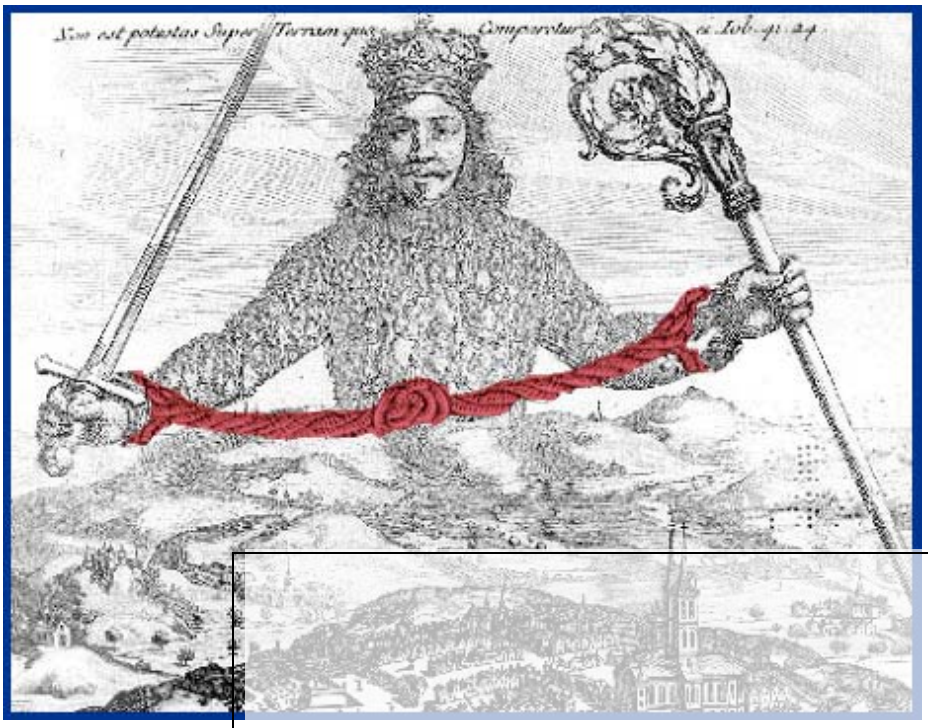

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Determinants of the capacity to adapt to climate change in multi-level governance systems – a meta-analysis of case study evidence

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Abstract

Background:

It has been well established that institutions are decisive for the capacity of society to adapt to climate change. But it is largely subject of debate, how in detail institutions in interaction with the available resources and the characteristics of the actors involved foster or impede the adaptive capacity in multi-level governance systems. Therefore, synthesizing the diverse findings of empirical case studies on this question in a methodologically coherent and integrative manner may provide theoretical foundations for answers on how to organize enhanced adaptive capacity to climate change within and across governance levels.

Method:

1. Against this background this paper develops a comprehensive multi-tier conceptual map of variables that systematically influence adaptive capacity. This is done by adopting the conceptual groundwork of the Institutional Analysis and Development framework (Ostrom 1990; Ostrom/Gardner/Walker 1994; Ostrom 2005).
2. This conceptual map is applied to conduct a model-centered meta-analysis of case studies in order to identify patterns in which adaptive capacity is influenced by the complex interactions of institutional, resource and actor variables.

Results:

The main results are:

1. The study provides a comprehensive and coherent multi-tier framework of variables determining the adaptive capacity with special focus on the role of institutions.
2. The meta-analysis finds several models that characterize how institutions shape adaptive capacity in their functions to structure the governance system as a whole, the interplay between different levels of governance and in their inherent characteristics.

1. Introduction

Unmitigated climate change is expected to increase the occurrence and severity of natural hazards such as sea level rise, changes in temperature, droughts, storms or floods and threatens a wide range of ecological and social systems (Parry et al. 2007). The ability to adapt to climate change (including climate variability and extreme events) is a crucial characteristic of societies to cope with and use climatic challenges to economic and social development. In general, climatic hazards are conceived to vary mostly on a local to regional level. Exposure and the sensitivity to hazards as well as the capacity to adapt are seen highly context specific (Brooks et al. 2005, Kelly/Adger 2000). This creates a diverse picture how specific locations around the world are and will be affected by climate change. Accordingly, adaptation actions need to be fitted to the local circumstances of the specific location. However, adaptation is not only an issue for governance on the local level, but for multi-level governance. De facto, there are numerous examples for adaptation governance on various levels, such as the Nairobi Work Programme, the National Adaptation Programmes of Action (NAPAs) and several funding schemes within the United Nations Convention on Climate Change, a green and a white paper on the EU level, numerous examples of national level initiatives or transnational horizontal collaboration of municipal networks (e.g. Kern/Bulkeley 2009, Biesbroek et al. 2010). Furthermore, there are sound theoretical reasons to approach adaptation on higher than local levels, too, e.g., reasons of global justice, the provision of national, transboundary or global club or public goods (such as data, know-how and information), the prevention of transboundary conflicts in the face of climatic changes, and the cross-level and cross-scale character of many environmental problems (Cash/ Moser 2000; Cash et al. 2006; Brondizio et al. 2009; Drieschova et al. 2009). In short, this paper conceives adaptation as an issue for governance in multi-level or nested systems, i.e. as "involv[ing] cascading decisions across a landscape made up of agents from individuals, firms and civil society, to public bodies and governments at local, regional and national scales, and international agencies." (Adger et al. 2005:79, cf. Engle/Lemos 2010).

Along with increasing awareness about climate change and decreasing confidence towards international mitigation efforts scholarship on adaptation expanded rapidly in recent years. Correspondingly, a large number of diverse factors has been identified to affect the capacity to adapt to climate change. A generally accepted, but abstract conclusion is that institutions, i.e. the rules and norms that frame human actions, are decisive for enabling, impeding and shaping adaptation (e.g., Adger et al. 2007, Werners et al. 2009). Institutions are sources of constraints, rewards, or punishment. They permit actors to form expectations and co-ordinate behaviour (Ferejohn 2003). They prescribe, permit or forbid certain actions or outcomes (Ostrom 2005). Therefore, the ability to take effective action in response to or expectation of climatic changes crucially depends on the presence of an enabling institutional framework.

One of the major challenges to research in this area is to gain a substantially more detailed understanding of which institutional characteristics foster or impair the adaptive capacity in different social, material and biophysical contexts. One strategy to tackle this question taken in the literature is to develop a general framework of relevant institutional characteristics that are theorized to have an impact on adaptive capacity. Taking this road, Arun Agrawal (2008; 2010) and Agrawal/ Perrin (2009) use the literature on common-pool resources and decentralization to derive 20 factors that they assume to affect the performance of local institutions for the adaptation of the rural poor. In a similar manner, Joyeeta Gupta et al. (2010) present six dimensions with 22 criteria to assess the adaptive capacity of institutions based on the climate change adaptation literature. All these studies present comprehensive lists of variables that can serve as analytical tools to understand the roles of institutions for adaptation.

However, they point out that the relative importance and the interrelatedness between the variables still need empirical verification. A second strategy to tackle the above question is to perform in-depth case-studies. They uncover how institutions affect the adaptive capacity in a highly specific context often identifying complex interrelationships between institutional and non-institutional variables based on empirical data. A recognized weakness of the case-study approach is that its results cannot easily be extrapolated to other contexts (van Laerhoven 2010).

Against this background this article is an inquiry into the question: How do institutions function to foster or impede the adaptive capacity in multi-level governance systems? It first builds a comprehensive, multi-tier conceptual map of variables that were found to shape the adaptive capacity of society. Secondly, the paper presents a meta-analysis of case study evidence. It identifies specific patterns of relationships between institutional and non-institutional variables with adaptive capacity both within and across governance levels. Particular attention is paid to variable interactions across governance levels and interactions of institutional variables with non-institutional variables.

The article is organized as follows: Section 2 presents definitions of key terms, conceptual links between institutions and adaptive capacity, and the conceptual map of variables determining adaptive capacity. Section 3 explains the meta-analytic method applied here. The results are presented in section 4. Finally, section 5 discusses the findings and draws conclusions.

2. The conceptual framework

This section presents the conceptual framework. It serves as the heuristics or diagnostic framework (Ostrom 2007) for the subsequent meta-analysis of adaptive capacity.

2.1. Institutions and the capacity to adapt to climate change in multi-level governance systems

Adaptation in the climate change literature commonly refers to an adjustment in individual or group behavior or in natural or human systems in response to observed or expected climatic change, risk, hazard or opportunity (Pielke 1998, Smit et al. 2000, McCarthy et al. 2001, Smit/Wandel 2006, Nelson et al. 2007, Adger et al. 2009, Mertz et al. 2009). For the purposes of this article *adaptation* is defined as the action and adjustment in behavior undertaken by actors in response to or in anticipation of changed environmental conditions. Effective adaptation reduces exposure or sensitivity to natural hazards or enhances the capacity for future adaptations. The term *adaptive capacity* denotes the ability of an individual or a group to undertake adaptive action, i.e. it captures the constraints and possibilities of adaptive action. It can be thought of as the action space for adaptation available to individual or collective actors.

Adaptive capacity can be seen within the context of larger research programs on the resilience of social-ecological systems (Berkes/Folke 1998, Gunderson/Holling 2002, Anderies et al. 2004, Walker et al. 2004, Folke 2006, Ostrom 2007, Young 2010). *Resilience* in this program usually is defined as the characteristic of a system to absorb, adapt to and shape change and still retain the same function and structure. The resilience in the face of climate change depends on mitigative and adaptive responses. *Mitigation* refers to avoiding climate change in the first place through the reduction of greenhouse gases. It combats the “origins” of anthropogenic climate change and has special importance as there seem to be barriers and limits to and high costs of adaptation (Stern et al. 2006, Parry et al. 2007, Adger et al. 2009). While mitigation targets the “origins” of climate change,

adaptation happens to the "ecological consequences" of climate change such as sea level rise, droughts, floods, storms. Thus, this article is an investigation into the adaptation side of resilience.

Institutions are the rules that structure human interaction. They comprise formal constraints (e.g., laws, constitutions), informal constraints (e.g., norms of behavior, conventions, codes of conduct), and their enforcement characteristics (North 1990, Miller et al. 1997, Ostrom 2005). Contrary to colloquial language, institutions are not synonym to organizations. Organizations, such as firms or government agencies, operate within the set of societal institutions, e.g. laws, and they normally use rules to internally co-ordinate behaviour of their members. The term *multi-level governance* is used here to denote the institutions, actors (including organizations) and the processes within these institutions. The term multi-level refers to the characteristic that governance systems usually are nested, i.e. processes of one particular spatial level of action arena (e.g., local or global) may be affected by and imbedded into governance structures of other levels (Hooghe/Marks 2003, Eckerberg/Joas 2004, Janssen et al. 2007). One prominent example is institutional interplay, where institutions on one level affect institutions on others, e.g. through functional dependencies between levels or through deliberate, strategic linking of institutions (Berkes 2002, Young 2002, 2003, 2006).

The conceptual link between institutions and adaptive capacity is the following: They are linked by the concept of the action space of an actor. The action space is defined by the available options for and the constraints on actions. Institutions can fundamentally influence the type and size of the action space by permitting, prescribing or allowing certain practices or outcomes, by co-ordinating human interactions and creating more secure expectations, setting incentives and enforcing behaviour of interaction partners. The action space can be that of an actor making private decisions or the space for collective action. Typically, the action space on a particular level of governance (e.g., in a municipality) is structured by a nested system of multiples layers of institutions.

2.2. A multi-tier conceptual map of adaptive capacity as the heuristics for the meta-analysis

The question what determines the capacity of societies to adapt to climate change has been approached with methods and perspectives from many disciplinary and interdisciplinary research programs. Consequently, the literature uses a broad range of concepts and provides many findings which are specific to a certain context and/or scale. In order to make this complexity more tractable while minimizing the risk to lose relevant information I adopt the idea of a *multi-tier or nested conceptual map* (cf. Ostrom 2005, 2007, 2009). This is a classificatory framework that organizes variables which were found to influence adaptive capacity. It partitions these variables into classes and subclasses on multiple conceptual tiers such that the lower-tier variables are subcomponents of the higher-tier variables. It helps identify single factors or combinations of them that may impact on adaptive capacity in one type of situation and not in others. The development of this framework was guided by the conceptual groundwork and explanatory context of the Institutional Analysis and Development framework (Kiser/Ostrom 1982, Ostrom 1990, Ostrom et al. 1994, Ostrom 2005). The conceptual map builds on a comprehensive literature review of the climate change adaptation literature. Major studies include those of McCarthy et al. 2001, Yohe/Tol 2002, Brooks/Adger 2004, Ivey et al. 2004, Adger et al. 2007, Schneider et al. 2007, Adger et al. 2009, Agrawal/Perrin 2009, Agrawal 2010, Gupta et al. 2010 as well as several dozens studies that have been investigated in the preparation to this meta-analysis.

Figure 1 shows the broadest conceptual level of the multi-tier conceptual map developed here. The variables in class A define the scales and levels involved and further situational variables in a particular study, theory or model of adaptive capacity. The biophysical and material conditions (variable class B), the attributes of the actors and groups involved (C) and the governance system (D) jointly and in interaction define the options for and constraints on adaptation actions, i.e. the adaptive capacity, of the system in question.

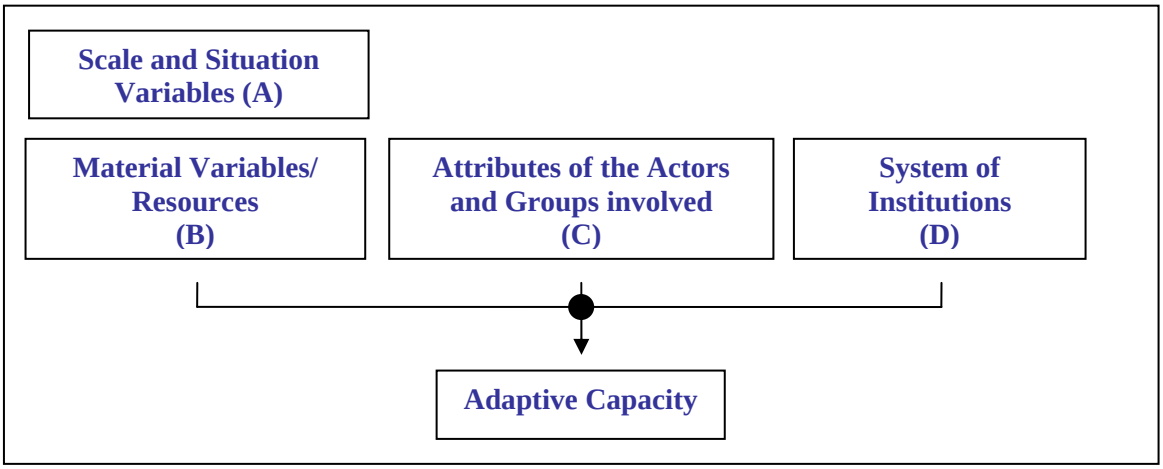

Figure 1: First-Tier Variable Classes (author's compilation).

Table 1 lists the second- and third-tier variables that have been identified in many empirical and conceptual studies as shaping the patterns of adaptive capacity to climate change.

This multi-tier conceptual map represents and integrates variables and their subcomponents across a very broad range of cases which are characterized by specific settings. It is important to note that in a particular case typically only a subset of these variables are examined and only a subset may matter for the adaptive capacity in that case. "The choice of relevant second or deeper levels of variables for analysis (from the large set of variables at multiple levels) depends on the particular questions under study, the type of social-ecological system, and the spatial and temporal scales of analysis." (Ostrom 2009:420) Furthermore, the possible manifestations of the variables may differ from case to case. For example, establishing an early-warning system against storm surges will require quite different information and knowledge than the adoption of agricultural production to changing soil quality. Thus, this framework helps to identify the niche of a specific case and helps to avoid panaceas (Ostrom 2007). In this sense, it is highly useful for the meta-analysis of a highly disordered literature, because it helps to understand relationships between the concepts and variables in single (case) studies and provides the ground for results that go beyond the primary studies.

Scale and Situation Variables (A)

- A1 Spatial scale
- A2 Temporal scale
- A3 Jurisdictions involved
- A4 Hazards and Exposure
  - a. type
  - b. intensity, frequency, regularity
- A5 Co-occurrence of competing goals, pressures or conflicts
- A6 Market situation

Material Variables/ Resources (B)

- B1 Physical infrastructure and technology
- B2 Financial resources, Access to credit and insurance
- B3 Availability of information, access to extension
- B4 Availability of natural and other resources

Attributes of the Actors and Groups (C)

- C1 Socio-economic attributes
- C2 Mental models, awareness and concern, values
- C3 Relationships between the actors
  - a. social capital, trust
  - b. distribution of power
  - c. presence of leadership
  - d. communication
- C4 Characteristics of organizations
- C5 Number of actors
  - a. in relation to fix costs of adaptation technologies
  - b. fragmentation of markets
- C6 Dependency on adaptive measures

System of Institutions (D)

<u>Structuring the governance system as a whole</u>

- D1 Learning Capacity
- D2 Resources
- D3 Allocation of roles and responsibilities
  - a. clearness of allocation
  - b. provision of authority for adaptive measures
  - c. balanced allocation of power
  - d. leadership
- D4 Secure property rights

<u>Structuring the interaction between governance levels</u>

- D5 Cross-level co-ordination and co-operation
- D6 Degree of decentralized decision making in collective choices
- D7 Provision of external support

<u>Properties of the institutional system itself</u>

- D8 Fit with the scope of the climatic hazards
- D9 Adaptiveness and Flexibility
- D10 Stability
- D11 Relation of climatic hazards to other stressors or goals
- D12 Principles of fair governance
  - a. legitimacy
  - b. inclusiveness
  - c. responsiveness
  - d. accountability and transparency

Table 1: Second- and third-tier variables (author's compilation based on comprehensive literature review).

The subsequent meta-analysis will investigate in detail the interactions of institutional variables with adaptive capacity. The "non-institutional" variables of the classes A, B and C are implicit to the meta-analysis in that they are sources of potential interaction effects between variables and adaptive capacity, e.g. moderating or mediating effects. Table 2 gives descriptions of the institutional characteristics.

Institutional Characteristics	Description
Characteristics concerning how institutions structure the governance system as a whole	
Learning Capacity	Whether institutions enable actors to refine routines and to change fundamental assumptions and mental models (single- and double-loop learning).
Resources	Whether institutions set incentives to generate resources for the provision of goods and services (e.g., technologies, infrastructure, insurance, credit, extension).
Allocation of roles and responsibilities a. clearness of allocation b. provision of authority c. balanced power d. leadership	Institutions can create positions in action arenas and prescribe, permit or allow for specific actions or outcomes for actors in certain positions. This comprises several dimensions: how clearly the allocation of roles and responsibilities is done; how symmetrically power is allocated; whether adaptive measures are legally available to actors; whether institutions allow for leadership.
Secure property rights	Whether secure property rights for goods and services are provided.
Characteristics concerning the interaction between multiple levels of governance	
Cross-level co-ordination and co-operation	Whether institutions are in place that provide for cross-level co-ordination and co-operation.
Degree of decentralized decision making in collective choices	How decision making power for collective choices is allocated between hierarchical levels of governance.
Provision of external support	How institutions shape the provision of external support (resources) for local action arenas.
Characteristics of the institutional system itself	
Fit with the ecosystem challenge	Whether the boundaries of the institutional system match with the scope of the climatic hazards.
Adaptiveness and Flexibility	Whether institutions create room to adjust or change these institutions according to new circumstances.
Stability	Whether institutions create predictability of behaviour and for interactions of participants.
Relation of climatic hazards to other stressors or goals	How institutions reflect and affect the relation between climatic hazards and other stressors or goals (e.g. complementarity, trade-off).
Principles of fair governance a. legitimacy b. inclusiveness c. responsiveness d. accountability and transparency	Legitimacy: whether an institution receives public support. Inclusiveness: whether actors affected can participate in decision making. Responsiveness: whether collective decision making shows response to the individuals' preferences. Accountability and transparency: whether the institutions provide for accountability procedures.

Table 2: Description of the institutional variables
(source: partly Gupta et al. 2010 with further references, partly author's compilation).

3. The meta-analytic method and the meta data set

The conceptual map presented in section 2.2 serves as the heuristics for the subsequent meta-analysis of case study evidence. Meta-analyses often examine the statistical evidence of the primary literature on the effect of some variable(s) X on another variable Y (cf. Cooper et al. 2009). Usual steps are to pool the effect sizes (e.g., regression coefficients, correlation coefficients, t-statistics) of

the primary studies, to compile an overall effect size and to perform a moderator analysis. This presupposes that the primary literature uses statistical tests for a common research question with fairly homogenous indicators for the variables in question. However, the climate change adaptation literature provides a different research landscape. The majority of studies uses qualitative methods for the analysis of data. The few studies that report statistical effect sizes (e.g. Tol/Yohe 2007, Bryan et al. 2009, Posey 2009) differ largely in the type of effects that they quantify. For this type of primary literature Rudel (2008) suggests to pool the "models" that have been derived from the original data rather than pooling the data or effect sizes themselves. The next step is to look for systematic patterns across the models. A model in this terminology is a statement about the relationship between variables X and Y that has been empirically supported in the primary research. Such an approach is taken, e.g., by Geist/Lambin (2001) and Misselhorn (2005). Appropriate to the highly heterogeneous and often qualitative body of primary literature in the field of climate change adaptation and appropriate to the purposes of this study, I conduct a meta-analysis of case study evidence using a similar procedure. The approach takes five steps as shown in table 3.

Steps of the meta-analysis:	
1	Giving a clear organizing research question
2	Identifying the relevant literature
3	Selecting the studies
4	Coding the study results
5	Analyzing the meta-data set and presenting the results

Table 3: Steps of a model-centered meta-analysis.
(Source: Author's compilation based on Rudel 2008 and Cooper et al. 2009).

(1) The research question that guides this research synthesis is: How do institutions function to foster or impede the adaptive capacity in multi-level governance systems? Section 2 gives clear definitions of and elaborates on the main concepts in use.

(2) The search strategy for primary literature comprised the use of databases, manual screening of key journals and cross-references. Identification of the literature in the databases and key journals was based on a keyword search. This step provides the primary sample of studies for this meta-analysis.

(3) The primary sample is subject to several filters to be fulfilled in order to be included into the meta-analysis. First, the study must show sufficient methodological quality in terms of transparency, reliability, and validity (based on Miles/Huberman 1994, Mayring 2002, Yin 2003). Table 4 shows the criteria used to evaluate the methodological quality of the primary studies. Second, the primary study must use systematically empirical data or evidence and this evidence must support its findings. This implies that results from reviews or from a theoretical model unexposed to systematic empirical observations are not included into the subsequent meta-analysis. Third, the studies must investigate the relation between institutions (rules) and adaptive capacity to climate change. For instance, studies that *describe* existing governance arrangements in the field without investigating their relations with adaptive capacity explicitly are not included.

Criterion	Operationalized Criterion
Transparency and reliability	- Clear documentation of the whole research process - Use of case study protocol or database
Internal and construct validity	- Adequate and clearly stated theoretical preconceptions - Systematic analysis of the empirical material - Alternative explanations are examined - Use of different interpreters - Validation of interpretations, e.g. key informants review draft of case study report - Use of multiple sources of evidence - Coherent interpretations
Other	- No apparent methodological bias

Table 4: Criteria of the methodological quality of the primary studies.
(Source: Author's compilation based on Miles/Huberman 1994, Mayring 2002, Yin 2003).

Finally, from this sample 21 primary studies were chosen for inclusion into the meta-analysis presented here. Further studies will be included in the next steps of this paper. A case is defined as a distinct time and place specific action arena. Six of these 21 studies originate from two research projects representing two study areas. Therefore, the final sample of this meta-analysis consists of 17 studies from distinct research projects in distinct action arenas. These 17 studies, authored by 50 researchers and published in 14 different journals or books, contain research on 229 cases. Table 5 gives more descriptive details on the included sample of case studies.

Hazards		Locations		Type of Arena		Data Sources	
Multiple	8	Canada	5	Household	1	Interviews	11
Water Quantity and Quality	4	Norway	2	Rural Community	3	Documents	8
Flood	3	Burkina Faso, Norway, Great Britain, Niue, South Africa, Ethiopia, Tanzania, Mozambique, China, Brazil, Sweden, Netherlands	1 each	Municipality	6	Focus groups	3
Drought	1			Region	5	Scientific literature	3
Temperature and Rainfall Change	1			Country	3	Fieldwork/ participant observation	2

Table 5: Descriptive characteristics of the case studies (N = 17 studies).

(4) In the next step the empirically based results of each study about relations between institutions and adaptive capacity have been coded. The coding scheme made a detailed, six-fold distinction as to which types of effect have been found in the study: direct effect, undetermined effect, differential effect, moderator effect, conjoint effect, or mediator effect. Figure 2 illustrates the different effect types of this meta-analysis. Combinations of these types are possible in a model, e.g., where two mediation effects lead to an undetermined change in the outcome.

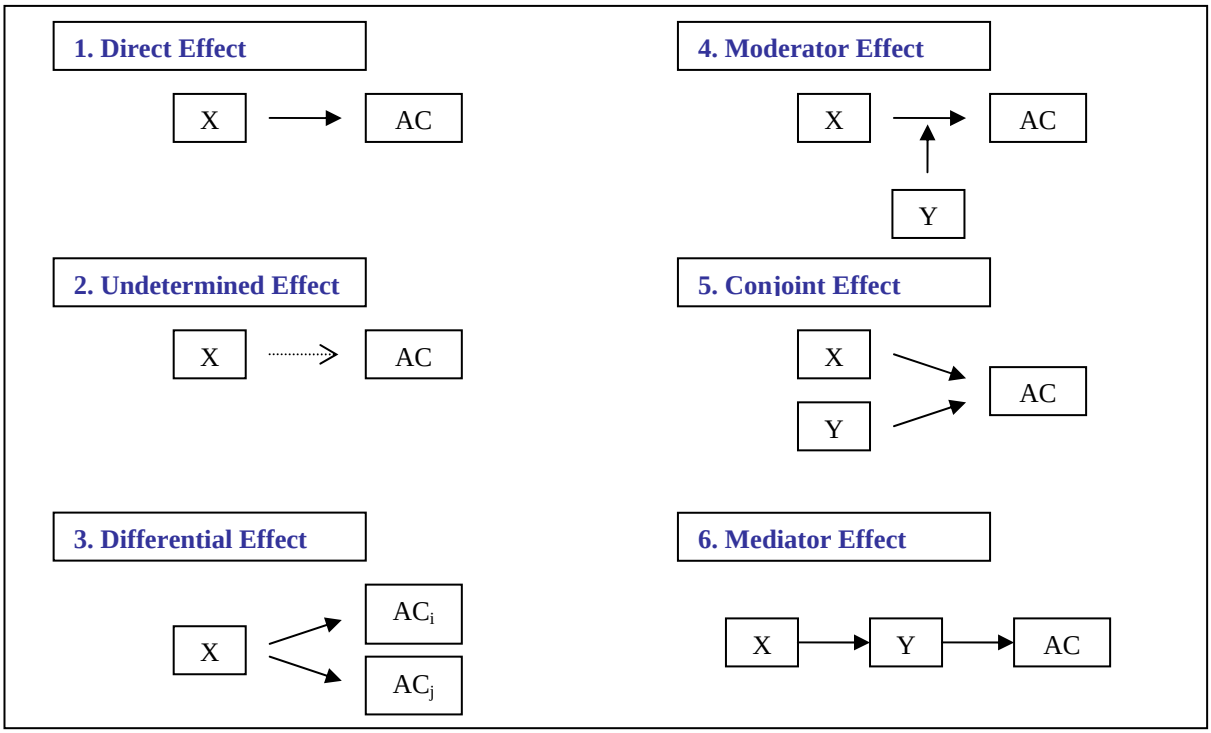

Figure 2: Effect types investigated in the meta-analysis (author's compilation).
X: Institutional Characteristic; Y: Other Variable; AC: Adaptive Capacity; i/j: Index for actor i/j.

(5) The final step is to analyze the obtained meta-data set. This step first presents the frequency distribution of effects. It captures a picture of how often direct effects of institutions for adaptive capacity have been found, and how often more complex interactions seem to characterize the relation of institutions and adaptive capacity. The models obtained for each institutional characteristic are reported and discussed.

4. Results of the Meta-Analysis

Table 6 presents the frequency scores for the models empirically supported in the case studies. It shows the number of case studies in which the institutional characteristics are reported to have a positive, undetermined, differential, moderator, conjoint or mediator effect on the adaptive capacity of the actors involved. For the general descriptions of these effect types, I refer to section 3. This meta-analysis identifies several models, how institutional characteristics shape the adaptive capacity of society. In the following, I will report and discuss the findings in three parts: first, how institutions structure the governance system as a whole; second, how institutions affect the interaction between multiple levels of governance; and third, how characteristics of the system of institutions itself affect adaptive capacity of society.

Institutional Characteristic	Direct Effect	Undeter-mined Effect	Differential Effect	Moderator Effect	Conjoint Effect	Mediation Effect	Total
Characteristics how institutions structure the governance system as a whole							
Learning Capacity	2	-	-	1	-	-	3
Resources	1	-	-	-	-	-	1
Allocation of roles and responsibilities	4	1	-	-	1	1	7
Secure property rights	2	-	-	-	-	-	2
Characteristics concerning the interaction between multiple levels of governance							
Cross-Level co-ordination and co-operation	5	1	-	-	1	-	7
Degree of decentralized decision making	1	1	2	6	2	-	12
Provision of external support	1	2	2	2	-	1	8
Characteristics of the institutional system itself							
Fit of institution with the scope of the climatic hazard	2	-	-	-	2	-	4
Adaptiveness	2	-	-	-	-	-	2
Stability	-	-	-	-	-	-	0
Relation of climatic hazards to other stressors/ goals	5	-	-	-	-	-	5
Principles of fair Governance	3	-	-	1	-	-	4

Table 6: Frequencies of the institutional characteristics and effect types (N = 17 studies).

4.1. Institutions in their function to structure the governance system as a whole

There is general support that a high *capacity to learn* (in the sense of the ability to change fundamental assumptions and mental models) is a crucial element for the capacity to adapt to climate change (direct effect model). The case studies identified two important ways in which institutions can shape the learning capacity. First, the regulatory framework may encourage awareness for climate change, e.g., by integrating climate change considerations into organizational routines or plans. Second, if institutions provide a basis for building trust between the sender and the receiver of information about climatic hazards, willingness and thus ability to learn is enhanced. Identifying a more complex interaction, one study (Lemos et al. 2002) found a moderator effect asserting that, on the one hand, the provision of scientific forecast information can enhance adaptive capacity. On the other hand, three moderating factors might deter this linkage: information can be subject to distortion, misinterpretation and manipulation in the political and economic process; the dissemination of information has to take the needs and decision making behavior of the end user into account; and

actions based on scientific information might undermine traditional knowledge leading to reduced adaptive capacity.

Institutions also structure action arenas in that they *allocate roles and responsibilities* to the actors involved. In this function, institutions are theorized to enhance adaptive capacity if roles and responsibilities are allocated clearly; if authority for adaptive measures is provided; if power is balanced among actors; and if they allow for leadership. Indeed, the meta-analysis shows that missing or unclearly allocated roles and responsibilities served as substantive barriers for adaptation in numerous cases (direct effect model). Furthermore, unbalanced power in decision making can stall social learning by filtering information and thus reduce adaptive capacity (mediator effect model). The role of leadership is ambiguous (undetermined effect model). On the one hand, authorities who were progressive and positive on climate issues were able to foster adaptation. On the other hand, leadership requires a certain power position about those who are led. Therefore, institutionalizing these unbalanced power positions might invoke the negative consequences of power asymmetries for adaptive capacity.

Institutions also affect the adaptive capacity by *generating resources and regulating the provision of goods and services* such as infrastructure (direct effect model). Finally, the definition, implementation and enforcement of *secure property rights* for goods is reported to enhance the ability take adaptive measures (direct effect model).

4.2. Institutions in their function to shape the interaction between multiple levels of governance

Adaptation to climate change involves multiple levels of governance in many cases. The meta-analysis investigates three important ways, in which institutions shape the interaction between multiple governance levels: whether they provide for cross-level co-ordination and co-operation; to which degree they allocate decision making power to lower levels of governance; and how they shape the provision of external support for an action arena.

The meta-analysis shows that for the *provision of cross-level co-ordination and co-operation* most case studies support the direct effect model for adaptive capacity, if one of two conditions is met. Cross-level co-ordination and co-operation seems advisable, if the scope of the climatic hazard goes beyond the boundaries of the established governance arenas so that cross-level adaptation could use economies of scale and scope, resolve transboundary conflicts and/or shape social dilemmas between the single areas. But even if the climatic hazard would fit into the boundaries of an established governance arena (e.g. a municipality that is confronted with a highly localized climatic hazard), the traditional governance system might restrict the action space in this arena (e.g. when legal authority for some crucial actions is allocated at higher levels of governance) and make cross-level co-ordination and co-operation advisable. In particular, barriers for adaptation related to cross-level governance were the missing cross-level co-ordination and inconsistent approaches on different levels, lack of cross-level learning and unclear roles and responsibilities in the co-ordination between multiple governance levels. In one case as reported by Shepherd et al. 2006, cross-level co-ordination had an undetermined effect on the adaptive capacity. On the one hand, upper-tier influence from the provincial level seemed necessary to obtain funding, training and expertise for an adaptive measure at the local level. On the other hand, the provincial influence met with suspicions and mistrust and fuelled public opposition by a major interest group.

The *degree of decentralized decision making in collective choices* is often subject of studies. Several authors theorize that a high degree of decentralization or poly-centric governance enhances adaptive capacity (e.g. Pahl-Wostl 2009, Tanner et al. 2009). The meta-analysis clearly puts this statement into a new perspective.

Only one of the studies confirms a simple, direct effect model for decentralization, where another study reports mixed evidence (undetermined effect model). The clear tenor of this meta-analysis in regard to the degree of decentralization is the following: A higher degree of decentralized decision making tends to invoke a higher adaptive capacity of the actors involved. However, several moderating factors can reverse this relation (moderator effect models). In particular, seven moderators are identified:

- the (lack of) knowledge, awareness, and experience at local levels;
- (inappropriate) management expertise and communication structures at local levels;
- (unclear) allocation of roles and responsibilities between governance levels and within the local arena;
- stark local conflicts about local policy priorities;
- (inconsistent) approaches to decentralization, e.g., the allocation of responsibilities to lower levels with a lack of capabilities in terms of finances and authority;
- the (lack of) cross-level co-ordination and co-operation where it might prove helpful due to the scope of the climatic hazard or due to traditional governance constraints; and
- (unbalanced) power positions at local levels.

Where power in local arenas is clearly unbalanced, a decentralized system tends to produce differential adaptive capacity effects of external support (differential effect model). When external emergency support meets strong local power imbalances in a decentralized decision making system, measures tend to be taken out at the expense of weaker interests and local elites have the incentive to enhance short-term resilience of the population, but do not have the incentive to enhance long-term adaptive capacity. Put differently, continued vulnerability and recurring urgency situations can cement local power structures.

Furthermore, the conjoint effect models show, that a larger scope of the climatic hazard (e.g. flood risk at a transboundary river) might make a system “too decentralized” and would require higher level decision making or collaboration between local level agents in order to provide a fit between the institutional system and the ecosystem challenge.

The *provision of external support* also shows more complex relations with adaptive capacity. Obviously, external support usually enhances the resources available for adaptive measures. However, the case studies provide a more differentiated picture. First, it becomes clear, that the concrete adaptation response to external support depends on the form of aid and the needs of the receiver (undetermined model). Second, unbalanced power structures can lead to differential outcomes of support in terms of adaptive capacity, as reported in the section on decentralized decision making (differential effect model). Third, one study (Barnett 2008) provides a combined mediation and undetermined effect model, where external support on the one hand enhances adaptive capacity by reducing the resource constraint. On the other external support is found to undermine good governance by leading to problems of moral hazard, inertia, aid supply dictates demand, and accountability and legitimacy.

4.3. Characteristics of the institutional system

The conceptual map presented in section 2 contains five characteristics of the institutional system itself that are expected to enhance adaptive capacity.

The meta-analysis confirms that a *fit between the scope of the institutional system and the ecosystem challenge* serves as important prerequisite for adaptation (direct and conjoint effect model). In particular, problems of fit in the case studies related to a "too decentralized" system for the climatic hazard without appropriate cross-level co-ordination between the local agencies and a misfit between a relatively short-term cycle of political elections and the long-term character of climate change and adaptation.

Equally clearly, the *adaptiveness* of the rule system is fundamental for the adaptive capacity of the people living within the rule system. Specifically, the cases illustrate that path-dependence of institutions can serve as a barrier for adaptation to new climatic hazards. Notably, however, none of the case studies makes reference to the *stability* of institutions, although the broader literature theorizes stability and adaptiveness of institutions as potentially being in conflict: While institutions need to be flexible enough to be changed to new circumstances, they also need to show a degree of permanence in order to help actors to develop stable expectations, coordinate collective action and improve routines (Pahl Wostl 2009).

How institutions affect and reflect the *relationship between climatic hazards and other stressors or goals* is a further important institutional characteristic that shapes adaptive capacity. Usually, climatic hazards are only one of multiple stressors on social-ecological systems next to, e.g., development needs, social conflicts or other environmental hazards. In cases where the climatic hazards are not well understood or potentially far in the future, they are prone to get lower priority compared to other stressors or goals undermining adaptive capacity. Furthermore, cases of "policy externalities" are reported, where policies aimed at other goals or stressors constrain the ability to adapt to climate change. Subsequently, to integrate climate change considerations into policies and organizational routines ("mainstreaming") is highlighted as a step to enhance adaptive capacity.

If the institutional system incorporates *principles of fair governance*, i.e. legitimacy, inclusiveness, responsiveness, accountability and transparency, it is expected to enhance adaptive capacity. Indeed, three case studies confirm this proposition. However, one case study (Tol et al. 2003) finds a moderator effect model, where inclusive, democratic decision making under specific circumstances can stall adaptation decision making. In this study, the relevant factors that moderate the relation between democratic/fair governance and adaptive capacity are an unequal distribution of risks, costs and potential adaptation benefits; if the necessity of adaptation projects is not clear (vague nature of climate change projections vs. concrete costs); and if compensation for net losers is inadequate.

At the current stage the meta-analysis synthesizes results from 17 studies comprising 229 distinct cases. Inclusion of more case studies will further strengthen the comprehensiveness of the results.

5. Conclusion

This article explores how institutions function to foster or impede the capacity of society to adapt to climate change in multi-level governance systems. It first provides a comprehensive, multi-tier conceptual map of determinants of adaptive capacity based on the review of the climate change adaptation literature and guided by the Institutional Analysis and Development framework (Ostrom 2005). This conceptual map serves as analytical heuristics for the subsequent meta-analysis of case study evidence about the complex relations between institutions and the capacity of society to adapt to climate change in multi-level governance systems. The meta-analysis makes a six-fold distinction as to which types of models have been found in the primary case studies: direct effects, undetermined effects, differential effects, moderator effects, conjoint effects, and mediator effects.

The meta-analysis (see section 4) presents several interaction effects between institutional characteristics, resources and actor characteristics on the one hand and adaptive capacity on the other. Taken together, two types of interaction effects can be highlighted of particular importance to the adaptive capacity (figure 3).

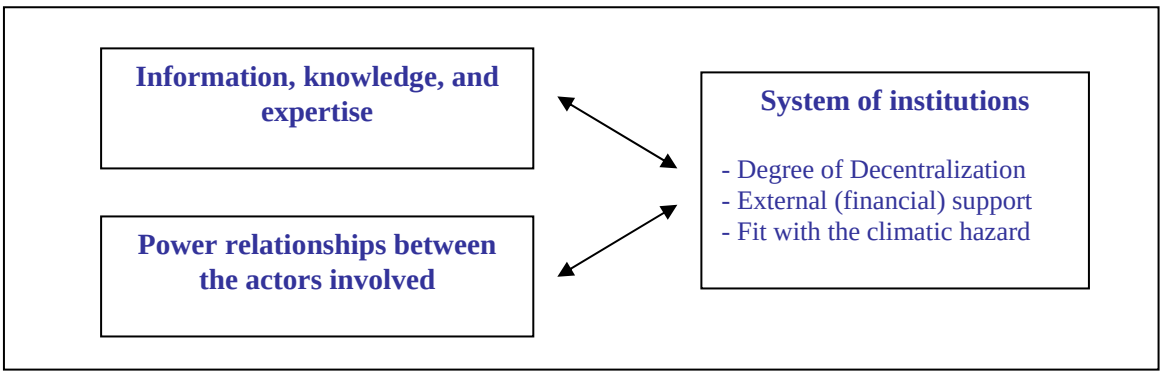

Figure 3: Interactions Effects between Actor Characteristics and Institutional System (author's compilation).

First, it becomes clear, that the information, knowledge and expertise available at different governance levels are important preconditions for effective adaptation. Consequently, the adaptive capacity depends on the assignment of adaptation responsibilities to governance levels where expertise is high and information and knowledge available. At the same time institutional arrangements may shape the availability of these resources and skills. Taken together it seems that there is not one optimal solution of centralization/ decentralization. Rather the governance system needs to show a fit between (i) its degree of decentralization, (ii) the existing information, knowledge and expertise at different governance levels, and (iii) the institutional effects on information, knowledge and expertise availability.

Second, an unbalanced distribution of power in local arenas has prevented to find easy, direct effect models for several institutional characteristics in the meta-analysis. One aspect these findings have in common is that an unequal distribution of local power will make it difficult to conceive of one overall adaptive capacity of the local arena. Unbalanced local power can reverse the enhancing effects of external support and decentralized decision making for those groups not well represented (moderator and differential effect model). Furthermore unbalanced power can stall social learning and impede the institutionalization of equally effective leadership.

In summary, institutions seem to be a crucial instrument for members of society to enhance their adaptive capacity by coordinating individual and collective action, shaping the generation and use of resources and shaping the capacity for individual and social learning. The results of this meta-analysis

suggest that the following principles for institutional design would enhance adaptive capacity of society:

1. Clearly allocated roles and responsibilities within and across governance levels.
2. Balancing power positions.
3. Define, implement and enforce secure property rights for goods and services.
4. Institutions should not only show a fit with the scope of the climatic hazard, but also with the expertise, knowledge and information as well as prevailing conflicts and power distributions at different governance levels.

Considering the adaptiveness of institutions and principles of fair governance, these characteristics tend to enhance adaptive capacity. However, there might be important trade-offs at play with the stability of rules and increased complexity of decision making, respectively. To investigate these trade-offs in more detail is one of the most interesting future research directions.

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