



Controlling the water: citizens' place-related adaptation to landslides in mid-Norway

Sara Heidenreich¹ · Robert Næss¹

Received: 8 May 2023 / Accepted: 20 February 2024 / Published online: 5 March 2024
© The Author(s) 2024

Abstract

In light of an increasing frequency of climate change-related hazards such as landslides, climate adaptation is increasingly on the agenda of Norwegian municipalities. Nevertheless, municipalities face constraints in addressing these challenges, with smaller, remote municipalities being particularly susceptible. They often cover expansive geographical areas with high landslide risk, yet have limited financial resources, expertise, and personnel for climate adaptation. Consequently, the active involvement of citizens in adaptation plays an important role in these remote places. This paper investigates how citizens of three small remote communities deal with landslides, emphasizing the role of people–place relations in shaping adaptive practices. Grounded in assemblage theory, our analysis reveals that most citizens maintained a pragmatic relation to landslides, while only a few expressed concern. Regardless of the degree of concern, all citizens constructed landslides as integral element within their socio-material place assemblages, as part of their lives in the respective places. Furthermore, citizens developed various adaptive practices, including nature observation, reporting to authorities, and implementing practical preventive measures to control water that could trigger landslides. These practices are manifestations of socio-material assemblages that have evolved through citizens' relations to their specific places. Importantly, irrespective of the level of concern regarding landslides, these practices were carried out as part of everyday life. Through these practices, enabled by experience-based, embodied, and often tacit local knowledge, citizens acted as community guardians. Thus, comprehensive people–place relations emerge as a pivotal factor for a community's adaptive capacity in the face of climate change-induced hazards.

Keywords Climate adaptation · Landslides · Place · Citizens · Socio-material assemblage · Norway

Introduction

Recently, the IPCC noted that “[h]uman-induced climate change, including more frequent and intense extreme events, has caused widespread adverse impacts and related losses and damages to

nature and people” (IPCC 2022, 9). Norway is experiencing a “new normal” with higher temperatures and more extreme weather events (Miljødirektoratet 2023). Increased precipitation, often combined with high groundwater levels, snowmelt, and temperature rise, is a contributing factor to landslides (Trøan 2017), which result in significant damage each year to infrastructure such as roads, railways, and buildings and sometimes kill people. Climate change increases the landslide risk both in terms of number and size as well as occurrence in new locations (Hisdal et al. 2021). This paper studies how small remote communities in mid-Norway deal with climate change-induced landslides, including debris, rock, and quick clay¹ slides.

Communicated by Nina Baron and accepted by Topical Collection Chief Editor Christopher Reyer

This article is part of the Topical Collection on *Place Attachment and Climate-change related hazard in small remote communities*.

✉ Sara Heidenreich
sara.heidenreich@ntnu.no

Robert Næss
robert.ness@ntnu.no

¹ Department of Interdisciplinary Studies of Culture, Norwegian University of Science and Technology, N-7491 Trondheim, Norway

¹ Mid-Norway has high risk for quick clay slides due to large quick clay deposits. Quick clay has a highly unstable structure and high water content. When subjected to stress, e.g., extreme rainfall or vibration from construction activities, it can suddenly change from solid to fluid form and cause landslides.

Municipalities hold significant responsibilities for climate change adaptation, encompassing tasks related to land use, critical infrastructure, and local preparedness planning (DSB n.d.). Nevertheless, the extent to which municipalities are equipped for climate adaptation varies, with a majority experiencing limited capacities to address this challenge (NOU 2023: 9; Næss and Solli 2013; Scherzer et al. 2019). This limitation is particularly pronounced for smaller municipalities, which often cover expansive geographical areas with high risk of landslides, yet possess limited financial resources, expertise, and personnel for climate adaptation work. Additionally, constrained budgets compel small municipalities to navigate the allocation of resources between climate adaptation and other municipal responsibilities, such as those related to health and education (NOU 2023: 9; NOU 2010: 10). The limited capacity of local authorities increases the importance of the role of citizens in climate adaptation (Brink and Wamsler 2019). Therefore, we need to deepen our understanding of citizens' engagement with the adaptation to climate change-related hazards (Hegger et al. 2022; Mortreux et al. 2020; Uittenbroek et al. 2022; van Valkengoed et al. 2022).

A common focus in climate adaptation research is on adaptive capacity, encompassing the ability to adjust or respond through, e.g., financial resources and expertise. However, Mortreux et al. (2020) argue that adaptive capacity may not correlate with actual adaptation practices, thus underscoring the importance of examining not solely a community's capacity, but also citizens' actual practices. Studies have identified various factors driving citizens' adaptation efforts, such as awareness of climate change effects, knowledge of preventive actions, experience with hazards, the burden of covering the costs of damages, trust in local authorities, and the presence of strong social networks (Dapilah et al. 2020; Fletcher et al. 2020; Lujala et al. 2015; Mortreux et al. 2020; Torres et al. 2018).

Previous research has also investigated the role of people–place relations, often conceptualized as place attachment, place bonding, rootedness, or sense of place (Amundsen 2015; Feng et al. 2022; Liu et al. 2021; Masterson et al. 2019; Scannell and Gifford 2010), in climate adaptation. Findings suggest that place attachment can both motivate and hinder adaptation efforts. Motivation may stem from people's commitment and emotional connection to place, while hindrance may result from a lower risk perception (Amundsen 2015; Bonaiuto et al. 2016; Brink and Wamsler 2019; de Dominicis et al. 2015; Devine-Wright and Quinn 2020; Hovelsrud et al. 2010; Lie et al. 2023; Zwiers et al. 2018). Much of this research typically views place attachment through emotional bonds to places (Amundsen 2015; Lewicka 2011).

Another articulation of people–place relations is encapsulated in the concept of local knowledge. Setten and Lein

(2019) characterize local knowledge as situated, inherently tied to a specific place, and developed over time through sustained engagement with the material aspects of that place, thereby constituting embodied knowledge. They also identify social dimensions of local knowledge, manifested through social networks and relationships. Often considered invisible or tacit, local knowledge tends to emerge only when put into practice (Setten and Lein 2019; Solli and Ryghaug 2014). Prior studies underscore the crucial role of local knowledge in climate adaptation within the Norwegian context (Naess 2013; Næss and Solli 2013; Setten and Lein 2019; Solli and Ryghaug 2014; Tøsse 2012). Local knowledge, for example about the landscape, weather patterns, and natural phenomena that serve as warnings of hazards, is rooted in experience, shaped by long-term practices, and contributes to effective prevention of and preparedness for hazards both in Norway and internationally (Cieslik et al. 2019; Kervyn et al. 2015; Mertens 2021; Naess 2013; Næss and Solli 2013; Solli and Ryghaug 2014).

Our study of three small remote communities in mid-Norway explores the intricate dynamics of people–place relations in the context of climate adaptation, particularly focusing on citizens's knowledge, understandings, practices, and strategies for dealing with landslides. In exploring these relationships, we go beyond the common understanding of people–place relations as emotional bonds that may or may not motivate adaptive practices. Instead, we investigate existing adaptive practices and their relationships with various articulations of people–place relations through the lens of assemblage theory. Thus, this paper contributes to a more nuanced understanding of citizen engagement in climate adaptation, providing valuable insights for policy interventions aimed at encouraging community participation in local adaptation efforts.

Theoretical perspective: socio-material assemblages

Climate change poses an adaptive challenge that is intricately connected to people's beliefs, values, politics, identities, and interests—it is always context-dependent (Nelson et al. 2007). Hence, it is crucial to comprehend the complex interplay between climate change, adaptation, and people's relations to place within a local context. In this paper, we study this interplay through the lens of assemblage theory and consider both place and adaptation as socio-material assemblages. We also follow calls to engage with socio-material assemblages from a perspective of care (McGowran and Donovan 2021; Puig de la Bellacasa 2011).

Assemblage theory is rooted in Deleuzian philosophy (Deleuze and Guattari 1987) in which an assemblage is understood as a holistic entity that emerges from the

interconnections and dynamic interactions of its constituent parts. Both the individual components and the entire assemblage derive their identities and functions from the collaborative connections and synergies that arise within this flow (Dovey 2020). An assemblage can be described as a “collection of relations between heterogeneous entities to work together for some time” (Müller and Schurr 2016, 219).

In our study of climate adaptation in small remote communities, we examine how citizens create and utilize situated knowledges and practices to deal with climate change-induced landslides. This entails considering biophysical, social, and cultural elements of place. Inspired by assemblage theory, we understand place as an assemblage of socio-material elements (Anderson and McFarlane 2011; Berroeta et al. 2021). Instead of asking what a place *is*, assemblage theory focuses on the connections that hold the (interpretations of) place together. Place is not considered a given, but rather continuously produced. This enables valuable insights into the mechanisms of place composition and “how spatial forms and processes are held together” (Anderson et al. 2012, 172). Dovey (2020, 23) argues that a place is a stabilized assemblage that “works through a mix of both materiality and meaning.” Thus, houses, roads, topography, rivers, bridges, and municipal buildings form a place together with everyday routines, rhythms of work, school and leisure activities, place-specific events, values, symbols, emotions, social relations, and so on. In using assemblage theory, we go beyond the common separation of the social and natural realms that, according to Latour (2018), limits our understanding of the Anthropocene’s challenges. Thereby, we also address some of the research gaps in the literature on the sense of place identified by Raymond et al. (2017): a lack of attention to the sensory, socio-material, relational, and dynamic aspects of people–place relations.

Müller and Schurr (2016) point out that assemblage theory is particularly useful when studying change in the form of events. Places consistently change as new roads, buildings, bridges, inhabitants, and forms of social organization enter the assemblage and (re)shape the place. In this context, landslide events and the threat of such events can also become part of how we understand and connect to a place. As Dovey (2020, 26) reasons: “We say that an event ‘takes place,’ but the event also creates place.” In this sense, a place is something that is both dynamic and stable, where events or changes in the surroundings will influence people’s relationship with it, requiring both practical and mental adjustments to maintain stability (Ratnam and Drozdowski 2018).

Assemblage theory directs attention to dynamic interactions and relationships between various gatherings of things, stories, environmental processes, actors, memories, and practices that together can facilitate adaptive capacity (Williams and Miller 2020). It also highlights the flexibility

of systems and their ability to adapt to changes. Thus, this perspective can be applied to analyze how different components adjust and change over time to meet new requirements or challenges, such as landslides, or other climate change-related hazards. For our study, this means that we do not consider a community’s adaptation as a fixed characteristic but rather as constantly created and (re)shaped as various biophysical, social, and cultural elements become intertwined and relations between them evolve. Assemblage theory enables a focus both on processes of stabilization and on dynamics of change (Mertens 2021).

Conceptualizing place and adaptation as assemblages of both human and non-human elements directs attention towards practices (Mertens 2021; Solli and Ryghaug 2014). In this paper, we view practices as performed through the intertwining of the social and the material (Orlikowski 2007). Drawing inspiration from Puig de la Bellacasa’s (2011, 85) call to “treat [...] sociotechnical assemblages as ‘matters of care,’” we engage with the interrelated assemblages of place and adaptation through the lens of care (Lindén and Lydahl 2021). The term “care” has multiple meanings in its everyday usage, encompassing emotional attachment, protection, responsibility, attention, and concern as well as expressions of being troubled or worried (Murphy 2015). Within Science and Technology Studies (STS), one way of understanding the concept is as a form of practice, thus emphasizing the role of care in everyday practices (Lindén and Lydahl 2021), characterized as “persistent tinkering, in a world full of complex ambivalences and shifting tensions” (Mol et al. 2010, 14). This perspective underscores that continuous everyday caring practices are often invisible, neglected, or taken-for-granted, while simultaneously being vital for the thriving and survival of individuals and communities. Puig de la Bellacasa (2011, 100) describes care as a “signifier of necessary yet mostly dismissed labors of everyday maintenance of life.” A focus on caring practices proves particularly beneficial for this study as it accentuates the place-based nature of the socio-material assemblages through which adaptation materializes. Arora et al. (2020) argue that transformation processes guided by care can facilitate adaptation, persistent tinkering, adjusting, and repair, enabled by the relations between social and material elements of assemblages.

Methods

This paper is based on a case study conducted as part of the CliCNord project,² focusing on adaptation to climate change-induced hazards. The case study included three small

² <https://www.clicnord.org/>

remote communities in three different municipalities: one located in a mountain area, one in a coastal area, and one inland municipality. These locations were anonymized as part of our ethical contract with our study participants to ensure confidentiality. We selected the communities based on their similarity in terms of size, remoteness, and landslide occurrence, but they also have differences in terms of infrastructure (roads, railways, electricity lines), industry, businesses, and tourism that allowed us to examine a certain breadth of elements that are representative of small remote communities in mid-Norway. All three communities are located in places with high landslide risk and with regular smaller and occasional bigger landslide events with impacts such as regular road closings. The communities can therefore be characterized as being exposed to chronic landslide hazard (Cieslik et al. 2019). Hence, climate adaptation, and in particular prevention of and response to landslides, is high on the agenda of the local authorities and a pertinent topic for many citizens.

The study employed a qualitative methodology with two main methods: storytelling workshops and individual/two-person interviews with 42 study participants in total (see Online Resource 1). Storytelling is particularly suited to address complex problems such as climate adaptation. It aims to bring together a diverse group of stakeholders, create an environment for recognizing various perspectives and experiences regarding the issue at stake, and enable mutual learning (Heidenreich and Rohse 2023; Mourik et al. 2021). The method is also adept at collaboratively generating empirical data on socio-material assemblages and on the evolving relationships between social and material elements enacted in practices (Orlikowski 2007; Moezzi et al. 2017). Stories offer a holistic view of how individuals navigate and negotiate their relationship with materials, bringing out the complexities of their interactions.

The setup of the storytelling workshops was as follows: After a brief introduction of the participants and the project, the participants were asked to write down keywords based on a pre-designed story spine with questions about (1) stories about landslides (their own experiences and/or other community members' experiences/stories), (2) landslides in everyday life (related to their home, work, leisure activities), (3) challenges of living in a high-risk area, and (4) climate change and increased landslide risk. Each participant was then asked to tell their story. This was followed by a facilitated focus group discussion about commonalities and differences between the stories and generally about landslide prevention, preparedness, and response in the respective communities. We conducted three storytelling workshops—one in each community—which lasted around 4 hours and had four to nine participants who were local stakeholders involved in climate adaptation, such as local authorities, professional emergency and rescue organizations

(e.g., fire brigade, police), relevant business sectors (e.g., agriculture, construction), and civil society organizations (e.g., Red Cross, Norwegian People's Aid). These stakeholders also participated as citizens; they were not only asked for their professional perspectives but also their personal stories as community members and inhabitants of their respective places. In this paper, we primarily focus on the citizen perspective.

After the three storytelling workshops, we conducted 19 individual and two-person in-depth interviews with citizens who did not participate in the storytelling workshops and were residents of areas exposed to landslides. This allowed us to engage in more in-depth discussion of issues that came up during the workshops. Although interviews sometimes have been considered limited in their ability to address socio-materiality (Moura and Bispo 2020), in our interviews, we asked specific questions encouraging our participants to share detailed stories about the landslide events they experienced and the specific places where they happened. Many of the interviews also had a "walking interview" part where our participants showed us their houses, barns, workshops, gardens, fields, streams, gutters, and the places where landslides happened while reflecting on their relations to material objects and surroundings and how these shaped their actions.

We recorded, transcribed, and anonymized the storytelling workshops and interviews. The data material was thematically coded using the NVIVO software. The analysis started with a deductive coding of the material based on the pre-given research questions followed by an inductive coding to identify topics emerging from the data (Bingham 2023). Based on this coding, we identified assemblage theory as a suitable perspective and returned to the data for a more targeted coding, focusing on identifying the specific elements of the socio-material assemblages that constituted people–place relations and adaptive practices. Hence, we followed an abductive approach to qualitative data analysis (Dey 2004), that is, a continuous movement between inductive open coding and deductive theory-informed coding. To ensure validity, both data collection and analysis were conducted by both authors. Further, the authors returned to the communities to present and discuss the findings with participants of the storytelling workshops.

We acknowledge that by directly asking our participants about landslides, climate change, and adaptation, we, as researchers, create landslides as an "issue" without necessarily being perceived as such by our participants. During workshops and interviews, we brought the issue of landslides from our participants' "back of the mind" to their "front of the mind" (see next section) and possibly influenced their level of concern. However, after thorough discussions with the local authorities in the three municipalities who were worried that our research would create unnecessary concern among their citizens, we very thoughtfully introduced the

topic in the interviews making sure not to exaggerate the landslide risk. We also acknowledge that we, through our choice of qualitative methods and selection of informants, only bring some stories and realities to light. As Mertens (2021, 17) states “we need to be aware of the fact that we mobilize certain actors into our assemblages at the expense of others.” However, as we will see in the following section, where we discuss how people related and adapted to landslides, assemblage theory opens for uncovering several realities and understandings.

Results

Landslides as an element of a socio-material place assemblage

In this section, we explore the role of people–place relations in how citizens in our three small remote communities relate to landslides. We have identified two main relations: (1) a *pragmatic* relation ascribing landslides an inconspicuous role in the socio-material place assemblage, which a majority of our study participants represented, and (2) a *concerned* relation attributing landslides a prominent role in the socio-material place assemblage, which a minority of participants articulated.

“It’s in the back of our minds”: the pragmatic relation

The three communities we investigated are all located in areas with high landslide occurrence. Hence, all our study participants had stories to tell about landslides they had either experienced themselves and/or heard about. Interestingly, however, it often took time for them to remember these events. In a typical interview/storytelling setting, they would first deny any experience with landslides, only to later remember events they or other community members had experienced. This illustrates that for most of our participants, landslides were something they had in the *back of their minds*, something they constantly lived with but did not consciously think of or were concerned about in their everyday lives. As one study participant said: “We have to keep it in the back of our minds, but we can’t have it in our heads all the time, then one goes crazy” (M-Int2-W).

Many study participants demonstrated a rather pragmatic way of dealing with the smaller landslide events they experienced while driving or close to their homes. One couple, for example, observed clay and gravel masses coming down onto the road while driving and reacted by merely driving around it without making any more fuss:

A: It does occasionally block one lane, but then you drive over to the other and drive around.

B: [laughs] Then we drive around and then continue. (M-Int2-M/W).

People found ways to continue their daily routines through pragmatically relating to and making sense of landslides as an element in their everyday biophysical environment. This pragmatic, sometimes incautious, way of relating to landslides was typical for a majority of study participants. It can be briefly summarized as follows: “What it means for me to live with landslide risk? To cut a long story short: It is a bit like that we take it as it comes” (I-Sto-M).

People’s relation to place played into this pragmatic way of relating to landslides in several ways. First, our study participants argued that living in places with high landslide occurrence and risk requires this kind of pragmatism: “When you live in a place like this, [...] you can’t get hysterical” (M-Int4-M). Second, they noted that their experience of living in these places made them knowledgeable and able to do realistic risk assessments and contributed to less irrational fear: “You can live with a certain danger as long as you have knowledge about it. [...] We [who live in this remote place] live close to things, and we have a bit more overview [...] while in a city you live far away from it” (C-Int4-M). Third, the fact that no serious landslide events with human fatalities had happened at the respective places in the recent past contributed to a feeling of safety: “I actually feel that it is safe [...]. Nothing has ever happened while we’ve been here” (I-Int3-M). Other participants explained: “I believe a certain way of thinking has taken hold that is ‘what is there, is there’ [laughs]” (M-Int2-W) and: “We think that it has gone well before” (C-Int1-W). Fourth, many participants expressed trust in local authorities and representatives of the Norwegian Water Resources and Energy Directorate (NVE), with whom they often had personal relations and who they believed either implemented sufficient prevention measures or at least would inform the citizens if there was a significant risk.

This illustrates how prominent our participants’ long-term relations to their place featured in their relations to landslides. It further confirms previous research arguing that place attachment leads to a low risk perception and that strong bonds with a place can “favour positive images in terms of pleasantness, healthy and safeness” (Rollero and De Piccoli 2010, 200; see also Domingues et al. 2021; Luís et al. 2016; Guillou et al. 2016).

However, the socio-material people–place relations that play into how people relate to landslides are dynamic. Only one biophysical element of the assemblage—the weather—needed to change to bring landslides from the *back of the mind* to the *front of the mind*: “You think about it when there is a period with a lot of rain, for example, such as during the weekend before Christmas when there were extreme amounts of rain here. [...] That’s when you get

the landslides. Then, I think, people will think about it a bit" (C-Int4-M). Hence, it is a practice of "attending and attuning" (Stewart 2008, 72); people attuned their risk perceptions to changing socio-material assemblages and took precautions when necessary. Most of them mentioned, for example, that they would not drive certain roads when landslide risk was high due to heavy rainfalls, unless they really had to: "You can't wear a helmet all the time. But we know that there are landslides down here in the valley, and it is clear that you don't need to drive when it is pouring rain and windy" (M-Int3-M). Some participants also mentioned that they had the necessary equipment in their car: "You have the chainsaw in the car if you go somewhere because you'll never know if there will be a tree on the road [...] You have to be a bit solution-oriented, I think, when you live where you live" (M-Int7-M). Again, this pragmatic way of dealing with potential landslides is related to people–place relations. If you live in these places, you take precautions.

We also investigated whether the role of landslides in the socio-material assemblage changed if we explicitly introduced the element of climate change. Interestingly, all study participants recognized climate change as part of the place assemblage through their own observation and experience of changing weather patterns, such as more frequent heavy rains, and less stable winters. They attributed their experience of increased landslide frequency to climate change. However, although many participants recognized that landslide risk would further increase in the future, this did not make those with a pragmatic relation to landslides more concerned. Aspects such as trust in local authorities, an increased focus on climate adaptation and landslide prevention measures both locally and nationally, and their own experiences of dealing with landslides as part of life in these places seemed to balance out the increased landslide risk due to climate change. Furthermore, landslides were not considered the most urgent challenge related to climate change—for some informants, more global aspects such as food crises and climate refugees created more concern.

"I'm thinking about it every day": the concerned relation

Diener and Hagen (2022, 181) write that people "define themselves through their knowledge of different landscapes and their ability to navigate them. These landscapes can include places of pleasure, accomplishment, security, and comfort, as well as places of risk and fear." While most study participants demonstrated a pragmatic approach to landslides, our analysis also uncovered a minority who expressed strong concern and fear.

A study participant who had built her house on quick clay moved to her mountain cabin every time there were heavy rainfalls because she was so concerned about landslides:

I'm thinking about it [landslide] every day. Maybe more than two and three times per day. I always think about it when I go to bed, and when it's raining, I feel bad. When the last extreme weather event was forecasted, I moved to my cabin. I was the only one on the mountain in the storm and people were concerned about me, but I never felt that good. Because the cabin is on mountain bedrock, it could rain as much as it wanted (M-Int9-W).

A couple who experienced a landslide only a few meters from their home told a story in which the fear of their grandchildren's parents impacted their actions. Their grandchildren were not allowed to stay overnight: "We get a lot of visits from our grandchildren [...]. I hear from their parents that they ask whether something is done with the landslide. It will perhaps be the biggest disappointment if they are not allowed to come and stay over" (M-Int5-M). Both examples demonstrate a rather strong concern for health and life. The fear of a landslide event affected our study participants' daily routines and relationships, and some of them paid a rather high emotional toll for living in these places.

Interestingly, there was a gendered dimension to this concerned relation. Several men we interviewed referred to their woman partners as being more concerned. As one of them said: "You should have interviewed my partner instead, because she is more nervous" (M-Int3-M). Whether or not this pattern was an expression of othering one's own concerns because it is more socially acceptable for women to express concern, this gendered dimension demonstrates the impact of gender norms and expectations in how people make sense of landslides and their cognitive and emotional relations to it.

The participants also reported that concern within the community increased when the media reported stories about serious landslide events, such as the 2020 quick clay slide which killed ten people in Gjerdrum, around 40 km north of Oslo, and thus 500–700 km away from our case communities. This demonstrates the dynamic nature of people's risk perceptions related to the places they live in. As one participant described: "If we cannot live in places where there is landslide risk in [mid-Norway], we have very few places to live. But it is clear that people get afraid when they see Gjerdrum and such, of course they do. Then there is this calculated risk. We must live in places where there is landslide risk also" (M-Sto-W).

The question of why they still lived in the places they lived was more relevant for the participants representing the concerned relation than for the dominant pragmatic relation. Again, people–place relations played an important role, which was expressed in several ways. One participant mentioned social bonds to the community but also attachment to material aspects of the place and her house as main

reasons for staying: “It would have been absolutely terrible for me to move away from here, really. Because when this house was built, I was alone. Me and my mother have built the foundation of this house. So here lies a lot of blood, sweat and tears” (M-Int9-W). Some expressed attachment to specific aspects of their homes, such as the lawn, veranda, or workshop, while others referred to the value of remoteness and space: “I like to live in such a way that I don’t look at the neighbor” (M-Int1-W), and to feelings of peace and tranquility. Some participants also mentioned that moving away would have significant economic costs.

In these participants, we identify strong connections to social and material elements of place. People–place relations made up of human and non-human elements, a socio-material assemblage of neighbors, houses, plants, verandas, workshops, views, money, and feelings, all contributed to people not moving away despite strong concern and fear. Landslides, fear, home, gender, extreme weather, cabin, neighbors, and family all actively co-constituted a strong sense of belonging to the places.

Overall, it is striking that, whether taking a pragmatic or concerned stance towards landslides, our participants did not perceive landslides as an external threat. Rather, landslides were constructed as part of the citizens’ embodied, sensory, and material experiences of the places they live in. They were one, more or less prominent, element in the complex and dynamic socio-material assemblage that constitutes place and home. They learned to live with landslides and integrated them into their sense of place.

Citizens as guardians: adaptive practices

Regardless of being pragmatic or concerned, our participants took many small practical measures that collectively contributed to preventing landslides. Many of these measures related to controlling water, since water gone astray is a major cause of landslides. In this section, we discuss the different adaptative practices of community members and explore the role of people–place relations in these practices.

Observing and reporting

One adaptive practice all study participants engaged in was observing and monitoring their natural environment. The most common practice was to follow the weather conditions: “We sit here all the time and have control over when it rains” (M-Int7-W). Heavy and long-term rainfall sometimes combined with storms significantly increases landslide risk. Under such weather conditions, people became particularly attentive to early-warning signs for landslides, for example when they drove on the roads: “When the weather has been bad for a long time, and perhaps windy, then you have it a bit in your mind when you drive” (M-Int2-M).

Trees are significant for people’s relation to place (Jones and Cloke 2008). For many participants, trees served as important reference points in observing changes that might indicate landslide risk. Here, early-warning signs included both sounds, such as trees cracking, and visual aspects: “I was looking at the trees that are still standing over there and I have to say that I’m watching them: are they standing straight or have they started to lean over” (M-Int5-M). Other early-warning signs that people were attentive to were cracks in the ground and changes in the color of the river’s water.

Many of our participants thus engaged in semi-systematic observation and monitoring practices to identify changes in nature and the landscape. This included regular observation walks where mobile phones were used to document change:

It is us who live in this place who take walks and notice things. When I have walked a thousand times towards the bridge down there and see that yesterday something had slidden down, I take pictures, so that I see that half a meter had slidden down and then a tree had come, and that tree that was there before, had moved here (M-Int9-W).

A long-term relation to place created knowledge about and familiarity with the environment, which was central to recognizing changes and early-warning signs: “I register that nature changes, that my land is changing [...] I walk in this terrain many times a year and notice how it changes from year to year” (I-Int2-M).

Other participants took regular drives for observation purposes:

When I drive and there is a lot of rain and wind, I check. But I check the roads almost every day all year. [...] I check the water, gutters, if water is coming up, if water is going down. [...] It’s good to check if the terrain is changing. [...] You have to observe when there is a lot of water, because it is the water that is the problem (M-Sto-M).

The role of water is a critical factor when it comes to landslides; usually extreme and/or long-term rain, snowmelt, and changing streams due to human construction activities lead to the environmental changes that our study participants monitored and the early-warning signs they looked out for.

In that sense, many of our participants took on the role of community guardians through doing this observation work. One couple said: “we are pretty much small policemen who go and take pictures and document” (M-Int7-W). This role required a thorough understanding of the local environment. Such continuous observation of non-human cues in the socio-material place assemblage further underscores how the sense of place is enacted through people’s observation practices, and that such practices are necessitated by

the specific landscape properties of the place. Experience and familiarity with a place enabled the identification of potential dangers and informed responses.

One way of responding was to report the above-described observations to the local authorities so that they could respond to acute incidents, send experts to check the observed early-warning signs, and if these were considered serious, organize preventive measures. As one participant said: “I have reported such things two–three times – here you must take preventive measures [...] Quick clay is not dangerous if the water runs past it. But when the water starts digging into it, blends with it, and washes out the salt, then it is dangerous” (C-Int5-M).

This reporting practice was confirmed by municipality representatives who regularly received reports from citizens about incidents and observations of early warning signs:

These are enormous areas, and we are completely dependent on support and input from the public. Many areas along the river are characterized by agricultural lands and the farmers want to take care of their land. They are very alert and follow things closely. It is helpful that they have understood that they must report to us when something starts to happen. [...] This happens several times per year (I-Sto-M).

Some citizens mentioned semi-formalized agreements with local authorities and the NVE to monitor and report: “I made contact with the municipality quite early. Then someone from the technical department came and checked. They asked me to follow it up a bit. [...] I also took contact with someone from NVE [...]. He also asked me to monitor it. So, I sent him quite many pictures” (I-Int3-M).

In addition to reporting to local authorities and the NVE, citizens also reported their observations to other community members. They formed Facebook groups and called each other to share observations. These reporting practices relate to people–place relations and the specific characteristics of small remote places. As one participant reasoned: “I think that the municipality is so small and transparent that people themselves come and report that a small landslide happened to them” (M-Int1-W). People experienced a closer relationship both to other community members and local authorities, which is not only relevant for reporting observation of incidents but also for organizing necessary resources in acute emergency situations. They knew whom to call when an excavator was needed to free the road from debris. This demonstrates the important role of social networks as part of the place assemblage.

All citizens who participated in our study—both pragmatic and concerned—engaged in observation and monitoring work, and many reported their observations. In that sense, they acted as guardians for their community contributing to the collective perception of safety. Interestingly, the

citizens were not very consciously reflective about their role as guardians or the importance their practices might have for the community. Rather, it seemed as something they “just did,” a normal everyday practice they engaged in as part of living in the place without thinking too much about it. One participant confirmed that: “I’m convinced that if I would not have taken my observation round and reported that there were four places where things had started to erode, [...] it would not have been fixed. So I take the honor that it was done,” and then later during the interview: “Yes, I have taken that role [of the guardian] without knowing it” (M-Int9-W).

Practical prevention measures

In addition to observing and reporting, citizens also took practical measures to prevent landslides. These actions focused on controlling water. One measure was to take care of water streams and prevent water from finding new routes. This was done, for example, through keeping streams free from branches, especially when heavy precipitation was forecasted: “The owner over there had cut some trees and there were branches and some additional stuff in the water stream. [...] So we removed them. I rented a mini-excavator and cleaned the stream when I saw the weather forecast” (M-Int7-M). Another measure was to fill streams with stones and gravel: “I have a stream that goes through the property here and I have to watch it. Add stones. The route where the stream runs has to be paved with stones all the time because there is only soil below. When the stones disappear, and the stream starts to dig in the soil, there will only be ‘cacao’ down here” (M-Int2-W).

Citizens not only took care of the water on their own property but also engaged in practical measures protecting publicly owned roads. A typical action was cleaning gullies and waterpipes: “It is very natural for me when we are out and take a walk to check the gutters down here. Because I know that it is very important that they are open when the entire catchment area comes down from the mountain. [...] I have been there with the shovel and digging out the gutters several times” (C-Int5-M). Other measures related to construction practices: “When I built this barn, there was roof water. This big roof surface collects quite some water. I lead that water from the roof all the way down to the stream. I didn’t just lead it to the ground, I dug all the way down to ensure that my land and the ground is stable” (M-Int3-M).

Similar to their observation practices, participants described taking practical measures to control the water as something people just did, without thinking too much about it. “There are people that do these things, digging up a gutter and such things, but this is not noticed. It happens everywhere. It’s what people do, but I don’t know if they question it at all, they just do it. [...] It is the sum of all this that has great importance. That people, maybe unconsciously, care”

(C-Int4-M). They connected engaging in these many small preventive practices to living in small remote places: “I grew up here. This is my home place. This is the stream I’ve followed and taken care of since I was born” (M-Int2-W). One participant explicitly drew on the concept of care: “If we see that the water comes towards our house, we go out and try to find a way to lead the water away from the house. [...] It is about caring” (M-Sto-M).

The many small practices of care that contribute to preventing landslides were carried out by citizens representing both the pragmatic and the concerned relation to landslides. This underlines that there is no direct link between how concerned people were about landslides and their adaptive practices. The practices were rather a result of an assemblage of material, social, and cultural aspects developed through their relation to their place. Regardless of the level of conscious or explicit concern about landslides, these practices were carried out as part of life in those specific places. In addition to the climate adaptation work done by the authorities, these practices contributed to building adaptive capacity in their communities. Through continually monitoring changes in their environment, citizens anticipated and prepared for potential risk and responded and adapted to the changes. They demonstrated commitment to protecting their place and community, and through various practices of care, they contributed to decreasing landslide risk and enhancing the community’s perception of safety. The practices carried out as community guardians can be associated with ideas of belonging to a place and can foster a sense of attachment to and ownership of a place, thereby increasing the motivation to protect it. Comprehensive knowledge of a place—often experience-based and embodied—can play a vital role in a community’s adaptive capacity in the context of climate change-induced hazards.

Lack of attachment as a challenge

As we have seen above, for the citizens in this study’s three case communities, observing, reporting, and taking practical measures to prevent landslides were a part of their everyday lives in these three specific places. An ability to detect early-warning signs, knowledge about what to report and how to take precautions, and skills related to controlling the water were all acquired through their relation to the place—a place constituted of a socio-material assemblage of which landslides are integrated elements. The importance of local knowledge about these places was frequently emphasized by our study participants:

You should not laugh about the farmer who says that something is happening here, who knows the stream on his property like the back of his own hand. Listen to those who actually know the landscape. When they say

that things are changing here, then one should have a look at it. Because it is the local knowledge that is very important for preventing large landslides (C-Int5-M).

This also hints at a concern some of our participants expressed regarding a lack of recognition of local knowledge and place-related skills by local authorities and society at large.

Another frequent concern was the challenge of keeping alive the local knowledge developed over generations of people–place relations. Several participants described younger generations as less attached to place, nature, and environment than older generations due to, among other things, the digitalization of school and leisure time, resulting in a lack of local knowledge and practical skills. The importance of being able to handle a shovel was mentioned several times:

We don’t dare to bow down and take up a shovel. That’s how it has become. [...] After some more years, they won’t even know what a shovel is anymore [...] I believe that today’s generation is not there. I follow the weather and precipitation and I make sure that the gutters are clean. That is something I inherited. [...] Earlier this summer dangerous torrential rain was forecasted, yellow hazard warning. We have some gutters around the property on the municipal road. I took the rake and spade and started to clean them, because I know that it [the water] will come. So, ‘Dad, what are you doing?’ He didn’t understand what I was doing (M-Int8-M).

Concern about lost knowledge and skills was also expressed in the context of certain professions, such as agriculture, forestry, and construction. According to our participants, older generations had more knowledge about how to manage their land and forest in ways that protected them from landslides: “They knew more before. They were a bit more careful. They cut the trees by hand [...]. They took away the forest where there was danger [of landslides]” (M-Int2-M). They also felt that farmers today do not engage in the same practices of maintaining ditches or paving water streams as previous generations: “People were much better at doing things with a spade before. They had very practical applied knowledge to work with water retention and such things” (M-Sto-M). Increased requirements for efficiency, new agricultural technology, and the difficult economic situation of farmers were some of the reasons participants used to explain these changes in land management practices.

Our participants were also concerned by people coming from outside the places—tourists, second-home owners, and entrepreneurs working on construction projects. Second-home owners were perceived as not having sufficient awareness of the landslide risk nor the local knowledge required to deal with it, even though they visited the places regularly.

Participants reported several incidents where second-home owners ignored warnings from local citizens, which resulted in local, often voluntary, resources being used for rescue operations. They also provided examples of second-home owners driving through closed roads: “There was water on the road [...] and the road was blocked. Then someone comes in a Tesla, and he just drives over the water [...] he is invincible. He just needs to go to his second home” (M-Sto-M). Participants also discussed the challenge of an increasing number of non-local construction workers: “We must have ownership to what we do, and local knowledge. It is only [place] who can solve the challenges of [place]” (M-Sto-M). They told various anecdotes of projects gone wrong due to a lack of local knowledge: a stream that was filled during road construction without providing an alternative route for the water; or railway renovations in which steel bars with nets to prevent pipes from clogging were removed, which led to the tracks sliding away the next winter.

Thus, our participants emphasized the importance of local knowledge and practices for dealing with landslides and expressed concern about those they experienced as not sufficiently attached to the place—younger generations and non-locals—and hence not able to deal with hazards in the same way as those with strong relations to the place. These groups were perceived as not having the experience, skills, and knowledge required to take on the role of community guardians. This insider perspective, problematizing outsiders and newcomers to communities, is a phenomenon frequently observed in place attachment research (Lewicka 2011). In our study, we did not observe a difference in local knowledge and adaptive practice between the younger (around 30 years) and older (around 70 years) participants. Perhaps, local knowledge and adaptive practices are related to a “phase-of-life,” and people become more engaged when they own their own houses and establish families. Another possible explanation is that this insider perspective is related to grand societal narratives regarding the loss of practical skills in favor of theoretical knowledge. This, however, needs to be investigated further.

Discussion: climate adaptation through caring practices

Our study unveiled two primary stances through which our participants related to landslides: a dominant pragmatic relation and a minor concerned relation. In the pragmatic relation, landslides are a constant background element in people’s minds, seamlessly integrated into everyday life and the socio-material assemblages of the respective places. This pragmatic mindset is closely tied to their long-term relationship with the place, fostering realistic-sometimes incautious- risk assessment, trust in local authorities, and a sense

of security due to the absence of recent serious landslide incidents. Conversely, the concerned relation involves a conscious and ever-present awareness, sometimes accompanied by fear, with landslides being a significant and troublesome element of the place assemblage. Citizens who expressed this relation were deeply affected by the potential danger of landslides. However, both material and social elements prevented them from moving to places with lower landslide risk. Importantly, both the pragmatic and concerned relations demonstrate the local integration of landslides into the socio-material place assemblages, challenging the perception of landslides as external threats. This integration is dynamic, adapting to factors like changing weather patterns, emphasizing citizens’ practices of “attending and attuning” (Stewart 2008) to evolving socio-material conditions.

This paper also highlights the crucial role of citizens as guardians in preventing landslides and adapting to climate change through their caring practices. Both pragmatic and concerned citizens engaged in “persistent tinkering” (Mol et al. 2010, 14), caring for their places, environments, and communities. This tinkering involved adaptive practices constituted of material elements (e.g., the spade, phone, tree, crack in the ground, Facebook group) and social elements (e.g., warning neighbors, sharing knowledge and skills, teaching new generations). Through caring practices, such as observing, reporting, and many small practical preventive measures to control water flows, or “labours of everyday maintenance of life” (Puig de la Bellacasa 2011, 100), they collectively contributed to the thriving and survival of their communities. Notably, these practices did not result from explicit or systematic community organization but were carried out by various individuals as a self-evident part of everyday life. Nevertheless, all these small individual adaptive actions together formed collective caring practices. Surprisingly, we found little conscious or cognitive reflection on the practices. Instead, they were embodied and enabled through local, practical, experience-based, often tacit knowledge and skills, as well as social networks developed through long-term relations to a place. Our findings reinforce previous studies on climate adaptation in Norway (e.g., Næss and Solli 2013; Setten and Lein 2019; Solli and Ryghaug 2014), affirming the significance of local knowledge for climate adaptation. However, we find evidence that this is true not only for professional actors, such as local authorities or road managers, construction workers, or farmers, but also for regular citizens of small remote places engaged in caring practices as integral aspects of their daily lives.

Debating whether the practices identified in this paper qualify as adaptive practices is a valid point, as they are embodied outcomes of long-term learning processes rather than adjustments to sudden changes. However, given the current reality of climate change with rising temperatures, more frequent extreme weather events, and increased landslide

occurrence, these practices which have existed for a long time have already been adapted to the current climate conditions and landslide frequency. Climate change adaptation is not about adapting to one abrupt change, but to a slow continuous change, in this case manifested in a range of landslide events, making it a chronic hazard. Therefore, both assemblage theory, which emphasizes processes of stabilization and change, and care theory, which focuses on the persistent small everyday practices, prove valuable for comprehending how citizens engage with climate change adaptation.

Returning to the debate on whether people–place relations motivate or hinder adaptation (e.g., Brink and Wamsler 2019; Devine-Wright and Quinn 2020; Lie et al. 2023), our findings show that people’s long-term attachment to place can result in a pragmatic and sometimes incautious relation to landslides, but it can also hinder the concerned citizens from relocation. Importantly, engaging in adaptive practices was not linked to people’s risk perceptions. Both citizens with a pragmatic approach to landslides and citizens who were concerned exhibited similar levels of engagement in these practices. Different articulations of people–place relations, such as local knowledge, place-based practices, and social networks, contributed to, rather than hindered, citizens’ involvement in adaptation. This underlines the important role of qualitative research that studies the actual practices (Mortreux et al. 2020), shedding light on people’s “back of the mind,” their (often) tacit knowledge, and (often) invisible everyday practices. This nuanced understanding of people–place relations adds depth to the conversation about complex adaptation processes.

Conclusion

This paper investigated how three small remote communities in the mid-Norway deal with climate change-induced landslides employing a qualitative methodology. Our primary focus was on the role of people–place relations in shaping citizens’ adaptive practices through the lens of assemblage theory (e.g., Deleuze and Guattari 1987; Dovey 2020; McGowran and Donovan 2021). We find that most citizens maintain a pragmatic relation to landslides, while only a few express concern. Regardless of the degree of concern, citizens engaged in everyday adaptive practices, such as observing the environment, reporting observations of early-warning signs, and conducting various practical measures to control water flows that could trigger landslides. Through these adaptive practices, which are manifestations of socio-material assemblages that have developed through citizens’ relations to their specific places, citizens act as community guardians and enhance their adaptive capacity.

Looking forward, climate change will likely lead to an increased occurrence of landslides, making incidents more frequent and exacerbating the physical vulnerability of many small remote communities. Local authorities, already facing limited capacity for climate adaptation (NOU 2023: 9), are further challenged by concerns about the potential loss of local knowledge and skills for adaptation as more permanent and temporary residents become detached from the unique characteristics and rhythms of the places. We argue that sustaining and strengthening citizens’ adaptive practices is essential in the face of the current scenarios for climate change. Newcomers and visitors to the communities who do not have the same relation to a place in terms of local knowledge and practices must be educated and integrated into these community practices of landslide prevention, to counteract the challenges linked to a lack of place attachment. Local authorities need to recognize the importance of the often-invisible adaptive practices carried out by their citizens and incorporate these practices and local knowledge more effectively into their climate adaptation and resilience-building efforts.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s10113-024-02207-6>.

Acknowledgements We would like to thank our study participants in the three municipalities for their valuable input and the reviewers and editors for their very helpful feedback.

Funding Open access funding provided by NTNU Norwegian University of Science and Technology (incl St. Olavs Hospital - Trondheim University Hospital). This paper is based on research conducted within the CliCNord project that has received funding from the NordForsk Nordic Societal Security Programme under Grant Agreement No. 97229.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article’s Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article’s Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

References

- Amundsen H (2015) Place attachment as a driver of adaptation in coastal communities in Northern Norway. *Local Environ* 20(3):257–276. <https://doi.org/10.1080/13549839.2013.838751>
- Anderson B, McFarlane C (2011) Assemblage and geography. *Area* 43(2):124–127. <https://doi.org/10.1111/j.1475-4762.2011.01004.x>

- Anderson B, Keanes M, McFarlane C, Swanton D (2012) On assemblages and geography. *Dialogues Hum Geogr* 2(2):171–189. <https://doi.org/10.1177/2043820612449261>
- Arora S, Van Dyck B, Sharma D, Stirling A (2020) Control, care, and conviviality in the politics of technology for sustainability. *Sustain: Sci Pract Pol* 16(1):247–262. <https://doi.org/10.1080/15487733.2020.1816687>
- Berroeta H, Laís de Carvalho P, Castillo-Sepúlveda J (2021) The place–subjectivity continuum after a disaster: enquiring into the production of sense of place as an assemblage. In: Raymond CM, Manzo LC, Williams DR, Di Masso A, von Wirth T (eds) *Changing senses of place: navigating global challenges*. Cambridge University Press, New York, pp 43–52
- Bingham AJ (2023) From data management to actionable findings: a five-phase process of qualitative data analysis. *Int J Qual Methods* 22:1–11. <https://doi.org/10.1177/16094069231183620>
- Bonaiuto M, Alves S, De Dominicis S, Petrocelli I (2016) Place attachment and natural hazard risk: research review and agenda. *J Environ Psychol* 48:33–53. <https://doi.org/10.1016/j.jenvp.2016.07.007>
- Brink E, Wamsler C (2019) Citizen engagement in climate adaptation surveyed: the role of values, worldviews, gender and place. *J Clean Prod* 209:1342–1353. <https://doi.org/10.1016/j.jclepro.2018.10.164>
- Cieslik K, Shakya P, Upreti P, Dewulf A, Russell C et al (2019) Building resilience to chronic landslide hazard through citizen science. *Front Earth Sci* 7:278. <https://doi.org/10.3389/feart.2019.00278>
- Dapilah F, Nielsen JØ, Friis C (2020) The role of social networks in building adaptive capacity and resilience to climate change: a case study from northern Ghana. *Clim Dev* 12(1):42–56. <https://doi.org/10.1080/17565529.2019.1596063>
- De Dominicis S, Fornara F, Ganucci Cancellieri U, Twigger-Ross C, Bonaiuto M (2015) We are at risk, and so what? Place attachment, environmental risk perceptions and preventive coping behaviours. *J Environ Psychol* 43:66–78. <https://doi.org/10.1016/j.jenvp.2015.05.010>
- Deleuze G, Guattari F (1987) *A thousand plateaus*. University of Minnesota Press, Minneapolis, London
- Devine-Wright P, Quinn T (2020) Dynamics of place attachment in a climate changed world. In: Manzo L, Devine-Wright P (eds) *Place attachment: advances in theory, methods and applications*. Routledge, London, pp 226–242
- Dey I (2004) Grounded theory. In: Seal C, Gobo G, Gubrium JF, Silverman D (eds) *Qualitative Research Practice*. Sage, London, pp 80–93
- Diener AC, Hagen J (2022) Geographies of place attachment: a place-based model of materiality, performance, and narration. *Geogr Rev* 112(1):171–186. <https://doi.org/10.1080/00167428.2020.1839899>
- Domingues RB, Neves de Jesus S, Ferreira Ó (2021) Place attachment, risk perception, and preparedness in a population exposed to coastal hazards: a case study in Faro Beach, southern Portugal. *Int J Disaster Risk Reduction* 60:102288. <https://doi.org/10.1016/j.ijdrr.2021.102288>
- Dovey K (2020) Place as assemblage. In: Edensor T, Kalandides A, Kothari U (eds) *The Routledge Handbook of Place*. Routledge, London, pp 21–31
- DSB (n.d.) Prevention of natural hazards in Norway. Direktoratet for samfunnsikkerhet og beredskap. <https://www.dsb.no/lover/risiko-sarbarhet-og-beredskap/artikler/internasjonalt/disaster-prevention/prevention-of-natural-hazards-in-norway/> Accessed 22 Nov 2023
- Feng X, Zhang Z, Chen X (2022) Paper analysis of the relevance of place attachment to environment-related behavior: a systematic literature review. *Sustainability* 14(23):16073. <https://doi.org/10.3390/su142316073>
- Fletcher AJ, Akwen NS, Hurlbert M, Diaz HP (2020) “You relied on God and your neighbour to get through it”: social capital and climate change adaptation in the rural Canadian Prairies. *Reg Environ Change* 20:61. <https://doi.org/10.1007/s10113-020-01645-2>
- Guillou E, Krien N, Meur-Ferec C (2016) Inhabitants of coastal municipalities facing coastal risks: understanding the desire to stay. *Pap Soc Representations* 25(1):8.1–8.21. fhal-01521636
- Hegger DLT, Mees HLP, Wamsler C (2022) The role of citizens in sustainability and climate change governance: taking stock and looking ahead. *Environ Policy Gov* 32(3):161–166. <https://doi.org/10.1002/eet.1990>
- Heidenreich S, Rohse M (2023) Storytelling. Engagement methods for climate, energy and mobility transitions. No. 11. SSH CENTRE, Cambridge. <https://sshcentre.eu/wp-content/uploads/2023/05/Infosheets-11-SSH-CENTRE-Storytelling.pdf>. Accessed 19 Feb 2024
- Hisdal H, Vikhamar-Schuler D, Førland EJ, Nilsen IB (2021) Klimaprofiler for fylker. Et kunnskapsgrunnlag for klimatilpasning. NCCS report no 2/2021. https://klimaservice.senter.no/kss/rapporter/rapporter-og-publikasjoner_2. Accessed 19 Feb 2024
- Hovelsrud GK, Dannevig H, West J, Amundsen H (2010) Adaptation in fisheries and municipalities: three communities in northern Norway. In: Hovelsrud GK, Smit B (eds) *Community Adaptation and Vulnerability in Arctic Regions*. Springer, Dordrecht Heidelberg London New York, pp 23–62
- IPCC (2022) Summary for policymakers [H-O Pörtner, DC Roberts, ES Poloczanska, K Mintenbeck, M Tignor, A Alegría, M Craig, S Langsdorf, S Löschke, V Möller, A Okem (eds)]. In: *climate change 2022: impacts, adaptation and vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [H-O Pörtner, DC Roberts, M Tignor, ES Poloczanska, K Mintenbeck, A Alegría, M Craig, S Langsdorf, S Löschke, V Möller, A Okem, B Rama (eds)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp 3–33. <https://doi.org/10.1017/9781009325844.001>
- Jones O, Cloke P (2008) Non-human agencies: trees in place and time. In: Knappett C, Malafouris L (eds) *Material agency*. Springer, Berlin, pp 79–96
- Kervyn M, Jacobs L, Maes J, Che VB, Hontheim Ad et al (2015) Landslide resilience in Equatorial Africa: moving beyond problem identification! *Belgeo* 1. <https://doi.org/10.4000/belgeo.15944>
- Latour B (2018) *Down to earth: politics in the new climatic regime*. Polity Press, Cambridge
- Lewicka M (2011) Place attachment: how far have we come in the last 40 years? *J Environ Psychol* 31(3):207–230. <https://doi.org/10.1016/j.jenvp.2010.10.001>
- Lie LB, de Korte L, Pursiainen CH (2023) “Here, I will stay until I die”—exploring the relationship between place attachment, risk perception, and coping behavior in two small Norwegian communities. *Reg Environ Change* 23(115). <https://doi.org/10.1007/s10113-023-02106-2>
- Lindén L, Lydahl D (2021) Editorial: care in STS. *Nord J Sci Technol Stud* 9(1):3–12. <https://doi.org/10.5324/njsts.v9i1.4000>
- Liu Q, Zhu Z, Zhuo Z, Huang S, Zhang C et al (2021) Relationships between residents’ ratings of place attachment and the restorative potential of natural and urban park settings. *Urban For Urban Green* 62:127188. <https://doi.org/10.1016/j.ufug.2021.127188>
- Luís S, Pinho L, Lima ML, Roseta-Palma C, Martins FC et al (2016) Is it all about awareness? The normalization of coastal risk. *J Risk Res* 19:810–826. <https://doi.org/10.1080/13669877.2015.1042507>
- Lujala P, Lein H, Rød JK (2015) Climate change, natural hazards, and risk perception: the role of proximity and personal experience. *Local Environ* 20(4):489–509. <https://doi.org/10.1080/13549839.2014.887666>
- Masterson VA, Enqvist JP, Stedman RC, Tengö M (2019) Sense of place in social–ecological systems: from theory to

- empirics. *Sustain Sci* 14(2):555–564. <https://doi.org/10.1007/s11625-019-00695-8>
- McGowan P, Donovan A (2021) Assemblage theory and disaster risk management. *Prog Hum Geogr* 45(6):1601–1624. <https://doi.org/10.1177/03091325211003328>
- Mertens K (2021) Reassembling disaster risk: towards a more self-reflexive and enabling geography. *Belgeo* 4. <https://doi.org/10.4000/belgeo.53076>
- Miljødirektoratet (2023) Klimaendringer i Norge. <https://miljostatus.miljodirektoratet.no/tema/klima/klimaendringer-i-norge/> Accessed 19 Feb 2024
- Moezzi M, Janda KB, Rotmann S (2017) Using stories, narratives, and storytelling in energy and climate change research. *Energy Res Soc Sci* 31:1–10. <https://doi.org/10.1016/j.erss.2017.06.034>
- Mol A, Moser I, Pols J (2010) Care: putting practice into theory. In: Mol A, Moser I, Pols J (eds) *Care in practice: on tinkering in clinics, homes and farms*. Transcript Verlag, Bielefeld, pp 7–25
- Mortreux C, O'Neill S, Barnett J (2020) Between adaptive capacity and action: new insights into climate change adaptation at the household scale. *Environ Res Lett* 15:074035. <https://doi.org/10.1088/1748-9326/ab7834>
- Moura EO, Bispo MS (2020) Sociomateriality: theories, methodology, and practice. *Can J Admin Sci* 37(3):350–365. <https://doi.org/10.1002/cjas.1548>
- Mourik RM, Sonetti G, Robison RAV (2021) The same old story – or not? How storytelling can support inclusive local energy policy. *Energy Res Soc Sci* 73:101940. <https://doi.org/10.1016/j.erss.2021.101940>
- Müller M, Schurr C (2016) Assemblage thinking and actor-network theory: conjunctions, disjunctions, cross-fertilisations. *Trans Inst Br Geogr* 41(3):217–229. <https://doi.org/10.1111/tran.12117>
- Murphy M (2015) Unsettling care: troubling transnational itineraries of care in feminist health practices. *Soc Stud Sci* 45(5):717–737. <https://doi.org/10.1177/0306312715589136>
- Naess LO (2013) The role of local knowledge in adaptation to climate change. *Wires Clim Change* 4(2):99–106. <https://doi.org/10.1002/wcc.204>
- Næss R, Solli J (2013) Klimakunnskap og kunnskapsklima: Hvordan drives klimatilpasning? Akademika forlag, Trondheim
- Nelson D, Agder W, Brown K (2007) Adaptation to environmental change: contribution of a resilience framework. *Annu Rev Environ Resour* 32:395–419. <https://doi.org/10.1146/annurev.energy.32.051807.090348>
- NOU (2010: 10) Tilpassing til eit klima i endring— Samfunnet si sårbarheit og behov for tilpassing til konsekvensar av klimaendringane. Oslo <https://www.regjeringen.no/contentassets/01c4638b3f3e4573929f3b375f4731e0/nn-no/pdfs/nou201020100010000dddpdfs.pdf> Accessed 19 Feb 2024
- NOU (2023: 9) Generalistkommunesystemet. Likt ansvar – ulike forutsetninger. Oslo. <https://www.regjeringen.no/contentassets/5a25f42bd97345c29593c03a515738d2/no/pdfs/nou202320230009000dddpdfs.pdf> Accessed 19 Feb 2024
- Orlikowski WJ (2007) Sociomaterial practices: exploring technology at work. *Organ Stud* 28(9):1309–1454. <https://doi.org/10.1177/0170840607081138>
- Puig de la Bellacasa M (2011) Matters of care in technoscience: assembling neglected things. *Soc Stud Sci* 41(1):85–106. <https://doi.org/10.1177/0306312710380301>
- Ratnam C, Drozdowski D (2018) Assembling attachments to homes under bushfire risk. *Geogr Res* 56(1):42–53. <https://doi.org/10.1111/1745-5871.12250>
- Raymond CM, Kyttä M, Stedman R (2017) Sense of place, fast and slow: the potential contributions of affordance theory to sense of place. *Front Psychol* 8:1674. <https://doi.org/10.3389/fpsyg.2017.01674>
- Rollero C, De Piccoli N (2010) Place attachment, identification and environment perception: an empirical study. *J Environ Psychol* 30:198–205. <https://doi.org/10.1016/j.jenvp.2009.12.003>
- Scannell L, Gifford R (2010) Defining place attachment: a tripartite organizing framework. *J Environ Psychol* 30(1):1–10. <https://doi.org/10.1016/j.jenvp.2009.09.006>
- Scherzer S, Lujala P, Rød JK (2019) A community resilience index for Norway: an adaptation of the baseline resilience indicators for communities (BRIC). *Int J Disaster Risk Reduct* 36:101107. <https://doi.org/10.1016/j.ijdrr.2019.101107>
- Setten G, Lein H (2019) “We draw on what we know anyway”: the meaning and role of local knowledge in natural hazard management. *Int J Disaster Risk Reduction* 38:101184. <https://doi.org/10.1016/j.ijdrr.2019.101184>
- Solli J, Ryghaug M (2014) Assembling climate knowledge - the role of local expertise. *Nordic J Sci Technol Stud* 2(2):18–28. <https://doi.org/10.5324/njsts.v2i2.2151>
- Stewart K (2008) Weak theory in an unfinished world. *J Folk Res* 45(1):71–82. <http://www.jstor.org/stable/40206966>. Accessed 19 Feb 2024
- Torres HR, Alsharif KA, Tobin GA (2018) Perspectives on adaptive capacity to climate change in hazardous environments: insights from Broward County, Florida. *Weather Clim Soc* 10(2):361–372. <https://doi.org/10.1175/WCAS-D-17-0094.1>
- Tøsse SE (2012) Uncertainties and insufficiencies: making sense of climate adaptation. Dissertation, Norwegian University of Science and Technology. Doctoral theses at NTNU, 2012:245 https://ntnuopen.ntnu.no/ntnu-xmlui/bitstream/handle/11250/244191/586333_FULLTEXT01.pdf?sequence=1 Accessed 19 Feb 2024
- Trøan B (2017) Poretrykksutløste jord- og flomskred: En studie av skredhendelser i Melen i Forradalen, Sjørdal kommune. NTNU: Institutt for geovitenskap og petroleum. <https://ntnuopen.ntnu.no/ntnu-xmlui/handle/11250/2451648?locale-attribute=no> Accessed 19 Feb 2024
- Uittenbroek CJ, Mees HLP, Hegger DLT, Driessen PPJ (2022) Everybody should contribute, but not too much: perceptions of local governments on citizen responsabilisation in climate change adaptation in the Netherlands. *Environ Policy Gov* 32(3):192–202. <https://doi.org/10.1002/eet.1983>
- van Valkengoed AM, Perlaviciute G, Steg L (2022) Relationships between climate change perceptions and climate adaptation actions: policy support, information seeking, and behaviour. *Clim Chang* 171(14). <https://doi.org/10.1007/s10584-022-03338-7>
- Williams DR, Miller BA (2020) Metatheoretical moments in place attachment research: seeking clarity in diversity. In: Manzo L, Devine-Wright D (eds) *Place attachment: advances in theory, methods and applications*, 2nd edn. Routledge, London, pp 13–28
- Zwiers S, Markantoni M, Strijker D (2018) The role of change- and stability-oriented place attachment in rural community resilience: a case study in south-west Scotland. *Commun Dev J* 53(2):281–300. <https://doi.org/10.1093/cdj/bsw020>

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.