# Strategic Planning for Climate Adaptation

## A case study of Åre municipality

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Kajsa Kronkvist

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Kajsa Kronkvist

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Internal supervisor: Helen Avery, Centre for Environmental and Climate Science, Lund University

External supervisor: Malin Bergqvist, Åre municipality

CEC – Centre for Environmental and Climate Science
Lund University
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# Abstract

Åre municipality, a well-known skiing resort in Sweden, has been classified as a primary risk area for landslides, due to a combination of global warming and increased pressure from expansion. The purpose of this study is to explore options to strengthen climate adaptation planning and reduce vulnerability in Åre. This thesis is a qualitative single-case study with results relevant for sensitive mountain regions. The method is based on (1) empirical material, consisting of two municipal overarching policy documents, five planning decisions relevant to climate adaptation and interviews with municipal officials, (2) an analytical framework to evaluate climate adaptation planning, and (3) a literature review, in which adaptation options for developed mountain regions are explored. Out of 19 adaptation processes, listed in the analytical framework, 9 could not be identified in any of the empirical material. Additionally, the results suggest that there are no consistent links between climate adaptation plans in Åre municipality. While the overarching policy documents consider goals, implementation and evaluation factors, the analysed planning decisions focus on knowledge acquisition and ´low-risk´ capacity-building. Adaptation to landslide risk is managed by means of risk assessments, based on historical climate trends and expert investigations. Several blind spots in Åre's adaptation strategy can be identified, such as the lack of success criteria, assessment of human capital, options appraisal, and communication. Adaptation options that could be relevant to strengthen adaptation planning processes in Åre municipality include, but are not limited to, goal-clarification, improving knowledge base, collaboration, and stakeholder engagement.

*Keywords:* Climate change adaptation; municipal planning processes; landslide risk management; mountain tourist destinations

# Strategisk planering för klimatanpassning i Åre kommun

Åre kommun, en välkänd skidort i Sverige, är i behov av att effektivisera sin klimatanpassningsstrategi för att undvika katastrofer till följd av den övergripande rasrisk som präglar kommunen. Ett urval av möjliga åtgärder för att hantera de nuvarande bristerna är att konkretisera målsättningar, förbättra kunskapsbasen, samarbeta med olika aktörer i samhället samt engagera medborgare för identifiering av verklighetsbaserade utmaningar och lösningar.

Den här studien syftar till att utforska strategisk planering för klimatanpassning i Åre kommun. Baserat på en uppsättning kärnkomponenter för effektiv klimatanpassning har klimatanpassningsstrategin i kommunen kunnat utvärderas. Övergripande kan strategin klassas som en traditionell metod för klimatanpassning som fokuserar på kunskap- och kapacitetstärkning. Resultaten tyder på att klimatanpassningsstrategin saknar en definition av vad som kännetecknar framgångsrik klimatanpassning för just Åre kommun. Det saknas även beskrivningar om hur kunskapsnivån om klimatförändringar, bland tjänstemän och beslutsfattare i kommunen, kan utvärderas och förbättras. Därutöver saknar strategin hänsynstaganden till antaganden och osäkerheter, olika klimatanpassningsalternativ, hur klimatanpassning kan interagera med andra åtaganden samt hur långsiktig implementering av strategin kan ske. Slutligen saknas metoder för hur klimatanpassningsstrategin ska kommuniceras till relevanta intressenter samt hur övervakning av strategins efterlevnad ska utföras.

Även om det idag finns tillgängliga styrinstrument för klimatanpassning är det generellt få beslutsfattare som vet hur man kan använda dem för att stärka planeringsprocesser för klimatanpassning. Därutöver finns ett ömsesidigt beroende mellan klimatpåverkan, institutionell styrning och klimatanpassningsstrategier, samtidigt som planer för klimatanpassning ofta inte integreras med redan existerande styrmedel och processer. Därmed behövs djupare utredningar av klimatanpassningsplaner och beslutsfattningsprocesser för att synliggöra vilka processer de är uppbyggda av och hur de implementeras i praktiken. Därutöver är klimatanpassning i bergsregioner extra utmanande på grund av den lutande terrängen och kraftiga växlingar i väderförhållanden på olika höjder; i synnerhet för bergsregioner i ekonomiskt beroende av vinterturism och skidåkning. I Åre har kombinationen av klimatförändringar, ett intensivt skogsbruk, ökande exploatering samt anläggning av nya skidbackar och bebyggelse, förstärkt den redan existerande rasrisken i kommunen.

Genom att kartlägga brister i Åre kommuns klimatanpassningsstrategi kan potentiellt lämpliga alternativ till klimatanpassning identifieras. Ett mer effektivt klimatanpassningsarbete kan stärka kommunens kapacitet att hantera klimatförändringar och minska sårbarheten för ras. Studien är utforskade och utgör en utgångspunkt för mer systematiska och tekniska undersökningar i Åre kommun. Ur ett bredare perspektiv kan studien användas av andra bergsregioner, nationellt

såväl som internationellt, för att ge exempel på hur klimatanpassningsplaner kan utvärderas och effektiviseras. På så vis kan studien användas i utbildningssammanhang och kapacitetsstärkning av kommunal planering för klimatanpassning.

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# Introduction

Developments in climate change over the past few decades constitute one of the most urgent challenges human societies are facing today, along with biochemical flows, land-system change and genetic diversity loss (Steffen et al., 2015). These challenges, which are amplified when combined (Lade et al., 2020), are the result of humanity overstepping planetary boundaries in a way that threatens Earth systems' capacity to recover from human impact and ultimately support human societies (Steffen et al., 2015).

Additionally, intensive exploitation and construction can cause significant stressors on natural environments which increases vulnerability to climate change impact and risks of associated disasters, such as landslides or flooding (Wamsler, 2014). Therefore, decision-makers in spatial planning are faced with the complex task of reducing climate-related vulnerability and risk in urban areas by adapting construction to projections of future climate change; usually with limited knowledge of what, when and how to do so (Wamsler, 2014). At the same time, research indicates that adaptation plans in developed nations often overlook necessary aspects of climate adaptation planning, such as integration with existing policies and processes (Preston et al., 2011) or assessments of outcomes and impact (Owen, 2020). Therefore, there is need for critical evaluations of planning and decision-making processes for climate adaptation, to uncover how adaptation plans are constructed and implemented, as well as how they can be improved (Preston et al., 2011).

Climate adaptation in mountain regions is especially challenging due to a complex topography and climate impacts that tend to vary at different elevations (Vij et al., 2021). A dependance on winter tourism and snow cover increases the sensitivity to climate variations in mountain regions further (Bonzanigo et al., 2015). Additionally, research suggests that there is a necessary interdependence between climate impacts, governance systems and adaptation strategies and that this knowledge in relation to European mountain regions is particularly scarce (Vij et al., 2021).

In Sweden, Jämtland mountain area has been classified as one of ten primary climate-related risk areas, in a report by the Swedish Geotechnical Institute and the Swedish Civil Contingencies Agency (SGI & MSB, 2021). Landslides compose the primary risk factor, due to a combination of extreme weather, intense forestry and

construction of new skiing slopes and buildings (SGI & MSB, 2021). As a result, expansion projects in Åre have been held back; stagnating the municipality's development (P4 Jämtland, 2021; Löfgren, 2021). Moreover, the occurrence of landslides can cause severe disruption in communities, such as damaging homes and infrastructure, and require large costs to finance recovery (Wamsler, 2014).

This study will evaluate climate adaptation planning in Åre municipality to identify potential blind spots and explore more efficient adaptation options, based on current knowledge on climate adaptation in mountain regions in scientific research (see Appendix 5). The investigation is conducted by creating an inventory of identified adaptation processes, based on an analytical framework by Preston et al. (2011) consisting of 19 processes for effective climate adaptation. These 19 processes are categorized by four stages of an effective adaptation strategy: (1) Goal-Setting, (2) Stock-Taking, (3) Decision-Making, (4) Implementation and Evaluation.

By exploring new strategic options, this study has potential to highlight more suitable pathways to sustainable climate adaptation in Åre municipality. Furthermore, this study can be relevant to a wider range of sensitive alpine regions through its exploration of climate adaptation options on an international scale, pointing to potential challenges and blind spots, as well as management of conflicting interests. Thus, this study contributes to the wider knowledge foundation about climate adaptation in mountain regions and supports development efforts towards climate resilience.

# Purpose and research questions

The purpose of this study is to explore how processes involved in climate adaptation planning could be strengthened in Åre municipality. In order to do so, the current adaptation strategy and associated processes will be mapped out and discussed in relation to challenges and opportunities, against the background of literature in the field. The study aims to answer the following research questions:

- How is climate adaptation planning currently structured in Åre municipality?
    - To what extent is climate change and landslide risk considered in development planning?
- What processes could be relevant to strengthen climate adaptation planning in Åre municipality?

This thesis will begin with a background section covering aspects of climate change management that are significant to the context of this study. After framing the wider context, the methodology section will cover the chosen research approach, the process of selecting and gathering empirical material, the analysis procedure, the conduction of the literature review, as well as critical reflections and ethical considerations. Thereafter, the analytical framework by Preston et al. (2011) is presented, followed by a description of the case which covers Åre municipality's plans and projections, topography, landslide risk and significant municipal guiding instruments for climate adaptation. This section is followed by the results and analysis, which accounts for decision-making processes and adaptation processes that either could or could not be identified in the empirical material. The subsequent discussion section will discuss the suggested blind spots in Åre municipality's climate adaptation strategy and present alternative options found in scientific publications, on climate adaptation in mountain regions, which could be relevant to strengthen the adaptation strategy (see Appendix 5). In addition, the discussion section will cover potential limitations with the research approach. Lastly, conclusions are drawn in the conclusions section.

# Managing climate change

Climate change is a global challenge with a wide array of local impacts, and associated losses and damages, that affects both human societies and natural environments (IPCC, 2022). The Intergovernmental Panel on Climate Change (IPCC) *Sixth Assessment Report* (AR6) presents stronger evidence than ever before of the connection between human activity and global warming (IPCC, 2021). The report shows that the past intensity and frequency of extreme weather events, such as cloudbursts, heatwaves or droughts, will increase with every additional increment of global warming (IPCC, 2021). Additionally, climate-related impacts and associated risks are increasingly becoming more challenging to manage since multiple risks will occur simultaneously, causing a compounding and cascading effect across sectors and regions (IPCC, 2022). Furthermore, the report states that several effects from both historical and future greenhouse gas emissions will be irreversible for hundreds to thousands of years to come, as components of the climate system, such as the ocean or land surface, take a long time to respond to human intervention (IPCC, 2021).

Options to respond to climate change can essentially be categorized in one of two ways: adaptation or mitigation (IPCC, 2022).

> "Mitigation is a human intervention to reduce the sources or enhance the sinks of greenhouse gases." (IPCC, 2014, p.4).

> "Adaptation is defined, in human systems, as the process of adjustment to actual or expected climate and its effects in order to moderate harm or take advantage of beneficial opportunities. In natural systems, adaptation is the process of adjustment to actual climate and its effects; human intervention may facilitate this." (IPCC, 2022, p.7).

The integration between these two strategies is crucial in order to support climate resilient development (IPCC, 2022). Resilience has broadly been described as the ability to recover from disturbance, maintain essential function, structure and identity, as well as capacity to transform (IPCC, 2022). In addition, it is the combination of local prerequisites, such as politics, culture or economy, that frames a region's capacity to implement climate strategic measures and reduce vulnerability (Owen, 2020).

# Common adaptation approaches, challenges and solutions

Decision-making processes and governance structures are key components of effective climate adaptation and progress in adaptation planning has been observed to generate multiple benefits across all sectors and regions (IPCC, 2022). However, adaptation plans can differ vastly in both form and detail (Preston et al., 2011) and their local and context-dependent nature mean that challenges and barriers are difficult to categorize or generalize across different regions (Biesbroek et al., 2013). Even though adaptation planning and implementation is advancing, certain adaptation blind spots in common approaches have been observed, which limits the overall progress of climate adaptation (IPCC, 2022).

> "Adaptation gaps are defined as the difference between actually implemented adaptation and a societally set goal, determined largely by preferences related to tolerated climate change impacts and reflecting resource limitations and competing priorities." (IPCC, 2022, p.22).

Most adaptation approaches are small-scaled, fragmented, sector-specific and overall revolve around the planning phase rather than actual implementation (IPCC, 2022; Preston et al., 2011). Common approaches to climate adaptation planning concern assessments of future development in climate change, potential impacts by those changes, potential actions to manage those impacts and communicate knowledge to stakeholders (Preston et al., 2011). This approach focuses on building capacity through knowledge acquisition but fails to consider potential consequences throughout the assessment process (Preston et al., 2011). Preston et al. (2011) refers to this as a ´low-risk´ approach, in which investments or more difficult or controversial processes are avoided (Preston et al., 2011). Additionally, adaptation initiatives often focus on risks in the immediate or near future, rather than long-term and transformational adaptation (IPCC, 2022). However, as climate adaptation generally takes a long time to implement, it is vital to engage in long-term planning in order to close adaptation gaps (IPCC, 2022).

Furthermore, adaptation plans commonly omit to target the dimension of institutional and governance issues (Preston et al., 2011). In fact, social and institutional dimensions are considered prominent barriers to climate adaptation in middle- and high-income countries (Biesbroek et al., 2013). It is often assumed that developed nations, with their considerable wealth, technology and education, have high adaptive capacity (Preston et al., 2011). However, research indicates that developed nations have a long-term evolution of planning and practicing climate adaptation ahead of them, before effective adaptive capacity-building can be achieved (Preston et al., 2011). Additionally, key conditions to accelerate

adaptation implementation are political commitment, knowledge, institutional frameworks, access to financial resources, inclusiveness in decision-making, concrete guiding instruments and systems for monitoring and evaluating efforts (IPCC, 2022).

## Institutional context for climate adaptation in Sweden

In Sweden, climate adaptation is controlled by several strategies, laws and regulations. The government, parliament and public authorities (*myndigheter*) are the main responsible entities (Klimatanpassning.se, n.d.) and a National Council of Experts for Climate Adaptation (*Nationella expertrådet för klimatanpassning*) has been appointed by the government to monitor and evaluate development every five years and provide recommendations for future work (Swedish Environmental Protection Agency, n.d.a).

Two key institutions exist to act on the government's behalf: environmental assignments are carried out by the Swedish Environmental Protection Agency, whose task it is to (1) compile knowledge and documentation, (2) develop environmental policy, and (3) implement environmental policy (Swedish Environmental Protection Agency, n.d.b). Additionally, the Swedish Meteorological and Hydrological Institute (SMHI) operates a national knowledge centre for climate adaptation, to facilitate implementation for different actors (Klimatanpassning.se, n.d.).

Furthermore, a national network of 27 public authorities have been assembled to provide information regarding current and future climate change impacts in their respective sectors. Within this network, representatives from the Country Administrative Boards (*länsstyrelser*) and the Swedish Association of Local Authorities and Regions (*Sveriges kommuner och regioner*) are responsible for the coordination of regional climate adaptation (Swedish Environmental Protection Agency, n.d.a).

## National laws and regulation on climate adaptation

In 2018, the Swedish parliament passed *The National Strategy for Climate Adaptation* (Nationell strategi för klimatanpassning) (2017/18:163) to sustainably strengthen climate adaptation in Sweden and improve coordination around these efforts (Miljö- och energidepartementet, 2018). It involves the identification of climate adaptation goals, distribution of responsibilities, guiding principles and financing (Miljö- och energidepartementet, 2018).

In 2019, the *Regulation on Climate Adaptation in Public Authorities* (Förordning om myndigheters klimatanpassningsarbete) (SFS 2018:1428) was passed, which governs both public authorities and the County Administrative Boards. The regulation states that public authorities are obligated to support and monitor climate adaptation efforts in the nation and report the development to the Swedish Meteorological and Hydrological Institute (SMHI) (*Förordning om Myndigheters Klimatanpassningsarbete*, SFS 2018:1428). Additionally, it states that the County Administrative Boards shall assist climate adaptation efforts by municipalities within their region (*Förordning Om Myndigheters Klimatanpassningsarbete*, SFS 2018:1428).

# Methodology

This thesis is a qualitative single-case study of climate adaptation planning in a Swedish municipality, with results relevant for sensitive mountain regions. The method is composed of (1) empirical material of relevance to climate adaptation and reduction of landslide risk, consisting of overarching policy documents and local development planning decisions at the municipal level, (2) an analytical framework to evaluate climate adaptation planning processes, and (3) a literature review, in which adaptation options for developed mountain regions are explored.

Two municipal overarching policy documents, with significant importance for climate adaptation, were reviewed to understand the broader climate adaptation strategy in Åre municipality. Additionally, the inclusion of five randomly chosen planning decisions was anticipated to generate insights into considerations, actors, timelines, and procedures in the real-life planning practice. The municipality had however no influence over the selection of empirical data in this study. Planning decisions were explored through service statements (*tjänsteyttranden*) and minutes (*sammanträdesprotokoll*) as well as semi-structured interviews with central actors. The analytical framework developed by Preston et al. (2011) (see Appendix 3) was then used to map out key adaptation processes in the empirical material and identify potential blind spots in Åre municipality's planning strategy. For an overview of the research components facilitating the exploration of blind spots, see Table 1. To address identified planning gaps, a literature review was conducted in which some adaptation options, relevant for developed mountain regions, were explored. For full overview of these publications, see Appendix 5. The identified adaptation options could be relevant to improve the adaptation strategy in Åre municipality. The following sections of the methodology will provide an account of the case-study approach, empirical data, interviews, analysis procedure and literature review. Finally, the methodology is concluded with methodological reflections and ethical considerations.

**Table 1: Core components of the exploration of adaptation planning blind spots in Åre municipality's adaptation strategy**

| | | |
|---|---|---|
| **Analytical tools** | Analytical framework | Four ´stages´ of adaptation planning with 19 ´adaptation processes´ for effective climate adaptation, distributed within the stages (Preston et al., 2011) |
| **Empirical material** | Overarching policy documents | Åre municipality's *Municipal Comprehensive Plan* (2012), adopted in 2017, and the *Climate Adaptation Plan* (2019) |
| | Planning decisions | Five planning decisions issued during September-October 2021; one from each of the following units: (1) Planning, (2) Building, (3) Project and Investment, (4) Water and Sewer, (5) Land and Exploitation |
| | Interviews and personal communication | (1) Interviews related to the five selceted planning decisions, (2) personal communication with Planning and Building Units representatives on the standard decision-making processes, (3) personal communication with the Sustainability Strategist, an Environmental Inspector and the former Climate Adaptation Coordinator |

# A qualitative single-case study

Case studies can be well suited for both qualitative and quantitative studies, provided depth is aspired above breadth (Flyvbjerg, 2006). The single case study facilitates the exploration of revelatory, critical, common, or exceptional cases (Yin, 2018). When aspiring to explore a relatively new and complex set of interrelated and geographically situated challenges like this, an in-depth case study is an appropriate method (Flyvbjerg, 2006). This approach is chosen due to the complex challenges municipalities face when confronted with climate change impacts, as well as the significance of local context for their specific planning systems for adaptation. Case-study as a methodology enables the researcher to put him or herself within the context being studied, which in turn can give multifaceted insights into matters concerning social actors (Flyvbjerg, 2006), such as in the case of decision-making in Åre municipality. Despite their reputation of offering little value beyond the chosen context, case studies can often be generalized despite their narrow scope (Flyvbjerg, 2006). An extended discussion of both the value and the limitations of generalizing a single-case study, in relation to the investigated topic, is accounted for in the methodological reflection.

# Empirical material

Two overarching policy documents and five randomly selected planning decisions, with relevance to climate adaptation and reduction of landslide risk, were explored with the aim of obtaining an overview of the current adaptation strategy, and associated processes, in Åre municipality. The inclusion of both policy documents and planning decisions also enabled a comparison between guidelines and real-life practice.

Åre municipality mainly has two overarching policy documents that directly relate to climate adaptation and reducing the risk of landslides: (1) the *Municipal Comprehensive Plan* (*översiktsplan*) and (2) the *Climate Adaptation Plan* (*klimatanpassningsplan*). Spatial planning has been described as a key tool for climate adaptation in Åre (Åre kommun, 2012). The *Municipal Comprehensive Plan*, published in 2012 and accepted by the City Council (*kommunfullmäktige*) in 2017, is a strategic document that guides overarching spatial planning in the municipality in relation to broader goals (Åre kommun, 2012). For that reason, the *Municipal Comprehensive Plan* was reviewed to explore the broader scope of the climate adaptation strategy in Åre municipality's spatial planning. In addition, the *Climate Adaptation Plan*, produced and accepted on municipal management-level (*ledningsnivå*) in 2019, is meant to guide the internal organization's efforts in implementing adaptation measures (Åre kommun, 2019). Due to its explicit focus on adaptation planning, the *Climate Adaptation Plan* was reviewed with the aim of obtaining a more nuanced account of the adaptation strategy. The contents and purpose of both overarching policy documents are described in more detail in the section covering Åre as a case. In the same section, the *Municipal Comprehensive Plan* is used to describe different background information about Åre, such as population statistics and future exploitation plans.

Due to the purpose of obtaining a comprehensive and detailed understanding about the processes involved in adaptation planning, the selection of planning decisions was limited to one decision for each of five different municipal units: (1) the Building Unit, (2) Planning Unit, (3) Project and Investment Unit, (4) Water and Sewer Unit and (5) Land and Exploitation Unit. These units were chosen due to their relevance to spatial planning and landslide risk, which in turn enabled an exploration of possible links and coordination across units. Randomization of the selection of decisions was achieved by choosing a random date that acted as a condition. The condition was that the first planning decision made after the 15$^{th}$ of August 2021 would be explored in this study. This date was chosen due to its

position *after* the publication of the *Climate Adaptation Plan* but *before* the initiation of this study. The actual identification of these decisions was made through the assistance of the municipality's Committee Secretary (*nämndsekreterare*).

Apart from utilizing municipal service statements and minutes, the exploration of planning decisions was conducted through interviews with actors that either had been central to the decision or had a comprehensive overview of its process. These actors were also identified with the aid of the municipality's Committee Secretary. The exploration of planning decisions involved an overview of central actors, distribution of responsibility, timeframe and an account of steps involved in the decision-making. In addition to exploring considerations to climate adaptation, it was important to investigate the context in which the decision was made. The amount of information in the service statements and minutes varied significantly between the planning decisions and therefore they were utilized at different lengths.

Some decisions never proceeded to the stage in which climate adaptation is typically made. To ensure that no significant considerations to climate adaptation were left out - due to the planning decision's specific circumstances - an investigation of the ´standard decision-making process´ at the Planning Unit and Building Unit was conducted to complement the five planning decisions. This investigation was only conducted for the Planning Unit and Building Unit due to the units´ centrality in all spatial planning decisions. This extension, beyond the limits of the randomly selected planning decisions, enabled more comprehensive conclusions to be drawn about the climate adaptation strategy in Åre. Information on the standard decision-making process was mainly gathered through personal communication with two representatives from these units, during the end of April to middle of May 2022.

## Interviews

The interviews were conducted in the form of an *informant investigation* (informantundersökning) in which respondents were treated as witnesses of a certain reality (Esaiasson et al., 2017). The purpose of this approach is to strengthen the ability to describe the reality in question - a sequence of events or how something works (Esaiasson et al., 2017), which for this study was the exploration of Åre's climate adaptation strategy. Hence, the focus was not on the interviewees' *perceptions* of climate adaptation within decision-making but rather on *if*, and *how*, a certain decision had been made in relation to climate adaptation and landslide risk.

Furthermore, the selection of informants was based on *centrality*, meaning that the most prominent people were chosen (Esaiasson et al., 2017) in relation to the five

planning decisions. However, there was no predetermined number of interviews to be conducted. Rather, it was the level of saturation in terms of information that determined the conclusion of the interview stage (Esaiasson et al., 2017). In other words, if needed, more central actors were identified and interviewed through the so-called *snowball method* until sufficiently comprehensive material was collected to conclude the mapping stage (Esaiasson et al., 2017). For a full list of the informants, see Table 2.

**Table 2: List of informants interviewed for the exploration of the five planning decisions**

| ***Informant*** | ***Proffessional role*** | ***Topic*** | ***Date*** |
|---|---|---|---|
| Liselott Thottmark | Administrator at the Water and sewer Unit | Water and sewer decision | 2022-04-08 |
| Peter Tjärnefors | Manager at the Building Unit | Building decision | 2022-04-08 |
| Micael Fredriksson | Manager at the Land and Exploitation Unit | Land and exploitation decision | 2022-04-20 |
| Sara Larner | Manager at the Project and Investment Unit | Project and investment decision | 2022-04-26 |
| Roger Sennå | Administrator at the Technical Department | Project and investment decision | 2022-05-04 |
| Annalena Wigge | Production manager at the Planning Unit | Planning decision | 2022-05-16 |

In this study, the identification of key professional roles and responsibility division was a crucial point in exploring the planning decisions. However, by accounting for professional roles that had been central to the planning decisions, the individual behind that position would simultaneously be revealed. Anonymizing the informants, to protect their identity, would have defeated the objectives of this research. Therefore, this study does not anonymize the informant's identity and certain ethical considerations had to be made as a result, which are accounted for in the Ethical considerations section.

Central actors for each planning decision were identified by the assistance of the municipality's Committee Secretary. The suggested actors were then contacted by email. On some occasions the intended person was not available, and he or she would appoint someone else with a similar level of knowledge about the subject. The email consisted of a short description of the study and its purpose, a request for an interview about the respective decision, and a reference to an attached letter of consent, see Appendix 1, which consisted of two parts: (1) an informative part explaining the purpose of the interview in more detail and (2) conditions of consent, such as videorecording, voluntary participation and management of personal data.

More details on informed consent are provided in the section for ethical considerations.

Interviews were conducted individually during the beginning of April to the middle of May 2022 and varied in length between 20-60 minutes. It was important that the informants could express themselves freely, while still focusing on the climate-related aspects of the decision-making process. Therefore, the interviews were semi-structured with open-ended questions which to some extent were predetermined to explore a subject from a desired angle (Given, 2008). An interview guide was created (see Appendix 2) consisting of (1) an introduction where a short presentation of the study was made and the informant was asked about their professional role in the planning decision, (2) questions about the planning process, timeline and actors involved, followed by (3) more specified questions about climate change and landslide risk. Informants were not asked the exact same questions since the context of each decision could differ considerably. In accordance with the semi-structured approach, questions did not follow a certain order and were complemented with spontaneous follow-up questions whenever relevant (Given, 2008). If, by the end of the interview, the subject of climate change had not been sufficiently covered, more direct questions were asked, and a definition of climate change adaptation was provided. It was important not to define climate change adaptation at the beginning of the interview, unless it became clear that the informant was unsure about the question. The purpose of this strategy was to not direct their answers towards certain steps of the decision-making process, but rather allow them to identify the frame of climate adaptation planning themselves.

All but one interview were conducted through *Teams* video-call, which had both advantages and disadvantages. At the start of the interview, the informant would receive a digital notification that they were being recorded which had to be approved or denied – which ensured that he or she could not miss this information. Even though all participants had their cameras on, aspects of human connection such as body language and eye contact could not contribute much to the interpretation of their answers. However, the ability to share screens enabled a pedagogical distribution of information about how their system works and what digital tools are typically used in decision-making.

Furthermore, the interviews were not transcribed or coded, since the focus was on discovering the planning processes in relation to their context, rather than to make a thematic analysis of a sample which would have limited the extent of detail that could otherwise be uncovered. Upon the completion of the interview stage, the informants were sent the section of this study that they had contributed to. They reviewed the way their answers had been portrayed and got the opportunity to have any adjustments made. This process was essential to ensure that their information had been interpreted correctly and that they were satisfied with the way their answers has been used, particularly since there is no anonymization.

## Analysis procedure

In accordance with the first research question, the specific focus of this study is on assessing the structure of the climate adaptation strategy in Åre municipality, by identifying considerations to climate change adaptation and landslide risk in land use and economic planning. To answer this, the analysis is based on the analytical framework by Preston et al. (2011), which is used to map out climate adaptation processes employed in each of the overarching policy documents and selected planning decisions. Through this evaluation, ´planning gaps´ in terms of unidentified adaptation processes can be revealed (Preston et al., 2011) and potential strategies for addressing them are presented based on adaptation options identified in scientific publications. Unidentified adaptation processes are presented in Table 5. For a full account of the analytical framework and criteria descriptions, against which the adaptation processes are assessed, see Appendix 3.

In Preston et al.´s (2011) evaluation framework, the success criteria (or adaptation processes) were intended to be evaluated according to a scoring system. However, for the purposes of this study, the adaptation processes will only be mapped according to whether the processes can be identified or not. Hence, if at least some aspects of the criteria is met, the process is considered identified and is presented as such in the results-section, see Table 4. If parts of the empirical material were not sufficient to adequately assess the compliance with an adaptation criterion, the informant was asked additional questions. In some cases, this resulted in deeper understanding of the planning decisions. Otherwise, limitations in the capacity to assess the compliance with the framework's adaptation processes is accounted for when relevant in the discussion section.

## Literature review procedure

The literature review was carried out during the first week of February 2022 in the bibliographic database *Scopus*. The aim of the literature review was mainly to identify adaptation options in previous case studies about climate adaptation in developed mountain areas (that might have similar resources, opportunities and constraints as Åre municipality), which could potentially be implemented to fill blind spots in Åre municipality's current planning strategy and processes. The articles were used to gain an overview of the specific challenges sensitive mountain

regions face and the institutional contexts within which their climate adaptation takes place. Additionally, the focus of the literature review was limited to planning processes and governance rather than technical or physical actions to reduce vulnerability to climate impact. The search thread, displayed in Table 3, generated 57 results, whereof only 14 were deemed relevant after a review of abstracts. Considering the scarcity of academic publications that met the inclusion criteria, the review was thus based on a total of 14 scientific articles.

**Table 3: Search thread and inclusion criteria for selecting scientific publications**

| *Database* | *Search terms* | *Inclusion criteria* | *Results* | *Selected articles* |
|---|---|---|---|---|
| Scopus | *alpine OR alps OR mountain OR mountainous OR montane (Topic) and climate ( Topic) and adaptation OR adaptive (Title) and "case stud*" (Topic) | (1) Case studies from developed high-income countries, (2) articles with a governance or strategic focus, (3) academic peer-reviewed articles written in English | 57 | 14 |

# Critical reflection and potential applications

Due to the limited data set, it is not possible to cover all aspects of adaptation planning processes in Åre; neither is it the purpose of this research. Rather, the purpose is to give an *indication* of the state of climate adaptation planning in Åre and explore some options that could contribute to diminishing the overall vulnerability to climate impact. Additionally, since landslide risk is the most serious and immediate risk for this municipality (SGI & MSB, 2021) such improvements can be considered vital to prevent future disasters.

Even though single-case studies cannot by their own be viewed as entirely generalizing studies, they can become generalizable if carried out in sufficient numbers (Flyvbjerg, 2006). This study on Åre can thereby contribute to the relatively limited body of research on climate adaptation planning in mountain regions, that considers climate impacts, governance systems and adaptation strategies (Vij et al., 2021).

Moreover, the strength of case studies is not to *prove* something, but to contribute to a baseline of *learning* from a highly contextual case (Flyvbjerg, 2006). In this way, the case-study, with its focus on contributing to context-dependent experience, is key to developing knowledge in forms and areas that can be useful to practice (Flyvbjerg, 2006), as well as for identifying potential obstacles and opportunities for policy implementation.

The results of this single study cannot be assumed to apply to all municipalities as it concerns planning processes in a specific municipality. Different regions face different climate-related challenges and have different means of coping with them. At the same time, it is likely that at least some aspects of the planning processes in Åre may apply to other municipalities, since municipal decision-makers today generally lack knowledge of how to use guiding instruments to strengthen climate adaptation planning (Preston et al., 2011). This study can thereby provide an example for other municipalities how climate adaptation planning can be evaluated and analysed to create a more comprehensive and effective strategic system. According to Flyvberg (2006), true expertise can only be achieved through the practice and implementation of knowledge, which in turn is easier to do when learning from real-life situations. This study can thus also be of use in the context of training and capacity-building for climate adaptation planning at municipal levels.

This study is an exploratory and preliminary investigation of climate adaptation planning in Åre, with a focus on planning with relevance for landslides, since this risk has already been identified as particularly significant for the municipality (SGI & MSB, 2021). While the case-study approach is particularly appropriate for preliminary investigations, it should be noted that their potential is not constricted to being pilot studies (Flyvbjerg, 2006). Additionally, a case-study investigation has great potential to reduce bias caused by preconceived views about the phenomena being studied, since it requires in-depth understanding about real-life situations and provides plenty of opportunities to falsify bias (Flyvbjerg, 2006). Despite the advantages of the adopted approach, it can be assumed that numerous aspects of the planning process have yet to be discovered. Based on the results of this study, the municipality should proceed with a more systematic and technical investigation to reevaluate the indicated blind spots and solutions for Åre, including a focus on other climate-related risks or challenges. A more systematic investigation would also introduce a level of research validity to the results (Esaiasson et al., 2017), which is not possible in an exploratory and contextual study with limited data.

# Ethical considerations

The following ethical considerations have been taken in addition to compliance with ethical requirements and guidelines from the Swedish Science Council (*Vetenskapsrådet*) (2017).

Landslide management can be a sensitive subject for decision-makers. Especially in the case of Åre where some of the driving factors of landslide risk, such as tourism, expansion and new skiing slopes, constitute the prerequisites for

the municipality's financial stability and development. At the same time, growth opportunities are held back by the risk of landslides, creating an inefficient feedback loop which ultimately both increases risk and reduces growth. These contradicting ambitions, of climate adaptation and risk reduction of landslides, on the one hand, and growth and expansion opportunities, on the other, suggest that there is no straightforward solution to strategies for climate adaptation in Åre.

Ultimately, these two vital perspectives, growth versus risk reduction, and their intertwined relationship had to be considered throughout this research by exerting an understanding of, and respecting, the vulnerable position of informants. Åre is a relatively small municipality facing large-scale challenges, which creates a sensitive situation for decision-makers. Additionally, since informants could not be anonymized, it was crucial that they reviewed the way their answers had been portrayed in the final report, and consented to it, before conclusions were drawn. Any requests for edits were obliged in order to ensure their information had been perceived correctly and in a manner that informants felt comfortable with.

The letter of consent played a key role in the overall ethical considerations of this study. It explained the researcher's role and how informant's contributions would be used. It also accounted for the main points to be covered in the interview and its approximate length. In the terms of consent, the informant was notified of the treatment of their personal data according to the general data protection regulation (GDPR), the voluntary nature of their participation, their rights to review their answers and demand any edits or withdraw without consequences, and that no grants or benefits were offered as compensation. Furthermore, the letter of consent explained the reason for not anonymizing their answers, and no objections were made to this point. Additionally, their recordings could only be accessed by the researcher, kept on a password protected computer, and all the collected material would be destroyed upon the approval of this research project. Additionally, the researcher also had to sign a letter of consent to get access to the municipality's internal networks and ensure no information would be used outside of this study.

# Analytical framework

According to research by Preston et al. (2011), climate adaptation plans in developed nations are largely underdeveloped. Not enough attention is directed towards (1) non-climatic factors (such as biophysical and socioeconomic) and (2) challenges around adaptation capacity, which includes necessary capital (Preston et al., 2011). Adaptation plans have a strong tendency to focus on low-risk knowledge acquisition and capacity-building, which means that the most accessible and ”easiest” options are prioritized as opposed to the most effective and systematic (Preston et al., 2011). These neglected factors often result in an incomplete and biased perception of risk which ultimately leads to an ineffective adaptation strategy (Preston et al., 2011). However, these issues could be addressed by utilizing guidance to frame Climate Adaptation Plans within the wider governance system in which it is meant to operate (Preston et al., 2011). There is need to evaluate adaptation plans to identify blind spots, ensure reduced vulnerability to climate change, create opportunities for learning and operationalize adaptation action (Preston et al., 2011). Decision-making processes are key to building robust strategic systems (Preston et al., 2011). Based on this understanding, Preston et al. (2011) proposes a systematic framework to evaluate critical adaptation planning processes based on a set of sucess criteria. The framework emerged due to a lack of consensus observed among previous guiding instruments and the indication that there was need for a more systematic approach for evaluation and monitoring of climate adaptation (Preston et al., 2011). The framework is constructed based on a classic evaluation model of policymaking called the *Logic Framework Analysis*, which promotes an analysis of:

> “(a) the relationships among program goals and objectives; (b) the activities by which those objectives may be realized; (c) the inputs and resources required to undertake those activities; and (d) the outputs that emerge from the execution of identified activities.” (Preston et al., 2011, p.414).

With the aim of linking evaluation theory with adaptation planning-guidance for decision-making, Preston et al. (2011) organized their framework similarly by four key *adaptation planning-stages*: (1) ´Goal-Setting´, (2) ´Stock-Taking´, (3) Decision-Making´, and (4) Implementation and Evaluation´.

To use these planning stages to evaluate adaptation plans, a set of processes that mirrors the range of activities for effective adaptation planning had to be identified. While the active *use* of guiding instruments for adaptation-planning is generally scarce, there exists an extensive amount of research on this topic which was used to identify the key adaptation processes in the analytical framework. The processes represent common practices in adaptation guidance-tools and should thus be considered in all strategies for adaptation-planning. 19 such adaptation processes were ultimately identified. Two were categorized as processes in the ´Goal-Setting´ stage, five in the ´Stock-Taking´ stage, eight in the ´Decision-Making´ stage, and four in the ´Implementation and Evaluation´ stage (Preston et al., 2011). For a full account of the analytical framework, stages, criteria, and processes, see Appendix 3.

Furthermore, the emphasis of the framework is, not on adaptation action, but rather on the larger planning process of those actions as well as infrastructure to support comprehensive implementation (Preston et al., 2011). This is due to research indicating that the best approach to ensure thorough climate adaptation is to establish a methodical and detailed adaptation planning process (Preston et al., 2011).

# The case: Åre municipality

Åre, located in Jämtland county in western Sweden, is one of Sweden's most well-known tourism destinations. The municipality is home to approximately 12 100 inhabitants (Åre kommun, 2022) and most people live along the bigger roads, mainly Åredalen, Undersåker, Järpen, Mörsil and Mattmar, while the western countryside is the least populated (Åre kommun, 2012). Highest expansion pressure occurs in Åredalen and Åre village where large investments are made, primarily to meet demands from the tourism sector (Åre kommun, 2022).

## Plans and projections

Tourism plays a key role in the municipality's economy and therefore physical planning largely revolves around it (Åre kommun, 2012). In 2019, the Jämtland mountain area had 700 000 overnight guests in hotels, cabins or hostels and the number of guests is anticipated to keep rising (SGI & MSB, 2021). The goal of the municipality is to expand the supply of activities and events available for tourists in the future and easy access to the mountains is an essential component (Åre kommun, 2012). For example, the municipality sees benefits in strengthening the cross-border tourism at the national boarder to Norway, which would most likely involve the construction of new lift- and ski areas as well as paths for other types of winter and summer sports (Åre kommun, 2012). At the same time, increasing construction projects and densification to meet demands from the tourism sector, results in higher pressure on bare mountain areas and vulnerability to climate change impacts (Åre kommun, 2012).

## Topography

The topography consists of a forest-covered landscape in the southeast and mountain areas in the west, with the highest mountains in the south and very north parts of the municipality (Andersson & Lundström, 2018). Morain is the primary soil type, with peatlands in the north and west (Andersson & Lundström, 2018).

The river Indalsälven runs through the municipality in a west-eastern direction and several smaller lakes feed into it (Andersson & Lundström, 2018). Åre village, where the densest construction is located, primarily has vegetation, cultivation and residential areas closest to Åre lake (Andersson & Lundström, 2018). Spruce and mountain birch forests occupy the higher altitudes until the hillside transitions into bare mountain slopes above the tree line (Andersson & Lundström, 2018). Several lifts, slopes and transport routes for skiing permeate these areas (Andersson & Lundström, 2018).

## A primary risk area for landslides

The Jämtland mountain area has been classified as one of ten primary climate-related risk areas in Sweden, in a report by SGI and MSB (SGI & MSB, 2021). The community center in Åre has been highlighted as extra exposed to climate impact due to the sloping terrain and increasing precipitation, which has proven to be a recipe for landslides, with subsequent sludge streams, based on past observations (SGI & MSB, 2021). When the soil becomes saturated with water the solidity weakens, which makes the ground more prone to movement (SGI & MSB, 2021). It has been estimated that the soil in several areas of the municipality is prone to such movements (Andersson & Lundström, 2018). Landslides and sludge streams have been observed on all larger mountains but are most common in the high mountain areas (Andersson & Lundström, 2018).

This development can be tracked back to the 1970s, when large regional investments in winter tourism led to considerable deforestation to enable the construction of skiing slopes, which left large cohesive areas exposed (SGI & MSB, 2021). Since then, expansion has accelerated, intense deforestation has continued, and a lot of construction has been built in areas with considerable risk of being impacted by landslides (SGI & MSB, 2021). In addition, buildings and infrastructure are often not constructed to withstand such events, which could lead to disasters that impacts not only residents but the growing number of tourists as well (SGI & MSB, 2021). Landslides and sludge streams can severely damage natural and cultural resources and economic activity as well as negatively impact health and environment in general (SGI & MSB, 2021).

Investigations have been conducted to broadly map out risks of landslides and sludge streams in built-up areas of the municipality, and these can be used in combination with the *Municipal Comprehensive Plan* and action plans to reduce vulnerability (Andersson & Lundström, 2018). The considerable landslide risks in Åre demand certain considerations to be made in spatial planning, especially since the amount of precipitation, tourism and expansion is estimated to increase (SGI & MSB, 2021).

# Two guiding instruments for climate adaptation

The following documents can be considered primary guiding instruments for climate adaptation in Åre municipality: (1) the *Comprehensive Overview Plan* (2012), adopted in 2017, and (2) the *Climate Adaptation Plan* (2019).

## The Municipal Comprehensive Plan

*The Municipal Comprehensive Plan* sets the standard for spatial planning and exploitation of both built and natural environments (Åre kommun, 2021). While not legally binding, it involves guidelines for strategic use, preservation and development of land and water areas, with planning principles considered to be valid until 2035 (Åre kommun, 2012). It is reviewed every term of office to ensure that it relates accurately to political willpower and general development (Åre kommun, 2012). Its guidelines concern the entire municipality and therefore is not meant to be detailed or balance different interests (Åre kommun, 2012). For detailed and legally binding regulation of geographic areas, the municipality produce detailed development plans (*detaljplaner*), regulation of certain districts (*områdesbestämmelser*), preliminary decisions (*förhandsbesked*) and building-permits (*bygglov*) (Åre kommun, 2012). All binding regulation should be framed in relation to the approaches described in the *Municipal Comprehensive Plan* (Åre kommun, 2012). The plan is used as a key tool in decision-making to enable isolated decisions to be framed in a larger context and to facilitate long-term spatial planning in accordance with development goals (Åre kommun, 2012). In relation to public and national interests, the plan is also used to facilitate communication between the municipality and government (Åre kommun, 2012).

## The Climate Adaptation Plan

The *Climate Adaptation Plan* describes the overarching plans and implementation of climate adaptation efforts in Åre municipality (Åre kommun, 2019). It was written by the sustainability strategist and the climate adaptation coordinator and accepted by the municipality's management team (*ledningsgrupp*) in 2019 (Åre kommun, 2019). Alexander Håkansson, who was climate adaptation coordinator at the time, explains during personal communication on May 5th, 2022, that it was mainly financial means and personal engagement that motivated the production of the plan at that specific time. In addition, heat waves and increasing landslide risk

as well as flooding, due to overexploitation and deficient day-water systems, contributed to the urgency of adaptation. The structure of the plan was based on climate adaptation guidelines from SMHI and klimatanpassning.se, while the theoretical base about climate impacts in Åre was largely gathered from a report on risk- and vulnerability work in Jämtland, produced by the County Administrative Board (A. Håkansson, personal communication, May 5, 2022).

# Results and analysis

This section presents the results from the mapping of climate adaptation considerations in two overarching policy documents and five planning decisions in Åre, according to the analytical framework by Preston et al., (2011) (see Table 4). It will also account for the standard decision-making process at the Planning Unit and Building Unit, and the mapping of identified adaptation processes in these decision-making processes can be found in Appendix 4. Finally, Table 5 will present those adaptation processes which could not be identified in either overarching policy documents or planning decisions.

**Table 4: Identified adaptation processes, risks considered and compliance with regulatory documents in overarching policy documents and selected planning decisions**

| *Adaptation stage* | *Adaptation process* | *Municipal Comrehensive Plan* | *Climate Adaptation Plan* | *Planning Unit decision* | *Building Unit decision* | *Project and Investment Unit decision* | *Water and Sewer Unit decision* | *Land and Exploitation Unit decision* |
|---|---|---|---|---|---|---|---|---|
| **Goal-Setting (Goals, objectives, purpose)** | **Articulation of objectives, goals and priorities** | Strengthen social structures through spatial planning | Map risks & vulnerabilities; prioritize actions; identify opportunities; facilitate incorporation; | | | | | |
| **Stock-Taking (Inputs)** | **Assessment of social capital** | | | Compliance with Municipal Comprehensive Plan; regulation on spatial planning | Compliance with Municipal Comprehensive Plan: regulation on spatial planning | Compliance with conditions from the County Administrative Board | Compliance with law on Public Water Services; Order from the County Administrative Board | |
| | **Assessment of natural capital** | Nature based solutions; ecosystem services; sensitive natural environments | | Inventory of natural landscape; national interest, water-protected area | Inventory of natural landscape; natural resources | Ground water source | | |
| | **Assessment of physical capital** | Existing infrastructure; public solutions, | | Estimated water- and sewer solutions; existing construction | Technical aspects; Water- and sewer issues | Technical solutions | Issues with existing water- and sewer systems; leakage of raw sewage water | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Assessment of financial capital** | Large short-term investments; Day-water management; Long-term benefits | | | | | | |
| **Decision-Making (Activities)** | **Stakeholder engagement** | | | | Opinions from applicant, neighbours and departments | | | |
| | **Assessment of climate drivers** | Historical trends; current variability; future projections | Historical trends; future projections | | | Historical climate trends; 100-year rain | | |
| | **Assessment of non-climate drivers** | Growth and expansion targets | | | High demand to build in the area | Manage larger amounts of sludge; sustainable processing | Several previous applications to expand facilities | |
| | **Assessment of impacts, vulnerability and/or risk** | Demands on risk assessments; 1000-year rain; | Impact projections, cloudbursts; flooding; landslides | Analysis through GIS; Site-visit; Assessment of risks; shallow water | Analysis through GIS; Site-visit; Assessment of risks | Leakage of sewage water; contamination of ground water source | | |
| **Implementation and Evaluation** | **Definition of roles and responsibilities** | | Coordination group; working groups | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Implementation** | Spatial planning | Risk analysis; internal action plans | | | | | |

# Overarching policy documents for climate adaptation

## Municipal Comprehensive Plan

In the *Municipal Comprehensive Plan* (Åre kommun, 2012), adopted in 2017, climate change is described as one of the primary future challenges in Åre and spatial planning is expressed as an important tool to implement climate adaptation measures. The overarching goal is to strengthen social structures to ensure that the community can withstand the expected stressors from climate change.

Six strategies are meant to guide decision-making concerning spatial planning, and climate adaptation is explicitly mentioned in relation to two of them: (1) *robust construction* and (2) *noticing the potential of the landscape*. Some of the methods for robust construction concern ensuring climate adaptation of construction and infrastructure. A main goal is to build from the inside-out to facilitate more public solutions, such as connecting buildings to public water- and sewer systems. Furthermore, nature-based and local solutions should be prioritized in day-water management and ecosystem services shall be integrated in plans for construction. It is also stated that:

> "Exploitation and actions in sensitive or risky areas is executed with special care, especially areas with significant risk or that are worthy of protection should not be exploited." (Åre kommun, 2012, p.23)

Additionally, risk assessments and associated actions will be performed with regard for the wider community, which means that the public interest shall prevail over the individual. Methods to *notice the potential of the landscape* concerns balancing different interests in exploitation, map out and prioritize public values, and adapt exploitation projects to the natural landscape.

In the section on impact assessments, a set of general approaches to climate adaptation are accounted for: (1) adapt social structures, (2) increase demands on risk assessments, (3) adaptation of agriculture, forestry and industries dependent on biological or natural resources, and (4) consider vulnerabilities in the heating system. A description of the specific risks - which are managed through these approaches - are accounted for as well as how reduced vulnerability is achieved. Among these are the higher demand of adapting construction and infrastructure to withstand a 1000-year rain instead of the previous 100-year rain. The plan accounts for historical climate trends, current climate variability as well as future climate change projections. Additionally, considerations are made to adaptation in relation

to the general growth and expansion targets in the municipality, such as densification which complicates adaptation measures.

While no account is given to a specific budget, the plan acknowledges the necessity of large investments to achieve the aspired adaptation targets; costs of day-water management is especially highlighted. It is also stated that all short-term investments in adaptation are expected to benefit the municipality in the long run.

In terms of evaluation, no clear success criteria can be identified against which progress would be measured. Criteria do exist for the climate *mitigation* strategy, which concerns reduction of greenhouse gas emissions, but no such evaluation measures exist for climate *adaptation*.

## Climate Adaptation Plan

Åre's *Climate Adaptation Plan* (Åre kommun, 2019) states that the purpose of the adaptation efforts is to map out risks and vulnerabilities within the internal organization in order to prioritize actions, prevent negative impacts and take advantage of opportunities. The plan itself is meant to guide the internal organization to facilitate incorporation of climate adaptation throughout the municipality's different sectors, and consequently strengthen preparedness both within and beyond the internal organization. In addition, it is stated that the municipality's development shall be conducted within the region's biological limits, in other words not causing stressors on the natural environment which ecosystems cannot recover from (Åre kommun, 2019).

In the first section, the plan shortly describes the representative concentration pathways (RCP) 4,5 and 8,5, and how these climate projections will impact Åre municipality. There is however no account of current climate variability. Climate impacts and the associated risks are considered along multiple dimensions, cloudbursts, flooding and landslide risk, among others. The implementation strategy for the adaptation plan is based on the completion of risk analysis for each of the municipality's internal sectors. This includes mapping out specific risks for each sector and prioritizing them in a so-called *risk matrix* to ultimately create "action plans" with concrete adaptation actions.

It should be noted however, that these action plans have not been obligatory and that only one internal sector – the Water and Sewer Unit – has completed one to date (J. Sjölund, personal communication, April 7, 2022). Alexander Håkansson, who was Climate Adaptation Coordinator when the *Climate Adaptation Plan* was produced, explained during personal communication on May 5th, 2022, that the action plans for each of the internal sectors was not supposed to be voluntary. When asked about possible reasons for the interrupted efforts, Håkansson says that the financial means ran out and that both himself and the Sustainability Strategist left their positions at the municipality (A. Håkansson, personal communication, May 5,

2022). However, had Håkansson remained, he would have managed the production of action plans for the remaining sectors.

The overarching responsibility of climate adaptation in Åre falls on the coordination group (*samordningsgruppen*), consisting of the Sustainability Strategist and the Climate Adaptation Coordinator (*klimatanpassningssamordnaren*)(Åre kommun, 2019). Their task is to collaborate with the different internal sectors in the production of action plans, ultimately creating teams referred to as "working groups" (Åre kommun, 2019). A primary task for the coordination group is to mediate between working groups, management and politics, among which the levels of knowledge and insights might differ (Åre kommun, 2019). However, today there is no person hired as Climate Adaptation Coordinator, and it is unclear whether someone new will be hired for this position in the future (J. Sjölund, personal communication, April 7, 2022).

The manager at the respective internal sectors is responsible for the construction, implementation and yearly evaluation of the actions plans (Åre kommun, 2019). The evaluation shall be reported yearly to the Climate Adaptation Coordinator and in turn the Municipal Management Office (*kommunledningskontoret*) reports a compilation of the different evaluations to the Municipal Board (*kommunstyrelsen*). Finally, the Municipal Management Office is responsible for the evaluation of the entire adaptation plan which shall be conducted once every term of office (Åre kommun, 2019). However, no description is given as to how such evaluations could practically be executed or against what success criteria progress could be measured.

Furthermore, the *Climate Adaptation Plan* highlights the importance of spreading information about climate-related risks to the public as well as actors within different internal sectors, as an effort to strengthen overall preparedness (Åre kommun, 2019). It is principally up to the different working groups to communicate between and within different internal sectors and ensure an iterative knowledge exchange (Åre kommun, 2019). While the responsibility for communication has been distributed, there is no strategic description of this process in the adaptation plan.

## Climate adaptation in planning decisions

The following section consist of a description of the key decision-making processes in municipal spatial planning in Åre; specifically at the Planning- and Building Units due to their high level of involvement. Moreover, a description of the five planning decisions will be presented along with the identified adaptation processes, based on the analytical framework by Preston et al. (2011).

## Standard decision-making processes at the Planning Unit

This section describes the standard decision-making process at the Planning Unit. The purpose of this section is to give context to the planning decisions being analysed. Unless otherwise stated, the following information is based on personal communication with Martin Engdahl, Planning Architect at the Planning Unit, on April 27, 2022.

The Planning Unit is responsible for the coordination and production of new detailed development plans as well as the interpretation of existing ones. Detailed development plans are necessary for larger geographical areas with significant construction, and it is generally in this context that considerations to climate change impacts are made (E. Swenn Larsson, personal communication, May 5, 2022). In general, the need for a planning process increases when building in an area starts to be considered cohesive, meaning that buildings can no longer be viewed as solitary units and must be viewed in a larger context (Annalena Wigge, personal communication, May 16, 2022).

All cases begin with an application to exploit a piece of land in some way. The applicant can be a private person, company or even the municipality itself. In most cases, the application initially concerns a building-permit which turns into a planning process if the project is anticipated to require a detailed development plan. Then the applicant must submit an additional "planning-application" which the Planning Unit reviews with the purpose of establishing whether a planning-process could be initiated for the type of exploitation requested. Maps, site-visitation, and any relevant policy will facilitate the identification of potential risk-factors concerning natural resources, surrounding infrastructure and terrain. The decision to proceed with a planning process depends on the preconditions to build in the area and what investigations might be required to proceed. However, M. Engdahl highlights that an approval of initiating a planning-process does not mean that a detailed development plan will be finalized, or building-permit issued, but only that the Planning Unit sees an opportunity to examine the application further.

During the production of a detailed development plan, the Planning Unit will request expert investigations from consultants or other departments at the municipality to assemble all relevant factors that need to be considered in the upcoming plan. These requested investigations depend on the Municipal Comprehensive Plan, political willpower, legislation for spatial planning and consultations with the County Administrative Board and the Environmental Department. The County Administrative Board will make a list of suggested investigations based on the knowledge gained in preliminary investigations. Engdahl explains that even if municipalities have monopoly on their spatial planning, recommendations from the County Administrative Board are always thoroughly considered. The purpose of consultation with other institutions is to

create opportunity to discover new perspectives, that might otherwise have been missed.

If investigations concerning climate change impacts are necessary, the Planning Unit will turn to external consultants for environmental impact statements. Expert knowledge is especially requested when there is an estimated risk concerning landslides, day water management and sludge streams. Such investigations are not carried out by the officials at the Planning Unit since they do not have expert knowledge in the field of climate change. Their expertise lies in the field of strategic project management and the ability to balance public and private interests in a building project. Engdahl also says he doesn't know what kind of climate-related data external consultant use or precisely how they conduct their investigations. Building-permit administrator Erik Swenn Larsson says the same during personal communication on May 4, 2022.

After the investigations have been completed, the plan goes through a democratic process in which it is published on the municipality's social channels and the public are invited to submit their viewpoints, which might result in adjustments (E. Swenn Larsson, personal communication, May 4, 2022). After the completion of a detailed development plan, the next step is for the applicant to apply for a building-permit which is submitted to the Building Unit (E. Swenn Larsson, personal communication, May 4, 2022).

A detailed development plan will govern how the location can and cannot be used no matter how old the plan is and no matter how old the data used in its production is. A detailed development plan produced in 1950 will still be used as the primary guiding instrument for that area unless someone applies for the plan to be updated. The fact that new data and knowledge about climate change impacts has been released, such as the IPCC reports, does not in itself motivate for a detailed development plan to be updated.

## Standard decision-making processes at the Building Unit

The following section is based on personal communication with Building-permit administrator Erik Swenn Larsson, on May 4, 2022.

The typical decision-making process at the Building Unit is largely controlled by Swedish legislation, Swenn Larsson explains. Primarily, his job is governed by *The Planning and Building Act* (SFS 2010:900), *Boverket's Building Regulations* (BFS 2011:6) and the *Swedish Environmental Code* (*Miljöbalken* 1998:808).

The Building Unit is involved in decision-making regarding building-permits both within and outside of detailed development planned areas. However, the decision-process for applications *within* detailed development planned areas is much narrower says Swenn Larsson, since the Planning Unit and political leaders have already passed a plan with explicit directions for exploitation. In such cases,

the main initial task for the Building Unit is to review the application based on the directions in the detailed development plan. The initial examination of the application is based on drawing-documents and if nothing deviates from the directives, the building-permit is issued without further ado. This means that no investigations are principally made - even if certain risks are noticed - since the detailed development plan is supposed to have considered all relevant factors. Thus, any considerations to climate adaptation at the Building Unit are typically made for cases *outside* detailed development planned areas.

If an application concerns a property that is *not* included in a detailed development plan, it falls under the directions of the *Municipal Comprehensive Plan,* in addition to Swedish legislation. The Building Unit starts by looking at the zone in the *Municipal Comprehensive Plan,* that the area in questions falls under, and mainly pays attention to growth opportunities and risks. By using geographical information systems (GIS) they estimate where it is appropriate versus inappropriate to place construction, what the water- and sewer systems looks like and if there are possibilities to implement public sewer systems – which is a general aim in the municipality in order to diminish risk factors in relation to private sewer systems. Officials at the Building Unit also investigate if there are risks concerning landslides by noticing sloping terrains, type of soil, and utilizing information by the Swedish Geotechnical Institute (SGI) to establish if there are any specific risk-factors in the area of concern.

When asked about what level of competence in climate change impacts that are required to work at the Building Unit, Swenn Larsson explains that experience is key to notice potential red flags and that it ultimately comes down to an assessment of each individual case. Because of the necessity of experience, new employees must start with more straightforward cases *within* detailed development planned areas. He further explains that cases *outside* of detailed development planned areas are generally more complex since no investigations have been carried out previously and information might be limited at the outset.

Government reports, GIS-maps and site-visits constitute the main knowledge base for employees at the Building Unit. Furthermore, the GIS tools give them access to many different types of maps such as field-inventories from SGI. They also have their own maps, which gather and update field-inventories from the Swedish National Forest Board (*Skogsstyrelsen*) and the Swedish Environmental Protection Agency (*Naturvårdsverket*) for information on natural capital.

The *Municipal Comprehensive Plan* mentions certain geographical risk-areas related to landslides which are used to notice potential problems at an early stage. However, while it is the Building Unit's job to notice potential risks, it is the applicant's responsibility to make sure enough considerations has been made to facilitate the decision-making process. It is common that the Building Unit demands complimentary investigations of the applicant. These investigations are

often geotechnical or geohydrological, especially in relation to areas where there are unstable soil conditions in a sloping terrain and risk of landslides.

Additionally, Swenn Larsson names day-water management as a main challenge. Through GIS data they assess how much flooding might occur in the case of a 100-year rain or a 1000-year rain. According to the *Municipal Comprehensive Plan*, new construction should not be built in areas that cannot withstand such events of extreme precipitation. However, Swenn Larsson admits that parts of existing construction are positioned within these high-risk areas.

Furthermore, Swenn Larsson states that a general principle for approving a building-permit is that it is estimated to facilitate a resilient construction in terms of construction technology and potential risks. However, the political leaders in Åre have the final say concerning whether a permit is passed or not. In a handful of cases, their opinions have differed from the Building Unit's assessment, but in general the public interest will always prevail over the individual.

Furthermore, Swenn Larsson mentions that the *Planning and Building Act* states the necessity to build robustly and sustainably, but that climate adaptation per se is not an expression used in legislation. He adds that the *Planning and Building Act* also refers to the *Swedish Environmental Code* which in turn states that both land and water areas shall be used for purposes that are best suited regarding that area's limitations.

## Planning Unit – application for detailed development plan of plots

Unless stated otherwise, the following description is based on an interview on May 16, 2022, with Production Leader Annalena Wigge.

The randomly selected decision at the Planning Unit concerns an application for a detailed development plan of several land plots in Storvallen, in which the applicant wished to build new residential plots (Wäng, 2021). Upon receiving the application on the 23rd of April 2021, Wigge distributed the case to a Planning Architect at the Planning Unit for further investigation. In accordance with the *Planning and Building Act* the Planning Unit had four months to decide whether to approve the application or not.

An initial assessment was carried out to determine the preconditions to build in this location and how it relates to relevant regulation. It involved mapping existing construction, vegetation, terrain, potential landslide risk and assess if any aspects fall under the regulation on protected areas, such as national interests. Additionally, the Planning Architect investigated if there were opportunities to provide public service according to instructions in the *Municipal Comprehensive Plan*. Particularly relevant for this decision was the directive to concentrate construction to locations that facilitated public solutions for water- and sewer

systems (Wäng, 2021). The Environmental Department was also invited to contribute with viewpoints and recommendations to aid the Planning Architect's decision.

While there is no ´check-list´ specifically for climate adaptation, officials at the Planning Unit always make climate-related considerations such as day-water management, landslide risk and cloudbursts. These assessments must be carried out in accordance with regulation on spatial planning but are not explicitly considered as climate adaptation.

When asked about what data relating to climate change the Planning Unit have access to, Wigge explains that most of the data in their GIS maps comes from the Geodata Collaboration (*Geodatasamverkan*), which is a digital service containing national geographical data from public authorities. However, no comprehensive investigations are conducted at this stage. The assessments are carried out on a theoretical level based on site-visitation, maps and data from public authorities. Hence, no consultants will be included in the process until the planning-process has been initiated.

Upon the site-visitation on the 18th of June 2021, risks concerning shallow water were noticed (Wäng, 2021). The entire property was located within a primary water-protected area (*vattenskyddsområden*) and should not be exploited according to the *Municipal Comprehensive Plan* (Wäng, 2021). Furthermore, this property was considered a national interest for outdoor life, according to the *Swedish environmental code* (Wäng, 2021). On these grounds (among others) the larger part of the application for a detailed development plan was rejected (Wäng, 2021). However, the south side of the property was deemed suitable for construction of 2-3 plots, since this area was covered in forest and deemed less vulnerable (Wäng, 2021).

A planning process could be initiated for a limited part of the property with certain conditions to further reduce vulnerability (Wäng, 2021). The Community-building Office (*Samhällsbyggnadskontoret*) decided that a nature value inventory (*naturvärdesinventering*), sewer-water investigation and geotechnical survey were required to proceed with a detailed development plan (Wäng, 2021). Upon the initiation of the detailed development plan, it will be the administrator who is responsible for assigning these investigations to external consultants. The case was finally placed in a queue and the actual planning-process was estimated to start in 2024 and take approximately 1,5 years to finalize (Wäng, 2021).

## Building Unit – preliminary building-permit for a single-storey villa

The following description is based on an interview with Peter Tjärnefors, manager at the Building Unit, on April 8, 2022, unless stated otherwise.

This planning decision concerns the permission to build a single-storey villa with an appurtenant treatment plant (*reningsverk*), on a land plot in Edsåsen village (Frengen, 2021). The specific location in question was not covered by a detailed development plan, hence the decision was based on the *Municipal Comprehensive Plan* as well as national regulation for spatial planning (Frengen, 2021).

The application was ultimately rejected due to several issues concerning technical and water- and sewer solutions, which revealed a need for assessing this application within a larger context – which is done through detailed development planning (Frengen, 2021). Tjärnefors states that passing this application would not be in line with the municipality's vision of a resilient society, as stated in the *Municipal Comprehensive Plan*. He further explains that since the application was not approved, this errand did not reach the stage in which climate adaptation considerations are principally made at the Building Unit.

Officials from the Building Unit had made site-visits with the purpose of noticing potential problems or risks, landslide risk among others. In preparation for these in-person observations GIS was used to analyze the location through a variety of maps. At the actual site-visit, they made field-inventories of natural resources, terrain and potential risk factors, as well as observed the natural and built environment surrounding the land plot. In this case however, landslide risk and environmental factors were not considered a problem.

What further motivated the rejection, was the estimation that this area had an overall high demand to build, which ultimately justified a precautionary approach. The forecast, that a significant addition of construction is likely to be contributed to this location in the future, means that this environment is likely to experience physical stressors which further motivated a process in detailed development planning. Furthermore, Tjärnefors adds that the applicant, neighbours, the Environmental Department and Technical Department contributed with their opinions before the rejection was issued.

## Project and Investment Unit – expansion of a sludge plant

The description of this decision is based on two interviews. The first part is based on information from Roger Sennå, on May 5th, 2022, who is administrator at the Technical Department, and the second part on information from Sara Larner, on April 26th, 2022, who is manager at the Project and Investment Unit.

This planning decision concerns the upgrade of a sludge plant in Brännvallen. Sennå explains that the purpose of the upgrade was (1) to manage larger amounts of sludge, (2) for the plant to become independent and (3) enable a circular and sustainable processing of sludge through composting. The detailed development plan for this land plot was produced in 1965 (M. Engdahl, personal communication May 3, 2022) and the plant had been active since 1976. He further clarifies that

“sludge” is the substance that remains after sewer water has gone through an initial treatment in which larger materials (such as q-tips or tampons) are removed. The initial processing of sewer water had been outsourced thus far, while the sludge plant was used to further process and dry sludge.

Sennå continues by explaining that the management of sludge is classified as a potentially environmentally hazardous activity, and as such the application for the upgrade initially had to be sent to the County Administrative Board for approval. Due to several issues – people resigning among others – the application was not approved until 2019. The County Administrative Board then made a report with conditions for carrying out the upgrade.

In terms of direct climate change considerations, Sennå explains that the highest risk factor is likely a leakage of sewage water into the ground water source during an extreme cloudburst (*skyfall*). The dams containing sludge water were therefore constructed with a two-meter distance to the groundwater level, which Sennå states more than fulfills the conditions from the County Administrative Board. He also explains that the upgrade was constructed so that it would be able to withstand a 100-year-rain without leakage.

Once the application had been adjusted and approved by the County Administrative Board, the errand was handed over to the Project and Investment Unit, which Sara Larner accounts for in her interview. She explains that the Technical Department consists of the Sanitation Unit, Water and Sewer Unit and Project and Investment Unit. The task of the latter is to execute projects on behalf of the other two units. In this decision, the Sanitation Unit had ordered the Project and Investment Unit to carry out the requested upgrade of the sludge plant.

She explains that this case did not follow standard procedure. It is common that the “customer” (in this case the Sanitation Unit) has prepared a design (*projektering*) before submitting the order together with project instructions to the Project and Investment Unit. In this case however, the proposal was more of an idea which the Project and Investment Unit in turn delivered to an entrepreneur (*totalentreprenad*) that created the technical solutions for the plant, based on a set of requested functions, and carried out the construction. These functions then had to be evaluated by the Project and Investment Unit and the Sanitation Unit together, to ensure all requested functions were indeed in place. Larner perceived that the assignment from the Sanitation Unit mainly concerned improvements of the sludge plant that facilitated a more efficient and sustainable management of sludge, rather than functions related to climate adaptation.

## Water and Sewer Unit – public water and sewer systems

Unless otherwise stated, the following description is based on an interview with Liselott Thottmark, administrator at the Water and Sewer Unit, on April 8, 2022,

and personal communication with Andreas Karlsson, Environmental Inspector at the Environmental Department, on April 29 and May 20, 2022.

In December 2012, the County Administrative Board ordered Åre municipality to arrange for both planned and existing properties in South Bydalen to get public drinking water and sewer systems, and thereby be established as one of the municipality's areas of activity *(verksamhetsområden)*. The final decision for South Bydalen was made by the City Council in September 2021 and concerned 23 properties. However, South Bydalen was only the first of several areas to be upgraded.

Karlsson explains that the decision was initiated by a specific application, which concerned the extension of an existing sewage system in Höglekardalen's holiday village. Due to the scope of the requested extension, which would have considerably increased the pressure on the receiving systems, the Environmental Department contacted the County Administrative Board for consultation. This led to an investigation, conducted by the County Administrative Board and the Environmental Department, of the status of sewage systems in Höglekardalen. During this investigation it was discovered that the sewage systems in the area were insufficient. Up until that point, there had been a few different public water and sewage systems, which had experienced problems such as leakage of raw sewage water to sensitive natural environments (A. Karlsson, personal communication, April 29, 2022). This process finally resulted in the County Administrative Board's decision to upgrade sewage systems in South Bydalen, which was substantiated by the *Law on Public Water Services* (*Lagen om allmänna vattentjänster*) (2006:412) (Thottmark, 2021)

Thottmark explains that the entire area was already planned through a detail development plan. Therefore, any investigations considering climate change impacts should already have been conducted. Two detailed development plans had been produced for this area in total, of which the latest one was issued in 1992 (L. Thottmark, personal communication, April 26, 2022). Therefore, no new investigations were conducted during her involvement. Thottmark further adds that a direct order from the County Administrative Board means the construction is compulsory and *must* be executed.

## Land and Exploitation Unit – extension of land reservation

The following description is based on an interview with Micael Fredriksson, manager at the Land and Exploitation Unit, on April 20, 2022.

The planning decision from the Land and Exploitation Unit concerns an application from the company *Duved Framtid AB* to reserve a land plot in Duved for the construction of a large greenhouse. The application was received in June 2021 and was granted with the purpose of giving the applicant time to bring forth

certain documentation needed to determine if the process of a detailed development plan could be initiated. Fredriksson explains that there was no detailed development plan for this land plot prior to the application, however, such a plan had been deemed necessary in order to assess the potential construction of the greenhouse.

The land plot was initially reserved for the applicant's purposes for three months - until September 2021. This gave the applicant time to develop the proposal and present the project for the municipality. However, upon deadline, the requested documentation had not yet been presented due to various complications, which resulted in a decision to extend the reservation with an additional three-months, until December 2021. Because of further complications this case is still open today. Partly due to an expansion of the applicant's initial application which naturally extended the process. Fredriksson refers to the case as "messy" and says that it deviates from a standard procedure. He adds that he was not directly involved in this planning decision but has a comprehensive overview of its process.

Furthermore, he explains that land-use reservations must be approved by the political leaders in Åre, and there are informal meetings with them to ensure that the municipality follows the desired path. If there is incentive to proceed with the project in future, the Planning Unit will produce a detailed development plan for the area together with the applicant. The detailed development plan will account for in what ways the land can and cannot be used and what limitations apply to potential construction. Fredriksson continues by stating that it is in this part of the process - the detailed development planning - in which climate adaptation consideration are made, including geotechnical- and day-water investigations related to landslide risk. No investigations or considerations to climate change are made at the Land and Exploitation Unit. However, in some cases they can reject an application based on an immediate observation that the location is unsuitable to build on, but it is by principal no lengthy investigation. No adaptation processes from the analytical framework can therefore be identified for this decision.

## Unidentified adaptation processes

Table 5 presents adaptation processes, in overarching policy documents and planning decisions, which did not meet the criteria in the analytical framework by Preston et al. (2011). The following adaptation processes therefore represent blind spots in Åre municipality's climate adaptation strategy and their implications will be discussed in the discussion section.

**Table 5: Adaptation processes which could not be identified in the empirical material**

| *Adaptation stage* | *Adaptation process* |
|---|---|
| **Goal-Setting (Goals, objectives, purpose)** | Identification of success criteria |
| **Stock-Taking (Inputs)** | Assessment of human capital |
| **Decision-Making (Activities)** | Acknowledgement of assumptions and uncertainties |
| | Options appraisal |
| | Exploitation of synergies |
| | Mainstreaming |
| **Implementation and Evaluation** | Communication and outreach |
| | Monitoring, evaluation and review |

# Discussion

The analysis suggests that there are no consistent links between the *Municipal Comprehensive Plan*, the *Climate Adaptation Plan* and individual planning decisions. The *Municipal Comprehensive Plan* had implemented several processes in its guidelines for spatial planning whereas only a few processes could be observed in the *Climate Adaptation Plan*. Regarding the planning decisions, adaptation processes could only be identified in the `Stock-Taking` and `Decision-Making` stages. The mapping of adaptation processes in the standard decision-making processes at the Planning and Building Units confirmed this observation by yielding a similar result as the planning decisions. However, these results do not consider whether this inconsistency is a strategic part of the climate adaptation strategy or not. In this study, unidentified adaptation processes are consistently considered potential blind spots which could be relevant to strengthen adaptation planning in the municipality.

The decision-making process in the planning decisions considered environmental vulnerability and risks along multiple dimensions. However, the focus of the planning decisions was directed towards knowledge acquisition (assessing different types of capital) and some decision-making activities, mainly concerning risk assessments, and considering non-climate-related trends that influence adaptation measures. Preston et al. (2011) refers to this as ´low-risk capacity-building', in which investments or more difficult adaptation processes are avoided. The general risk of focusing mainly on knowledge-acquisition is that the understanding of climate adaptation might not match the real-life situation; ultimately knowledge must be translated into action (Grüneis et al., 2016).

The results suggests that a total of 9 adaptation processes, distributed over all four adaptation stages, cannot be identified in any of the empirical material. In the `Goal-Setting` stage, the main blind-spot was the lack of concrete success criteria by which goals, objectives and priorities for adaptation will be measured. At an early stage in the adaptation strategy, this gap could result in all other adaptation processes being harder to concretize since decision-makers does not know what successful adaptation looks like. Goal-clarification can facilitate implementation of adaptation measures by framing the desired outcome in a less abstract and more practical way (Roman et al., 2010).

In the `Stock-Taking` stage, there were no mentioning of evaluating the competence in matters of climate adaptation. Several of the informants said that

they do not have expert knowledge in this field. However, to translate knowledge into action, it is essential to assess the current understanding of adaptation-related concepts among officials and decision-makers so that ambiguous concepts can be operationalized in a real-life context (Timberlake & Schultz, 2017). Additionally, having limited knowledge can make it challenging for decision-makers to assess how and when to adapt to climate change (Bai et al., 2014). By investigating and improving the current knowledge base, governance issues, such as how to link adaptation with broader strategies, can be addressed (Cattivelli, 2021). Measures can be taken to help non-experts better understand advanced climate projections and relate regional priorities to a selection of adaptation options (Bai et al., 2014).

Processes not identified in the `Decision-Making` stage concern the absence of considerations to uncertainties, alterative adaptation options, synergies with existing policy and methods to institutionalize the adaptation strategy (mainstreaming). The latter can be addressed by integrating adaptation measures into the broader policy context, operationalized by investigating - and identifying facilitating factors - in three levels of adaptation: system, territorial and action (Cornwell et al, 2012).

The question of how to manage uncertainty about the nature and magnitude of climate change impacts can be addressed in several ways. Diversification is one way to spread out overall risk (Morrison & Pickering, 2013). Moreover, research emphasizes the importance of collaboration between different actors, with different competences, to share knowledge and improve projections of future impacts (Roman et al., 2010; Johnson & Becker, 2015; Timberlake & Schults, 2017; Ingold & Balsiger, 2015; Cativelli, 2021)

In terms of synergies, identifying ´hidden adaptation measures´ (measures not motivated by climate change but that contribute to climate adaptation nonetheless) is encouraged to bridge adaptation knowledge with practical real-life action (Grüneis et al., 2016). Officials involved in the planning decisions had both awareness and expertise concerning various environmental considerations that had to be taken in the planning processes, in compliance with regulations. However, even if such considerations can be viewed as part of climate adaptation, this connection did not seem immediately apparent to informants.

Even though none of the interview participants identified it as such, stakeholder engagement can be considered a ´hidden adaptation measure´ in Åre. Inviting different stakeholders to provide their viewpoints is a compulsory step in spatial planning and aspects of climate adaptation can be addressed by all stakeholders during this process. Therefore, it is motivated to highlight the agreement in previous research that stakeholder engagement is a core component in decision-making regarding the design and implementation of adaptation measures (Bonzanigo, Giupponi & Balbi, 2016; Ingold & Balsiger, 2015; Moser, & Baulcomb, 2020; Lavorel et al., 2019). For example, by investigating similarities and differences in values and attitudes among stakeholders, different perspectives

and common solutions can be identified (Moser, & Baulcomb, 2020). In relation to winter tourism, stakeholder engagement can facilitate the analysis of what sustainable tourism mean and how much environmental quality can be sacrificed for economic development (Bonzanigo, Giupponi & Balbi, 2016).

Finally, in the `Implementation and Evaluation` stage, the municipality seem to lack an explicit account of how the adaptation strategy will be communicated to the community. Even though stakeholders get a voice in decision-making by principle, any concrete strategies for communicating climate adaptation methods could not be identified. Additionally, the results suggest that the municipality lacks a system for how the adaptation strategy should be monitored, evaluated and reviewed. The *Climate Adaptation Plan* explains the division of responsibilities for monitoring and evaluation. However, the absence of success criteria ultimately results in the inability of concretizing such a process. Hence, there is no account of how an evaluation would be executed and no description of what such a procedure would consist of.

The *Climate Adaptation Plan* states that its main purpose is to guide the different municipal sectors in their implementation of adaptation measures. However, neither action plans nor the *Climate Adaptation Plan* itself was ever mentioned during interviews or personal communication. This suggests that officials and decision-makers at the municipality either do not know that the plan exists or have no guidelines on how to use it in their respective roles. No procedures appear to exist that require consideration of the municipal *Climate Adaptation Plan* at different stages of the planning process. Additionally, several of the informants stated that it is only during the production of detailed development plans that climate-related considerations are made. It therefore seems that the main purpose of the *Climate Adaptation Plan* - of implementing adaptation measures within all municipal sectors - has not yet been acknowledged or acted upon. The challenge of linking adaptation measures with broader strategies is highlighted as a key barrier to climate adaptation in previous research, and long-term cross-sectoral adaptation policies are presented as a possible solution (Cattivelli, 2021). Moreover, lack of engagement in strategic climate adaptation indicates a need to investigate the cause of `non-adaptive behaviour` as well as the link between this behaviour, barriers to adaptation and motivational factors (Meinel & Höferl, 2017). One reason for the limited engagement within municipal sectors could be that the adaptation plan has not been accepted on a political level, and consequently has limited authority.

Since the production of detailed development plans has been expressed as the main component of climate adaptation in Åre, it is vital to explore the adaptation processes involved in this context of spatial planning. As expressed in interview answers and personal communication, the officials at the municipality - who are either making or supporting decisions - are not knowledgeable in the field of climate change. It should be noted that it is not an explicit duty in their respective professional roles either and as such climate-related investigations are entrusted to

external consultants. However, none of the informants with experience in detailed development planning knew what kind of climate-related investigations are carried out by consultants or what kind of data they use. Even if the assessments are carried out by external consultants, the municipal officials need to have an understanding of the issues in order to request relevant investigations at appropriate stages of the processes, as well as to evaluate if assessments undertaken by external actors are adequate.

The most concrete consideration to climate change mentioned by informants was adapting construction to potential events of extreme precipitation, or cloudbursts. Specifically, informants talked about a 100-year and a 1000-year rain. A 100-year-rain refers to an event of extreme precipitation that has been measured once during the past 100 years, based on statistics from the years 1900-2011, by the SMHI (Wern, 2012). The volume of rain during the occurrence of a 100-year rain is 44 mm during 30 minutes (MSB, 2017). The occurrence of a 1000-year rain, which has occurred once in the past 1000 years, measures 95 mm during 30 minutes (MSB, 2017). It should be noted however that these events are not based on any prognosis about future climate change (Wern, 2012). In other words, the SMHI does *not* claim that the type of extreme cloudburst that has occurred once during the past century will continue to occur in the same frequency (Wern, 2012). In fact, a rainfall we today consider a 100-year rain, will occur more frequent in the future as a result of global warming (MSB, 2017). It should also be noted, that to adequately respond to climate change impact, and facilitate social-ecological resilience, responses must be developed based on assessments of anticipated environmental change rather than historical contexts (Johnson & Becker, 2015). Long-term planning for climate impact is a key factor to close climate adaptation gaps (IPCC, 2022).

Several of the informants referred to the spatial planning strategy ´robust construction´ in the *Municipal Comprehensive Plan.* While robust construction can act as a mainstreaming facilitator for climate adaptation (Cornwell et al., 2021), it is essential to base environmental impact statements on updated and thorough data on future climate projections. Additionally, the fact that Åre municipality is a mountain region dependent on winter tourism and snow cover only adds to the urgency of reducing vulnerability to future climate impacts (see Vij et al., 2021; Bonzanigo et al., 2015).

The fact that detailed development plans in Åre are not updated with new environmental impact statements, when new knowledge about climate change projections are published, motivates the question of how `robust` climate adaptation in Åre's spatial planning ultimately becomes. Research has raised the issue of municipalities continuing to plan according to old norms that does not mirror new knowledge on climate adaptation (Antonson et al., 2016). The result might be counteractive, hence there is need for exploring new approaches which integrates updated climate change projections (Antonson et al., 2016).

Increased interaction and negotiation with regional authorities has been suggested as a solution to balance municipalities' self-determination with adequate projections of climate impact and efficient adaptation options (Antonson et al., 2016). By considering the interaction of societal values, governance rules and knowledge of future impacts, the decision-making context can be reframed to facilitate transformational change (Colloff et al., 2016; Lavorel et al., 2019).

# Limitations

Despite a rather limited selection of empirical data, the mapping of climate adaptation considerations in Åre municipality has resulted in the identification of several blind spots in the adaptation strategy. It should be noted however that indirect considerations to climate adaptation might have been missed during the interviews, since informants were not asked questions specifically about the respective adaptation processes in the analytical framework. The questions were broad and mainly open-ended to allow informants to account for how climate adaptation had been considered throughout the decision-making process and in their respective roles. Even though the focus of this study is not on decision-makers' perceptions, but rather on the mapping of considerations made in the selected decisions, the interview questions involved a certain level of interpretation on their behalf of the meaning of "climate adaptation" as a concept. At the same time, their understanding of their professional roles in relation to the adaptation strategy was key to the assessment of how well climate adaptation had been communicated to officials and institutionalized at the municipality. For example, one of the adaptation processes in the analytical framework is `exploitation of synergies´ which, to be considered identified, required an assessment and acknowledgement of where opportunities exist to intertwine adaptation with other actions. Had informants received an explicit question about synergies, it would have been harder to uncover if it really was a connection they had made prior to the interview. Rather, the intention was to ask broadly about considerations to climate adaptation and assume that the topic of synergies would have been brought up if this was a significant part of the informants' professional roles.

Additionally, some of the planning decisions did not reach the stage of the decision-making process in which climate adaptation considerations are typically made. Therefore, informants were also asked about the entire timeline of the planning decision. If it concerned a rejection, they were asked about how the decision process would have proceeded had it not been rejected. Furthermore, to ensure that no major considerations in spatial planning were left out, an exploration of the standard decision-making process at the Planning and Building Units was conducted.

# Conclusions

The results suggest that adaptation processes in the ´Stock-Taking´ and `Decision-Making` stages could be identified in the selected planning decisions. The fact that no adaptation processes in the ´Goal-Setting´ or ´Implementation and Evaluation´ stages could be observed likely depends on the fact that the adaptation strategy in Åre is based on a traditional approach, that focuses on knowledge acquisition and ´low-risk´ capacity-building (Preston et al., 2011), rather than an integrated long-term transformative approach to climate adaptation (IPCC, 2022). Additionally, while the overarching policy documents consider several aspects of future climate change and associated impacts, the analysed decisions mainly seem to consider rainfall based on historical data. Landslide risk is considered throughout the process by means of GIS-tools, site-visitation, and regulation on spatial planning. Risk assessments are natural components of decision-making in relation to spatial planning in Åre but expert investigations are primarily entrusted to external consultants. Though spatial planning officials have awareness and expertise concerning various dimensions of environmental vulnerability, there is lack of knowledge about what kind of data external consultants base their environmental impact statements on.

Nine adaptation processes, distributed among all four adaptation stages, could not be identified in the analytical framework, see Table 5. Adaptation options in developed mountain regions, that could be relevant to strengthen climate adaptation planning in Åre municipality, include, but are not limited to, goal-clarification (Roman et al., 2010), improving knowledge (Cattivelli, 2021; Bai et al., 2014), collaboration (Roman et al., 2010; Johnson & Becker, 2015; Timberlake & Schults, 2017; Ingold & Balsiger, 2015; Cativelli, 2021), and stakeholder engagement (Bonzanigo, Giupponi & Balbi, 2016; Ingold & Balsiger, 2015; Moser, & Baulcomb, 2020; Lavorel et al., 2019).

Several informants stated that it is primarily during the production of detailed development plans that climate adaptation considerations are made. The considerable importance of detailed development plans, in ensuring robust construction and resilient exploitation, suggests that the fact that these plans do not get updated, as new knowledge about climate projections becomes available, is a key weakness in current technical planning and decision-making processes.

Future studies could assess to what extent outdated projections in detailed development plans could impact overall resilience of a community. Additionally,

future research could explore how climate adaptation can be concretized in rural municipal planning processes in Sweden, considering the specific challenges such municipalities face. This could involve mapping specific needs to strengthen the knowledge base and capacity at different technical departments. Finally, Åre municipality would benefit from conducting a more systematic investigation, with a significantly larger data set, of the current state of climate adaptation planning, to introduce a level of validity to the results.

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# Appendix 1: Letter of consent

## Informationsbrev & samtyckesblankett

Uppsatsens titel: “Strategic Planning for Climate Adaptation; a case study of Åre municipality”
Författare: Kajsa Kronkvist
Informant:

Tack för ditt deltagande i ovanstående forskningsprojekt. Din intervju är en del av den mastersuppsats, inom institutionen Centrum för miljö- och klimatvetenskap på Lunds Universitet, som utförs av Kajsa Kronkvist. I enlighet med de krav på etiska hänsynstaganden som föreligger akademisk forskning behöver informanten uttryckligen ge sitt medgivande till att bli intervjuad samt till det sätt intervjusvar och personuppgifter ska användas. Avsikten med detta dokument är således att du som informant ska förstå syftet med din intervju och att studenten kan säkerställa ditt medgivande utifrån de villkor som beskrivs i detta dokument. Du är välkommen att kontakta Kajsa Kronkvist via mejl vid eventuella frågor.

Vänligen läs följande information och återkom med din underskrift.

### Studiens innehåll och syfte

Studien ämnar undersöka processerna i Åre kommuns strategiska klimatanpassningsarbete, med särskilt fokus på rasrisk, genom att kartlägga hänsynstaganden i kommunal beslutsfattning. Vidare ämnar studien att identifiera framstående förbättringsområden och diskutera potentiella vägar till att effektivisera arbetet i kommunen. Därutöver är det övergripande syftet att utforska möjliga ansatser för kommuner att stärka klimatanpassning i känsliga bergsregioner.

### Intervjuinformation

Medverkandet innebär en individuell intervju med Kajsa Kronkvist. Syftet är att kartlägga en viss beslutsprocess på kommunal nivå genom att utreda hur beslutsfattningen gick till, i vilken utsträckning man tagit hänsyn till klimatanpassning och rasrisk, samt vilka aktörer som var inblandade. Intervjun beräknas ta mellan 30-45 minuter, företrädesvis i fysisk form eller i annat fall via zoom, och kommer utföras under april 2022.

## Samtyckesvillkor för intervju

Intervjun kommer att utföras i enlighet med följande villkor:

- Dina personuppgifter behandlas enligt ditt informerade samtycke. Deltagandet i studien är frivilligt och du kan när som helst under arbetets gång dra tillbaka medgivandet till ditt bidrag utan orsak och konsekvens. Vid ett eventuellt tillbakadragande kommer dina intervjusvar raderas omedelbart.
- Om du inte vill besvara en särskild fråga under intervjun har du rätt att neka ett svar utan förklaring eller konsekvens.
- På grund av studiens utformning, där beskrivningen av centrala aktörer i beslutsprocesser är en nyckeldel, är det inte möjligt att anonymisera dina intervjusvar.
- Intervjun kommer att spelas in men inte transkriberas eller kodas eftersom syftet enbart är att kartlägga hur en viss process såg ut och vilka aktörer som var inblandade. Det inspelade intervjumaterialet kommer att lagras på en lösenordskyddad dator som endast Kajsa Kronkvist har tillgång till. Inspelningen kommer därefter att förstöras när mastersuppsatsen har blivit godkänd.
- Du kommer att få möjlighet att läsa igenom hur dina intervjusvar framställs i den slutliga rapporten innan publicering. Om du önskar få något av svaren raderade eller redigerade kommer detta önskemål efterföljas.
- Resultatet av intervjuer och analys av centrala dokument kommer att presenteras inför Åre kommun och Lunds Universitet samt publiceras på Lunds Universitets webbsida för studentuppsatser.
- I enlighet med EUs dataskyddsförordning har du rätt att ta del av samtliga personuppgifter om dig och rätta eventuella fel. Du har även rätt att begära radering, begränsning eller att invända mot behandling av personuppgifter.
- Du har rätt att lämna klagomål till datainspektionen som nås via e-post datainspektionen@datainspektionen.se eller per telefon 08-657 61 00.

## Skriftligt bekräftande av samtycke

Genom din underskrift bekräftas att du samtycker till att delta i studien och är införstådd med följande:

1. Din medverkan är frivillig
2. Den inspelade intervjun kommer att användas enligt ovan beskrivning
3. Du har läst och är införstådd samtlig information i detta dokument
4. Du medverkar utan arvode eller förmåner
5. Du har rätt att kontrollera och göra eventuella ändringar i framställandet av dina intervjusvar
6. Du har möjlighet att kontakta studenten via mejl för att ställa frågor om intervjun

…….
Underskrift

……. ……
Namnförtydligande Ort och datum

Kontaktuppgifter till studenten:
kajsakronkvist@gmail.co

# Appendix 2: Interview guide

## 1. Introduction

- Short presentation of the study and purpose
- What was your professional role in this decision?

## 2. Process-related questions

- Could you broadly account for the decision?
    - How was it initiated?
    - Who was involved and how was the responsibility for different tasks divided?
    - What did the timeline look like?
    - What "steps" did the decision consist of?
- Can you account for the different assessments/investigations that was conducted to determine if the location was suitable to build on?
    - Who was responsible for these assessments/investigations?
    - What criteria was assessments/investigations based on?
- Were aspects of climate change considered in the decision? How?
- Were aspects of landslide risk considered in the decision? How?
- Can you explain the decision-hierarchy related to this decision?

## 3. More nuanced follow-up questions

## 4. Ending

- Reminding the informant that he/she would be sent the finalized text for review and approval

# Appendix 3: Description of stages and criteria in the analytical framework

The following Table describes the stages and criteria in the analytical framework by Preston et al. (2011).

| Adaptation stage | Stage description | Adaptation processes | Criteria description |
|---|---|---|---|
| *Goal-Setting (Goals, objectives, purpose)* | Establishing what decision-makers seek to achieve through adaptation and how performance with respect to obtaining goals will be determined. | Articulation of objectives, goals and priorities | Establishing the objectives, goals and priorities for adaptation. |
| | | Identification of success criteria | Consideration of what successful adaptation will look like and how it will be measured. |
| *Stock-Taking (Inputs)* | Assessing institutional assets and liabilities that facilitate or hinder adaptation planning and policy implementation. As such, this stage effectively represents an assessment of adaptive capacity. | Assessment of human capital | Consideration of the existing skills, knowledge and experience of individuals responsible for adaptation planning and implementation. |
| | | Assessment of social capital | Consideration of the existing governance, institutional and policy contexts for adaptation, including the capacity and entitlements of those institutions, organizations and businesses responsible for designing, delivering and implementing adaptation measures. |
| | | Assessment of natural capital | Consideration of natural resource stocks and environmental services which are sensitive to climate and/or integral in the management of climate risks. |
| | | Assessment of physical capital | Consideration of material culture, assets and infrastructure that is sensitive to climate and/or integral in the management of climate risks. |

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| | | Assessment of financial capital | Consideration of stocks and flows of financial resources and obligations within and among individuals and institutions including cash revenue, credit and debt and mechanisms for financial risk management. |
| *Decision-Making (Activities)* | Processes associated with determining what adaptation policies and measures are appropriate. This stage encompasses a variety of tasks, from engaging with stakeholders about preferred adaptation responses, assessment of climate and non-climate system drivers, assessment of impacts, vulnerability and risk and the prioritization of different adaptation options and their harmonization with existing policy structures. | Stakeholder engagement | Engagement of relevant stakeholders and communities throughout the adaptation process. |
| | | Assessment of climate drivers | Consideration of historical climate trends, current climate variability and future climate projections. |
| | | Assessment of non-climate drivers | Consideration of variability and trends in other environmental and socio-economic factors relevant to the system of interest. |
| | | Assessment of impacts, vulnerability and/or risk | Assessment of the impact of changes in climate, vulnerability or resilience to those changes and the relative importance of climate and non-climate risks. |
| | | Acknowledgement of assumptions and uncertainties | Transparency about the assumptions made to establish those impacts and risks and the uncertainties involved in their estimation. |
| | | Options appraisal | Identification and comparison of different adaptation options and a means for selecting between them. |
| | | Exploitation of synergies | Identification of where opportunities exist to implement adaptation in a manner that promotes synergies with existing policies or plans, including mitigation. |
| | | Mainstreaming | Identification of ways in which climate change adaptation can be institutionalized or embedded into existing or new policies and plans. |
| *Implementation and Evaluation* | Processes associated with the implementation of preferred adaptation options which may include | Communication and outreach | Communication and dissemination of adaptation plans and any downstream outcomes to the appropriate stakeholders and communities. |

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| | communication, the removal of barriers and the assignation of roles and responsibilities. In addition, this stage also includes downstream processes associated with monitoring and evaluation of implemented actions. | Definition of roles and responsibilities | Establishing who is responsible for different aspects of an adaptation strategy. |
| | | Implementation | Establishing the mechanisms that will allow implementation of adaptation measures. |
| | | Monitoring, evaluation and review | Establishing a system of monitoring and evaluation that allows the performance of adaptation to be assessed against success criteria and for review of inputs and procedures. |

# Appendix 4: Identified adaptation processes in standard decision-making at the Planning and Building Units

| ***Adaptation stage*** | ***Adaptation process*** | ***Planning Unit*** | ***Building Unit*** |
|---|---|---|---|
| **Stock-Taking (Inputs)** | Assessment of human capital | Acknowledging the limited knowledge in matters of climate change; external consultants | Acknowledging the need of experience to notice risks |
| | Assessment of social capital | Municipal Comprehensive Plan; political willpower; legislation for spatial planning; recommendation from the Environmental Department | The Planning and Building Act; Boverket's Building regulations; the Swedish Environmental Code |
| | Assessment of natural capital | Mapping of natural resources and associated risks | Field-inventories; maps from the Swedish National Forest Board & the Swedish Protection Agency |
| | Assessment of physical capital | Mapping of existing infrastructure and construction | Estimating construction opportunities; water-and sewer systems |
| **Decision-Making (Activities)** | Stakeholder engagement | Democratic process; inviting the public for viewpoints | |
| | Assessment of climate drivers | | Adapting to historical climate trends; 100 & 1000-year rain |
| | Assessment of impacts, vulnerability and/or risk | Mapping potential risk factors; GIS maps; site-visits; risk & impact assessments by consultants | Mapping potential risk factors; GIS maps; site-visits; adapting to flooding scenarios |
| | Exploitation of synergies | | Building robust and sustainably according to legislation for spatial planning |

# Appendix 5: Scientific publications on climate adaptation options, challenges, and institutional context in developed mountain regions

| *Author(s)* | *Title* | *Year of publication* | *Case study location* | *Institutional context* | *Main challenge* | *Adaptation options* |
|---|---|---|---|---|---|---|
| Bai, Y., Kaneko, I., Kobayashi, H., Kurihara, K., Takayabu, I., Sasaki, H., & Murata, A. | A Geographic Information System (GIS)-based approach to adaptation to regional climate change: A case study of Okutama-machi, Tokyo, Japan | 2014 | Japan | Regional climate adaptation; local governance | How and when to adapt to regional climate change when decision-makers have limited knowledge | Use a GIS-based approach to help non-expert local authorities to understand specialized climate projections (in a concrete and informative way) so that decision-makers can relate regional priorities to a selection of adaptation options |
| Bonzanigo, L., Giupponi, C., & Balbi, S. | Sustainable tourism planning and climate change adaptation in the Alps: a case study of winter tourism in mountain communities in the Dolomites | 2016 | Italy | Local development; regional authorities in winter tourism | How to integrate climate adaptation with the local discourse on sustainable tourism | Identify capabilities and decision-support tools and facilitate participatory processes (stakeholder engagement); address the definition of sustainable tourism and the balance between environmentl quality and economic development; move away from reliance on snow |
| Cattivelli, V. | Climate adaptation strategies and associated governance | 2021 | Italy | European, regional and local level | Three governance issues: governance structures, stakeholder | Cross-regional actions, strategies and policies for efficient collaboration; |

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| | structures in mountain areas. The case of the Alpine regions | | | | engagement and links with exisitng large-scale strategies | strenghtening measurement networks for projections of future climate change; defining responsibilities of local-level institutions; collaboration between various actors with different competences; consider long-term cross-sectoral adaptation policies; improve knowledge-base and plan for its dissemination |
| Colloff, M. J., Doherty, M. D., Lavorel, S., Dunlop, M., Wise, R. M. & Prober, S. M. | Adaptation services and pathways for the management of temperate montane forests under transformational climate change | 2016 | Australia | Natural resource managment and policy | Traditional approaches to manage the state of ecosystems are inadequate under conditions of uncertainty about the nature and scope of climate change impact | Identify adaptation services in ecosystems (factors that aid people in adapting to climate change); identify key decisions to preserve or positively transition ecosystems; investigate the interface between values, knowledge and rules to reframe the context of decision-making; establish an approach for adaptation management pathways |
| Cornwell, E., Sposito, V., & Faggian, R. | Agricultural adaptation mainstreaming and its study through a systemic adaptation assessment framework: a sub-alpine case-study | 2021 | Australia | Agricultural adaptation; rural development; regional policy | How to adapt, what to adapt and who should adapt | Assessments on three levels to improve implementation: system, territorial and action; identify mainstreaming facilitators (such as resilient building) transformational change and multifunctional landscapes |
| Grüneis, H., Penker, M., & Höferl, K. | The full spectrum of climate change adaptation: testing an | 2016 | Austria | Regional and sector-specific adaptation | The current scientific understanding of climate adaptation does | Bridge the gap between expert scientific knowledge and practical real-life action by |

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| | analytical framework in Tyrolean mountain agriculture (Austria) | | | | not match real-life conditions due to (1) a general focus on planned pro-active measures and (2) a selective focus on climate-centred impacts | identifying (1) "hidden" adaptations (measures not motivated by adaptation but which contributes to sector-specific climate adaptation), (2) explicit adaptations and (3) multi-purpose adaptation (driven by other forces in addition to climate change) |
| Ingold, K., & Balsiger, J. | Sustainability principles put into practice: case studies of network analysis in Swiss climate change adaptation | 2015 | Switzerland | Local climate adaptation and policy | Incorporating sustainability principles in adaptation policy | Cross-sectoral and multilevel collaboration; networking between different actors in the local community; assessing sustainability perception |
| Johnson, B. B., & Becker, M. L. | Social-ecological resilience and adaptive capacity in a transboundary ecosystem | 2015 | USA | Natural resources management agencies | Institutional capacity to achieve social-ecological resilience; how to adequately respond to climate change impact | Collaboration between natural resource agencies and resource users; multilevel collaboration between agencies and collaborative organizations; develop responses based on significant environmental change rather than the historical context |
| Lavorel, S., Colloff, M. J., Locatelli, B., Gorddard, R., Prober, S. M., Babillet, M., Devaux, C., Laforgue, D., & Peyrache-Gadeau, V. | Mustering the power of ecosystems for adaptation to climate change | 2019 | France | Regional goverance and community capacity | Barriers to integration between governance structures and community capacity to manage climate impact | Identify pathways through engaging and empowering local and regional stakeholders; assess the interaction between values and rules |

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| Meinel, U., & Höferl, K. | Non-adaptive behavior in the face of climate change: First insights from a behavioral perspective based on a case study among firm managers in alpine Austria | 2017 | Austria | Firm management | Lack of engagement in strategic climate adaptation among firm managers | Assessing (1) causes of non-adaptive behaviour, (2) different motivational factors, and (3) analyze the interaction between `non-adapters`, barriers and motivational factors |
| Morrison & Pickering | Limits to Climate Change Adaptation: Case Study of the Australian Alps | 2013 | Australia | Local governance | Biophysical, economic, technological and societal limits to climate change adaptation | Diversify to year-round tourism; development of higher terrain; snowmaking; snow manipulation; control/limit invasive species; reduce erosion; restore connectivity; reabilitate disturbed sites; increased real estate sales |
| Moser, D. J., Baulcomb, C. | Social perspectives on climate change adaptation, sustainable development, and artificial snow production: A Swiss case study using Q methodology | 2020 | Switzerland | Rural mountain tourism; governance on multiple organizational levels within the nation | Balancing economic development and ecological resilience; how to align the intrests of different stakeholders | Investigate similarities and differences in values and attituedes among different stakeholders in order to evoke discussion and identify solutions |
| Roman, C. E., Lynch, A. H., & Dominey-Howes, D. | Uncovering the essence of the climate change adaptation problem-a case study of the tourism sector at Alpine Shire, Victoria, Australia | 2010 | Australia | Business community; tourism sector | How to address contextual vulnerability and adaptability under climate stressors; several threats in addition to climate change compete for attention | Strenghtening adaptive capacity; identifying common interests and issues among operators in the tourism sector through goal-clarification; frame goals in a less abstract and more practical way |

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| Timberlake, T. J., & Schultz, C. A. | Policy, practice, and partnerships for climate change adaptation on US national forests | 2017 | USA | Land management agencies | Managing climate change impact on ecological processes under conditions of uncertainty; translating knowledge into action | Utilize partnerships to address climate change impact; operationalize ambiguous concepts (such as resilience) |

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Lunds universitet

Miljövetenskaplig utbildning
Centrum för miljö- och klimatforskning
Ekologihuset
223 62 Lund