GLACIER THINNING AND ADAPTATION ASSEMBLAGES IN NAGAR, NORTHERN PAKISTAN

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With 4 figures, 1 table and 3 photos
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Summary: This article draws on assemblage and actor-network theories to analyze local struggles of adaptation to glacier thinning in Nagar, a high mountain community in the central Karakoram of northern Pakistan. Framing adaptation as a process of assemblage-building of heterogeneous human and non-human actants, two village case studies are investigated where glacier thinning has dried up a source of irrigation water, turning cropland into desert. While in the first case case, villagers were able to construct a new and extraordinary water supply scheme with the help of external development agencies, in the second case, several approaches to utilize alternative water sources over three decades were unsuccessful. An account of the adaptation assemblages shows how a diversity of actants such as individual leaders, community, external agencies, construction materials, landslides and geomorphological features play variable and contingent roles in the success or failure of adaptation efforts, thus co-defining their outcome in complex ways. This article argues that a framing of adaptation as assemblage could offer an empirical and conceptually balanced perspective on adaptation that has the potential to account for the socio-natural complexities involved. While bearing some analytical challenges, it may provide an alternative to other understandings of adaptation to environmental and climate change by refraining from environmental reductionist theories, while avoiding to downplay the natural environment as a mere stage or object of sociopolitical struggles.

Zusammenfassung: Auf Grundlage von Assemblage- und Akteur-Netzwerk Theorie untersucht dieser Beitrag lokale Anpassungen an Gletscherveränderungen in Nagar, einer Hochgebirgsgemeinde im zentralen Karakorum Nordpakistans. Anpassung wird hierbei als ein Prozess des Assemblage-Bildens konzipiert, an dem unterschiedliche menschliche und nichtmenschliche Aktanten beteiligt sind. Zwei lokale Fälle werden analysiert, in welchen absackende Gletscheroberflächen zur Austrocknung von Bewässerungsquellen und somit zur (temporären) Verwüstung von Ackerflächen führten. Während in einem Fall die Dorfbevölkerung erfolgreich ein neues, unkonventionelles Bewässerungssystem errichten konnte, schlugen im anderen Fall mehrere Versuche, alternative Bewässerungsquellen anzuzapfen, fehl. Eine Analyse der Anpassungs-Assemblages zeigt, wie eine Vielzahl von heterogenen Aktanten wie lokale Aktivisten, Dorfgemeinschaften, externe Organisationen, Baumaterialien, Erdrutsche und andere geomorphologische Elemente in unterschiedlicher Art und Weise, aber ähnlich signifikant zum Erfolg oder zum Scheitern von Anpassungsprozessen beitragen. Der Assemblage-Ansatz bietet dabei eine empirisch orientierte, konzeptionell relativ unvoreingenommene Perspektive auf Anpassung, welche der Komplexität sozio-natureller Zusammenhänge Rechnung tragen kann. Trotz analytischer Herausforderungen könnte dieser Ansatz eine Alternative zu anderen gegenwärtig diskutierten Anpassungsbegriffen darstellen, da diese häufig entweder zu umweltreduktionistischen Argumentationsweisen oder zu einer Vereinfachung der natürlichen Umwelt als bloßes Objekt oder Arena soziopolitischer Auseinandersetzungen tendieren.

Keywords: Adaptation, assemblage theory, glacier change, irrigation, high mountains, Pakistan

1 Introduction

Approaches of assemblage or more-than-human geographies (Whatmore 2006; Robbins and Marks 2010) have received much attention in recent geographic research, but surprisingly little in the extensive conceptual discussions on adaptation to environmental or climate change. There is a growing body of literature discussing how actor-network theory (Bosco 2006; Müller 2015), assemblage theory (Anderson et al. 2012; Dittmer 2014), and object-oriented philosophy (Meehan et al. 2013; Weisser 2015) can help to overcome nature-society dichotomies by considering material entities as integral and agential elements of society.

Scholars increasingly acknowledge the "radical entanglement of the social and the natural" (Swyngedouw 2014, 25) in the context of the Anthropocene, calling for "[t]heoretical frameworks that explore the relationality of ecologies, technologies, bodies and socialities" (Head 2010, 240). Yet, studies on climate and environmental

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change have given little consideration to the insights from this geographical debate, which would offer great potential in addressing this call. Focusing on environmental or climate change politics, scholars have studied the active role of particular non-human actants such as trees (Weisser 2015), policy documents (Weisser 2014), or adaptation concepts as "travelling ideas" (Gebauer and Doevenspeck 2015; Weisser et al. 2014) in shaping politics and narratives. Investigating the recent transformation of Thailand's forest politics into an instrument of climate change mitigation, Mattissek and Wiertz (2014, 163–166) demonstrate how an assemblage approach can be instrumental in understanding how power relations are shaped by interactive symbolic and material processes. However, the physical or material dimensions of *adaptation* to environmental change have received little attention in this line of research.

In consideration of these insights, I argue that concepts from assemblage and actor-network theories can likewise enrich adaptation research as they offer a way to seriously engage with the material effects of a changing environment, while bypassing the traps of an environmental reductionism – or determinism – often found in science and policy debates on climate change (Hulme 2011; Nielsen and Sejersen 2012). This article aims to outline a concept of "adaptation assemblage" (Head 2010, 237) and to demonstrate its application in a study of adaptation to glacier changes in the high mountains of the Karakoram. I draw upon several months of field research undertaken in 2014 and 2015 in the district of Nagar (Gilgit-Baltistan, Pakistan) in order to employ this concept in a comparative analysis of two cases where glacier thinning dried up a source of irrigation water, resulting in desertification of cropland. By providing accounts of the complex adaptation assemblages, I intend to identify why in the first case, a new and successful irrigation scheme could be established, while in the second case several attempts over almost three decades to reirrigate the land have failed. An assemblage approach to adaptation reveals how the outcome of adaptation efforts is co-defined by a multitude of contingent and heterogeneous actants such as geomorphological features, construction materials, development agencies, and community leaders, rather than being caused by a single type of (f)actors.

The following section briefly discusses current conceptual debates of adaptation that predominantly focus on adaptation to climate change. Drawing mainly on the work of DeLanda and Latour, section three outlines some key arguments from assemblage, actor-network, and related theories that form the theoretical basis for my understanding of adaptation. The fourth and main section focuses on the two case studies: After introducing the subject of glacier thinning in the Karakoram, the study area, and the methodology of this study, I provide detailed empirical descriptions (or *translations*) of the emergence of local adaptation assemblages. In a subsequent analytical summary, the main components – or actants – of the presented assemblages will then be "mapped" in terms of their *material*, *expressive*, *territorializing* and *deterritorializing* roles in the success or failure of adaptation efforts. In the final section, I conclude the findings from the case studies and discuss strengths and challenges of the assemblage approach for adaptation research.

2 Adaptation: a contested concept

Although the adaptation concept has been more broadly applied in a variety of fields such as cultural ecology and hazard research (Burton et al. 1993; Smit and Wandel 2006; Head 2010), the term is now predominantly discussed in the context of climate change. Here, the International Panel on Climate Change (IPCC) appears to provide the most widely-used conception of the term (see Bassett and Fogelman 2013), defining adaptation as a simple "response" or "adjustment" to climate (stimuli) and its (their) effects (IPCC 2007, 869; IPCC 2014, 1758). This understanding has been criticized by social scientists as being environmentally reductionist and narrowly technical, downplaying the social and political-economic causes of vulnerability to climate change (Ayers and Dodman 2010; Pelling 2011; Ribot 2011). Although somewhat elaborated through resilience and complex systems theories, the current paradigm seems to be a revival of earlier, functionalist views of adaptation that were criticized by political ecologists already in the 1970s and 1980s (Bassett and Fogelman 2013; Watts 2015). As a response to this "stand-alone" (Ayers and Dodman 2010, 165) or "adjustment" (Bassett and Fogelman 2013, 44) understanding of adaptation, alternative concepts have emerged that emphasize the wider social or political context. For instance, a "community-based" adaptation approach focuses on socio-economic development to increase the capacities of vulnerable groups to cope with a variety of stressors that include, but are not limited to, climate change (van Aalst et al.

2008; Reid et al. 2009; Ayers and Dodman 2010). Influenced by political ecology, others highlight the deeper root causes of vulnerability: rather than just technical modifications of the status quo, the challenges associated with climate or environmental change require more radical, "transformative" changes in political-economic regimes and rights systems (Ribot 2011; O'Brien 2012; Bassett and Fogelman 2013). As Pelling (2011, 3) makes clear: "adaptation is a social and political act; one intimately linked to [...] power relations in society".

There are important analytical, ethical, and practical considerations behind these responses to the pitfalls of an adaptation concept that currently dominates climate change research. However, – unless one considers the term "social" in the Latourian sense[1] – there are many instances where adaptation is more than a social and political act, since it also has a clear physical or technical dimension. Few scholars would generally deny the need for "hard" (Sovacool 2011, 1176) adaptation measures such as modified irrigation systems or flood protection measures in particular situations. Still, recent social science concepts of adaptation seem to give little importance to these activities and their material or biophysical complexities, leaving them mainly in the hand of the criticized adjustment or stand-alone approaches. Yet, as will be shown in this article, even "hard" adaptation measures cannot be sufficiently grasped with a stand-alone understanding of adaptation, since there is always a multitude of interacting environmental, social, political and economic (f)actors involved.

I argue that a theoretical framing that fully accounts for the active role of biophysical processes *and* takes the socio-political complexity of adaptation seriously is largely missing from current adaptation debates. One reason might be that the social and the natural are being treated as two distinct domains, with social scientists or human geographers focusing on the former and treating biophysical processes predominantly as external black boxes, whose investigation is solely the concern of natural scientists. A framing of adaptation in terms of assemblage and actor-network theories withdraws from this dualism.

[1] Criticizing the common usage of the term that postulates a specific domain of reality restricted to humans alone, Latour proposes to widen its meaning by designating "by the same word a trail of associations between heterogeneous elements", including nonhumans (Latour 2005, 5, emphasis in original).

3 Socio-material assemblages

Latour (1993) famously pointed out that modern science and philosophy have traditionally been dominated by a distinction between two ontological categories, with society or culture being "historical and contingent, while nature is characterized by necessity and eternity" (Bryant 2014, 252, punctuation modified). This distinction is problematic in various regards. First, what we conceive as nature is very much historic and contingent, as philosophers like DeLanda (2006) and Bryant (2014) argue and evolutionary theory, big bang theory, and "new ecology" (see Zimmerer 1994) suggest. Second, the proliferation of seemingly "hybrid" phenomena – e.g. technologies or climate change adaptation projects – has rendered the analytical task of "purifying" empirical realities into the two categories more and more difficult (Latour 1993). Third, even ostensibly pure social phenomena always involve natural or material entities shaping their character or outcome, Latour contends: rather than serving as mere "intermediaries" of human intentionality, these nonhumans often act as "mediators" that modify, distort or destroy what they are meant to transport in very unexpected ways (Latour 2005, 39). The famous study of relations between scientists, scallops and fishermen by Callon (1986) or the account of the North American blackout by Bennett (2005, 2010), for instance, provide valuable illustrations of how non-human actants play active and contingents roles within socio-material assemblages. Consequently, these approaches reject the existence of an ontological split between a social and a natural or material world, or between humans and non-humans. Instead, they propose a "flat ontology" where all entities or actants are on equal ontological footing (see e.g. DeLanda 2002; Harman 2009; Bryant 2011). Yet, how can nonhumans act?

A second important feature found in actor-network, assemblage and related theories is what can be called a "distributive" (Bennett 2010, 31) or "decentered" (Bakker and Bridge 2006, 19) conceptualization of agency. An action is conceived as always involving a number of actants at the same time. As the original meaning of the word actor indicates, an actor performs on a stage where he or she is never alone in acting since there are also a story, a specific lighting, an audience, a backstage crew and many other elements co-defining the act (Latour 2005, 46). Such a relational understanding is decentered as it "does not posit a subject as the root cause of an effect" (Bennett 2010, 31), imagining an actor as some kind of "moving target of a vast array of

entities swarming toward it" (Latour 2005, 46). Literally anything can be an actor – or actant, to use a less human-centered term –, given it "does modify a state of affairs by making a difference" (Latour 2005, 71). Persons can be actants just as tubewells (Birkenholtz 2009), gorillas (van der Duim et al. 2014), or standardized tests (Meehan et al. 2013). While individual human intentionality can play an important role, it is seen as "less definitive of outcomes" for it is "always in competition and confederation with many other strivings" (Bennett 2010, 32). Conceptualizing agency this way rejects the notion of an all-too-powerful human subject, while at the same time avoiding a deterministic logic of natural causation by locating causality "not in a pregiven sovereign agent, but in interactive processes of assembly through which causality operates as a nonlinear process" (Anderson et al. 2012, 180). Thus, for instance, rather than conceiving climate factors as "causing" adaptation, they must be understood as actants among many others in an adaptation assemblage. As Latour (2005, 107) puts it, "a factor is an actor in a concatenation of actors instead of a cause followed by a string of intermediaries". Applied in strict terms, this conceptualization of action and causality implies that actants cannot be accepted to be simply *doing* something, as "a bewildering array of participants is simultaneously at work in them" (Latour 2005, 202). Consequently, actants presented in empirical accounts must always be understood as what Latour (2005, 53–54) describes as "figurations" of what is *doing* the action, and whether they denote "individual agencies", "statistical aggregates", or something else.[2)]

An assemblage, broadly speaking, can be defined as an ad-hoc grouping, a provisional spatio-temporal formation of "heterogeneous elements that may be human and non-human, organic and inorganic, technical and natural" (Anderson and McFarlane 2011, 124). These components or actants are themselves assemblages, and can play variable roles both within the assemblage and in its relation to other assemblages. These roles can be characterized in terms of two axes[3)] (Fig. 1): First, they can be *material* or *expressive*, or a mixture of both – examples for purely expressive components would be language, ideas, or genetic codes. Second, their role can be *territorializing* or *deterritorializing*, i.e. having a stabilizing or destabilizing effect on the assemblage in question (DeLanda 2006, 12). As will be shown later, both expressive and material elements can contribute to the territorialization or deterritorialization and thus the outcome of an adaptation assemblage.

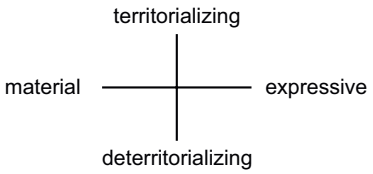

Fig. 1: A two-axes model characterizing components of assemblages (cf. DeLanda 2006)

An assemblage is a "web with an uneven topography" (Bennett 2005, 445), with some components playing a more powerful role than others – but none of the components is ever able to fully determine the outcomes or activities of the assemblage. Assemblages can be described by their scale, i.e. their "*extensive* properties" that include geographical scale and other characteristics such as "amount of energy and number of components" (DeLanda 2006, 6, emphasis in original). Yet, there is no ontological hierarchy between a small-scale and large-scale assemblage, even if the former acts as a component part of the latter: defined by its specific history, each assemblage is an individual actant in its own right that both affects and is being affected by its components and other assemblages (cf. DeLanda 2006, 28). This understanding forbids, for instance, a simple logic of "downward causation" – from causes in the earth system to local effects – that Nielsen and Sejersen (2012) argue to be prevalent in human geographic studies of climate change.

An assemblage of any scale is not to be confused with a "system" as in the resilience approaches criticized by Watts (2015), since no self-organizing laws or principles are postulated. As DeLanda (2006) highlights, assemblage thinking refrains from an "organismic metaphor", as even the relations between the "component organs" of an organism are conceived not as "logically necessary but only contingently obligatory: a historical result of their close

[2)] For instance, when I write in section three about a group of men "constructing" an irrigation channel or about a "moving" glacier, both the group of men and the glacier must be understood as figurations that are, in Latour's sense, not more concrete than "statistical aggregates obtained from a questionnaire and given a label" (Latour 2005, 53): their actions are always co-defined by a large variety of other recognized and unrecognized agents (here e.g. construction materials, practical knowledge, geomorphology, climate).

[3)] DeLanda (2006, 19) also introduces a third axis of coding/decoding, but I drop it here since this dimension can also be interpreted as one way of (de)territorializing (cf. Dittmer 2014).

coevolution" (ibid., 8, 11–12). In this sense, adaptation is not a mechanism of self-reorganization of a disturbed system, but a process of (partially deliberate) reformation of heterogeneous human and non-human actants in a socio-material assemblage where multiple contingencies are at play. Section 4 will provide an account of emerging adaptation assemblages of glacier thinning in the high mountain community of Nagar.

4 Glacier thinning and adaptation assemblages in Nagar

Glaciers have been described as valuable objects of study in the context of climate change, since so-called impacts are generally highly visible and consequences appear to be relatively clear (Orlove 2009). If that is so, then the Karakoram is an exception: the glaciers of this mountain range have triggered significant confusion in debates on global warming. In contrast to shrinking glaciers in the neighboring Himalayas, most of the Karakoram glaciers have remained stable or have advanced, at least over the last 10 to 20 years (Hewitt 2005, 2014; Minora et al. 2013). This so-called "Karakoram anomaly" (Hewitt 2005, 332) is possibly the result of increased winter precipitation, declining summer temperatures (in contrast to warming winters, see Bocchiola and Diolaiuti 2013), and a relatively high debris cover that could inhibit melting (Scherler et al. 2011; Minora et al. 2013; Hewitt 2014). The findings on a relatively stable glacier area and length are further supported by recent studies that indicate a small increase in glacier surface level between the years 2000 and 2008, resulting in a slightly positive glacier mass balance (Gardelle et al. 2012, 2013). However, the mass gain is mainly a result of glacier thickening in the accumulation zones above approximately 5000 m a.s.l., while the lower ablation areas have predominantly lowered their surface level by up to 13 meters (Gardelle et al. 2013, Fig. 11 on p. 1279). While this phenomenon might not be significant for total glacier mass balance, for the irrigation assemblages of nearby farming villages it often is. As Parveen et al. (2015, 69) have recently argued, despite the existence of the Karakoram anomaly "there are many cases where glacier termini are in retreat and where ablation reduces glacier extent, often resulting in the desiccation of irrigation channels across lateral moraines." Focusing on upper Hunza in the western Karakoram in Gilgit-Baltistan, northern Pakistan, they provide deep historical descriptions of two cases of glacier downwasting (i.e. thinning) making considerable adaptations of irrigation systems in nearby villages necessary (Parveen et al. 2015).

In Nagar, a district of 23 rural settlements neighboring to Hunza, Gilgit-Baltistan (Fig. 2), I discovered three additional cases (Pisan, Minapin, and Hopar) where thinning glacier ablation zones have desiccated irrigation channels, resulting in some village cropland being cut off from their source of irrigation water. In two of these cases, Minapin and Hopar, considerable adaptation assemblages emerged when a variety of new actants engaged in community's attempts to utilize new water sources for the barren land. These two cases will be the focus of this article. However, it must be noted that both glaciers (Minapin and Barpu/Hopar) are most likely to be "surge-type" glaciers. Therefore, climate change is improbable to play a major role in current thinning, if at all. The last known surges (i.e. sudden advances followed by phases of thinning/retreat) of these glaciers were in the late nineteenth century (cf. Hewitt 2014, 219–244). However, the surge behavior and the roles of geomorphological, climatic and other processes are not thoroughly understood and require further research (ibid.).

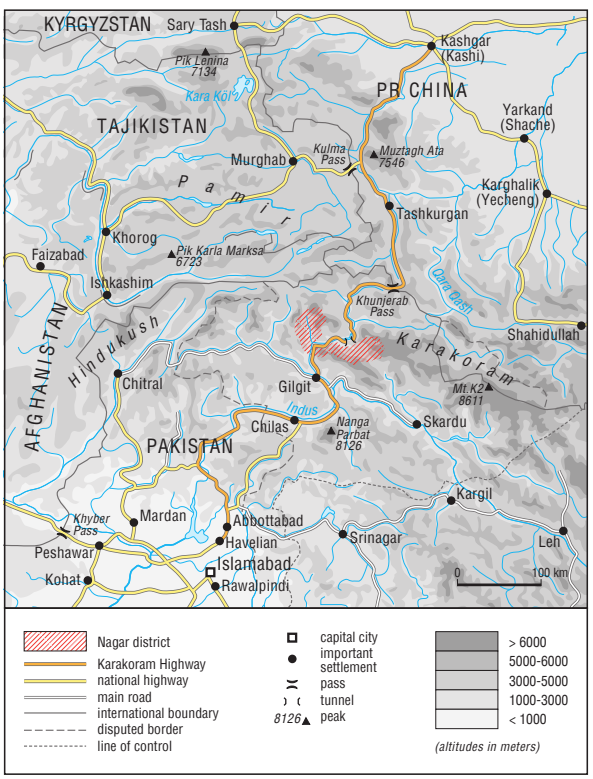

Fig. 2: Location of Nagar district (source: Kreutzmann 2015, 13, modified)

Before discussing the methodological approach and turning to these two case studies, I briefly introduce the study area of this article. The villages of Nagar are located in the arid or semi-arid (Hewitt 2014, 19–21) valley bottoms of the western Karakoram on elevations ranging from 1900 to 3100 m a.s.l. Agricultural practices rely on the utilization of glacier melt water through sophisticated irrigation networks. These networks have evolved through the negotiations of many generations of farmers with the biophysical environment and can be described as complex assemblages of glaciers, streams, irrigation channels, field terraces, farmers, rules, and practices; in recent decades development agencies, government institutions, and markets in downcountry Pakistan have increasingly played their part as well (Butz 1994; Kreutzmann 1991, 2011; Parveen et al. 2015). Traditionally, wheat, barley, and apricots are produced in family-owned smallholder farms for home consumption, but farmers increasingly cultivate potatoes, apples and other cash crops that now dominate most fields and many orchards. Unlike in other parts of Pakistan (Hussein et al. 2004), sharecropping and hired agricultural labor play only a minor role. Sheep, goats, and cattle are the dominant livestock. They are seasonally kept in high pastures and constitute an important element in the "combined mountain agriculture" (Kreutzmann 2006a, 329) of the region. While agriculture is still considered a major component of the local economy, off-farm employment in the government and private sector are becoming more and more important (Malik and Piracha 2006).

4.1 Methodological approach

The empirical data for this article was collected during eight months of field research in 2014 and 2015, as part of a wider study on recent transformations in irrigation agriculture in Nagar. The two cases of glacier thinning were discovered during initial discussions and observations in the two villages of Minapin and Hopar, before deciding to study them in more detail. Adopting Latour's (2005, 12) approach to "follow the actors themselves", I explored the adaptation assemblages primarily through discussions and interviews with people who were directly involved. To include other perspectives, certain issues were also discussed with residents of neighboring villages. Most data on the two cases was gathered during 16 open and semi-structured interviews (nine in Minapin, seven in Hopar) and several informal discussions with community activists, village elders and other local informants. The majority of the interviews were carried out in cooperation with local assistants who interpreted between English and the local language Burushaski. Some interviews and most informal discussions were held in English, the second official language in Pakistan. To "follow" also the non-human actants emerging in the case studies and to triangulate information provided by informants, I repeatedly visited all locations of the past and present irrigation networks described below in order to observe and physically experience geomorphology, channel status and damages, walking distances, and other material aspects. Most of these visits took the form of transect walks, where a local guide accompanied me and provided further information. Maps were created with the help of GPS measurements, field observations, satellite imagery, and data gathered from the various informants.

As Ruming (2009, 452) argues, research informed by actor-network theory must recognize "theory, methodology and self as vital means through which an emergent reality is created – a research reality/network." All data from the field is mediated by the interview partners, interpreters, interview techniques, my own position as researcher and my perceptions and ideas of and in the field, among others. When these actants encounter the assemblage being studied, they become constituent parts of a new assemblage that must be understood as a *translation* of the former (cf. Ruming 2009; Sheehan 2011). This translation, when it takes the form of an account, is always mediated, partial, and selective, as only few of the actants from the "original" assemblage make it into the new one. The result can never be an objective representation of a certain reality, instead a new "research reality" Ruming (2009, 452) is constructed. This research reality should be described as best as possible, without claiming to be a true or objective representation of the "real" situation. A good account, Latour (2005, 128) writes, "is a narrative or a description or a proposition where all the actors *do something* and don't just sit there". In other words, it should focus on actants that make a difference in the account ("mediators") while disregarding those that do not ("intermediaries"). In the following, I attempt to highlight those actants that make a difference in the two accounts of adaptation assemblages, as translated by local informants, the methodology, myself, and others. I begin with detailed chronological descriptions of the two cases, followed by a comparative "mapping" of major actants.

4.2 Case one: Khaiadar and Tamareil, Minapin

The village of Minapin has abundant water resources available compared to other settlements in the area, due to having exclusive access to a river (Minapin River) originating from a large glacier. However, agricultural land is relatively scarce, as the village is bounded between two rivers and a mountain slope (Fig. 3). For this reason, approximately 100 years ago farmers constructed a long irrigation channel to cultivate the lands of Khaiadar and Tamareil on the slopes and moraine terrace just above the settlement. Tapping some spring water streams four to five kilometers away, the channel crossed a steep artemisia slope above Minapin Glacier and facilitated the extensive cultivation of fodder crops. Due to landslides caused by the steepness of terrain, water leakages, glacier movements, and other factors, the water channel was destructed in the 1930s or 1940s. Subsequently, a new channel was built to utilize a different water source, a supraglacial meltwater stream discharging to the right margin of Minapin Glacier. However, in the following decades the glacier slowly and gradually lowered its surface, making it more

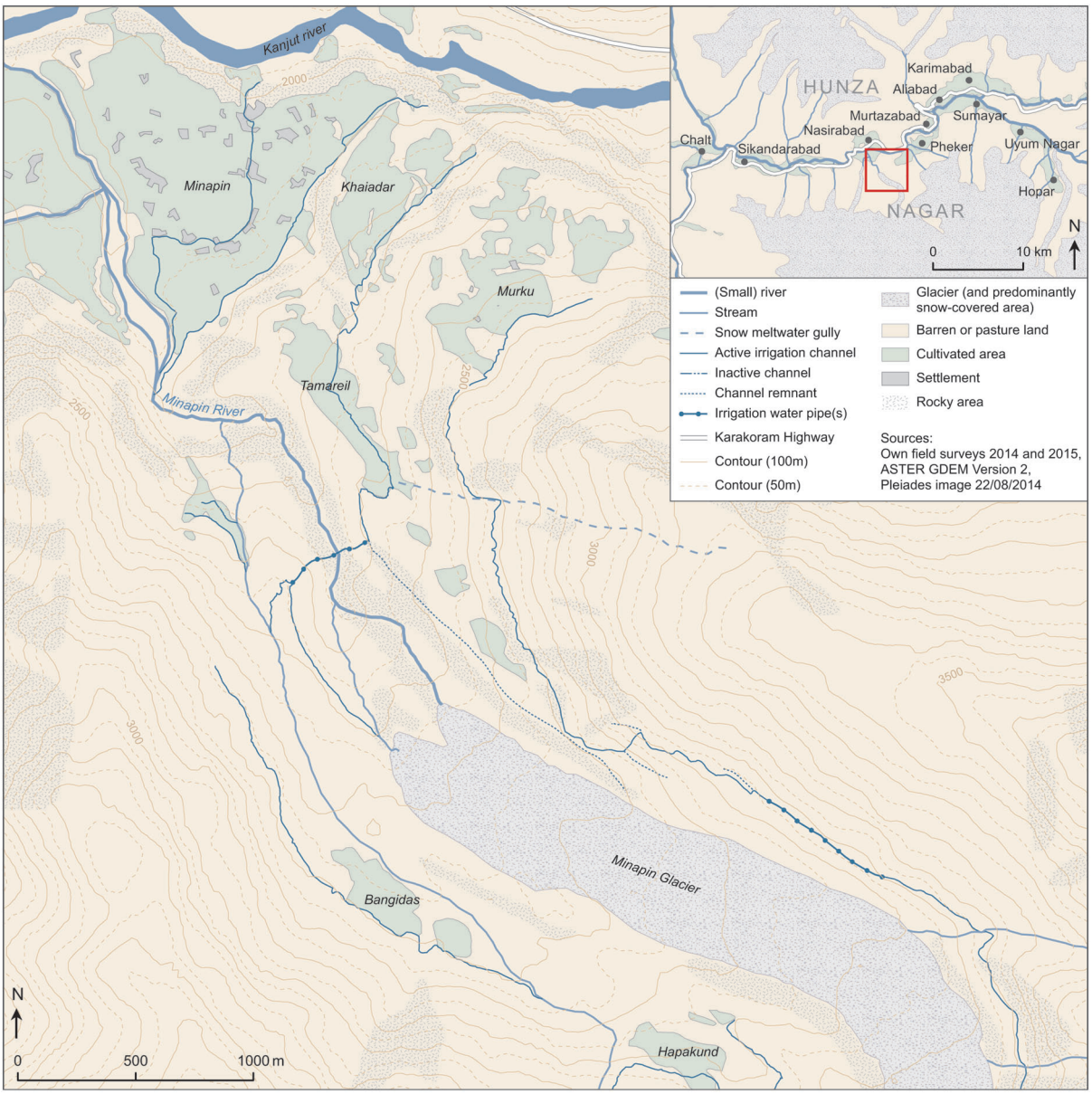

Fig. 3: Primary irrigation channels in Minapin

and more difficult to divert meltwater over the lateral moraine towards Khaiadar and Tamareil. Following an exceptionally warm winter in 1971/1972, the water source eventually descended to an altitude where it failed to deliver water across the moraine. Meanwile, approximately in the 1940s or 1950s, the *tham* (local ruler) of Nagar had ordered some farmers from Minapin and other villages to repair and extend the old, landslide-destructed water channel, in order to cultivate an area called Murku (Fig. 3). With their previous water source now being put to another use, the landowners of Khaiadar and Tamareil did not see any other option to irrigate their land and left it barren for the following 20 years. To mitigate the land shortage, some villagers extended the irrigated land area in Bangidas and Hapakund (Fig. 3). As local elders recapitulate, a significant shortage of winter fodder remained and many farmers bought expensive alfalfa from neighboring villages.

In the early 1990s, a group of village activists surveyed the water source area again. One of the men, being locally famous for his self-educated engineering skills, had an unusual idea: as the main headwater stream of Minapin River was not utilizable due to its low elevation and its steep banks of loose morainic deposit, he proposed to tap a small springwater stream and a glacial stream about 30 meters higher. Both of these water sources were located on the other side of the glacier and Minapin River (Fig. 3). This required a way to transport water across a deep river gorge with steep and rocky slopes on both sides. Based on this man's idea and the specific geomorphological setting, a complex assemblage of diverse material and expressive components emerged in the following two years that resulted in the construction of a new and successful irrigation scheme.

The idea was to construct a bridge, with heavy steel pipes transporting water through an inverted siphon from one side of the gorge to the other. The bridge scheme required considerable funds for about one kilometer of steel pipes, several hundred meters of thick steel rope, and other materials that the small village community of about 200 households could not afford. Fortunately for Minapin, Syed Yahyah Shah, a famous community leader and activist in Nagar, was one of the initial supporters of the idea. In cooperation with the local village organization, he played an important expressive role by using his political influence to engage two important external actants in the assemblage: Local Bodies & Rural Development (LB&RD), a government institution focusing on local development, and the Aga Khan Rural Support Programme (AKRSP), a non-government organization that had become active in the region about ten years earlier. While LB&RD donated half of the required steel pipes and some money, AKRSP provided the funds needed for the remaining non-local materials, which some villagers purchased in downcountry Pakistan. Another actant, itself a highly territorialized assemblage of material (people) and expressive (traditions, expressions of solidarity, etc.) components played a central role in the successful formation of this adaptation scheme: the community of Minapin. Owing to a social cohesion that is partly the achievement of Yahyah Shah and other charismatic village activists from the influential and relatively wealthy Syed family, men from almost every household volunteered to carry and fix the heavy pipes, construct the bridge, dig new and repair old water channels. Others donated expensive meat and butter to the 90–120 volunteers per day, according to the chairman of the village organization of that time. Some less wealthy villagers were further motivated by members the local Syed family, who promised to donate parts of their land in Khaiadar to them. Although local narratives might exaggerate the level of solidarity in Minapin, informants from other parts of Nagar too have a high opinion of the social cohesion in this village. According to local sources, no external experts or engineers were involved in constructing the scheme apart from a carpenter from a different part of Nagar. All laborers worked on a voluntary basis as the funds provided by LB&RD and AKRSP were sufficient only for purchasing materials. There appear to have been few elements that posed hindrances to the success of this adaptation assemblage – some individual sceptics openly doubted the feasibility of the scheme, and the deep river gorge allowed only for those with a good head for heights to conduct the work on the bridge. Overall, however, informants report that a high degree of motivation prevailed among the villagers and after four months of work, the new irrigation scheme was finalized (see Photo 1). Since the year 1994, the pipe system has provided a stable source of water for Khaiadar and Tamareil.

4.3 Case two: Shishkin, Hopar

Located on a terrace about 100 meters above Bualtar and opposite the terminus of Barpu Glacier, Hopar forms the second-highest permanent settlement of Nagar. The main cropland of the five villages of Hopar is located on this terrace, and each vil-

Photo 1: The bridge scheme for irrigation in Khaiadar and Tamareil, Minapin. (Photo: Spies, April 2015)

lage owns significant land on mountain slopes above the terrace or across Bualtar Glacier, where farmers cultivate fodder crops and some potatoes. Holshal, with about 70 households the second smallest village of Hopar, is an exception: it has not had access to proper irrigated cropland outside the settlement terrace for more than 40 years now. Holshal's only cultivable land apart from the fields surrounding the village is located across Bualtar Glacier – in Shishkin, Maruk, and Shaltar (Fig. 4). Due to a lack of water, the land in Maruk has never been cultivated, while farmers abandoned the fields in Shaltar about 60 years ago because of their difficult access across a landslide-prone slope, as locals recall. However, two water channels used to direct water from a meltwater stream of nearby Barpu Glacier to irrigate the arable land of Shishkin. The stream was fed by supraglacial meltwater pools and crossed the thick terminal moraine of Barpu Glacier through a partly man-made water gully above Shishkin. Several generations of farmers benefited from this local irrigation assemblage and cultivated fodder crops, cereals, and apricots on plain and terraced fields. Mappings of the field remnants show that Shishkin used to comprise about one fourth of Holshal's irrigated cropland. Yet, the debris-covered glacier surface slowly and gradually subsided, and so did the meltwater source, until the stream failed to cross the terminal moraine around the year 1970. Since then, Shishkin has been barren (Photo 2). As a result, Hoshal is now the most land-scarce village of Hopar, with insufficient supply of winter fodder for livestock. Farmers spend a considerable amount of their income for dried alfalfa and straw from other villages, sometimes even from downcountry Pakistan.

In at least six failed adaptation attempts over the last three decades, different actors formed various temporary assemblages in order to reirrigate Shishkin. The first attempt was initiated in the mid-1980s. A local village organization, represented by some active community members, had formed and managed to get support from AKRSP for a new irrigation scheme. Local laborers were paid to construct a series of channels from the next available water source, the snow and ice melt water stream of Thobishen Nala about four kilometers away. Partly taking advantage of natural water gullies, water should descend about 1100 meters in altitude and traverse the unstable slope between Shaltar and Maruk through a long channel (see "channel remnant" symbols in Fig. 4). However, the villagers and AKRSP advisers probably underestimated the contingencies in the physical environment: just after completion of the scheme, rainfall-triggered landslides led to the destruction of the irrigation channel between Maruk and Shaltar.

In the early 1990s, a new opportunity emerged when some funds from the regional government became available. Supervised by a government contractor, local paid workers constructed a new irrigation channel located several hundred meters higher, above the unstable slope. Tapping the meltwater stream just below its source, the new channel head was about 200 meters higher than the previous one. Like before, geomorphology played an important role in this assemblage, as the flood and meltwater gully of Maruk Nala was used to drain water from a high channel into a lower one (see Fig. 4). Yet again, this new irrigation scheme failed to carry water to Shishkin, mainly due to leakages in the high channel that informants believe to be largely a result of poorly managed work. They blame a corrupt government contractor on the one hand, and a limited motivation of the village community to repair and maintain this distant channel on the other hand, for the failure of this second project. A transect walk to the area revealed that the channel has to cross places in Khu area with relatively loose ground material, making it difficult to construct a sufficiently imperme-

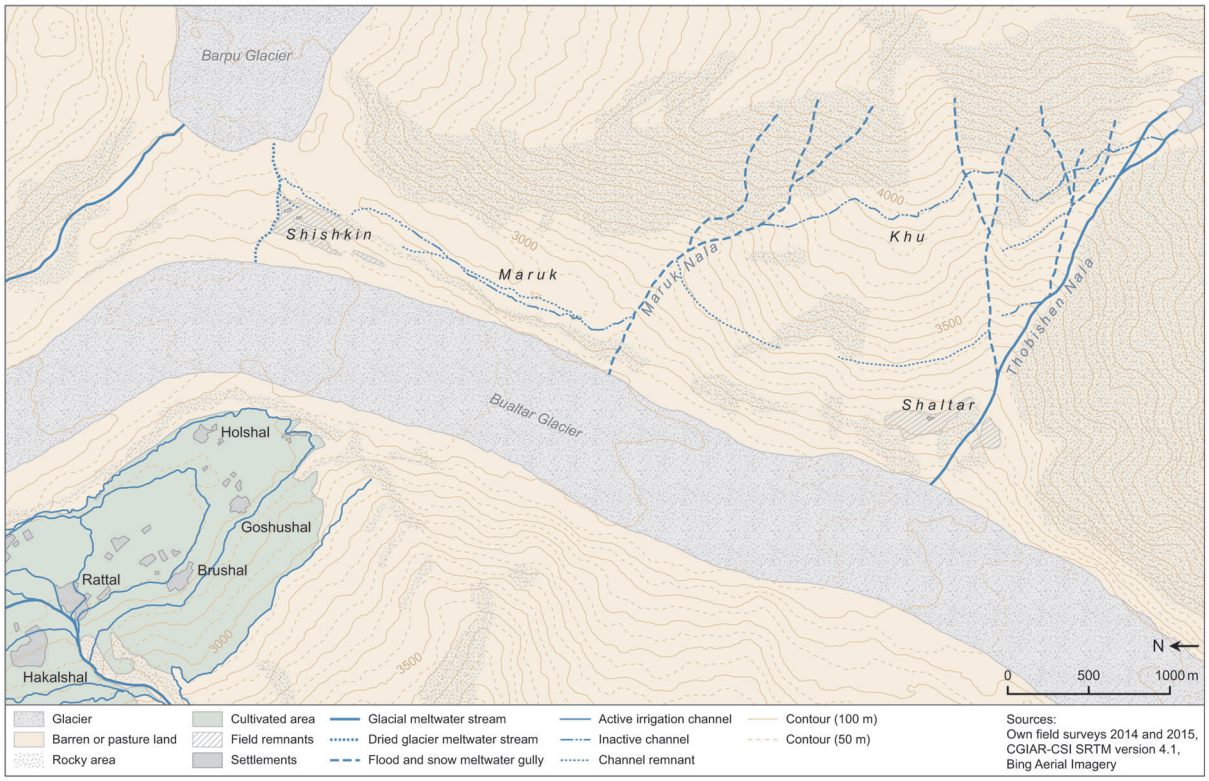

Fig. 4: Failed irrigation channels in Shishkin. The map inlet shows the main settlement terrace of Hopar

able channel bed in the absence of cement or other expensive construction materials. Furthermore, the channel traverses several steep flood and meltwater gullies between Khu and the channel head, where smaller debris- and mudflows are frequent (see Fig. 4).

It took about ten years until the next significant adaptation attempt was initiated, when a new government actor entered the scene in 2001. The Khushal Pakistan Program, a national poverty alleviation and physical infrastructure development program, provided funds to repair the upper irrigation channel and to widen it significantly in order to compensate for water losses on the way. In anticipation of an ample water supply, the Holshali laborers redirected the lower channel (between Maruk Nala and Shishkin) to a higher elevation in order to irrigate large parts of Maruk in addition to Shishkin (see "inactive channel" symbols in Fig. 4; adjacent channel remnants are from the previous projects). Alas, this project failed again. Water never reached Shishkin or Maruk because parts of the high channel were damaged soon after its completion due to debris- and mudflows, and land slumping caused by free-grazing yaks (see Photo 3). Like before, it appears that the community was not willing – or able – to spend a sufficient amount of their time and efforts on repairing and maintaining a channel that is four to five hours walking distance away from the village.

In 2007 or 2008, the village organization succeeded in its demands for a new and promising government project, this time for the rehabilitation of the lower channel created in the 1980s. Since the respective representative of the regional government promised to allocate a more substantial amount of money than the donors of previous attempts did, a long water pipe should be installed across the steep and landslide-prone slope. To protect the water flow from small to moderate landslides and debris- and mudflows, the pipe was to be buried into the ground in the most prone passages. Furthermore, the project proposal included the construction of a new and lower channel head in Shaltar to improve access for maintenance. However, no work has been done in this project apart from constructing the first 300 meters of new channel (see "inactive channel" symbol in Fig. 4) and purchasing about 60 percent of the required pipes. Villagers blame the responsible government representative and the appointed contractor for misusing most of the funds, as a local informant puts it: "all the money they invest in

Photo 2: View of the Barpu Glacier terminus from above Hopar. The blue dotted lines indicate the location of the former meltwater stream and irrigation channels in Shishkin. (Photo: Spies, April 2015)

themselves, little money they invest in the project." On the other hand, several informants described the village community of Holshal as relatively weak, both in internal terms and in its relation to other assemblages such as government offices and other institutions. Intergenerational conflicts, a generally low degree of unity, and a lack of political influence due to limited education and poverty, they explained, all contributed to the unhindered misuse of project funds by the above-mentioned actants.

After another unsuccessful project of rehabilitating and improving the upper channel – facilitated by AKRSP and funded by Caritas Switzerland in 2013 (see Photo 3) –, a new attempt to reirrigate Shishkin commenced in 2015. Repeated complaints to various government institutions by certain younger village activists, who had meanwhile taken over key positions in the village organization, led to a renewal of the water pipe project. A newly elected government representative allocated additional funds and appointed a new contractor, and in September 2015, I observed local workers starting to carry parts of the water pipe across the glacier to Maruk. The success of this new adaptation assemblage is not yet evident.

4.4 Mapping the actants

These two accounts of adaptation assemblages show that the failure or success of these attempts cannot sufficiently be explained without considering the wide range of human and nonhuman actants that operate in diverse and complex ways. I use the two axes of territorializing–deterritorializing and expressive–material (see Section 3) as a framework for briefly summarizing and "mapping" the major actants in their different roles within the narrated adaptation assemblages. Table 1 structures the main actants, as identified and translated in the case studies, according to their dominant roles.

In the Minapin case study, the availability of suitable water sources and the funds and materials provided by AKRSP and LG&RD play central material roles in the territorialization of the new irrigation scheme. The seemingly strong village community, in turn, appears to significantly contribute both in material and in expressive terms: in terms of its workforce on the one hand, and as a powerful concept motivating individual volunteers on the other hand. Predominantly expressive, but nevertheless important roles are played by Yahyah Shah

Photo 3: Blocked irrigation channel between Khu and Thobishen, Hopar area, due to land slumping triggered by free-grazing yaks. In the gully visible in the background of the picture, debris flows have destroyed parts of this channel that had been rehabilitated through a joint AKRSP-Caritas Switzerland project in 2013. (Photo: Spies, September 2015)

and other local leaders and activists by engaging external donors and persuading fellow community members. Furthermore, the whole adaptation assemblage would not be thinkable without the creative idea of the pipe and bridge scheme; it should therefore be considered a central expressive actant. Only two components are identified that play somewhat deterritorializing roles. The steepness of the river gorge poses a challenge to the workers, with only few of them being willing to fix the steel wires for constructing the bridge. On the expressive side, local skeptics who attempt to demotivate other villagers may be mentioned, but their effect within the community seems more than outweighed by the encouragement of village leaders and activists.

In the case of Shishkin, in turn, deterritorializing elements dominate the presented adaptation assemblages. Landslides, debris- and mudflows, the remoteness of the upper irrigation channel, and inadequate construction materials play significant material roles in the failure of various projects – but so do corrupt government contractors by embezzling large parts of project funds. In expressive terms, the seeming internal and external weaknesses of the village community of Holshal appear to play deterritorializing roles in adaptation attempts. Nevertheless, there are also territorializing actants – in particular the water source in Thobishen Nala and the various available funds from government and non-government donors that play important material roles. Individual village activists, in turn, provide substantial expressive contributions to the territorialization of various adaptation assemblages by working on engaging external agencies and on motivating the village community. Still, the constructive roles of these actants are outweighed by the deterritorializing effects of other elements, as all attempts to reirrigate Shishkin so far failed.

In summary, an analysis of these two cases reveals that not a single (type of) actant can be made solely responsible for the outcome of the described adaptation assemblages; the wider picture has to be taken into account. In practical terms, however, this distributed responsibility does not imply that individual actants such as the government contractors cannot be made accountable for their wrongdoings, as their roles within the assemblage are never fully determined by others. Each actant has its "degrees of

Tab. 1: Different roles of main actants in the translations of adaptation assemblages

Khaiadar and Tamareil, Minapin

	material	expressive
territorializing	- Suitable water sources - LG&RD pipes and funds - AKRSP funds - Strong village community	- Idea of pipe scheme - Local leaders - Strong village community
deterritorializing	- Steep river gorge	- Individual sceptics

Shishkin, Hopar

	material	expressive
territorializing	- Suitable water source - Various government funds - AKRSP/Caritas funds	- Village activists
deterritorializing	- Landslides, debris- and mudflows - Distant water channel - Corrupt government contractors - Insufficient construction materials	- Weak village community

freedom", as DeLanda (2006, 30) makes clear. Still, one should keep in mind that all of the actants presented here should themselves be considered individual assemblages (or figurations of assemblages) with their own histories that involve a variety of other actants or assemblages. For instance, a more detailed investigation of the village communities must consider the overall change in livelihood strategies in three decades of rapid socioeconomic development in the region (Kreutzmann 2006b): new income opportunities through labor migration on the one hand, and commercialization of agriculture on the other hand most likely play a significant part in the willingness of Holshalis to invest their time and efforts in rehabilitating land that is more than one hour walking distance away, on a difficult path across the glacier. Furthermore, as the translation of the studied assemblages is necessarily partial, there are many other actants that were not included into the case studies. For instance, ideas must have played important roles in the adaptation attempts in Holshal as well, but they did not feature as prominently here as in the Minapin case study due to the particular translation by the outlined methodology, the interview partners, my own perceptions and ideas, and other "research participants".

5 Advantages and challenges of the assemblage approach to adaptation

This article has outlined an assemblage concept to adaptation and has explored its use in an empirical study of adaptation to glacier changes in northern Pakistan. I have argued that an adaptation concept allowing for nonhuman elements to become active members in human-environment relationships does not necessarily need to downplay social complexities, as the "adjustment" approaches in climate adaptation research tend to do. On the contrary, the significant advantage of adopting this theoretical framework is that it encourages the researcher to consider all sorts of complexities shaping the case at hand, as no underlying natural or social mechanisms determining adaptation efforts and outcomes are postulated. While refraining from universal governing laws, both assemblage and actor-network theory suggest an inductive and empirical research design. Provided that findings are understood as translations of empirical phenomena, the conceptualization of adaptation as assemblage-building allows for high flexibility in the definition of actants or actors, granting equal explanatory power to material (e.g. landslides), expressive (e.g. the idea of the pipe scheme), and material-expressive (e.g. community) phenomena by putting them on the same ontological footing. What matters most are the constructive (territorializing) or destructive (deterritorializing) roles these components play in the assemblage, rather than their predefined domains (esp. natural vs. social) of influence and action. In this way, the assemblage approach can be flexibly applied in a diversity of settings on various scales. Its key advantage, however, is the avoidance of a *conceptual bias* towards a specific category or type of actants that the earlier discussed "adjustment" or "transformative" adaptation concepts appear to imply. While it cannot eliminate *analytical* or *methodological bias* in empirical research, this framework does provide a way for reflexive data interpretation that acknowledges the "multiple actors and actor-networks [...] at play in the doing of research" (Sheehan 2011, 341). I have briefly addressed this issue here, but there is much greater potential for exploring methodology and reflexivity through this lens (cf. Nimmo 2011; Ruming 2009).

Due to its principal openness in terms of actants, the assemblage approach also has its challenges: leaving much responsibility to the researcher to identify the assemblages and actants in an empirical case study, there is limited guidance on how to narrow them down for analysis. With the extent of assemblages generally being dynamic and fuzzy, where is it safe to draw boundaries without overlooking important actants? A valid answer to this question should be grounded in empirical inquiries, rather than in theoretical considerations. To curtail an analysis, Latour's (2005) advice to focus on *concrete* actants that make a difference (mediators) and to disregard those that do not (intermediaries) is again helpful. Concreteness, in this sense, "does not come from choosing some figuration over some other ones in the place of the actors, but from the increase, in the accounts, of *the relative share of mediators over intermediaries*" (ibid., 61, emphasis in original). This implies that not every "black box" of an actant needs to be opened, unless its component parts make a concrete difference in the assemblage in question: A government institution, for example, might appear as a concrete actant by simply providing funds or assistance, as in the first case study of this article. In another instance, its components clearly play substantial roles by themselves – e.g. when government representatives act in their personal interests, as in the second case study presented above.

By making explicit its specific ontological foundations for an otherwise empirical research agenda, the assemblage framework offers an open and conceptually impartial mode of explanation for adapta-

tion to environmental or climate change that directs attention to the heterogeneity of actants and to the complexity of relations. This article has provided an example of following this approach in local case studies on adaptation to glacier change, but wider applications in different contexts of environmental or climate change are surely thinkable.

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References

Anderson, B. and McFarlane, C. (2011): Assemblage and geography. In: Area 43 (2), 124–127. DOI: 10.1111/j.1475-4762.2011.01004.x

Anderson, B.; Kearnes, M.; McFarlane, C. and Swanton, D. (2012): On assemblages and geography. In: Dialogues in Human Geography 2 (2), 171–189. DOI: 10.1177/2043820612449261

Ayers, J. and Dodman, D. (2010): Climate change adaptation and development I: the state of the debate. In: Progress in Development Studies 10 (2), 161–168. DOI: 10.1177/146499340901000205

Bakker, K. and Bridge, G. (2006): Material worlds? Resource geographies and the 'matter of nature'. In: Progress in Human Geography 30 (1), 5–27. DOI: 10.1191/0309132506ph588oa

Bassett, T. J. and Fogelman, C. (2013): Déjà vu or something new? The adaptation concept in the climate change literature. In: Geoforum 48, 42–53. DOI: 10.1016/j.geoforum.2013.04.010

Bennett, J. (2005): The agency of assemblages and the North American blackout. In: Public Culture 17 (3), 445. DOI: 10.1215/08992363-17-3-445

– (2010): Vibrant matter: a political ecology of things. Durham.

Birkenholtz, T. (2009): Irrigated landscapes, produced scarcity, and adaptive social institutions in Rajasthan, India. In: Annals of the Association of American Geographers 99 (1), 118–137. DOI: 10.1080/00045600802459093

Bocchiola, D. and Diolaiuti, G. (2013): Recent (1980–2009) evidence of climate change in the upper Karakoram, Pakistan. In: Theoretical and Applied Climatology 113, 611–641. DOI: 10.1007/s00704-012-0803-y

Bosco, F. J. (2006): Actor-network theory, networks, and relational approaches in human geography. In: Aitken, S. and Valentine, G. (eds.): Approaches to human geography. London, 136–148.

Bryant, L. R. (2011): The democracy of objects. Ann Arbor.

– (2014): Onto-cartography: an ontology of machines and media. Edinburgh.

Burton, I.; Kates, R. W. and White, G. F. (1993): The environment as hazard. New York.

Butz, D. (1994): A note on crop distribution and microenvironmental conditions in Holshal and Ghoshushal villages, Pakistan. In: Mountain Research and Development 14 (1), 89–97. DOI: 10.2307/3673740

Callon, M. (1986): Some elements of a sociology of translation: domestication of the scallops and the fishermen of St. Brieuc bay. In: Law, J. (ed.): Power, action and belief: a new sociology of knowledge? London, 196–223.

DeLanda, M. (2002): Intensive science and virtual philosophy. London, New York.

– (2006): A new philosophy of society: Assemblage theory and social complexity. London, New York.

Dittmer, J. (2014): Geopolitical assemblages and complexity. In: Progress in Human Geography 38 (3), 385–401. DOI: 10.1177/0309132513501405

Gardelle, J.; Berthier, E. and Arnaud, Y. (2012): Slight mass gain of Karakoram glaciers in the early twenty-first century. In: Nature Geoscience 5 (5), 322–325. DOI: 10.1038/ngeo1450

Gardelle, J.; Berthier, E.; Arnaud, Y. and Kääb, A. (2013): Region-wide glacier mass balances over the Pamir-Karakoram-Himalaya during 1999-2011. In: The Cryosphere 7 (4), 1263–1286. DOI: 10.5194/tc-7-1263-2013

Gebauer, C. and Doevenspeck, M. (2015): Adaptation to climate change and resettlement in Rwanda. In: Area 47 (1), 97–104. DOI: 10.1111/area.12168

Harman, G. (2009): Prince of networks: Bruno Latour and metaphysics. Melbourne.

Head, L. (2010): Cultural ecology: adaptation – retrofitting a concept? In: Progress in Human Geography 34 (2), 234–242. DOI: 10.1177/0309132509338978

Hewitt, K. (2005): The Karakoram anomaly? Glacier expansion and the 'elevation effect,' Karakoram Hima-

laya. In: Mountain Research and Development 25 (4), 332–340. DOI: 10.2307/3674440
– (2014): Glaciers of the Karakoram Himalaya: glacial environments, processes, hazards and resources. Dordrecht.
Hulme, M. (2011): Reducing the future to climate: a story of climate determinism and reductionism. In: Osiris 26 (1), 245–266. DOI: 10.1086/661274
Hussein, M. H.; Saleemi, A. R. and Hussain, S. (2004): Bonded labour in agriculture: a rapid assessment in Sindh and Balochistan, Pakistan. ILO Working Paper 367536. Geneva.
IPCC (2007): Climate change 2007: impacts, adaptation and vulnerability. Working Group II contribution to the fourth assessment report of the Intergovernmental Panel on Climate Change. New York.
– (2014): Climate change 2014: impacts, adaptation and vulnerability. Working Group II contribution to the fifth assessment report of the Intergovernmental Panel on Climate Change. New York.
Kreutzmann, H. (1991): The Karakoram Highway: the impact of road construction on mountain societies. In: Modern Asian Studies 25 (04), 711. DOI: 10.1017/S0026749X00010817
– (2006a): High mountain agriculture and its transformation in a changing socio-economic environment. In: Kreutzmann, H. (ed.): Karakoram in transition: culture, development, and ecology in the Hunza Valley. Karachi, 329–358.
– (ed.) (2006b): Karakoram in transition: culture, development, and ecology in the Hunza Valley. Karachi.
– (2011): Scarcity within opulence: water management in the Karakoram Mountains revisited. In: Journal of Mountain Science 8 (4), 525–534. DOI: 10.1007/s11629-011-2213-5
– (2015): Pamirian crossroads: Kirghiz and Wakhi of High Asia. Wiesbaden.
Latour, B. (1993): We have never been modern. Cambridge.
– (2005): Reassembling the social: an introduction to actor-network-theory. Oxford, New York.
Malik, A. and Piracha, M. (2006): Economic transition in Hunza and Nager valleys. In: Kreutzmann, H. (ed.): Karakoram in transition: culture, development, and ecology in the Hunza Valley. Karachi, 359–369.
Mattissek, A. and Wiertz, T. (2014): Materialität und Macht im Spiegel der Assemblage-Theorie: Erkundungen am Beispiel der Waldpolitik in Thailand. In: Geographica Helvetica 69 (3), 157–169. DOI: 10.5194/gh-69-157-2014
Meehan, K.; Shaw, I. G. R. and Marston, S. A. (2013): Political geographies of the object. In: Political Geography 33, 1–10. DOI: 10.1016/j.polgeo.2012.11.002
Minora, U.; Bocchiola, D.; D'Agata, C.; Maragno, D.; Mayer, C.; Lambrecht, A.; Mosconi, B.; Vuillermoz, E.; Senese, A.; Compostella, C.; Smiraglia, C. and Diolaiuti, G. (2013): 2001-2010 glacier changes in the Central Karakoram National Park: a contribution to evaluate the magnitude and rate of the "Karakoram anomaly". In: The Cryosphere Discussions 7 (3), 2891–2941. DOI: 10.5194/tcd-7-2891-2013
Müller, M. (2015): A half-hearted romance? A diagnosis and agenda for the relationship between economic geography and actor-network theory (ANT). In: Progress in Human Geography 39 (1), 65–86. DOI: 10.1177/0309132513518833
Nielsen, J. Ø. and Sejersen, F. (2012): Earth System Science, the IPCC and the problem of downward causation in human geographies of Global Climate Change. In: Geografisk Tidsskrift-Danish Journal of Geography 112 (2), 194–202. DOI: 10.1080/00167223.2012.741885
Nimmo, R. (2011): Actor-network theory and methodology: social research in a more-than-human world. In: Methodological Innovations 6 (3), 108–119. DOI: 10.4256/mio.2011.010
O'Brien, K. L. (2012): Global environmental change II: from adaptation to deliberate transformation. In: Progress in Human Geography 36 (5), 667–676. DOI: 10.1177/0309132511425767
Orlove, B. (2009): Glacier retreat: reviewing the limits of human adaptation to climate change. In: Environment: Science and Policy for Sustainable Development 51 (3), 22–34. DOI: 10.3200/ENVT.51.3.22-34
Parveen, S.; Winiger, M.; Schmidt, S. and Nüsser, M. (2015): Irrigation in Upper Hunza: evolution of socio-hydrological interactions in the Karakoram, northern Pakistan. In: Erdkunde 69 (1), 69–85. DOI: 10.3112/erdkunde.2015.01.05
Pelling, M. (2011): Adaptation to climate change: from resilience to transformation. Abingdon, New York.
Reid, H.; Alam, M.; Berger, R.; Cannon, T.; Huq, S. and Milligan, A. (2009): Community-based adaptation to climate change: an overview. In: Patricipatory Learning and Action 60, 11–33.
Ribot, J. (2011): Vulnerability before adaptation: toward transformative climate action. In: Global Environmental Change 21 (4), 1160–1162. DOI: 10.1016/j.gloenvcha.2011.07.008
Robbins, P. and Marks, B. (2010): Assemblage geographies. In: Smith, S. J.; Pain, R.; Marston, S. A. and Jones III, J. P. (eds.): The Sage handbook of social geographies. London, 176–194.
Ruming, K. (2009): Following the actors: mobilising an actor-network theory methodology in geography. In: Australian Geographer 40 (4), 451–469. DOI: 10.1080/00049180903312653
Scherler, D.; Bookhagen, B. and Strecker, M. R. (2011): Spatially variable response of Himalayan glaciers to climate change affected by debris cover. In: Nature Geoscience 4 (3), 156–159. DOI: 10.1038/ngeo1068

Sheehan, R. (2011): Actor-network theory as a reflexive tool: (inter)personal relations and relationships in the research process. In: Area 43 (3), 336–342. DOI: 10.1111/j.1475-4762.2011.01000.x

Smit, B. and Wandel, J. (2006): Adaptation, adaptive capacity and vulnerability. In: Global Environmental Change 16 (3), 282–292. DOI: 10.1016/j.gloenvcha.2006.03.008

Sovacool, B. K. (2011): Hard and soft paths for climate change adaptation. In: Climate Policy 11 (4), 1177–1183. DOI: 10.1080/14693062.2011.579315

Swyngedouw, E. (2014): Anthropocenic politicization: from the politics of the environment to politicizing environments. In: Bradley, K. and Hedrén, J. (eds.): Green utopianism: perspectives, politics and micro-practices. London, New York, 23–37.

van Aalst, M. K.; Cannon, T. and Burton, I. (2008): Community level adaptation to climate change: the potential role of participatory community risk assessment. In: Global Environmental Change 18 (1), 165–179. DOI: 10.1016/j.gloenvcha.2007.06.002

van der Duim, R.; Ampumuza, C. and Ahebwa, W. M. (2014): Gorilla tourism in Bwindi Impenetrable National Park, Uganda: An Actor-Network Perspective. In: Society & Natural Resources 27 (6), 588–601. DOI: 10.1080/08941920.2014.901459

Watts, M. J. (2015): Now and then. The origins of political ecology and the rebirth of adaptation as a form of thought. In: Perreault, T.; Bridge, G. and McCarthy, J. (eds.): The Routledge handbook of political ecology. London, 19–50.

Weisser, F. (2014): Practices, politics, performativities: documents in the international negotiations on climate change. In: Political Geography 40, 46–55. DOI: 10.1016/j.polgeo.2014.02.007

– (2015): Efficacious trees and the politics of forestation in Uganda. In: Area 47 (3), 319–326. DOI: 10.1111/area.12203

Weisser, F.; Bollig, M.; Doevenspeck, M. and Müller-Mahn, D. (2014): The politics of a travelling idea in Africa: translating the 'adaptation to climate change' paradigm. In: The Geographical Journal 180 (2), 111–119. DOI: 10.1111/geoj.12037

Whatmore, S. (2006): Materialist returns: practising cultural geography in and for a more-than-human world. In: Cultural Geographies 13 (4), 600–609. DOI: 10.1191/1474474006cgj377oa

Zimmerer, K. S. (1994): Human geography and the "new ecology": the prospect and promise of integration. In: Annals of the Association of American Geographers 84 (1), 108–125. DOI: 10.1111/j.1467-8306.1994.tb01731.x

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