An Action Theory of Adaptation to Climate Change

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1 Introduction

Due to an (effective) global environmental agreement on climate change becomes less likely in the short-term, adaptation to the inevitable consequences of global warming is now getting further emphasis. Although adaptation research is rising on the scientific agenda, this interdisciplinary field is still characterized by an evolving epistemological base. It is often difficult to operationalize theoretical concepts for concrete research design. There is wide recognition that there are crucial barriers to adaptation, but a comprehensive set of theories that explain this observation is still not in sight. The purpose of this paper is thus twofold. We first want to contribute to the clarification of the concept of adaptation in a way that makes theory applicable for designing adaptation assessments. Second, we want to supply some new ingredients to the theory of adaptation that allow for the systematic construction of meaningful hypotheses about barriers to adaptation from an action-oriented view.

There is a broad set of theoretical literature that reflects on the relation between adaptation, vulnerability and resilience. We can only mention some examples. (Brooks, 2003) is careful in considering the difference between (actual) adaptation and adaptive capacity (potential adaptation that is not necessarily actual). This distinction is underlying much of the literature on vulnerability, although it is not always clearly stated. He further differentiates between social and biophysical vulnerability. The latter case refers to the consequences of a hazard, while the former is a property of the exposed system independently from the hazard event. In this framing, biophysical vulnerability is a function of hazard and social vulnerability. Adaptive capacity is the potential to reduce social vulnerability by realizing adaptations, that in turn decreases biophysical vulnerability. In a similar vein, (O'Brien et al., 2007) distinguish outcome vulnerability and contextual vulnerability. The former takes vulnerability as the residual effect of climate change after adaptive responses have been taken. Contextual vulnerability puts the exposure unit into the center. Adaptation to climate change can be targeted at changing contextual conditions or at reducing damage. Distinctions like this are broadly discussed in the literature. The resulting diversity of vulnerability definitions motivates a systematization by (Füssel, 2007b). He also argues that the distinction between potential adaptation

(adaptive capacity) and actual adaptation is needed to reflect the temporal dimension of climate change. Adaption is said to rely on information about the vulnerability to climate change. In this interpretation, vulnerability is neither partially determined by available adaptation options (which would be the case for outcome vulnerability), nor can adaptation change vulnerability (as in contextual vulnerability). Also (Kelly & Adger, 2000) (by recurring on Blaikie 1994) distinguish between biophysical and social conceptions of vulnerability. They define vulnerability by the *ability* of individuals or social groups to adapt to external stress (p. 328). Note that this refers to potential adaptations. They also state that "adaptation is facilitated by reducing vulnerability" (p. 348). Putting this together implies the statement that (i) actual adaptation reduces vulnerability, and consequently (ii) increases the potential to adapt (a sentence that probably needs to be read twice). (), in contrast, try to integrate social and biophysical vulnerability by adopting the perspective of coupled social-ecological systems. This lets the concept of resilience entering the stage: Similar to the (IPCC, 2001), vulnerability is a function of sensitivity, exposure and resilience. The latter is partially determined by adaptation and is seen as related to the concept of adaptive capacity. () is a further example for linking the adaptation with the resilience discourse. They define adaptation by decision-making processes and actions that enhance adaptive capacity. In contrast to this, it is also defined that adaptive capacity encompasses the enabling conditions for adaptation. Adaptive capacity is one component of resilience. While resilience approaches are oriented toward system properties that enable action, actor-oriented approaches mainly view that "adaptation is concerned with actors, actions and agency" (p. 398). System characteristics determine adaptation processes that can result in adaptedness as outcome. They point out some key areas for research to improve adaptedness, in particular the identification of barriers to implementing adaptation and the governance of adaptation. Last but not least, (Ionescu et al., 2008) undertake some effort to obtain a very precise definition of vulnerability. This sees adaptation as the values of control variables that avoid a system from becoming vulnerable. The adaptive capacity is the set of possible values that can be selected as adaptations. The literature that tries to disentangle these different interpretations of vulnerability is quite complex, and some of the above authors critically reflect on whether this effort is indeed productive. The complexity of concepts, to our opinion, arises from the difficulties with keeping potential and actual action apart, and with the sometimes unclear descriptive or prescriptive research motivation. We argue that it would be more helpful to concentrate on the basic ingredient of this discourse: adaptations as singular actions that are exercised by actors. Being more decent in this respect might be more clear-cut and productive.

There are other alternative approaches that are more decision-oriented. Although (Burton et al., 2002) and (Lim & Spanger-Siegfried, 2004) see a prominent role of the vulnerability concept, they give it an instrumental, "subordinate" role. Instead, they consider the design of adaptation assessments. In accordance with the (IPCC, 2007), they distinguish autonomous adaptation, being a component of vulnerability, and planned adaptation targeted at reducing impacts of climate change or reducing vulnerability. Vulnerability is a function of exposure, sensitivity and adaptive capacity. Adaptation comes more to the center of the proposed framework because there have always been adaptations to climatic *conditions* that offer a starting point for identifying specific adaptations to deal with climate *change*. () analyze in their seminal paper the following crucial components of adaptation. First, climate disturbances that affect a system under consideration provide the reason for adaptation. Both the characteristics of the biophysical disturbance and of the affected system are relevant for adaptation. Adaption is a response to climate change, that can be environmental change or human action. The latter can i.a. be distinguished by the intentions of the action (e.g. purposefully

or only incidentally addressing climate change) and by actor type (e.g. public or private). A similar analysis is provided by (Smit et al., 2000). They pose four core questions. “Adaptation to what?” refers to climate-related stimuli that affect a “sensitive system” or “exposure unit”. The exposure unit and its characteristics are specified by answering “who or what adapts?”. An exposure unit can both be a biophysical or social entity. It is acknowledged in a short note “… that ‘who’ and ‘what’ are not necessarily synonymous. For example, actions by forest managers (who) may result in adaptations in a forest (what)” (p. 236), but that relation is not further investigated. The third question, “how does adaptation occur?”, refers to some classifications that take a descriptive view on adaptation (e.g. (Carter et al., 1994)), in particular the intent, timing, localization and type of measures. Finally, “how good is the adaptation?” requires the evaluation of measures. These contributions provide a good basis for understanding adaptation and propose some crucial variables for adaptation theory. They are, however, less comprehensive in drawing conclusions for the governance of adaptations. One starting point could be to further refine the role of the systems or actor that adapt, and to refine the concepts about the *process* of adaptation. Although several papers informally characterize adaptations as “actions”, there is little work that explicitly exploits this framing. (Pelling & High, 2005) consider social capital as a determinant of adaptive capacity. They categorize adaptive interventions by being material or institutional, and by being purposeful or incidental. (Bohle, 2001) shortly mentions a role for action-oriented approaches to adaptation with a reference to Giddens’ relationship between structure and agency. This allows to analyze how means and ends of adaptations are interlinked. (Jetzkowitz, 2007) explores, with reference to Parsons, the norms and conditions that shape adaptive action in a particular application to tourism.

Our paper takes up this thread by expanding the analysis of (Eisenack, 2009). We will detail out the questions “who or what adapts?” and “how does adaptation occur?” by framing adaptation as (collective) action. In doing so, we will refrain from using the difficult terms “vulnerability” and “adaptive capacity”. By referring to established theories of action we want to clarify the meaning of adaptation in an applicable way and to derive potential barriers to adaptation. This should help to design adaptation policies or instruments. We thus restrict ourselves to adaptations that are exercised by human actors.

2 An Action Theory of Adaptation

This section first introduces the basic ingredients of the action theory of adaptation and then relates them to other theories. Some examples to illustrate concepts are taken from (Stecker et al., 2010), (Eisenack et al., 2010) and (Eisenack, 2009).

2.1 Core Concepts

The IPCC definitions and the analysis of (Smit et al., 2000) motivate adaptation by (potential) environmental stimuli that affect given entities, subjects or systems. Adaptations are processes of entities and systems, or adjustments of human systems. In our approach we are more specific by referring only to human systems, individuals and collective actors. This lends to the following outline of the action theory that can partially be built around established concepts (see Fig. 1). Action

requires actors and an intention. The intention is directed towards an impact of climate change. Furthermore, adaptations require the use of resources as means to achieve the intended ends. This outline will be detailed and qualified in the following.

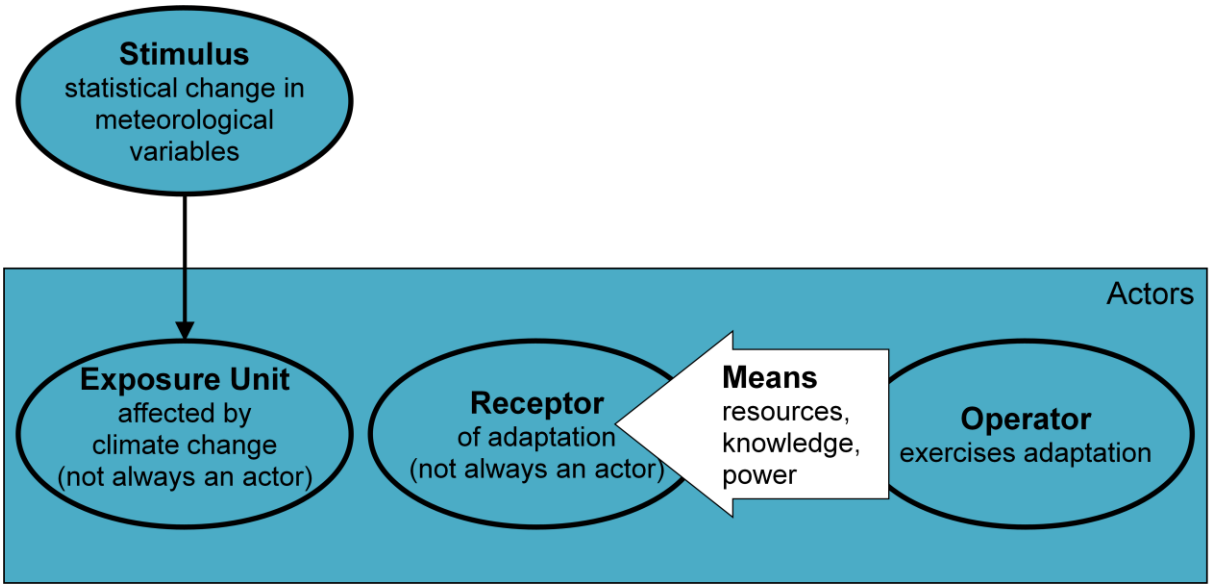

Fig. 1: Schematic representation of some core concepts of the action theory of adaptation. Exposure unit, receptor and operator can be actors. They are not necessarily identical. (Further explanations in the text.)

A *stimulus* is a change of biophysical (in particular meteorological) variables triggered by climate change. In a very precise meaning, this has to be distinguished from weather events. Stimuli refer to new statistical properties as averages intensity, higher momenta, or frequencies. They can also refer to abrupt large-scale events in the earth system. In many practical cases it is yet not relevant to insist on this distinction. There is also a difference between meteorological effects as temperature and precipitation patterns on the one hand, and more or less indirect effects as sea level rise or a changed frequency of river floods (we further discuss this issue below).

A stimulus is only relevant for adaptation when it influences an *exposure unit*. The latter term broadly refers to all those actors, social, technical or non-human systems that depend on climatic conditions, and are therefore exposed to stimuli. The abstract term is necessary to encompass the broad diversity of affected entities or systems that may be considered in an adaptation study. Although we are concerned with an action theory here, we explicitly do not restrict exposure units to human systems.

By an *impact* of climate change we understand a combination of a stimulus and an exposure unit. More broadly, it can be a set of stimuli with an associated set of exposure unit. For example, a reduced energy production of a thermal power plant (exposure unit) due to more frequent scarcity of cooling water (stimulus) is an impact. This is not a quantitative definition, e.g. in terms of a damage measure. Such a measure is not needed in the following, but might be a relevant extension.

In the following we want to illustrate the different concepts with an example for an adaptation. Consider a public early warning system that informs about upcoming extreme weather conditions (say, heavy rain) that bear risk for using specific transport modes (e.g. travelling by car, bicycle or by foot). This adaptation may be motivated by the impact of more frequent precipitation extremes (the stimulus) on transport safety. The exposure units are users of the mentioned transportation modes.

In the DPSIR-Framework (OECD, 1993, EEA, 1999), the stimulus refers to the state (S). An adaptation is the social response by an individual, as set of individuals or an organization in the broadest sense. The (collective) actor that exercises the response is called the *operator*. We need this distinct term, since actors will also play other roles in this theory (see below). An operator can thus be, e.g. a private household, a firm or a government. But it needs to be social entity, so that machines, artifacts and natural systems are ruled out to be an operator.

Not all activities of an operator are actions. Only those activities with a *purpose* qualify for this term. The operator tries to achieve intended ends that are associated with (other) actors, social or non-human systems. The ends are ultimately targeted at impacts (see below for a further discussion of this statement).

The actor or system that is addressed by the purpose of an adaptation is called the *receptor*. Receptors can be both biophysical entities (e.g. the crops of a famer) and social systems (e.g. the farmer household), depending on the objective of analysis. It is further not required that the receptor of an adaptation is an exposure unit at the same time. This is a crucial point as will become clear in what follows.

We illustrate this with the early warning system example. The operator is a public body that runs the system. It collects weather forecast and transmits them to the public in an accessible way. The purpose of that adaptation is to reduce harm to individual transport users (that might use other modes of transportation or avoid travelling in the case of a warning). The intention is to change behaviour of transport users, making them the receptors. The public body is not the relevant exposure unit (it is not affected by heavy rain), but the receptors of the early warning system are exposure units.

The emphasis of the purpose begs a comment. There are, of course, many social phenomena that do not follow a purpose. In this case, we do not call them actions, but mere processes. *Processes* are sequences of events in time that may occur to a biophysical, technical or social entity or system. They can be framed as linked through causality or in a mechanistic way. Actions are a special case of social processes that additionally have a teleological component (cf. (Weber, 1922) and the discussion in the next section).

To exercise the adaptation, the operator needs resources, called *means*. This can be access to financial or other material resources, legal power, social networks, knowledge and availability of information. Action is further shaped by constraints and resources that cannot be controlled by the operator. These are called the *conditions* (cf. (Parsons, 1937), see next section).

In the example, the primary means employed by the operator of the early warning system are the information that is provided to the receptors. Further means involved are the public funding and the education of the people running the system, but these are not channeled to the transport users. Examples for conditions are the attitudes of the receptors toward the early warning system (Do they

actually listen to the forecasts? Do they trust the forecasts? Does information lead to behavior change?) and the legal context for the operator (Is there a stable funding? Are operators liable for wrong forecasts?).

It is helpful to further differentiate three notions of means: *available means, employed means* and *necessary* means. Available means are those that are disposable by the operator, while the employed means is that part that is actually used for a specific adaptation. That does not imply that the adaptation is effective, since success requires the use of the necessary means – these might be available or not. It is important to note that these three types of means are not compulsory identical.

In the early warning system, there is probably the capacity to provide more detailed information (available means) than is currently done (employed means). However, the conditions of the transport users, e.g. missing willingness to draw attention to the warnings, may additionally require the temporary closure of certain roads to achieve the desired effect – other means than just information are necessary.

2.2 Complex Concepts

Based on the above concepts, further crucial characterizations can be made.

The most straightforward adaptations might be those where the receptor is an exposure unit at the same time: the purpose of the action is to improve the situation of a system that is affected by a climate stimulus. We may call this direct adaptation. In contrast, it may also be meaningful to consider actions where receptor and exposure unit are not identical. Then, adaptations are instrumental in the sense that the action might enable the receptor to take further measures, and only these are finally targeted to an exposure unit. It might be necessary to provide an actor with resources such that she has enough available means. The early warning system is a direct adaptation, since the receptors of the information are the transport users that are exposed to the weather. An instrumental adaptation would be, for example, an internal reform of the system to improve its quality. This action is only indirectly targeted at the exposure units. A distinction between direct and instrumental adaptation has some similarity to the difference between material and institutional intervention (Pelling & High, 2005).

Also operators and receptors do not need to be identical. When operators act with the purpose to change something for other actors or biophysical systems, this is called a facilitating adaptation (cf. (Hinkel, 2007)). If the purpose of the operator is to change something for herself, we can call this a reflexive adaptation. The early warning system is a facilitating adaptation, since it is distinct from the transport users (the receptors of the adaptation).

More closely investigating the case of the early warning system shows that the public body for information provision was set up by a political administration. This is a further adaptation that can be distinguished from the early warning system itself. 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. The stimulus and the exposure units that motivate the adaptation are the same as before, but not distinct from both operator and receptor. The action of the political administration is thus an instrumental and facilitating adaptation. It is intuitive to see that the roles of operators, receptors and exposure units may be combined in very different ways.

One might object that by admitting instrumental and facilitating adaptations nearly every action can be classified as an adaptation, since it is not required that adaptations improve the situation of an exposure unit towards a stimulus from climate change. Depending on the objective of research we might narrowly consider only direct adaptations, since only those obviously affect exposure units. The relevance of instrumental and of facilitating adaptations yet illustrates a basic property of social actions: means and ends tend to come in chains where the effect of one action is the pre-condition for another one. It might thus be practicable to consider (again depending on the research objective) only those adaptations where at least one means-end chain ends up in an exposure unit. This is, by the way, structurally similar to cause-effect-chains that might link direct and indirect impacts. Also here it depends on the boundaries of analysis whether only first and second order stimuli are considered (e.g. precipitation change or sea level rise), or also higher order stimuli (e.g. coastal flooding, closed harbor due to flooding, economic losses due to close harbors etc.).

A further distinction relates to the purpose of adaptation and a probably missing (ultimate) exposure unit. The literature already considers purposeful and incidental adaptations (Pelling & High, 2005). There a many actions that are not explicitly termed as adaptation, but nevertheless have strong (harmful or beneficial) side effects with respect to consequences of climate change. The purpose of such actions is not linked to any exposure units, not directly and also not instrumentally. It might be, however, that by interpreting the action just as a process it has a beneficial influence on an exposure unit with respect to a stimulus. It is an adapting process that the operator is not aware of. We propose to call the latter implicit adaptation, while the more straightforward case is denoted as explicit adaptation. Should actions that are only implicitly linked to exposure units be regarded as adaptations at all? The decision again depends on the research objectives.

2.3 Theoretical Background

For the core concepts of the action theory of adaptation it is not sufficient to consider social processes alone, as might be appropriate for a purely sociological issue. For investigating adaptation to climate change, we need to discuss the relation of actions beyond social processes and actions, since the interlinkages to the natural environment are crucial. We have to deal with an interdisciplinary problem of interlinked bio-physical and socio-economic systems. One of the straightforward options is the link to the Driver-Pressure-State-Impact-Response-Framework as already indicated above (DPSIR). The consequences of climate change are described according to the concepts of stimulus, impact, exposure unit, and response. The DPSIR framework is not without criticism, in particular due to the very 'linear' model it suggests. We nevertheless think it to be a good starting point for the action theory, because we only adopt that part of the framework that is structured by biophysical causality. Our approach remains compatible with conceptions of contextual vulnerability ((O'Brien et al., 2007), see introduction), since it is possible to focus on the means and conditions for operators independently from the actual occurrence of stimuli.

The definition of action as being the subset of social processes ('acts') that are associated with intention is established in analytical philosophy (e.g. (Wilson, 2008)). The further 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. Action is further shaped by norms and values (not discussed in our

theory yet). 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. Parson's action theory is not without criticism. With its focus on norms and values, it has been accused for being politically conservative by disregarding changing conditions. The action frame of reference is yet only one conceptual base of this theory. It is an established reference point for discussing alternative action theories.

3 Applications

3.1 Barriers to Adaptation

By combining the implication of the introduced concepts we can identify likely reasons that might limit the implementation of adaptations. It is, of course, an empirical matter of one or more of the following barriers to adaptation apply in a specific case. We nevertheless expect from the action theory of adaptation that it likely that these barriers will appear quite often. These barriers may be compared against those generally proposed by (Füssel, 2007a), and by the economic analysis of (Lecocq & Shalizi, 2007):

- There is no operator due to complete ignorance of impacts. In this case, not even the necessary means for adaptation are known. Although there might may be a vague problem awareness, adaptation is hindered on the base of missing means in terms of individual knowledge about impacts or due to conditions that prohibit problem awareness (e.g. high information costs, social habits and normative standards). This hinders adaptation although action is not constrained by limited available means.
- The necessary means are not available although there is an operator. Although there is no lack of perceived problem urgency (e.g. by exposure units themself), capacity or budget constraints hinder appropriate adaptation. This 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. In the worst case, missing adaptation due to unavailable means might result in poverty traps. Another variant are missing responsibilities, when motivated operators do not have the legal power to act.
- Means are not sufficiently employed although there is an operator to whom the necessary means are available. When an adaptation has positive externalities for other actors, the operator may choose to under-adapt when he gets no contributing means of other exposure units. By symmetry, it might also be the case that the operator over-adapts when the action has negative effects on other exposure units. There are also perverse moral hazard situations where means are employed to increase the consequences of impacts. In many cases settlements are (re)built in high risk areas (e.g. due to flooding). Investors (exposure units) push planning decisions towards their own favour, since they expect compensation from the public (as operator) in the case of a disaster. In sum, this type of barrier refers to misaligned incentives in the economic analysis.
- The network of exposure units, operators and receptors is too complex to come to decisions. Since climate change has very diverse effects which are relevant for many exposure units in different ways, there are likely to be many decision conflicts. This might be amplified by established institutional arrangements that are not tailored to the new type of adaptation

challenge. (Reckien et al., 2008) shows how different actor types can be entangled for adaptation in the transport sector. For new problems it is not always ex ante clear which the relevant actors are. Economically speaking, all these problems raise the transaction costs of information search, monitoring and contract enforcement. This inhibits the necessary means from being employed.

3.2 Analyzing other Concepts

We finally want to demonstrate how the action theory of adaptation links to some other established concepts of adaptation and vulnerability research.

The authors of the IPCC distinguish between autonomous and planned adaptation (IPCC, 2007). The precise meaning is not as clear as it first seems. (Füssel, 2007a) claims that planned adaptation refers to the usage of information about future conditions. We do not think that this is the underlying difference. Ecological changes in natural systems are typically considered as autonomous, while government programs are planned. There are thus at least two further interpretations. It might be the difference between adaptations as actions (as seen in this paper) and mere processes that lead improvements. Alternatively, the term “planned adaptation” refers to the type of operator, i.e. it is an actor category. Even when just processes considering, there is a broad spectrum of relevant entities between biophysical entities and governments, e.g. technical infrastructure, companies, markets, local authorities, educational institutions or NGOs. Where is the appropriate line to distinguish between planned and autonomous. One should at least be specific about that in a concrete research context.

Of similar prominence is the distinction of anticipatory and reactive adaptation (e.g. (IPCC, 2007)). It is often specified by the temporal dimensions of adaptations (e.g. (Smit et al., 2000, Füssel, 2007b)). We think that the core of the distinction is the question of whether to take action in advance. How can this be rooted in the action theory? One interpretation relates to the purpose of action that might lie in the future (cf. (Füssel, 2007a)). For some adaptations there is a substantial time lag between employing the means for the adaptation and its effect. Then, an adaptation is reactive when it is meant to become realized in the present, while it is anticipatory when it is planned to come into effect only in the future. Alternatively, the distinction can be based on the means available to the operator, in particular only knowledge about the present and the past (reactive), or also assumptions about the future, e.g. from climate projections or scenarios (anticipatory)? Finally, adaptation can also be anticipatory in the sense of expectations about means that are available in the future. These two interpretations are not equivalent. Adaptations that are reactive in the means-sense are likely also to be reactive in the purpose-sense as well, since in most cases actions that are planned to take effect in the future will take assumptions about the future into account. In contrast, it is not unlikely that actions which are reactive in the purpose-sense are based on anticipatory assumptions about the future. Of course, adaptations can also be anticipatory in both senses. This discussion supports the claim that the often made distinction between anticipatory and reactive adaptation is everything else but clear.

A classic IPCC typology of adaptations is provided by (Carter et al., 1994). They differentiate infrastructural, legal and legislative, institutional, administrative, organizational, regulatory, financial, research and development, market mechanisms and technological adaptations. This are basically means categories, that may also be associated with typical operator types.

By construction, many terms of action theory of adaptation can be mapped to the clarifying questions of (Smit et al., 2000). “Adaptation to what?” characterizes the purpose of an adaptation in terms of an impact, i.e. a stimulus that affects a considered exposure unit. “Who or what adapts?” asks for the operator, receptor, and their relation to the exposure unit. Finally, “how does adaptation occur?” requires a description on how means and purpose are interlinked, and whether just processes, or even actions are considered.

We finally want to try our best in shedding light on the difficulties with defining vulnerability and adaptive capacity as laid out in the introduction. When adaptive capacity refers to potential adaptation, it might be, in the simplest case, a measure for the available means. However, since we have seen that the available means are not likely to complete explain the implementation of adaptations, adaptive refers to conditions as well. In any case we avoid confusion between the statement that adaptive capacity enables adaptation on the one hand, and the statement that adaptations reducing vulnerability on the other hand. In the first statement, adaptive capacity considers means and conditions, while the second statement talks about facilitating adaptations where the operator is distinct from the receptor (the vulnerable system).

4 Conclusions

This paper presents a theory to analyze adaptation from an action-oriented perspective. It reveals potential barriers to adaptation and provides a terminology to clarify different types of adaptation.

In this terminology one could define adaptations as individual or collective actions that are explicitly or implicitly intended to affect impacts from climate change, or that are instrumental for achieving this end. This is yet just one possible definition with the terms introduced by the action theory of adaptation. It leaves it partially open what is to be considered as an adaptation. Depending on the research design or on practical questions it may be useful only to consider, e.g., direct or reflexive adaptations. We argue, however, that the theory can be fruitfully used to make precise statements about what adaptation processes are considered in a concrete context. The theory further makes explicit statements about crucial variables to understand adaptation

Further applications could exploit the terminology of the operator, receptor and exposure unit to map more complex actor networks. This could be the basis for understanding conflicts between different actors resulting of adaptation, or to measure transaction costs associated with the coordination of multiple actors in adaptation policies. The theory can also be used to classify and systematize collections of adaptations (as in, e.g. (UKCIP, 2007), see (Eisenack et al., 2010) for such an application of the action theory). There is also room for interesting extensions. Parson’s action theory gives a prominent role to the norms and values that shape social action. This is currently not discussed in the action theory of adaptation, but could – together with investigating available means for and conditions of action – improve the analysis of the institutional dimensions of adaptation. Finally, the important role of uncertainty in adaptation could make a more explicit consideration of the perceptions and beliefs of actors promising.

One difficulty is that the approach taken by the action theory of adaptation is very analytic in the following sense. Already Parson’s action frame of reference (1937) is meant to analyze a *unit act*. This bear the notion of an “atomistic” action unit into which all more complex actions can be

decomposed. “Simple” adaptations may be part of more “comprehensive” adaptations. Indeed, carefully investigating *prima facie* single adaptations in that terminology is likely to leads to a broad decomposed bundle of “atomistic” adaptations that are linked together in a kind of “molecule”. Similar problems are known in the literature on policy classification (cf. (Steinberger, 1980)): policies are difficult to delinate (when does a policy begin and end in time?, where does it enter the domain of another policy?, etc.), and classification schemes are known to depend on the frame of reference. We nevertheless have the impression, that that the proposed theory of adaptation is a helpful device for an action- and decision-oriented understanding of adaptation.

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