be placed in a broader context. The latter are intended to provide a means of designing interactional studies which may be more comparable and generalizable. Such studies combined could provide a more systematic overview of the way in which resilience functions across the scientific and policy dimensions of climate change deliberations. These studies could also help to redress knowledge gaps concerning the mobilization of resilience perspectives and the relationship between the linguistic mobilization of resilience and its social and material effects.

Power

- Pre-existing authority (e.g. presence of laws, enforceable regulations etc)
- Presence/absence of pre-existing sanctions/incentives
- Emergence of new sanctions/incentives
- Interests
- Socio-economic inequalities (e.g. gender, social class, ethnicity, age, access to education etc)
- Five capitals: Human, Social, Environmental, Financial, Manufactured
- Illicit behaviour

Scale

- Spatial
- Temporal
- Population
- Five capitals
- Heterogeneity

Reflexivity

- Intentionality and design
- Articulation of a priori positions
- Presence/absence of pre-existing boundary objects, organizations, infrastructures etc
- Awareness of communication barriers
- Changes in perceptions of sanctions/incentives
- Appeals to authority vs sense of individual responsibility
- Understandings of oneresponsibilityty
- Understandings of interests of others
- Presence/absence of learning systems

Institutions

- Jurisdictions
- Rules & procedures
- Levels of formalization
- Level of reflexivity

*Figure 1: Summary of the factors and possible variables introduced in this paper. Source: Author's own*



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Livelihoods are the lattice upon which all human organization hangs, and some of the worst-case scenarios of global change – displacement, migration, conflict and famine – all centrally concern the problems that people face in sustaining productive livelihoods.

The 2013-2014 Resilience Academy is a group of 25 international researchers and practitioners who have recognized that dangerous global change is a threat to the livelihood systems of the world's poor. The Academy met twice, in Bangladesh and Munich, Germany, and developed a set of working papers as an evidence base for the concepts and practices that we, as a cohort of colleagues, propose for addressing this pressing challenge.

