Archetypes of Adaptation to Climate Change

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Abstract. Management of social-ecological systems has to deal with highly diverse local or regional conditions. The same holds for adaptation to climate change, since the stimuli from new meteorological conditions as well as the affected bio-physical and socio-economic systems differ strongly from place to place. This may explain why little is currently done to moderate harm from current or expected climate change. However, learning from individual cases to improve adaptation in other cases may be crucial to reduce adaptation costs. This requires an adequate notion of generality, i.e. common patterns need to be identified without blurring local particularities. The archetype approach was developed for such tasks. The paper introduces the basic ideas, the history and some examples of this approach. The prime example is adaptation to climate change. To describe a set of archetypical barriers to adaptation, a precise definition of the concept is given within the action theory of adaptation. The following archetypes are discussed: missing frames of reference, moral hazard, poverty traps, mismatch of responsibilities, positive externalities and clash of interests.

Keywords. Social-ecological system, action theory, syndromes, barriers, public good.

Introduction

The potential impacts of climate change are expected to be substantial but regionally diverse. While it is highly certain that, for example, precipitation patterns will somehow change, it is not as clear which regions will become wetter or dryer. Depending on place, such bio-physical changes meet different socio-economic and institutional conditions and therefore have

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different effects. While the political debate on adequate reactions to this challenge has mainly focussed on mitigation of greenhouse gases as a means to avoid climate change, climate change is already occurring and will persist at least for decades. Therefore, adaptation to existing or potential changes has got increasing attention. The IPCC defines adaptation as "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (IPCC 2007: 869). It is also stated that „a wide array of adaptation options is available, but more extensive adaptation than is currently occurring is required to reduce vulnerability to future climate change. There are barriers, limits and costs, but these are not fully understood" (IPCC 2007b: 19). One example for such a barrier is the local diversity of impacts and vulnerabilities mentioned above. This makes it difficult for local decision makers to recognize the need for action and to learn through exchange with actors from other places (e.g. Lecocq and Shalizi 2007, Reckien et al. 2008).

The standard economic analysis frames the climate protection as a global public good, while adaptation is seen as a private good (e.g. Nordhaus 1990). Everyone profits from reduced damages due to slowed climate change, but the costs of greenhouse gas mitigation are only paid by those who protect the climate. Based on this tension, public goods are known to be insufficiently provided by private actors. Due to the global nature of the problem, a single government cannot resolve this problem. For adaptation, in contrast, it is claimed that costs and benefits both lie with those that adapt. These arguments imply that local, regional or business actors prefer adaptations over mitigation activities. In this light, the above proposition of the IPCC seems quite remarkable since it indicates the opposite of the theoretical expectation. The emergence of various bottom-up activities for mitigation during the last years (e.g. Cities Alliance 2007) further contributes to this puzzle. A further example is the „Schwarzenegger effect" (Urpelainen 2008), where the Californian government initiated international climate protection initiatives by bypassing the inactive federal government.

This paper is meant to contribute solving this puzzle and to understand barriers to adaptation that are not captured by the standard analysis. It starts from the hypothesis that the diversity of local conditions is one crucial barrier to adaptation. This hinders the transfer of insights about adaptation from one case to the other. There seems to be no single recipe that offers a general solution to adaptation barriers. A pessimistic consequence would be that adaptations to climate change have to be assessed case wise such that adaptation costs increase substantially. On the other hand there remains the impression that not every case of (potential) adaptation is utterly different,

but that typical local constellations hindering action re-appear. But how should one deal with locally diverse problems and solution contexts, if nevertheless common features can be identified? Can methodological proposals to deal with these questions help to understand local under-adaptation to (ongoing) climate change?

I address these questions by giving an overview of the archetype approach to interdisciplinary research about social-ecological problems. The approach tries to identify re-appearing functional patterns of change (archetypes) in a systematic way. Although until recently applied in other contexts, it is tailored for questions of the above type. I will sketch a preliminary set of such archetypes relating to barriers of adaptation. To become more precise on what I understand by adaptation to climate change and to give a clear description of the proposed archetypes, I introduce the action theory of adaptation as further ingredient.

The Archetype Approach

Local citizens and decision-makers are nowadays confronted with broad information on climate change, which is nevertheless difficult to comprehend, prioritize and process with limited resources or capabilities. If stakeholders have a basic problem awareness about an opportunity or a threat, they often ask whether they should react at all, and if so, what to do. However, blueprint solutions are often not available and successful practices depends to a high degree on the local context, bio-physical and socio-economic dynamics.

In principle, the context-dependence of social-ecological dynamics makes it difficult to draw *general* conclusions about determinants of effective governance. This view is established in the literature (e.g. Warren 2002, Schachhuber 2004), also on the level of ecological theory (e.g. Shrader-Frechette 1993). Institutional design principles meant to be generic can only reach their objective if they are formulated in a very abstract way (Schachhuber 2004) or over-simplify the conditions (Ostrom 2007). This requires considerable refinement when they are applied to concrete problems, raising the question whether they are of practical use beyond theory. On the other hand there are promising results, which do not represent a grand theory, but a collection of generic success factors (e.g. Ostrom 1990). It thus appears that many cases of (un)successful governance can be compared. To be useful for establishing best practices and transferring experience, such a comparison should not be too coarse-grained. This requires a notion of similarity on an appropriate level of abstraction.

A related challenge is the integration of knowledge from quantitative modelling with qualitative case study research. Quantitative analyses are

often criticized for overgeneralization since they disregard context by hiding processes behind data and variables. In contrast, qualitative studies are questioned for being vague and not transferable to other cases. This asserts a dichotomy between quantitative (statistical, mathematical, computational) and qualitative (interpretative, dialectic, hermeneutic) methods. Typically, quantitative work is identified with nomothetic, and qualitative with idiographic research (cf. Windelband 1919).

Archetypes are representative patterns of the interaction between society and nature bringing about global environmental change and/or being a response to such changes. They illustrate basic underlying processes and are made to draw connections between regions and to assist decision-makers recognizing their particular situation within a broad context. They are building blocks of social-ecological interaction that reappear in multiple case studies, meaning that they can be found at different places around the world because these places share certain conditions. Starting from the premise that every place is particular, speaking of reappearing patterns requires that the patterns are sufficiently abstracted to cover relevant properties of multiple specific cases. This abstraction should be general enough to be potentially found in more than one case, but *not* so abstract that it explains *every* case (which would make it meaningless). One criterion for the appropriate degree of generalization is the underlying assumption that successful institutional arrangements can be transferred between cases if they share archetypes. This approach is fundamentally different from deriving a grand theory that comprises all cases, and from idiographic descriptions of single cases that are not compared.

The usage of the term “archetype” starts from a vague sense that is similar to the use of the word “pattern”, although both terms are more crisply defined in different scientific domains (e.g. Kelso 1997). Its meaning refers to complex objects of cognition, for example as “ideas of modes and relations” (Locke 1690), but also to the common notion of a “primordial image, character, or pattern of circumstances that recurs throughout literature and thought consistently enough to be considered universal” (Encyclopædia Britannica 2006). The term does not refer to the psychology of Jung (1954), although he probably introduced the term for similar reasons. Speaking of an “archetype” instead of a “type” is justified since a pattern is not just a collection of entities that have common properties, but a complex of relations that re-appears in parts of multiple systems, even of different type. It is meant to deserve attention by being invariant on long time scales. Alternatively, we can use the term to denote a defining example for a certain type, and subsume different instances by similarity to this example. In this

sense, the notion of an archetype resembles that of an ideal type (Weber 1922). Then, reappearance of archetypes is not defined by being a member of the same abstract equivalence class of cases as indicated above, but by family resemblance (Wittgenstein 1953) to a paradigmatic case.

Archetypes are described as building blocks because it is not required that every case can completely be explained by a single archetype. That does not mean that single cases can be explained by different alternative archetypes, but that they cover social-ecological systems only partially. While one case can be considered as a functional unit of society-nature interactions and relations, each archetype covers only a selective part of these relations. For a comprehensive picture of a single case it is in general necessary to combine several archetypes. The above generalization criterion, which refers to shared archetypes, only makes sense in this context. When two cases can *partially* be described by the same pattern, this does not imply that they appear *completely* identical from the abstracted perspective.

For a more detailed presentation and discussion of the archetype approach see Eisenack et al. (2006). However, the basic ingredients of archetype analysis are not totally new. The motivation to distil general knowledge by comparative analyses is at least as old as modern science. The particular feature of archetype analysis is to understand the dynamics of social-ecological systems in a way as general as possible, but fine-grained enough to account for local particularities.

In systems dynamics, paradigmatic models of management problems were developed under the term of archetypes (e.g. Wolstenholme 2003). These models are formulated using causal-loop diagrams and aim at deriving generic solutions. These systems archetypes lead some authors to interesting distinctions of different ways of conceiving generic structure (Lane and Smart 1996). Ragin (1987) propagates Boolean analysis of qualitative data and selection of abstract variables for political science and history. His qualitative case study analysis (QCA) derives a general logical formula that explains all dependent variables of a selected set of cases. It can be equivalently transformed to so called disjunctive normal form, meaning that it is expressed like “the property described by the dependent variable holds for all cases where ... or ... or ....”, where a list of alternative conditions is linked by logical “or”. This resembles that not a single archetype can explain every case. Lambin et al. (2003) used a similar approach for extensive meta-studies to explain desertification and tropical deforestation. This work is also motivated by preserving descriptive richness of local case studies while contributing to a general understanding of the issue. Their comparative method identifies configurations of causes with similar outcomes. Ostrom (1990) and Ostrom (2007) develop a set of explaining variables and institutional design principles that contribute to the sustainable management

of the commons. Crucial in these approaches is their foundation in case study particularities and that they refrain from the determining a small set of variables that explain all cases. The variables need to be chosen in dependence of the particular management problem. The theory offers no generalized solution that fits all cases. However, the design principles finally derived hold for a broad set of commons, although not all of them are relevant in every situation. To understand the driving forces of urban sprawl and its environmental consequences, Couch et al. (2007) developed a set of four patterns of sprawl in Europe. In some of the cities investigated, several patterns apply. The patterns are associated with generalized policy recommendations.

A seminal example for an archetype analysis is the syndrome approach proposed by German Advisory Council on Global Change (WBGU 1993, Schellnhuber et al. 1997). Archetypes are identified as clusters of dynamic variables like “urbanization”, “increasing indebtedness” or “global warming”, called symptoms. These symptoms are relatively general in nature, allowing for case-specific refinement. For example, variables like “natural resources” can be specified as forests in one region and soil quality in another. These symptoms are related to each other by enforcing or dampening influences. Syndromes are then introduced to disentangle this web of relations by identifying sub-dynamics of closely related trends, such that the overall dynamics can be decomposed by appropriate syndromes. This resulted in 16 clusters, called Syndromes of Global Change, some being called utilization, some sink and others development syndromes. The syndromes were refined by developing quantitative indicators for their intensity and their disposition (Lüdeke et al. 1999, Kropp et al. 2001, Lüdeke et al. 2004). The former refers to the actual occurrence of syndromes in a specific region, while the latter to the potential that a syndrome may occur if certain exposition factors trigger a problematic development in the future.

By working with this method, two ways of defining a pattern of global change are possible: as a network of relations (which may bring about a set of scenarios), or as a set of scenarios (which may be explained by a relational network). In many modelling studies it was observed that relational networks that initially appeared as problematic can also produce positive scenarios under some conditions, making the term “syndrome” inappropriate. It is thus currently proposed to clarify the terminology by calling the relational network an archetype, and denoting solely the problematic scenarios consistent with the archetype as syndromes, while positive scenarios are called paradigms. Based on this distinction, refined research questions about the conditions leading an archetype to syndromes

or paradigms can be posed. It appears that the inter-locking of problematic trends is a central category to understand such conditions. If a case comes into a configuration with self-enforcing trend combinations, it can irreversibly "snap" into a syndrome or paradigm (Eisenack and Petschel-Held, 2002, Eisenack 2006). The analysis concentrates on clusters of mutually stabilizing trends that have the potential to bring about persistent dynamics that are judged as positive or negative according to normative specifications of the study.

Subsequently, the syndrome concept was further developed, in particular to strengthen the case study perspective. The Sahel syndrome and the overexploitation syndrome were investigated in more detail (Sietz et al. 2006, Kropp et al. 2006). The methods for describing syndromes were improved using qualitative differential equations (QDEs, Kuipers 1994). One interesting feature of this formal method is that it merely uses the causal-loop diagram (cf. Richardson 1986) as input, such that no quantities or mathematical functions have to be defined. Theoretically speaking, a causal loop diagram subsumes a broad set of cases, where, for example, a certain dampening influence may be weaker or stronger. They thus define a functional building block that can be applied to all cases where only the so-called polarity of influences (dampening or enforcing) fits (see Petschel-Held et al. 1999, Petschel-Held and Lüdeke 2001, Eisenack 2006).

An improved approach, already under the term "archetypes of vulnerabilities", was developed for assessing the vulnerability of human-environment systems to environmental and socio-economic change within the 4th Global Environment Outlook (UNEP 2007) and current follow-up research (Lüdeke et al. 2007, Kok et al. 2008). Archetype analysis is used to identify challenges and opportunities of cross-cutting environmental and social processes related to different components of human well-being. The degree of abstraction is determined by coherent technical and policy options to respond to the challenges and opportunities. The target is to provide responses that reduce vulnerabilities while protecting the environment. Organized around such responses, the non-exclusive list of archetypes relates to global commons, contaminated sites, drylands, energy production, Small Island Developing States, technological fixes for water shortage and urbanization in coastal zones. Each description is supplied with a list of potential responses that may help to reduce vulnerabilities. It is assumed that they can be considered as potentially successful if the basic problem description applies. The archetypes are brought about by environmental and socio-economic changes and conditions that create vulnerabilities. The problem descriptions exhibit the basic properties of archetypes: they refer to reappearing issues, e.g. the atmosphere or deep sea fisheries as global commons. They can be shared by multiple case studies, e.g. (rapid and

poorly planned) coastal urbanization in various agglomerations around the world. Finally, they are abstract descriptions to be capable of referring to generic problems. For example, technological fixes for water problems analyze the consequences of different large-scale options as canalization of rivers, large desalinization plants and dams. It is claimed that they can be subsumed under one archetype since successful responses can be transferred between these sub-types. The description concentrates on dams that are justified as prime examples for this archetype.

The Action Theory of Adaptation

To analyse adaptation to climate change in a systematic way using archetype analysis, it is necessary to clarify the understanding of adaptation in this paper and to introduce some concepts for more precise discussion. By restricting the analysis to adaptations that are exercised by human actors, adaptation can be framed as a kind of action. Thus, established theories of action can be used. In analytical philosophy, action is defined to be an act, exercised by an actor with an intention (e.g. Wilson 2008). We thus propose to use the following concepts for discussing adaptation. By an *impact* of climate change we understand a stimulus, i.e. changes of bio-physical (in particular meteorological) variables triggered by climate change that affects an *exposure unit*, i.e. actors, social or non-human systems. An *operator* is a (collective) actor that exercises an adaptation. For that, the operator employs *means* (e.g. material resources, legal power or social networks) to achieve certain intended ends. These ends are associated with (other) actors, social or non-human systems, called *receptors* of an adaptation. Receptors may be exposure units or not. Note that actors are inter alia employed with values, beliefs, norms and means, being important to understand or to evaluate adaptations. The distinction between *available means*, *employed means* (for an action) and *necessary means* (for an action) can be crucial. This terminology is rooted in the "action frame of reference" (Parsons 1937), that analyses actions by the actor, the ends, the situation, and the mode of relationship between these elements. The situation is decomposed into the conditions, referring to those elements the actor cannot control, and the means, which can be controlled. The ends of actions can be made more specific for our purpose, since they are directly or indirectly targeted at actors or systems that are influenced by changes in climatic conditions. We explore this direction by building on parts of the established Driver-Pressure-State-Impact-Response-Framework (DPSIR, e.g. OECD 1993, EEA 1999). Here, consequences of climate change are described according

to the concepts of state, impact, exposure unit, and response. In the context of adaptation, the responses are the actions defined above. An impact is caused by a change in the state of bio-physical conditions that influences an exposure unit which is sensitive to the change to some degree.

As a simple example, consider public information provision on risky travel behaviour with respect to e.g. heavy rain. This may be motivated by increasing frequency and strength of precipitation extremes. Information provision is not a concrete action, but may facilitate concrete actions to reduce harm by individual and voluntarily behaviour changes (e.g. using other modes of transportation after specific weather forecasts). Here, the stimuli are the changed extreme values of precipitation, and the exposure units are users and providers of transportation. The operator is a public body that collects and provides the information, being the means of the action. The intended end is to change behaviour of transport users, making them the receptors. Here, the receptors are a subset of the exposure units. The situation becomes more complex when we further consider the action of a political administration that sets up the public body for information provision. This is a further action that should be distinguished from information provision itself. The stimulus and the exposure units are the same, but the operator is now the political administration, employing legal means and financial resources for implementing the public body, that now has the role of a receptor. In this case the receptor is distinct from the exposure units. It is intuitive to see that the roles of operators, receptors and exposure units may be combined in very different ways.

It is necessary to provide some further explaining remarks on the above definitions. (1) When adaptations directly change the sensitivity of an exposure unit towards a stimulus, the exposure unit is identical with the receptor of that action. However, as the example illustrates, there can be meaningful measures that are only instrumental in the sense that they provide the means for other adaptations that would be impossible or difficult otherwise. Means and ends tend to come in chains where the effect of one action is the pre-condition for another one. Based on this, one might object that nearly every action can be classified as an adaptation, since it is not required that the receptor of the adaptation is not affected by stimuli from climate change. I avoid this problem by calling only those instrumental actions adaptations where the means-ends chain ends up at some unit that is exposed to a stimulus. (2) By speaking of actors we mean both individuals and collectives of individuals. This is necessary to represent e.g. households, companies and public bodies as actors, all playing an important role for adaptation. (3) The term “exposure unit” has to be so abstract to reflect the broad variety of actors, objects or systems that can be affected by climate change.

In sum, we understand adaptations as (collective) actions, directly or indirectly intended to change the way how actors or systems are influenced by climate change. The proposed definitions are a formal refinement and extension of the clarifying questions “adaptation to what?”, “who or what adapts?”, “how does adaptation occur?” (Smit et al. 2000). The first question characterizes the ends of an adaptation in terms of the stimulus that affects the considered exposure unit. The second question asks for the operator, and the third requires a description on how means and ends are interlinked. A fourth question by Smit et al. (“what adaptations are recommended?”) partially refers to the values and norms of the action frame of reference.

Archetypical Barriers to Adaptation

In this section I give a brief overview of the state of the art of adaptation to climate change. Based on a literature review, the archetype approach and the action theory of adaptation are applied to hypothesize about archetypical barriers to adaptation. In contrast to the expectations from economic theory outlined above, in many cases adaptation activities can only be observed to a very limited degree, even if compared with mitigation. The document review of Eisenack (2009) indicates that: (i) many economic sectors perceive and expect climate risks, (ii) mitigation partially plays a substantive role on the local level, due to governmental activities but also due to local initiatives, (iii) adaptations are often neither discussed nor consciously exercised. In many cases impulses for adaptation come from governmental actors and are unclear, only have the character of requests or targets. This is confirmed by the review of Reckien et al. (2008) for the transport sector, and in line with the study of Ott and Richter (2008) about market opportunities for German companies due to adaptation. For developing countries, the UNFCCC (2007) concludes that although awareness for climate risks has increased, adequate knowledge for action is still in a state of infancy. Although there are some existing adaptation projects, their implementation is often difficult due to informational and capacity limits.

This result gives rise to the question of what hinders adaptation to climate change on the local level. Using the archetype approach for this task is motivated by some crucial characteristics of climate change consequences, in particular:

1. Uncertainty: the type and degree of future climate impacts is highly uncertain due to unpredictable effects of future global climate policies and due to the difficulties of downscaling global climate change to local

effects, in particular with respect to extreme events. However, knowing about local effects is crucial for local measures.
2. Spatial diversity: many climate change stimuli strongly differ, even between adjacent regions. Moreover, the bio-physical and socio-political conditions these stimuli meet are very diverse as well.
3. Bio-physical complexity: even in single regions there is usually a broad set of exposure units that are affected in different ways and degrees.
4. Social complexity: exposure units are interlinked in multiple ways such that some adaptations affect multiple different receptors (not all of them exposure units) in a different way.

In short, to understand adaptation, a high diversity of local contexts needs to be considered. The archetype approach is specifically designed for such situations.

In the following I hypothesize about potential archetypical barriers to adaptation (and one paradigm) based on different literature studies (in particular Reckien et al. 2008, Eisenack 2009, Eisenack et al. 2009, Hilpert et al. 2007, Eisenack et al. 2007) and a theoretical paper of Lecocq and Shalizi (2007). The current paper does not present an operationalization and validation of these archetypes, since this is ongoing and future work.

(1) Missing Frames: Adaptation needs are only marginally discussed. This can be characterized as a situation where no operator for adaptations exists although there may be a vague problem awareness. This hinders adaptation although action is not constrained by limited means, and potential actors' (values) do not oppose action. This is caused by missing frames of reference to approach climate risks. Typical cases can be the framing of the climate problem as a mere mitigation challenge, or considering climate risks as a special case of natural hazards. In consequence, it becomes difficult to discuss, propose or even think adaptations, such that no operator occurs. This may be partially explained by (i) high information costs, (ii) social habits and (iii) normative standards. The first reason relates to the uncertainties and spatial diversity indicated above, making it difficult to see the need for action in a clear way even if the climate is already changing. Social habits can induce indolence if relatively new phenomena as climate change are put into established frames that may be not (completely) feasible any more. Normative standards in the public debate on climate change put a strong focus on justice, as in the form of the polluter-pays-principle. This requires a higher priority for mitigation activities, although it might be a matter of prudence and responsibility to complement them with adaptations. In these cases public information provision and mainstreaming of adaptation in sectoral policies may resolve this archetype.

(2) Moral Hazard: Risky projects are undertaken against better knowledge. This archetype shall explain why in many cases settlements are

(re)built in high risk areas (e.g. due to flooding). Investors push planning decisions towards their own favour, since they expect public compensation in the case of a hazard. Strained municipal budgets or local development may enforce this process: municipalities may be interested in not loosing investors after disasters. Analytically, the exposure units (investors) are different from the (potential) operators, namely public authorities. They can expect to be receptors of means (compensation). Since the exposure units themselves would have the means to adapt as well, there is a mismatch of incentives, i.e. appropriate operators and means are available, but not employed. Efficient responses seem to be efficient legal settings, e.g. building codes and clear liability rules with appropriate care standards.

(3) Poverty Traps: Inability to adapt although there is high pressure. When there are motivated operators (being exposure units at the same time), but capacity or budget constraints hinder appropriate adaptation (the necessary means are not available), there is a risk of poverty traps. The resulting under-adaptation can result in damages from climate change, making budget or capacity constraints even tighter, thereby entering a vicious circle. This archetype is crucial, in particular, for many developing countries that are disproportionally exposed to climate change and already have limited capacities to cope with other severe stresses. The risk may be most threatening for people already living on marginal land. In this case, the means need to be made available, be it by external support (with its own problems) or the appropriate local or regional institutional arrangements to improve access to missing resources.

(4) Mismatch of Responsibilities: Power to act is not assigned. Although there are (multiple) exposure units and actors that could take the role of operators, there is no actual operator of adaptation, since they all see the responsibility with other actors. It is unclear who has the duty or legitimacy to be the operator. This can refer to complaints about missing horizontal coordination between sectoral policies (possibly seen to be blocked by the other side), or to a shift of responsibilities to higher institutional levels, since local constraints for implementing adaptation measures (missing means) are seen as too strong. A third version can be institutionalized information flows or discretionary power between different organisations that may be well working in situations with a long experience, but not for climate change. Here, measures to restructure work-flows and responsibilities may be helpful.

(5) Positive Externalities: Less than possible is done. Actors may choose to under-adapt when a part of the burden of under-adaptation can be shifted to others. Consequently, the necessary means are not employed although

they are available to the operator. This is due to the existence of multiple exposure units that are positively affected by the same action, although only one (the operator) is receptor of the adaptation. An example can be privately owned infrastructure, where high fixed costs are involved to improve its resilience against weather extremes. Then, during times of infrastructure failure, damages occur for the infrastructure provider and its users as well (e.g. costs of traffic delays imposed on a railway company and on travellers). Since it is difficult to price in fixed costs, the infrastructure provider only adapts to reduce its own damage. The role of the public is crucial to resolve this archetype by requiring appropriate care standards or organizing side payments.

(6) Clash of interests: Local conflicts and adaptations with negative side effects hinder decision-making. With multiple operators, the necessary (and available) means may be not employed because proposed adaptations have multiple receptors with possibly costly side effects. An example are land use zoning policies that try to improve coastal protection against sea level rise and storm surges and require changes in land-use, e.g. re-settlement of flats. Negative externalities on the local level may cause additional adaptation costs, not only for exposure units. In this case, willingness, power and legitimacy to adapt may mismatch. Depending on the institutional settings this may result in the inability to reach majorities in local negotiation processes. Such problems may be resolved by trust-building or participatory approaches, but also by new powerful and legitimate actors and by side payments to compensate negative externalities.

(7) From the bottom and the top: A fit of local change agents and support from higher institutional levels promotes adaptation (paradigm). Local operators have the knowledge about necessary means and receptors, but no mean available. These are provided from operators on the regional or national level. An example are highly motivated spatial planners that do not have the budgets or capacities to make informed adaptation decisions, but are provided by climate change scenarios by the government. It might as well be that new national legal arrangements allow these planners to prohibit settlements at risky places. This paradigm can be just the opposite of the Mismatch of Responsibilities syndrome.

Of course, this list is neither complete nor exclusive. It is a starting point for further research that bears the promise to disentangle and sort the broad diversity of adaptation barriers and promoters observed in practice.

Conclusions

This paper introduced the archetype approach as a method to abstract from multiple and diverse case studies towards a comprehensive set of patterns on

an intermediate level of generality. As prime example in this paper, this approach was applied to the understanding of barriers (and potential promoters) of adaptation to climate change. Based on a definition of adaptation to climate change within the action theory of adaptation, a set of archetypical barriers (with currently hypothetical status) is presented. It is based on a qualitative survey on the state of the art in adaptation to climate change and its limitations.

The application of the archetype approach is justified by the broad variety of local and regional social-ecological systems that need to be considered to understand adaptation to climate change. In contrast, mitigation policies to reduce greenhouse gas emissions seem to be structured in a simpler way: there, the society-nature interface is mainly structured by main emitters of a small set of relevant greenhouse gases. The impacts of climate change are, in turn, more diverse and entangled. It seems that there are no simple instruments or policy target to achieve a responsible level of adaptation. There is no established common metric for a "degree of adaptedness", and there are serious doubts about whether it will ever exist (Klein et al. 2003, Lecocq and Shalizi 2007). This would leave us with the sceptical conclusion that there can be no general adaptation policy and the associated problems have to be solved independently for every case. The archetype approach offers to identify at least weak generalisations for the transfer of policies that do not take the form of a panacea, but may improve the task of adapting to climate change by learning from similar examples. The patterns shown in this paper should illustrate this claim.

Of course, the diversity of social-ecological systems is not only crucial for adaptation, but for other sustainability problems as well. There is no general first-best instrument for natural resource management, but structurally similar resources in similar social contexts may deserve similar solutions. Although there are no two ecological systems with completely identical features, there may be at least some of them that share enough properties to be governed in comparable ways. Poverty-generating social and ecological conditions may be too diverse to be solved with only one instrument, at least if it is not formulated in such an abstract way that it becomes meaningless. But there may be re-appearing impoverishing situations that can be addressed by the same policies. I hope that the presentation of the archetype approach in this publication motivates further use of the concept in the multiple contexts where it may be applicable.

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