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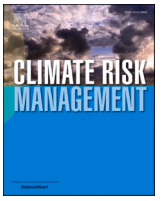

Anticipating climate risk in Norwegian municipalities

Leikny Bakke Lie *, Vilde Lysgaard, Are Kristoffer Sydnes

Department of Technology and Safety, UiT – the Arctic University of Norway, Hansine Hansens veg 18, N-9019 Tromsø, Oslo,Norway

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ABSTRACT

Climate change is increasingly being coupled to extreme weather and climate events, with an observed increase in intensity and occurrence of climate-related events. Norway is no exception. Though generally considered quite resilient to climate risk, with favorable conditions for adapting on a national level, studies point to regional and local differences. Applying a mixed methods approach we combine a literature review on climate adaptation in Norwegian municipalities showing patterns and trends, with a small-N case study allowing for an in-depth exploration of four Arctic municipalities, where warming occurs faster. We investigate how Norwegian municipalities observe, identify, and prepare for climate-related hazards, by applying the anticipation stage of resilience as an analytical approach. Findings demonstrate how municipal anticipatory capabilities largely rely on external expertise to gather information and/or reduce uncertainty. Experience and familiar hazards form the basis for preparing for future risk. This leaves municipalities running the risk of adapting to present risks while neglecting future developments in vulnerability and exposure to weather and climate events. Climate adaptation has been embedded in the existing processes for risk management, applying statutory risk- and vulnerability assessments as the primary tool for identifying climate risk. We find that this framing leaves a significant imprint on the municipal adaptation efforts. Based on our findings we recommend that municipalities look to strengthen in-house competency on climate adaptation and implement the use of distinct climate risk assessments to better capture long-term risk and identify local adaptation needs and measures.

1. Introduction

Climate change is a global challenge with impacts manifesting locally, putting local authorities at the front line of action (Archer and Rahmstorf 2013; IPCC 2021). Climate projections for Norway point to an increase in annual temperature and precipitation towards the year 2100, with impacts such as increase in mean sea level, more intense and frequent heavy precipitation episodes, rain-induced flood events, and the potential for increased occurrences of rainfall-triggered landslides and slush flows (Hanssen-Bauer et al. 2017). A substantial amount of Norway's land mass is located in the Arctic region,[1] which is warming at a pace of three (AMAP 2021) to four times (Rantanen et al. 2022) faster than the global average. The impact of climate change on natural hazards is already felt across the Arctic (Overland 2021), exemplified by thawing permafrost and avalanches challenging life in Svalbard (Tiller et al. 2022; Timlin et al. 2022), and increased uncertainty related to avalanche risk and road closures in Northern Norway (Jacobsen et al. 2016;

* Corresponding author at: Hansine Hansens veg 18, N-9019 Tromsø, Norway.
E-mail address: leikny.b.lie@uit.no (L. Bakke Lie).

[1] Acknowledging the absence of an universally agreed definition of the Arctic, we apply the definition provided by Arctic Monitoring and Assessment Programme (AMAP 2009) and commonly used by scientists.

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Hovelsrud et al. 2018). Although Norway overall is considered quite resilient, with high capacity and favorable conditions for adapting to climate risk, there are significant local differences (O'Brien et al. 2004; NOU 2010: 10 2010; Amundsen 2012; Juhola et al. 2012; Lujala et al. 2015; Aall et al. 2018). While recent studies highlight a North-South divide in climate resilience in Norway, with municipalities in the north less resilient despite higher exposure to climate risk, these conclusions rely on generalized indicators that oversimplify the complex and localized nature of resilience and adaptation (Scherzer et al. 2019; Aall et al. 2023). Contributing with more nuanced insight on climate adaptation efforts in Northern Norway, our study includes an in-depth study of how four arctic municipalities adapt through efforts of anticipating climate risk.

Acknowledging the need to develop resilient societies, the European Commission has adopted *five disaster resilience goals* (European Commission 2023). The first goal concerns anticipating risk through improved risk assessments, anticipation and disaster risk management planning, followed by goals relating to the subsequent steps in the disaster management cycle (Rosenthal et al. 2001): to prepare, alert, respond and secure. Anticipation is an important initial step in building resilience, as it directly contributes to the development of capabilities to respond and adapt to climate risk. Climate adaptation, the process of adjusting to actual or expected climate conditions (IPCC 2022, p.5), is perceived as an integral part of preparing societies to the impacts of a changing climate, alongside activities to strengthen resilience and reduce vulnerability (UNFCCC 2015; IPCC 2022). Our assumption is that municipalities can improve their capacity to prepare for, cope with, and withstand negative climate impacts – i.e., build resilience, through climate adaptation activities that enhance their anticipatory, coping, and adaptive capacities.

Finding that empirical knowledge on anticipation at local governance level is limited, our study investigates how Norwegian municipalities take measures to anticipate and prepare for climate-related (hydrometeorological and climatological) hazards, by seeking to answer the research question: How do climate adaptation efforts in Norwegian municipalities contribute to building resilient capabilities to identify, observe, and prepare for current and future climate risk? Applying a mixed methods approach we combine a literature review on climate adaptation in Norwegian municipalities identifying patterns and trends across a wide body of literature, with a small-N case study allowing for an in-depth exploration of the Arctic, a context where warming occurs faster, and resilience is considered lower compared to other regions. The latter contributes to identifying challenges in the Arctic that may prove valid in a wider context. The two studies are integrated and analyzed through a conceptual framework of resilience (Duchek 2020). We find that Norwegian municipalities in general, and Arctic municipalities in particular, are largely dependent on external knowledge and competency as input for anticipation processes, and that climate risk is internalized as familiar hazards and current risk levels, rather than anticipating how future climate could impact the municipalities.

The structure of the manuscript is as follows: first, section 2 presents climate adaptation governance in Norway in brief. In section 3, we elaborate on the theoretical framework on resilience applied in our analysis, particularly focusing on anticipation as the initial stage of the resilience process. Our methods, together with strengths and limitations, are described in section 4. The results from our study are provided in section 5, followed by a discussion on the implications of how municipalities observe, identify, and prepare for a changing climate in section 6. Finally, to conclude we summarize our main findings, implications, and recommendations in section 7.

2. Climate adaptation governance in Norway

Adapting societies and ecosystems to a changing climate is expressed as a national goal in the Norwegian climate adaptation strategy 'Changing Climate – together for a climate-resilient society' (Meld. St. 26 2022 – 2023), and formalized in the national planning guidelines for climate and energy planning and climate adaptation (SPR 2018). Responsibility for climate adaptation has been assigned according to the Norwegian principles for civil protection and emergency preparedness (Meld. St. 33 2012––2013; Norwegian Ministry of Justice and Public Security 2017; Meld. St. 5 2020–2021; Meld. St. 26 2022 – 2023). All relevant actors, from individuals and households to private companies and public authorities, have a responsibility to prepare for and handle extraordinary events that can affect tasks and functions within their jurisdiction (Meld. St. 5 2020–2021; Meld. St. 26 2022 – 2023). The responsibility principle encompasses both emergency preparedness measures in general as well as climate adaptation measures (Meld. St. 33 2012––2013; Meld. St. 26 2022 – 2023).

Certain actors are particularly central in implementing Norway's climate adaptation strategy. Due to the localized character of climate impacts, Norwegian municipalities hold a key role in preparing for and adapting to the impacts of climate change. As local planning authorities, (Plan- og bygningsloven 2008) Norwegian municipalities have considerable autonomy to regulate and define the direction of municipal development, as well as a responsibility to safeguard the public (Sivilbeskyttelsesloven 2010) against risks. This is to be achieved through tools like municipal master plans comprised of spatial- and development planning and holistic risk- and vulnerability assessments (RVAs). To facilitate local climate adaptation, central authorities with regional and/or sectoral mandates shall provide information and advice to the municipalities on matters associated with climate-related hazard risks and emergency preparedness. The County Governors and the Norwegian Water Resources and Energy Directorate (NVE) are examples of authorities with such responsibilities (Neby et al. 2023). The County Governors function as the regional representative of the central authorities, with auditing and advisory responsibility (Statsforvalterinstruksen 1981), while the NVE is the assigned national authority on flood and avalanche risk (St.prp. nr.1 2008–2009), including the provision of hazard mapping and allocation of funding for protection measures (Meld. St. 15 2011–2012; Forskrift om naturfaretilskudd 2022). Thus, while the municipalities enjoy substantial local autonomy, the vertical governance model ensures a degree of national control and support to further the implementation of national policies.

3. Strengthening resilience through anticipatory capabilities

Climate change acts as a modifier to various natural hazards that are impacted by hydrological, meteorological, and climatological processes, altering the conditions for when and where such hazards can occur (Thomas 2017; Zscheischler et al. 2020). These physical risks associated with climate change relate to the concept of climate risk. Climate risk as defined by the IPCC (2012) consists of three variables: the extreme weather or climate event types, exposure to such events, and the system's vulnerability to such events. Thus, climate risk is not determined solely by climate-related hazards but in the interaction of these hazards with non-climatic drivers (EEA 2024). Extreme weather and climate events exacerbated by climate change can develop and manifest at varying speeds, from the sudden onset of disasters such as flooding and landslides, to slow and creeping developments such as global temperature rise, sea-level rise, and desertification (Boin et al. 2021). Consequently, climate risk involves both a short-term and a long-term component: the municipalities must prepare for the sudden onset of extraordinary events while simultaneously preparing for future manifestations.

To reduce the negative impacts of climate risk and exploit the opportunities that might follow from a changing climate, strategies involving climate adaptation and resilience have been emphasized through international agreements such as the Paris Agreement (UNFCCC 2015) and risk governance frameworks such as the Sendai Framework for Disaster Risk Reduction (United Nations 2015). Whereas the strategy of climate adaptation specifically targets climate risk (Mercer 2010), the concept of resilience encompasses a broader approach to risks, independent of origin, and is often considered an integral part of the climate adaptation process (UNFCCC 2015; IPCC 2022). Resilience, a concept with various definitions and appliance (Holling 1973; Werner 1992; Walker et al. 2004; Linnenluecke 2017; Masten 2019), generally refers to the ability of a system to cope with and bounce back from extraordinary events, while maintaining essential functions, identity, and structures (Wildavsky 1988; Manyena 2006; Woods and Hollnagel 2006; IPCC 2012, 2022). Resilience can be perceived as an outcome, as a process (Kaplan 1999; Manyena 2006), or oriented towards resilience capabilities (Duchek 2020). Tying these three approaches together, Duchek's (2020) capability-based conceptualization of resilience proposes that a process of building resilient capabilities can result in a resilient outcome. Following Duchek's (2020) framework, we here define resilience as a circular, three-stage process of anticipation, coping and adaptation (Fig. 1). Activities within these three stages may occur simultaneously, preparing for current and future risk while responding to past events. Anticipation determines what one prepares for and is capable of coping with, as coping experience impacts processes of learning and change, inevitably impacting how to respond and adapt to future developments. Adaptation as a resilient capability differs from the concept of climate adaptation: from a resilience point of view adaptation is primarily oriented towards reflection, learning, and change (Sutcliffe and Vogus 2003; Madni and Jackson 2009), while climate adaptation, as outlined by the IPCC (2022), covers actions across all stages of the resilience cycle shown in Fig. 1.

Our study is primarily focused on the anticipation stage of the resilience process. Anticipation is formed by proactive activities prior to an extraordinary event. Once an event has become manifest, the coping stage follows, with concurrent action to reduce negative consequences. After the event, in the adaptation stage, the focus is on actions aimed at learning from and implementing necessary changes to enable better preparation for future events (Duchek 2020). The anticipatory stage involves building capacities to prepare for extraordinary events when it is not possible to know if, when, where, or how these will reveal themselves in the future. This stage is of a proactive character, relying on capacities to strengthen the ability to observe, identify, and prepare for extraordinary events and their potential impacts (Duchek 2020). Observation and identification are closely related: jointly, they enable organizations to detect early signals of threat and build preparedness.

The act of anticipation is a way of making the future actionable in the present (Anderson 2010) and entails the ability to imagine the future (Weick 2005). Resilient organizations anticipate the future without analogizing the future to the familiar (Shtob 2019), avoiding making decisions solely based on past experiences. There is a degree of epistemic and aleatory uncertainty embedded in the activity of

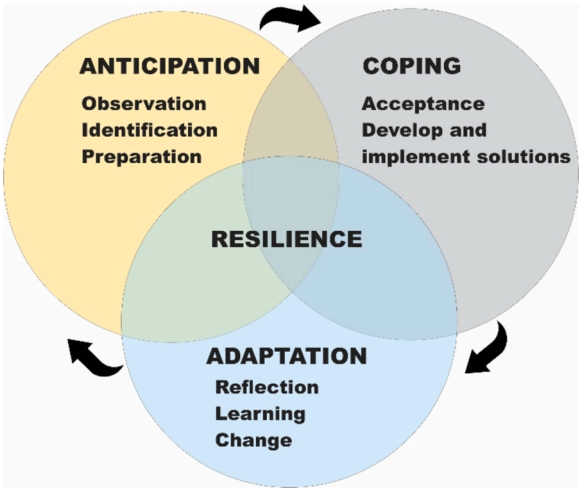

Fig. 1. A simplified resilience framework, adapted from Duchek's (2020) capability-based conceptualization of resilience.

anticipating the future. Aleatory uncertainty, often considered irreducible uncertainty (Skinner et al. 2014; Pelz et al. 2021), can here be related to natural variability and a certain degree of intrinsic randomness of climate model predictions (Proistosescu and Wagner 2020). Epistemic uncertainties are linked to lack of knowledge or insufficient data (Skinner et al. 2014; Pelz et al. 2021) that can be reduced by seeking more and better information (Wang et al. 2014). One way for municipalities to reduce epistemic uncertainty regarding climate risk is to seek expert advice. As Anthony Giddens (1991, p. 114) noted, "experts are often brought in as a fateful moment approach or a fateful decision has to be taken". Climate risk can be considered as such a fateful moment for the municipalities, considering their potentially dramatic impacts. However, expert advice does not necessarily provide clarity in what decisions to make (Giddens 1991).

Anticipation requires obtaining relevant knowledge and translating this into locally relevant, actionable information and behavior (Duchek 2020). Activities that could promote municipalities' capacity to anticipate future impacts of climate change encompass efforts to utilize internal and external knowledge and competences, translation of climate projections to local relevant information, incorporating climate change in risk- and vulnerability assessments, and implementation of climate risk in municipal planning within areas such as emergency preparedness and spatial planning. Anticipatory capabilities are mainly proactive activities prior to an event, functioning as a latent process that will reveal itself in times of need (Sutcliffe and Vogus 2003).

4. Methods

This study applies a mixed-methods approach, combining findings from a systematic literature review on the status of climate adaptation in a Norwegian context, with empirical data from a qualitative small-N case study (Lysgaard 2022) on how four Arctic municipalities build resilience through anticipating climate risk.

The literature review is based on a systematic review process (Berrang-Ford et al. 2015) with additional sources identified through snowballing and explorative searching. Relevant grey literature was included to shed additional light on climate adaptation implementation in Norwegian municipalities (Berrang-Ford et al., 2011; Berrang-Ford et al., 2021; Eisenack et al., 2012; Vij et al., 2021). The data set (N = 55) consists of peer-reviewed literature identified through a systematic search (N = 31) and literature identified through explorative searching (N = 24). We included 41 peer-reviewed documents and 14 grey literature documents in our analysis.

All documents identified in the data collection phase were evaluated against a pre-defined set of inclusion and exclusion criteria and subjected to a quality appraisal before inclusion. Acknowledging the challenge of combining peer-reviewed and grey literature without compromising the quality and reliability of the review (Ford et al. 2011; Berrang-Ford et al. 2021), we subjected all grey literature to an evaluation against the Authority, Accuracy, Coverage, Objectivity, Date and Significance (AACODS) checklist (Tyndall 2010). Data collected for the literature review were systematized and thematically analyzed for patterns and themes (Boyatzis 1998; Braun and Clarke 2006; Terry et al. 2017) using the qualitative data analysis software NVivo (O'Neill et al. 2018; QSR International Pty Ltd. 2022).

The qualitative case study performed by Lysgaard (2022) provided empirical data from four municipalities located in the northernmost counties of Troms and Finnmark, above the Arctic Circle (Dahle 2020; Bratberg 2024). Data collection was performed during 2022 through document analysis (N = 10) and semi-structured interviews (N = 8). Serving as secondary data, relevant documents were retrieved from public sources or directly from involved respondents, and consisted of municipal documents on planning, preparedness, and risk assessments (N = 4), regional risk- and vulnerability assessment (N = 1), and national guidelines on preparedness, risk assessments, and climate adaptation (N = 5). The documents were subjected to a qualitative content analysis. The document analysis provided valuable input in designing the interview guide and was actively utilized to strengthen and substantiate findings obtained during the interviews.

The case municipalities were randomly selected from within Troms and Finnmark county, while respondents participating in semi-structured interviews were chosen based on the relevance of their assigned positions to our research questions. Interviews were structured around the concepts of *resilience* and *anticipation*, probing into how municipalities identify climate risk and prepare for current and future risks affected by climate change. Five stakeholders from the four municipalities (N = 5), the County Governor of Troms and Finnmark (N = 2) and the Norwegian Water Resources and Energy Directorate (NVE) (N = 1) participated in our case study. Due to the geographical distances involved, the interviews were conducted via video calls.

4.1. Strengths and limitations

Our contribution is primarily empirical, providing insight into practical efforts of local adaptation and how these can contribute to strengthening resilience. A strength of our study is that it contributes to both a broad overview and an in-depth exploration. The literature review provides a broad overview of existing research and reported adaptation efforts in Norwegian municipalities, allowing for identification of patterns and trends in a Norwegian context across a wide body of literature. Our case study of four Arctic municipalities enables an in-depth understanding of how municipalities in a region that is impacted by climate change at a faster pace than the global average is building resilience through climate adaptation efforts. The integration of the two sources of data is enabled by applying a common analytical framework to gather and analyze the data. The mixed methods and data approach increase the validity of our findings.

The choice of resilience framework introduces a form of bias, as different interpretations of resilience could uncover other nuances or insights from the empirical data. Although the conceptual framework of resilience (Duchek 2020) was not specifically designed to analyze climate adaptation, we find that it does provide a relevant framework that enables an analysis of how climate adaptation can contribute to strengthen resilient capabilities of anticipation.

The scope of our study has been limited to the anticipation stage of the resilience process, leaving the stages of coping and adaptation unexplored in our study. Acknowledging the influence that the three stages of resilience have on each other (Sutcliffe and Vogus 2003; Duchek 2020) make this an interesting topic for future studies. Another issue raised, but not explored in full, is the element of uncertainty in climate change science and its effect on efforts to anticipate the future (Aven 2020).

5. Results

In this section we examine how Norwegian municipalities strengthen their resilience to climate risk through efforts of climate adaptation. First, we present findings from the literature review on the development of anticipatory capabilities in Norwegian municipalities. Next, we zoom in on four Arctic municipalities, presenting empirical findings from the case study of how these municipalities observe, identify, and prepare for the impacts of a changing climate. We highlight findings related to activities and capacities such as internal and external knowledge and competence, risk- and vulnerability assessments, and how climate risk is incorporated into existing municipal planning processes.

5.1. Anticipating climate risk in Norwegian municipalities

Results from the literature review emphasize how Norwegian municipalities' climate adaptation efforts contributes to the anticipatory stage of observing, identifying, and preparing for climate risk. The first step of the anticipatory stage is to observe and identify threats to determine what to plan and prepare for. Norwegian municipalities appear to utilize the statutory holistic risk- and vulnerability assessment (RVA) as their main tool for observation and identification of climate risk, with consequences of climate change increasingly being incorporated in the municipal RVAs (Andersen and Høgvold 2015; Jordbakke et al. 2017; Aall et al. 2018; Klemetsen and Dahl 2019; Riksrevisjonen 2022; Vindegg et al. 2022). There has been an increase in the number of municipalities that incorporate climate change into their RVAs, but the extent and manner still vary (Jordbakke et al. 2017; Klemetsen and Dahl 2019; Rusdal and Aall 2019; Vindegg et al. 2022). While climate change seems increasingly to be included in municipal RVAs, the quality of these assessments is variable. As noted in a survey from 2019: "Most municipalities carry out risk- and vulnerability assessments that include the consequences of climate change. However, some municipalities seem to leave out parts which, according to the regulations, must be included in the assessment. For example, less than four out of ten municipalities have analyzed future climate change and how the municipality may be affected" (Klemetsen and Dahl 2019, p. 8). In 2023, 28 % of the responding municipalities had considered the long-term consequences of climate change with a timeframe of 30 to 100 years, whereas 62 % had considered either current risk or short-term consequences with a timeframe between 10 to 30 years (Skjeflo and Romundstad 2023) – a relatively short timeframe in the context of climate change (International Organization for Standardization 2021).

Updated surveys (Klemetsen and Dahl 2020; Skjeflo and Romundstad 2023) find an increase in the number of municipalities that have assessed future climate risk: three out of four municipalities report that they consider the possible impacts on the municipality. However, almost half of these municipalities report that they have not documented these assessment (Skjeflo and Romundstad 2023). While self-reported surveys indicate that municipalities are concerned with future as well as current risks, findings from the Norwegian Audit Office (Riksrevisjonen 2022) indicate that many municipalities do not in fact consider climate-related hazards and vulnerability in terms of the effects of future climate. Similarly, a study of small and medium-sized Norwegian municipalities shows that although most of the municipalities had considered climate in their RVAs they had not necessarily related this to climate change (Rusdal and Aall 2019). Comparing the results from several surveys on the status of climate adaptation in Norwegian municipalities, Selseng et al. (2021a) found inconclusive results in terms of determining the progress in incorporating climate adaptation into existing RVAs. Beyond emphasizing the challenges in comparing studies applying differing terminologies, this calls into question how well Norwegian municipalities understand and interpret the concept of "climate adaptation." This raises the question of what forms of knowledge are applied in municipalities' efforts to observe and identify climate risk.

Collaborative networks and research projects, national guidelines, hazard maps, regional climate profiles, and other forms of externally developed climate risk analysis are seen as relevant sources of information for the municipalities. Orderud and Naustdalslid (2020) found that municipalities employ consultants for tasks such as developing risk- and vulnerability assessments, hazard mapping, and developing various plans. In addition, the municipalities rely heavily on national authorities for information and guidance on climate adaptation. Smaller municipalities (Rusdal and Aall 2019; Amundsen and Dannevig 2021) as well as some of the largest municipalities in Norway (Handberg and Pedersen 2018; Mabon et al. 2022; Karlson et al. 2023) make use of consultants – not only to develop various climate risk analyses but in some cases also to interpret externally developed information (Karlson et al. 2023). The use of experts appears to be seen as adding legitimacy and improving the uptake of information in the municipalities (Jordbakke et al. 2017; Handberg et al. 2019). The uptake of information is also frequently linked to experience with climate-related events (Dannevig et al. 2013; Angell and Stokke 2014; Rusdal and Aall 2019; Orderud and Naustdalslid 2020). Although experience is considered a strong driver of adaptation (Jordbakke et al. 2017; Rusdal and Aall 2019; Klemetsen and Dahl 2020; Vindegg et al. 2022), having felt the consequences of climate-related events does not automatically result in proactive actions to prepare for similar events in the future (Rauken et al. 2015; Amundsen and Dannevig 2021; Tiller et al. 2022). Advancing from observation and identification of climate risk to preparation is a significant step in the anticipation stage.

The municipalities need to prepare for identified climate risks, and, following the Norwegian adaptation strategy, new knowledge should be incorporated into existing processes (Meld. St. 26 2022 – 2023). Transferring knowledge from the identification and observation stage into the planning and preparation processes can be difficult (Riksrevisjonen 2022), particularly the inclusion of climate adaptation in financial plans (Rusdal and Aall 2019; Selseng et al., 2021b). Climate adaptation is more commonly integrated

into existing municipal planning processes of social development, spatial planning and emergency preparedness (Stokke 2014; Jordbakke et al. 2017; Mabon et al. 2022). A few municipalities have developed separate climate risk analyses (Jordbakke et al. 2017; Handberg and Pedersen 2018; Skjeflo and Romundstad 2023), implemented individual climate plans (Aall et al. 2018; Selseng et al., 2021b) or climate adaptation strategies (Handberg and Pedersen 2018; Mabon et al. 2022). These tend to be larger municipalities and/or municipalities that have participated in climate adaptation networks or research projects (Andersen and Høgvold 2015; Handberg and Pedersen 2018). In general, studies find that lack of knowledge is not the main barrier to adaptation, it is rather a question of the ability to locate and translate existing knowledge from external sources into information that can be utilized and acted upon by the municipalities (Næss et al. 2011; Vindegg et al. 2022), an exercise found to be challenging by the municipalities (Dannevig et al. 2012; Rusdal and Aall 2019; Amundsen and Dannevig 2021; Vindegg et al. 2022).

As summarized in Table 1, Norwegian municipalities generally observe and identify climate risk using statutory RVAs as their primary tool. The process of identification is strongly oriented towards current rather than future risks, and the use of external sources and experts is widespread. Implementing the identified and observed risks in the stage of preparation, climate risk is most often integrated in the processes relating to spatial planning and emergency preparedness.

5.2. Observing and identifying current and future climate impacts in the Arctic

In the following two sub-sections we elaborate on the findings from our in-depth study of four Arctic municipalities and their efforts to anticipate climate risk. Aligning with findings from our literature review, the statutory holistic risk- and vulnerability assessment (RVA) is widely accepted and utilized as the primary tool for identifying climate risk in the case municipalities. In particular, the RVA is employed to identify hazards that can be affected by climate change and that are considered to pose a threat to the municipality. The County Governor, responsible for advising and auditing municipal adherence to statutory requirements related to climate adaptation and emergency preparedness, confirms the use of RVAs:

> We see that the municipalities are focusing on climate change in their plan…. It is the holistic risk- and vulnerability assessment through the Civil Protection Act which is the main tool for assessing if the municipalities are taking care of climate change or not.

In utilizing the RVA as a tool for identifying climate risk, the municipalities appear to emphasize external information, knowledge, and competency as input to the assessments. They look to external sources such as the County Governor's regional risk- and vulnerability assessment, national guidelines and regulations, hazard maps, and other assessments performed by external actors when developing local RVAs. External expertise is perceived as providers of advice on topics where the municipalities lack knowledge or information. In example, all four case municipalities have received support from NVE in developing hazard maps for climate-related hazards.

> We obtain services from professional environments that know the subject, for instance geologists. Then they conduct mapping and analysis of the areas which we believe are at risk. That's how we work with monitoring and mapping.

This illustrates a strong dependency on external knowledge and competency in the Arctic municipalities, similar to what was uncovered in the literature review. We noted that within the process of developing local RVAs, the importance of including and collaborating with relevant stakeholders is highlighted by all respondents. One of the municipalities includes a broad spectrum of stakeholders in identifying relevant risk and future climate change impacts: private actors, volunteer organizations, and national authorities. Another states its dependency on a regional cooperation forum as a way of accessing relevant competency. As such, the use of external experts does not exclude broader stake-holder participation.

What types of climate risk are identified and observed through the RVA within these four Arctic municipalities? All four have identified impacts of a changing climate related to natural hazards. Sea-level rise is mentioned by all four municipalities and serves as a relevant example of a future climate impact that needs to be identified and observed in the present, to enable proactive actions. Other

Table 1
Summary of how Norwegian municipalities anticipate climate risk.

ANTICIPATION ACTIVITIES	MAIN FINDINGS – Systematic literature review
Observation and identification	Statutory holistic risk- and vulnerability assessments (RVA) are applied as the primary tool for observation and identification of climate risk. Climate change as a topic is increasingly incorporated into the municipal RVAs. The extent, and the quality of how climate change is incorporated into municipal RVAs varies. The majority of municipalities, having included climate change in their RVAs, assess climate impacts in a short time span of less than 30 years. Limited documentation exists for assessment of future risk among Norwegian municipalities. Some studies suggest that there is an incomplete understanding of climate risk and adaptation in Norwegian municipalities. Norwegian municipalities have a strong dependency on external experts and guidance on climate adaptation and risk management.
Preparation	Experience with climate-related events is a strong driver, however the experience does not automatically lead to change and proactive actions. Integrating climate adaptation into existing processes of spatial planning and preparedness appears the most common, while integration within financial processes is less common.

climate-related natural hazards identified are avalanches, landslides and rockslides, increased precipitation and flooding, storms and other extreme weather events. The municipalities note that they expect an increase in such events due to climate change. One municipality, despite having identified storms, sea-level rise, and flooding in smaller streams as a risk in its RVA, does not consider itself particularly exposed to future climate impacts. The three others note that they have experienced climate-related events that have challenged municipal preparedness, pointing to avalanches, landslides, and storms of such a magnitude that communication infrastructure was impacted.

Summing up, the case municipalities widely apply the RVA as a tool for observing and identifying climate risk, with an extensive use of external expertise providing input to these analyses. The process identifies predominantly current, familiar hazards, with sea level rise as the outlier indicating future climate risk.

5.3. Preparing for current and future climate impacts in the Arctic

Having implemented systems for identifying and observing climate impacts, the next step in building anticipatory capabilities is to prepare to meet these impacts. One respondent explains how this is done:

> In the Civil Protection Act, the holistic RVA is the governing document, also for the area plan, social plan, and emergency preparedness plan. [The RVA] must be in place and is updated every four years, or when we have had incidents. It is being followed up on and checked by the County Governor when they audit us…. Once we have prepared the RVA, we create measures that are put forward into the emergency preparedness plan. It is ensured through the municipal planning strategy of area- and social planning.

This entails that the climate risk identified in the RVA forms the basis for what a municipality anticipates and prepares for in its municipal planning processes. From our case study, all four responding municipalities report having included the topic of climate change in their emergency preparedness and spatial planning processes, albeit to varying degrees. None of the four municipalities has developed separate climate adaptation plans: the topic of adaptation is perceived as a natural part of their emergency preparedness plans.

> We do not have a separate climate plan. What do you need that for? It is natural that it is part of the emergency preparedness plan…. We have action plans, and based on the risk identified in the RVA, we make emergency preparedness plans. There we have identified climate change such as extreme weather, avalanches, rockslides, all types of avalanches, and then we make separate action plans for that.

Climate adaptation is thus perceived by the municipalities as a natural, integrated part of societal security, rather than as an issue requiring separate policies and procedures. This is important, as the framing of an issue largely determines how it is addressed, as will be discussed.

Anticipatory capabilities are oriented towards predicting the future to enable proactive actions in the present, aiming to reduce the likelihood of an extraordinary event or its negative consequences. We find that all four municipalities consider a proactive approach to climate change crucial and acknowledge the connection between proactive actions and resilience. Whether the four municipalities are considered proactive and resilient is less clear from the empirical data. Assuming a proactive approach to climate risk is considered challenging, and two of the municipalities admit to limited efforts on climate adaptation with stronger emphasis on reactive compared to proactive actions.

> We could improve on the preventive part, especially in terms of information and motivational measures reaching out to the public, what we can do to prevent things from happening and to prepare people. Prevention is the most important thing – that's what I believe.

Table 2
Summary of how four Arctic municipalities anticipate climate risk.

ANTICIPATION ACTIVITIES	MAIN FINDINGS – Case study
Observation and identification	The statutory holistic risk- and vulnerability assessment (RVA) is widely accepted and utilized as the primary tool for identifying climate risk. Strong emphasis and dependence on external information, knowledge and competency. Emphasis on cooperation with relevant stakeholders in observing and identifying climate risk. Municipalities mainly identify familiar risks and risk levels such as familiar and current climate-related hazards. For future risk, sea level rise is commonly mentioned. There is a general acceptance of climate change resulting in increased exposure to future climate risk, but varying acceptance of how own municipality will be affected. Three of four municipalities have experience with climate-related events that have affected the municipal preparedness.
Preparation	The municipal preparedness plans are based on climate risk identified in the RVA. Preparation for climate impacts is mainly done through the municipal emergency preparedness plan and complemented by other municipal processes such as spatial planning. The municipalities acknowledge the importance of working proactively in preparing to meet the impacts of climate change but emphasize that it is challenging. There appears to be a need for more localized data, resources, and internal competency on climate risk according to the responding municipalities.

Findings from our document analysis modify the impression of one of the self-proclaimed reactive municipalities, as it has included some proactive elements in its municipal planning. Here we found that the precautionary principle was applied as a guiding principle in a new municipal plan, with recommendations on safety zones around small streams to prevent future flood damage, and local requirements on where to build to accommodate for future sea-level rise. However, the general impression points to a predominance of reactive climate adaptation actions.

A central issue inhibiting a proactive approach relates to organization and resources. Some issues highlighted by our respondents are the need for more localized data, resources to map vulnerable areas and hazards, as well as in-house competency on climate change and adaptation. A recurring theme is the issue of competing tasks, as respondents find it difficult to prioritize proactive adaptation when balancing this against other important societal considerations.

> [The challenges related to prioritizing tasks within the municipality] lead to the municipality working with damage control, and not with prevention. This can lead to major damage in the long term and is not a good thing – for the economy, safety, or the citizenry.

From the perspective of the County Governors, the issues related to municipalities' knowledge, competency, and cooperation are largely confirmed. In addition, the County Governor highlights how a challenging municipal economy acts as a barrier to proactive climate adaptation. Findings from the case study point out that financial matters do play a significant role in municipalities adapting to climate change. Nonetheless, only one of the four municipalities consider the financial status of the municipality to hamper its progress in implementing measures.

Table 2 summarizes how the four case study municipalities observe, identify, and prepare for climate risk. Similar to the findings from the literature review, the Arctic municipalities apply RVAs as the primary tool for anticipating climate risk. Despite an expressed desire to be more proactively oriented, the municipalities admit to a predominantly reactive approach, illustrated by the identification of mostly short-term, familiar risk rather than future risk. The municipalities express a need for more localized data, additional resources, and internal competency to enable proactive adaptation. As illustratively concluded by one respondent: "We are as robust and capable as it is possible to be with the knowledge we possess.".

6. Discussion

Having examined how Norwegian municipalities are building anticipatory capacities through climate adaptation efforts, we now turn to the possible implications of our findings related to how municipalities observe, identify, and prepare for the impacts of a changing climate.

6.1. *Climate adaptation = risk management*

A central finding in our study, both in the literature review and our case study, is how the municipalities apply the RVAs as the primary tool for observation and identification of climate risk. A strong link was established early on between climate adaptation, natural hazards, and risk management in the first Norwegian adaptation strategy (Meld. St. 33 2012––2013). Climate adaptation involves a risk-based approach (Neby et al. 2023; Rhinard et al. 2023) in Norwegian climate policy and is integrated in existing processes of emergency preparedness and spatial planning (Meld. St. 33 2012––2013). Thus, it is logical that Norwegian municipalities have applied the statutory RVA as a tool for anticipating and managing climate risk. However, as elaborated below, we find that framing climate adaptation as an integral part of societal security results in climate risk in practice being managed through conventional risk management practices. Consequently, the tools intended to support municipalities in adapting to climate change might contribute to the adoption of an overly narrow anticipatory frame. This could inhibit the identification of future risk due to a failure of imagination.

6.2. *Outsourcing anticipation*

Norwegian municipalities rely on competency and knowledge developed by external actors as input when developing local RVAs. The widespread use of and dependency on external resources and experts was particularly evident in our four case municipalities, pointing to the importance of support from state level actors such as the County Governor and the Norwegian Water and Energy Directorate (NVE). This finding resonates with those of Jordbakke et al. (2017) and Orderud & Naustdalslid (2020), where municipalities expect the national authorities to assume a leading role in providing knowledge and guidance on climate adaptation. In many ways this is also a rational expectation, given the County Governor's role as advisor and auditor to the municipalities and the NVE as the national authority on flood and avalanche risk.

With this reliance on external experts and competences, the municipalities' anticipatory capabilities are heavily dependent on external actors' inputs, potentially orienting the municipalities to a more regional or general set of climate risks rather than tailoring their adaptation efforts to local concerns and considerations. Earlier studies (e.g.,Rusdal and Aall 2019; Amundsen and Dannevig 2021) as well as respondents from the case municipalities emphasized the need for more locally relevant data as a basis for climate adaptation. The strong dependence on national authorities and external competency could also hamper further development of local competency on climate risk and climate adaptation (Hovik et al. 2015). There appears to be a tendency in municipalities to rely on experts in so-called fateful moments where decisions about the future are to be made. It could be argued that it is reasonable for municipalities to engage experts to reduce epistemic uncertainty rather than striving to develop comprehensive in-house expertise on

all aspects of climate risk. On the other hand, as underlined by Giddens (1991), and exemplified below, the use of experts does not automatically generate clarity in which decisions to make. One municipality from our literature review obtained climate risk analyses from a group of experts, only to forward the report to a second group of experts for interpretation (Karlson et al. 2023). The proper use of experts in developing risk assessments and other forms of knowledge also relies on the level of procurement competency within the municipalities (Hauge et al. 2019; Orderud and Naustdalslid 2020; Karlson et al. 2023). Thus, to reduce epistemic uncertainty, the municipalities should strive to enhance their ability to identify what type of knowledge they need, as well as the ability to assess the quality of the product delivered by consultancies, and the competency to translate the knowledge into locally relevant action (Vindegg et al. 2022). Inability to internalize external knowledge hampers the development of resilience in municipalities. What is needed is proficiency in gathering relevant information and being able to integrate the information – observation and identification to preparation – as a whole. This, in turn, requires sufficient capacity and resources.

The expressed dependency on external knowledge and competency could be related to the lack of resources, often cited as a barrier for climate adaptation (Vindegg et al. 2022). If the municipalities lack necessary resources and personnel with relevant competencies, seeking outwards for support appears as a logical decision. Some municipalities also perceive the use of external experts such as consultancies as a way of learning (Orderud and Naustdalslid 2020), others as a way of providing legitimacy to the process and thus enhancing the implementation of adaptation actions (Handberg et al. 2019).

6.3. *Preparing for what can be imagined*

We argue that this form of "outsourcing" of the anticipatory capability affects the municipalities' ability to imagine and prepare for the future. In the worst case it might lead to a failure of imagination (Weick 2005) with potentially devastating consequences. Receiving a "finalized" product in the form of climate risk analyses, hazard maps, or regional climate profiles could inhibit creative thinking that is needed to uncover relevant localized risks and spark adaptive action (Hamilton 2016). Take, for example, the implementation of adaptation efforts targeting sea-level rise – the oft-cited climate-related hazard where municipalities generally think and attempt to plan in a long-term perspective. Sea-level rise is a very concrete hazard with a limited spatial area of impact, where national authorities and experts provide detailed information and easy-to-use hazard maps for the municipalities to apply in their planning processes. By contrast, other long-term challenges – like extreme precipitation events, avalanches, and flooding – are less concrete, often accompanied by considerable uncertainty as to where, when, and how they will impact. This necessitates a more demanding process of translation to locally relevant information. What we can imagine, or anticipate, is what we prepare for (Anderson 2010; Davoudi and Machen 2022). Preparing for the impacts of climate change in Norway has been embedded in the existing societal security doctrine, with risk identified in the RVA forming the basis for the municipal emergency preparedness plan (Sivilbeskyttelsesloven 2010). Climate change is translated into this existing format which has consequences for how municipalities frame climate as an issue, not least in terms of long-term perspectives. What the municipalities observe and identify in terms of climate risk in the RVA will largely determine how they adapt and prepare for the impacts of climate risk. While climate change generally is assessed based on averages across time periods of 30 years, emergency preparedness plans are not intentionally designed to look decades into the future. Assessing risk impacted by a changing climate within a period of less than 30 years is considered insufficient (International Organization for Standardization 2021) in terms of promoting adequate climate adaptation, eventually leaving society underprepared (Eisenack et al. 2014). Therefore, the framing of climate adaptation as a part of the current risk management doctrine could impede the implementation of a sufficiently long timeframe and creativity in the planning processes.

As noted, Norwegian municipalities tend to equate climate risk with climate-related natural hazards and tend to focus on those that they already are exposed to or have had some experience with. Although some of the impacts of a changing climate can already be experienced at the local level, an increase in both the frequency and intensity of extreme climate and weather events is expected (IPCC 2021). Consequently, focusing solely on current and familiar risk represents an insufficient strategy for preparing for the impacts of a future climate. Although all four case municipalities reply that they are considering natural hazards and climate change in their RVAs, and previous studies (Andersen and Høgvold 2015; Jordbakke et al. 2017; Aall et al. 2018; Klemetsen and Dahl 2019) confirm that assessing climate-related hazards is increasingly incorporated in local risk- and vulnerability analyses, future risks appears to be insufficiently addressed in the holistic RVAs (Rusdal and Aall 2019; Riksrevisjonen 2022; Skjeflo and Romundstad 2023). With RVAs predominantly focusing on current risk without identifying the potential risk stemming from future climate impacts, we would argue that the mere mention of "climate change" or "climate risk" in the RVAs is an insufficient indicator of how Norwegian municipalities are anticipating and adapting to the impacts of climate change. It is essential to consider the quality of these assessments, which our findings, in general, demonstrate to be insufficient.

The four case municipalities appear to equate the current climate, and today's familiar hazards such as flooding and avalanches, with those of the future. A study from the Pacific Northwest coastal US states has similar findings, referring to this phenomenon as an "analogy to the familiar" (Shtob 2019). Respondents in that study tended to equate the future effects of a changing climate to current, familiar hazards. In the absence of lived experience with a future climate to form current expectations, comparing or analogizing future risk to memories of past or current risk can be a way of dealing with such uncertainty. However, analogizing the effects of climate change to something familiar can potentially diminish the sense of being at risk for future climate impacts (Shtob 2019).

How climate change will impact locally in the future is embedded with uncertainty, offering a range of possible futures (Anderson 2010). Historical events may no longer offer a sufficient framework for preparing for future impacts (Diffenbaugh 2020; Sydnes et al. 2021) due to global warming altering conditions for the occurrence of extreme weather and climate events (e.g., Hodnebrog et al. 2019; Myhre et al. 2019). Probabilistic predictions must be combined with anticipatory capabilities to prepare for the unexpected, to enhance municipal resilience to the impacts of climate change (Giddens 1991; Anderson 2010). Analogizing future risks to those of

current, familiar risks can limit how municipalities act and adapt – as exemplified by Karlson et al.'s (2023) analysis of how the coastal municipality of Stavanger deals with physical climate risks; "it is as if the approach to handling well-known flooding and storms is simply reapplied to unwanted consequences of climate change" (p.12).

6.4. *Past, present, and future*

Related to the "analogy to the familiar" approach we find the manner of viewing experience with past events as a driver for adaptive action. One of the case municipalities, claiming to be situated favorably in relation to climate change, also expressed a lack of negative climate-related events – which could have shaped their perceptions of being less exposed to future climate impacts. The three remaining case municipalities have experienced climate-related events with negative impacts and acknowledge that they would be vulnerable to future climate impacts. Experience can help to orient municipalities towards accepting that climate change can pose a risk – but it also lends itself to reactive rather than proactive actions. Experience with climate-related events as a main driver for climate adaptation efforts is emphasized in international (Harries 2008) and Norwegian studies (Dannevig et al. 2013; Rusdal and Aall 2019). However, as pointed out by Harries (2017, p. 18), and evident in our empirical data, experience is an "imperfect change mechanism." Experience does not automatically result in adaptive actions. From our case study reactive actions appear to be the rule rather than the exception (Orderud and Naustdalslid 2020). Nuancing this finding is the observation of municipalities adapting to climate change even if actions have not necessarily been defined as "adaptive" action. Groven et al. (2012) notes a related phenomenon: they found that the most successful climate adaptation measures implemented between 2007 and 2012 were not originally intended or defined as climate adaptation. This indicates that there are adaptive efforts occurring within municipalities but outside the established risk management doctrine – a potential area for further studies.

7. Conclusions

How do Norwegian municipalities anticipate climate risk to prepare for impacts of a changing climate? The literature review largely uncovered similar mechanisms as we found in the Arctic municipalities, although the literature review naturally uncovered larger variations.

The municipalities find it challenging to deal with the considerable uncertainty embedded in climatic processes and the related task of anticipating the future. As a result, it appears that they are focusing on what is familiar, what they already know. In addition, we find a considerable use of external experts, as a way of reducing epistemic uncertainty and receiving guidance in decision-making about climate risk.

While there appears to be a significant awareness of climate change and potential impacts, we find that the municipalities anticipate climate risk of the near future, as opposed to conducting climate risk assessments with a sufficient time horizon. A related finding was the tendency to focus on hazards that are familiar and that the municipalities already have experience with, demonstrating that experience still is considered an important change agent. However, experience does not automatically lead to change, as seen in the cases of the Arctic municipalities. These municipalities, while acknowledging exposure to risk and previous experience, still admit to predominantly reactive adaptive actions. We interpret this as experience mostly impacting the level of awareness and intention to act as opposed to actual learning and change. This points to another finding: that the municipalities find it challenging to translate and internalize external knowledge and utilize it as a basis for decision-making and action.

Climate adaptation is increasingly incorporated into municipal processes, particularly within spatial planning and emergency preparedness, where the statutory risk- and vulnerability analysis is the primary tool. We argue that framing climate adaptation within the existing doctrine of societal security and conventional risk management processes, with considerable municipal dependency on external expertise and guidance, are variables affecting the municipalities' ability to anticipate climate risk – thereby affecting the resilience to climate-related natural hazards. Climate adaptation in Norwegian municipalities appear to be managed using tools already available for risk management, such as RVA, as opposed to defining the problem first, then determining what tools are needed. This is an interesting area in need of further research, probing into how current strategies and existing tools for climate adaptation are supporting or hindering the municipalities in reducing epistemic uncertainty relating to decisions about climate risk and adaptation.

Our study offers deeper insights into the strengths and weaknesses in current efforts to build resilience in Norwegian municipalities. Based on our findings, some general recommendations can be made as initial steps. First, municipalities should consider strengthening in-house competency on climate adaptation to reduce their dependency on external knowledge, improve ability to interpret and translate expert knowledge into action, and to develop locally appropriate adaptation strategies. Second, the municipalities should also consider implementing a distinct climate risk assessment as a tool to identify relevant weather and climate events, exposure level, and existing vulnerabilities to such events. This could further enable the municipalities to better capture a more long-term perspective of risks related to climate change, and to map uncertainty embedded in the process of assessing climate risk.

To build anticipatory capabilities to meet the challenges of a changing climate, municipalities must engage in activities that enhance their capacity to observe, identify, and prepare for climate-related risk. What and how municipalities anticipate climate risk affects what they will prepare for – and the current framing of the issue of climate risk affects municipal capacity to imagine how future risks might impact locally. The risks of tomorrow will require creativity and imagination, not only projections and predictions, to ensure resilient municipalities can meet the impacts of a changing climate.

CRediT authorship contribution statement

Leikny Bakke Lie: Writing – review & editing, Writing – original draft, Visualization, Validation, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Vilde Lysgaard:** Writing – review & editing, Methodology, Investigation, Formal analysis, Conceptualization. **Are Kristoffer Sydnes:** Writing – review & editing, Validation, Supervision, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data availability

Data will be made available on request.

References

Aall, C., Aamaas, B., Aaheim, A., Alnes, K., van Oort, B. et al., 2018. Oppdatering av kunnskap om konsekvenser av klimaendringer i Norge [Updating knowledge about the consequences of climate change in Norway] (2018:14). CICERO, Vestlandsforsking. https://www.miljodirektoratet.no/globalassets/publikasjoner/m1209/m1209.pdf.

Aall, C., Rød, J.K., Selseng, T., 2023. Hvilke kommuner er mest utsatt for klimaendringer, og hvilke gjør mest med problemet? [Which municipalities are most exposed to climate change, and which are doing the most to deal with the problem?]. Plan 55 (3), 46–49. https://doi.org/10.18261/plan.55.3.10.

AMAP. 2009. AMAP Assessment 2009: Human Health in the Arctic. https://www.amap.no/documents/doc/amap-assessment-2009-human-health-in-the-arctic/98.

AMAP. 2021. Arctic Climate Change Update 2021: Key Trends and Impacts. Summary for Policy-makers. Arctic Monitoring and Assessment Programme (AMAP). https://www.amap.no/documents/doc/arctic-climate-change-update-2021-key-trends-and-impacts.-summary-for-policy-makers/3508.

Amundsen, H., 2012. Illusions of Resilience? An Analysis of Community Responses to Change in Northern Norway. Ecol. Soc. 17 (4). http://www.jstor.org/stable/26269221.

Amundsen, H., Dannevig, H., 2021. Looking back and looking forward—adapting to extreme weather events in municipalities in western Norway. Reg. Environ. Chang. 21 (4), 108. https://doi.org/10.1007/s10113-021-01834-7.

Andersen, G., Høgvold, D.O., 2015. Klimatilpasning i Norge – fra forskning til praksis [Climate adaptation in Norway - from research to practice]. Kart Og Plan 75, 79–89.

Anderson, B., 2010. Preemption, precaution, preparedness: Anticipatory action and future geographies. Prog. Hum. Geogr. 34 (6), 777–798. https://doi.org/10.1177/0309132510362600.

Angell, E., Stokke, K.B., 2014. Vulnerability and adaptive capacity in Hammerfest, Norway. Ocean Coast. Manag. 94, 56–65. https://doi.org/10.1016/j.ocecoaman.2013.11.009.

Archer, D., Rahmstorf, S., 2013. In: The Climate Crisis. an Introductory Guide to Climate Change D. Cambridge University Press. https://doi.org/10.1017/CBO9780511817144.

Aven, T., 2020. Climate change risk – what is it and how should it be expressed? J. Risk Res. 23 (11), 1387–1404. https://doi.org/10.1080/13669877.2019.1687578.

Berrang-Ford, L., Ford, J.D., Paterson, J., 2011. Are we adapting to climate change? Glob. Environ. Chang. 21 (1), 25–33. https://doi.org/10.1016/j.gloenvcha.2010.09.012.

Berrang-Ford, L., Pearce, T., Ford, J.D., 2015. Systematic review approaches for climate change adaptation research. Reg. Environ. Chang. 15 (5), 755–769. https://doi.org/10.1007/s10113-014-0708-7.

Berrang-Ford, L., Siders, A.R., Lesnikowski, A., Fischer, A.P., Callaghan, M.W., et al., 2021. A systematic global stocktake of evidence on human adaptation to climate change. Nat. Clim. Chang. 11 (11), 989–1000. https://doi.org/10.1038/s41558-021-01170-y.

Boin, A., Ekengren, M., Rhinard, M., 2021. In: Understanding the Creeping Crisis A. Springer International Publishing AG. https://doi.org/10.1007/978-3-030-70692-0.

Boyatzis, R.E., 1998. Transforming qualitative information: Thematic analysis and code development. Sage Publications Inc.

Bratberg, T., 2024. Troms og Finnmark. In Store norske leksikon. https://snl.no/Troms_og_Finnmark. (Accessed 09 May 2024).

Braun, V., Clarke, V., 2006. Using thematic analysis in psychology. Qual. Res. Psychol. 3 (2), 77–101. https://doi.org/10.1191/1478088706qp063oa.

European Commission. (2023). Communication from the Commission to the European Parliament, the Council, the European economic and social committee and the Committee of the regions: European Union Disaster Resilience Goals: Acting together to deal with future emergencies (COM/2023/61 final). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2023:61:FIN.

Dahle, H., 2020. Polarsirkel. In Store norske leksikon. https://snl.no/polarsirkel. (Accessed 10 May 2024).

Dannevig, H., Rauken, T., Hovelsrud, G., 2012. Implementing adaptation to climate change at the local level. Local Environ. 17 (6–7), 597–611. https://doi.org/10.1080/13549839.2012.678317.

Dannevig, H., Hovelsrud, G.K., Husabo, I.A., 2013. Driving the agenda for climate change adaptation in Norwegian municipalities. Environm. Plan. C-Governm. Policy 31 (3), 490–505. https://doi.org/10.1068/c1152.

Davoudi, S., Machen, R., 2022. Climate imaginaries and the mattering of the medium. Geoforum 137, 203–212. https://doi.org/10.1016/j.geoforum.2021.11.003.

Diffenbaugh, N.S., 2020. Verification of extreme event attribution: Using out-of-sample observations to assess changes in probabilities of unprecedented events. Sci. Adv. 6 (12), eaay2368. https://doi.org/10.1126/sciadv.aay2368.

Duchek, S., 2020. Organizational resilience: a capability-based conceptualization. Bus. Res. 13 (1), 215–246. https://doi.org/10.1007/s40685-019-0085-7.

EEA. 2024. European climate risk assessment. Executive summary (01/2024). European Environment Agency. https://www.eea.europa.eu/publications/european-climate-risk-assessment.

Eisenack, K., Stecker, R., Reckien, D., Hoffmann, E., 2012. Adaptation to climate change in the transport sector: a review of actions and actors. Mitig. Adapt. Strat. Glob. Chang. 17 (5), 451–469. https://doi.org/10.1007/s11027-011-9336-4.
Eisenack, K., Moser, S.C., Hoffmann, E., Klein, R.J.T., Oberlack, C., et al., 2014. Explaining and overcoming barriers to climate change adaptation. Nat. Clim. Chang. 4 (10), 867–872. https://doi.org/10.1038/nclimate2350.
Ford, J.D., Berrang-Ford, L., Paterson, J., 2011. A systematic review of observed climate change adaptation in developed nations A letter. Clim. Change 106 (2), 327–336. https://doi.org/10.1007/s10584-011-0045-5.
Forskrift om naturfaretilskudd. 2022. Forskrift om tilskudd til flom- og skredforebygging og miljøtiltak i vassdrag (forskrift om naturfaretilskudd) [Regulation on subsidies for flood and landslide prevention and environmental measures in watercourses (regulation on natural hazard subsidies)] (FOR-2022-06-29-1237). Energidepartementet. https://lovdata.no/dokument/SF/forskrift/2022-06-29-1237.
Giddens, A., 1991. Fate, Risk and Security. Modernity and Self-Identity. Self and Society in the Late Modern Age. Polity Press.
Groven, K., Aall, C., van den Berg, M., Carlsson-Kanyama, A., Coenen, F., 2012. Integrating climate change adaptation into civil protection: comparative lessons from Norway Sweden and the Netherlands. Local Environm. 17 (6–7), 679–694. https://doi.org/10.1080/13549839.2012.665859.
Hamilton, S., 2016. Action, technology, and the homogenisation of place: why climate change is antithetical to political action. Globalizations 13 (1), 62–77. https://doi.org/10.1080/14747731.2015.1040282.
Handberg, Ø. N., & Pedersen, S., 2018. Lokal klimatilpasning. Erfaringer fra arbeid med klimatilpasningsstrategier i Oslo, Sandefjord og Kristiansand. [Local climate adaptation. Experiences from working with climate adaptation strategies in Oslo, Sandefjord and Kristiansand] (M-1165|2018). Menon Economics. https://www.miljodirektoratet.no/globalassets/publikasjoner/m1165/m1165.pdf.
Handberg, Ø. N., Juliebø, S., Pedersen, S., & Engebretsen, L. S., 2019. Evaluering av klimatilpasningsnettverket IFront [Evaluation of the climate adaptation network IFront] (M- 1477|2019). Menon Economics. https://www.miljodirektoratet.no/globalassets/publikasjoner/m1477/m1477.pdf.
Hanssen-Bauer, I., Førland, E. J., Haddeland, I., Hisdal, H., Lawrence, D. et al., 2017. Climate in Norway 2100 a knowledge base for climate adaptation (1/2017). NCCS. https://klimaservicesenter.no/kss/rapporter/kin2100. Accessed 09 December 2021.
Harries, T., 2008. Feeling secure or being secure? Why it can seem better not to protect yourself against a natural hazard. Health Risk Soc. 10 (5), 479–490. https://doi.org/10.1080/13698570802381162.
Harries, T., 2017. Ontological Security and Natural Hazards. In T. Harries (Ed.), Oxford Research Encyclopedia of Natural Hazard Science. Doi: 10.1093/acrefore/9780199389407.013.279.
Hauge, Å.L., Hanssen, G.S., Flyen, C., 2019. Multilevel networks for climate change adaptation – what works? Int. J. Clim. Change Strategies Manage. 11 (2), 215–234. https://doi.org/10.1108/IJCCSM-10-2017-0194.
Hodnebrog, Ø., Marelle, L., Alterskjær, K., Wood, R., Ludwig, R., et al., 2019. Intensification of summer precipitation with shorter time-scales in Europe. Environ. Res. Lett. 14, 124050. https://doi.org/10.1088/1748-9326/ab549c.
Holling, C.S., 1973. Resilience and Stability of Ecological Systems. Annu. Rev. Ecol. Syst. 4, 1–23. http://www.jstor.org/stable/2096802.
Hovelsrud, G.K., Karlsson, M., Olsen, J., 2018. Prepared and flexible: Local adaptation strategies for avalanche risk. Cogent Social Sciences 4 (1), 1460899. https://doi.org/10.1080/23311886.2018.1460899.
Hovik, S., Naustdalslid, J., Reitan, M., Muthanna, T., 2015. Adaptation to Climate Change: Professional Networks and Reinforcing Institutional Environments. Eviron. Plann. C. Gov. Policy 33 (1), 104–117. https://doi.org/10.1068/c1230h.
International Organization for Standardization. (2021). Adaptation to climate change — Guidelines on vulnerability, impacts and risk assessment (ISO Standard No. 14091:2021). In. https://www.iso.org/standard/68508.html.
IPCC. 2012. Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change C. B. Field, V. Barros, T. F. Stocker, D. Qin, D. J. Dokken, et al. (Eds.). Cambridge University Press. https://www.ipcc.ch/site/assets/uploads/2018/03/SREX_Full_Report-1.pdf.
IPCC. 2022. 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, D. C. Roberts, M. M. B. Tignor, E. S. Poloczanska, K. Mintenbeck, et al. (Eds.). Cambridge University Press. https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_FinalDraft_FullReport.pdf.
IPCC. 2021. Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change V. Masson-Delmotte, P. Zhai, A. Pirani, S. L. Connors, C. Péan, et al. (Eds.). Cambrigde University Press. https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Full_Report.pdf.
Jacobsen, J.K.S., Leiren, M.D., Saarinen, J., 2016. Natural hazard experiences and adaptations: A study of winter climate-induced road closures in Norway. Norsk Geografisk Tidsskrift - Norwegian Journal of Geography 70 (5), 292–305. https://doi.org/10.1080/00291951.2016.1238847.
Jordbakke, A., Røsjø, M.J., Skogvold, T., Karstensen, H., 2017. Kartlegging av 11 kommuners arbeid med klimatilpasning [Mapping of 11 municipalities' work with climate adaptation] (M-647|2016). Miljødirektoratet. https://www.miljodirektoratet.no/globalassets/publikasjoner/m647/m647.pdf.
Juhola, S., Peltonen, L., Niemi, P., 2012. The ability of Nordic countries to adapt to climate change: assessing adaptive capacity at the regional level. Local Environ. 17 (6–7), 717–734. https://doi.org/10.1080/13549839.2012.665861.
Kaplan, H.B., 1999. Toward an understanding of resilience: A critical review of definitions and models. In: Glantz, M.D., Johnson, J.L. (Eds.), Resilience and Development: Positive Life Adaptations. Kluwer Academic Publishers, pp. 17–83.
Karlson, C.W., Morsut, C., Engen, O.A.H., 2023. Politics of climate risk management in local government: a case study of the municipality of Stavanger. Frontiers in Climate 5 (15). https://doi.org/10.3389/fclim.2023.1136673. Article 1136673.
Klemetsen, M., & Dahl, M. S., 2019. Hvor godt er norske kommuner rustet til å håndtere følgene av klimaendringer? Spørreundersøkelse om klimatilpasning utført våren 2019 [How well are Norwegian municipalities equipped to handle the consequences of climate change? Survey on climate adaptation carried out in spring 2019] (2019:09). CICERO. http://hdl.handle.net/11250/2607609.
Klemetsen, M., & Dahl, M. S., 2020. Hvor godt er norske kommuner rustet for klimaendringer? Spørreundersøkelse om klimatilpasning våren 2020. [How well are Norwegian municipalities equipped to handle the consequences of climate change? Survey on climate adaptation carried out in spring 2020] (2020:05). CICERO. https://hdl.handle.net/11250/2686544.
Linnenluecke, M.K., 2017. Resilience in Business and Management Research: A Review of Influential Publications and a Research Agenda. Int. J. Manag. Rev. 19 (1), 4–30. https://doi.org/10.1111/ijmr.12076.
Lujala, P., Lein, H., Rød, J.K., 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.
Lysgaard, V. (2022). En studie om organisatorisk resiliens i kommunal beredskap mot fremtidige klimaendringer. [A study on organizational resilience in municipal preparedness against future climate change] [Master thesis, UiT The Arctic University of Norway]. Tromsø. https://hdl.handle.net/10037/26534.
Mabon, L., Barkved, L., de Bruin, K., Shih, W.-Y., 2022. Whose knowledge counts in nature-based solutions? Understanding epistemic justice for nature-based solutions through a multi-city comparison across Europe and Asia. Environ Sci Policy 136, 652–664. https://doi.org/10.1016/j.envsci.2022.07.025.
Madni, A.M., Jackson, S., 2009. Towards a Conceptual Framework for Resilience Engineering. IEEE Syst. J. 3 (2), 181–191. https://doi.org/10.1109/JSYST.2009.2017397.
Manyena, S.B., 2006. The concept of resilience revisited. Disasters 30 (4), 434–450. https://doi.org/10.1111/j.0361-3666.2006.00331.x.
Masten, A.S., 2019. Resilience from a developmental systems perspective. World Psychiatry 18 (1), 101–102. https://doi.org/10.1002/wps.20591.
Meld. St. 15. (2011-2012). Report to the Storting (white paper). Hvordan leve med farene – om flom og skred [How to live with the risk of floods and landslides]. Det kongelige olje- og energidepartmentet. https://www.regjeringen.no/no/dokumenter/meld-st-15-20112012/id676526/.
Meld. St. 26. (2022 - 2023). Report to the Storting (white paper). Klima i endring - sammen for et klimarobust samfunn [A changing climate - together for a climate-resilient society]. Det kongelige klima- og miljødepartementet. https://www.regjeringen.no/no/dokumenter/meld.-st.-26-20222023/id2985027/.
Meld. St. 33. (2012 - 2013). Climate change adaptation in Norway, white paper from the Norwegian Ministry of Climate and Environment. Norwegian Ministry of Climate and Environment. https://www.regjeringen.no/en/dokumenter/meld.-st.-33-20122013/id725930/.

Meld. St. 5. (2020-2021). Report to the Storting (white paper). Samfunnssikkerhet i en usikker verden [Social security in an uncertain world]. Justis- og beredskapsdepartementet. https://www.regjeringen.no/no/dokumenter/meld.-st.-5-20202021/id2770928/.
Mercer, J., 2010. Disaster risk reduction or climate change adaptation: Are we reinventing the wheel? J. Int. Dev. 22 (2), 247–264. https://doi.org/10.1002/jid.1677.
Myhre, G., Alterskjær, K., Stjern, C.W., Hodnebrog, Ø., Marelle, L., et al., 2019. Frequency of extreme precipitation increases extensively with event rareness under global warming. Sci. Rep. 9 (1), 16063. https://doi.org/10.1038/s41598-019-52277-4.
Næss, R., Solli, J., Sorensen, K.H., 2011. Usable climate knowledge? The relationship of local government employees to scientific knowledge about climate changes and climate adaptation. Tidsskrift for Samfunnsforskning 52 (3), 329–354.
Neby, S., Angell, E., Engen, O.A., Morsut, C., 2023. Klimatilpasning i Norge. Mellom risiko, beredskap og normalsituasjon. [Climate adaptation in Norway. Between risk, preparedness and normality]. Norsk Statsvitenskapelig Tidsskrift 39 (4), 159–176. https://doi.org/10.18261/nst.39.4.3.
Norwegian Ministry of Justice and Public Security. (2017). Instructions for the Ministries' work with civil protection and emergency preparedness. Norwegian Ministry of Justice and Public Security. https://www.regjeringen.no/contentassets/8513580ccb764cb6b88b9ec7f141e22a/samfunnssikkerhetsinstruks_engelsk.pdf.
NOU 2010: 10. (2010). Tilpassing til eit klima i endring. [Adapting to a changing climate]. Miljøverndepartementet. https://www.regjeringen.no/no/dokumenter/nou-2010-10/id624355/.
O'Brien, K., Sygna, L., Haugen, J.E., 2004. Vulnerable or resilient? a multi-scale assessment of climate impacts and vulnerability in Norway. Clim. Change 64 (1), 193–225. https://doi.org/10.1023/B:CLIM.0000024668.70143.80.
O'Neill, M.M., Booth, S.R., Lamb, J.T., 2018. Using NVivo™ for literature reviews: the eight step pedagogy (N7+1). Qual. Rep. 23 (13), 21–39. https://doi.org/10.46743/2160-3715/2018.3030.
Orderud, G.I., Naustdalslid, J., 2020. Climate change adaptation in Norway: learning–knowledge processes and the demand for transformative adaptation. Int. J. Sust. Dev. World 27 (1), 15–27. https://doi.org/10.1080/13504509.2019.1673500.
Overland, J.E., 2021. Rare events in the Arctic. Clim. Change 168 (3), 27. https://doi.org/10.1007/s10584-021-03238-2.
Pelz, P.F., Pfetsch, M.E., Kersting, S., Kohler, M., Matei, A., et al., 2021. Types of Uncertainty. In: Pelz, P.F., Groche, P., Pfetsch, M.E., Schaeffner, M. (Eds.), Mastering Uncertainty in Mechanical Engineering. Springer International Publishing, pp. 25–42. https://doi.org/10.1007/978-3-030-78354-9_2.
Plan- og bygningsloven. 2008. Lov om planlegging og byggesaksbehandling (plan- og bygningsloven) [The Planning and Building Act] (LOV-2008-06-27-71). Kommunal- og distriktsdepartementet. https://lovdata.no/dokument/NL/lov/2008-06-27-71.
Proistosescu, C., Wagner, G., 2020. Uncertainties in climate and weather extremes increase the cost of carbon. One Earth 2 (6), 515–517. https://doi.org/10.1016/j.oneear.2020.06.002.
QSR International Pty Ltd. (2022). *NVivo Release 1.7*. https://www.qsrinternational.com/nvivo-qualitative-data-analysis-software/home.
Rantanen, M., Karpechko, A.Y., Lipponen, A., Nordling, K., Hyvarinen, O., et al., 2022. The Arctic has warmed nearly four times faster than the globe since 1979. Commun. Earth Environm. 3 (1), 10. https://doi.org/10.1038/s43247-022-00498-3. Article 168.
Rauken, T., Mydske, P.K., Winsvold, M., 2015. Mainstreaming climate change adaptation at the local level. Local Environ. 20 (4), 408–423. https://doi.org/10.1080/13549839.2014.880412.
Rhinard, M., Morsut, C., Angell, E., Neby, S., Englund, M. et al., 2023. Understanding variation in national climate change adaptation: Securitization in focus. Environm. Plann. C: Polit. Space. Doi: 10.1177/23996544231212730.
Riksrevisjonen. 2022. Riksrevisjonens undersøkelse av myndighetenes arbeid med å tilpasse infrastruktur og bebyggelse til et klima i endring [The Office of the Auditor General of Norway's investigation of the authorities' work to adapt infrastructure and buildings to a changing climate]. https://www.riksrevisjonen.no/rapporter-mappe/no-2021-2022/undersokelse-av-myndighetenes-arbeid-med-klimatilpasning-av-bebyggelse-og-infrastruktur/.
Rosenthal, U., Boin, A., & Comfort, L. K., 2001. Managing Crises. Threats, Dilemmas, Opportunities. Charles C Thomas Publisher, Ltd.
Rusdal, T., Aall, C., 2019. Kartlegging av erfaringer fra arbeidet med klimatilpasning i små og mellomstore kommuner [Mapping experiences from climate adaptation in small and medium-sized municipalities] (4/2019). Vestlandsforskning. https://www.vestforsk.no/sites/default/files/2019-06/R-KT-statussm%C3%A5kommuner-endelig.pdf.
Scherzer, S., Lujala, P., Rød, J.K., 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.
Selseng, T., Klemetsen, M., Rusdal, T., 2021a. Adaptation Confusion? A Longitudinal Examination of the Concept "Climate Change Adaptation" in Norwegian Municipal Surveys. Weather Clim. Soc. 13 (3), 633–648. https://doi.org/10.1175/WCAS-D-21-0024.1.
Selseng, T., Skogvang, B.J., Aall, C., 2021b. Spørreundersøkelse til norske kommuner om status for 2021 i arbeidet med klimatilpasning [Survey to Norwegian municipalities about the status for 2021 on climate adaptation] (10 /2021). Vestlandsforskning. https://www.ks.no/globalassets/fagomrader/samfunnsutvikling/klima/KTP-kommuneundersokelsen-10122021.pdf.
Shtob, D.A., 2019. Remembering the Future: Natural Disaster, Place, and Symbolic Survival. Rural. Sociol. 84 (1), 123–147. https://doi.org/10.1111/ruso.12224.
Sivilbeskyttelsesloven. 2010. Lov om kommunal beredskapsplikt, sivile beskyttelsestiltak og Sivilforsvaret [The Civil Protection Act] (LOV-2010-06-25-45). Justis- og beredskapsdepartementet. https://lovdata.no/dokument/NL/lov/2010-06-25-45?q=sivilbeskyttelsesloven.
Skinner, D.J.C., Rocks, S.A., Pollard, S.J.T., 2014. A review of uncertainty in environmental risk: characterising potential natures, locations and levels. J. Risk Res. 17 (2), 195–219. https://doi.org/10.1080/13669877.2013.794150.
Skjeflo, S. W., & Romundstad, R. M., 2023. Hvor langt har norske kommuner kommet i klimatilpasningsarbeidet? Spørreundersøkelse om klimatilpasning våren 2023 [How far have Norwegian municipalities progressed with climate adaptation? Survey on climate adaptation Spring 2023] (2023-10). CICERO. https://pub.cicero.oslo.no/cicero-xmlui/handle/11250/3096713.
SPR. 2018. Statlige planretningslinjer for klima- og energiplanlegging og klimatilpasning [State planning guidelines for climate and energy planning and climate adaptation] (FOR-2018-09-28-1469). Kommunal- og distriktsdepartementet. https://lovdata.no/dokument/SF/forskrift/2018-09-28-1469.
St.prp. nr.1. (2008-2009). Stortingsporposisjon nr.1 (2008-2009) [Proposition to the Storting]. Det kongelige olje- og energidepartmentet. https://www.regjeringen.no/no/dokumenter/stprp-nr-1-2008-2009-/id530273/.
Statsforvalterinstruksen. 1981. Instruks for statsforvaltere [Instructions to the County Governors] (FOR-1981-08-07-3642). Kommunal- og distriktsdepartementet. https://lovdata.no/dokument/INS/forskrift/1981-08-07-3642/.
Stokke, K.B., 2014. Adaptation to sea level rise in spatial planning – Experiences from coastal towns in Norway. Ocean Coast. Manag. 94, 66–73. https://doi.org/10.1016/j.ocecoaman.2013.11.010.
Sutcliffe, K.M., Vogus, T.J., 2003. Organizing for resilience. In: Cameron, K.S., Dutton, J.E., Quinn, R.E. (Eds.), Positive Organizational Scholarship: Foundations of a New Discipline. Berrett-Koehler Publishers Inc, pp. 94–110.
Sydnes, A.K., Sydnes, M., Hamnevoll, H., 2021. Learning from crisis: The 2015 and 2017 avalanches in Longyearbyen. Saf. Sci. 134, 105045. https://doi.org/10.1016/j.ssci.2020.105045.
Terry, G., Hayfield, N., Clarke, V., Virginia, B., 2017. Thematic Analysis. In: Rogers, S., Willig, C. (Eds.), The SAGE Handbook of Qualitative Research in Psychology W. SAGE Publications Ltd. https://doi.org/10.4135/9781526405555
Thomas, V., 2017. Climate Change and Natural Disasters. Transforming Economies and Policies for a Sustainable Future. Routledge. Doi: 10.4324/9781315081045.
Tiller, R.G., Ross, A.D., Nyman, E., 2022. Social capital and institutional complexity in Svalbard: the case of avalanche disaster management. Disaster Prev. Manag. 31 (4), 425–439. https://doi.org/10.1108/DPM-05-2021-0168.
Timlin, U., Meyer, A., Nordström, T., Rautio, A., 2022. Permafrost thaw challenges and life in Svalbard. Current Res. Environm. Sustain. 4, 100122. https://doi.org/10.1016/j.crsust.2021.100122.
Tyndall, J., 2010. AACODS Checklist. Flinders University. https://fac.flinders.edu.au/dspace/api/core/bitstreams/e94a96eb-0334-4300-8880-c836d4d9a676/content.
UNFCCC. 2015. Paris Agreement to the United Nations Framework Convention on Climate Change. https://unfccc.int/sites/default/files/english_paris_agreement.pdf.

United Nations. (2015). Sendai Framework for Disaster Risk Reduction 2015 - 2030. Geneva: United Nations Office for Disaster Risk Reduction. http://www.wcdrr.org/uploads/Sendai_Framework_for_Disaster_Risk_Reduction_2015-2030.pdf.

Vij, S., Biesbroek, R., Adler, C., Muccione, V., 2021. Climate change adaptation in european mountain systems: a systematic mapping of academic research. Mt. Res. Dev. 41 (1). https://doi.org/10.1659/MRD-JOURNAL-D-20-00033.1.

Vindegg, M., Christensen, I., Aall, C., Arnslett, A., Tønnesen, A. et al., 2022. Barrierer for klimatilpasning på lokalt og regionalt nivå. [Barriers to climate adaptation at local and regional level] (2022:03). https://hdl.handle.net/11250/2994616.

Walker, B.W., Holling, C.S., Carpenter, S.R., Kinzig, A., 2004. Resilience, Adaptability and Transformability in Social–ecological Systems. Ecol. Soc. 9, 5.

Wang, X., Frattini, P., Crosta, G.B., Zhang, L., Agliardi, F., et al., 2014. Uncertainty assessment in quantitative rockfall risk assessment. Landslides 11 (4), 711–722. https://doi.org/10.1007/s10346-013-0447-8.

Weick, K.E., 2005. Organizing and Failures of Imagination. Int. Public Manag. J. 8 (3), 425–438. https://doi.org/10.1080/10967490500439883.

Werner, E.E., 1992. The children of Kauai: Resiliency and recovery in adolescence and adulthood. J. Adolesc. Health 13 (4), 262–268. https://doi.org/10.1016/1054-139X(92)90157-7.

Wildavsky, A., 1988. Anticipation Versus Resilience. In Searching for Safety. Transaction Publishing, pp. 77 -79.

Woods, D. D., & Hollnagel, E., 2006. Resilience Engineering: Concepts and Precepts (1 ed.). Milton: CRC Press. Doi: 10.1201/9781315605685.

Zscheischler, J., Martius, O., Westra, S., Bevacqua, E., Raymond, C., et al., 2020. A typology of compound weather and climate events. Nat. Rev. Earth Environm. 1 (7), 333–347. https://doi.org/10.1038/s43017-020-0060-z.