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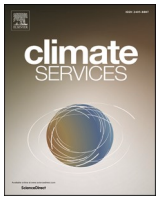

User evaluation of a national web portal for climate change adaptation – A qualitative case sstudy of the Knowledge Bank

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ABSTRACT

This paper describes the development and first user evaluation of a web portal (The Knowledge Bank) for collecting and presenting national data relevant to climate change adaptation in Norway, including insurance loss data for damages arising from natural hazards and weather events. The paper examines the major drivers for municipal decision-makers to use the Knowledge Bank, presenting the results of a qualitative case study with group interviews with 11 users representing both smaller and larger Norwegian municipalities, and an individual interview with one of the developers. The findings show that the drivers for using the Knowledge Bank depend on the level of user expectations, user trust in the tool and the data, expectations for a contribution to efficiency, expectations for increased cooperation between municipal departments and municipalities, and the ability to interact with the portal, especially the ability to transfer data to and from their own data systems. Increased uptake and use of the Knowledge Bank could be reinforced with networks of users sharing awareness of the portal, teaching other users, and promoting improvement. The study provides insights into the challenges and opportunities encountered in the development of the Knowledge Bank and gives examples of how the size of the municipality may shape the drivers for uptake. These insights may also apply to the development of other national web portals for climate change adaptation data, especially when trying to incorporate sharing of insurance loss data.

Practical implications

This study presents an analysis of a qualitative case study with group interviews, assessing the major drivers for using the Knowledge bank, a national web portal containing climate change adaptation data in Norway, developed by the Norwegian Directorate for Civil Protection (DSB). As one of the challenges concerning climate change adaptation is the translation of knowledge into practice, the findings from this study may be considered when developing and implementing similar web portals.

A national web portal with access to all available data relevant to climate change adaptation can improve communication and cooperation between different government offices, disciplines, and departments at the local and regional levels. However, drivers for using the portal depend on user expectations of data quality, efficiency, and digital interaction – and the fulfilment of these expectations.

Trust in the content and quality of the data is crucial for the success of the web portal. This can be enforced through web portal co-production between initiators and users. However, there are challenges with data quality that depend on contextual characteristics of the data, outside of the initiators' or users' control. The users, in this case, were especially interested in the insurance loss data for damages arising from natural hazards and weather events. In the Knowledge Bank, this data relies on recent and historical loss data provided by insurance companies, and are only available to municipal employees through log in. The users are excited about these data; however, the data have deficiencies that influence the employees' trust in the content of the web portal. We encourage climate web platform developers to implement insurance loss data on water damages, however, considering the challenges of privacy protection and competition sensitivity for the insurance companies (Hauge et al., 2020), and the data quality

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that is crucial for the municipality employees. Through digitalization and close cooperation with insurance companies, the data from 2022 in the Norwegian climate web portal will drastically improve. The challenge is to communicate the deficiencies present in the historical insurance loss data while simultaneously building trust in the quality of the web portal. Transparency and honest communication about shortcomings are important for realistic impressions of what the web portal providing insurance loss data can offer.

Drivers for using a national web portal for climate change adaptation are also connected to how the web portal facilitates and streamlines digital interaction while supporting multiple data systems. Many city municipalities have their own data for climate change adaptation (e.g., detailed data on natural hazards), and the case study provides examples of how employees in these municipalities express the need to use local and national data interchangeably in the same models. A lesson learned, is the importance of providing the ability to transfer data to and from their own local data systems.

Further, the users recommend that the early phases of introducing the web portal can begin with presenting and learning about the web portal in seminars in already existing municipal networks. The establishment of a social context for the use of the web portal takes advantage of social mechanisms that influence learning.

Data availability

The authors do not have permission to share data.

Introduction

Topic

Climate change is leading to an increasing need for climate adaptation of buildings and infrastructure. There has been a growing interest and support for research concerning the adaptation of buildings and infrastructure, to meet the needs of a changing climate (Goh, 2020; Kabisch et al., 2017). Learning and information are necessary for the responsible stakeholders to take the right decisions, in both public and private organizations. As a result of this, new webpages with information and help for climate adaptation of buildings and infrastructure are steadily emerging. Existing web pages and user guides in Norway were evaluated in a study by Hauge et al. (2017), which found over 80 relevant Norwegian user guides and webpages and categorized them thematically. The main results showed that there were large amounts of information on climate adaptation online, but there were challenges with users not knowing about it, not having time or capacity to use it, or getting confused or overwhelmed by the amount of information. Many of the developed climate service web pages were not in use.

This study focuses on the drivers that motivate municipal employees to utilize a new and unique climate service. The climate service investigated is a tool developed as a common web portal for collecting and presenting relevant national data. The web portal is named the Knowledge Bank (Kunnskapsbanken) and includes data on both expected societal risk and vulnerability from natural hazards, as well as approaches to addressing and reducing climate risk and vulnerability. This paper presents the results of a research study investigating what drives decision-makers in Norwegian municipalities to utilize a web portal supporting decision-making for climate change adaptation (CCA). The study combines the climate service literature with environmental psychology, a perspective that can shed light on human and social mechanisms providing great benefits when implementing a climate service (Clayton et al., 2016; Stoknes, 2015).

The need for climate change adaptation

Future human welfare will be affected by how we manage a changing climate. Climate services are aimed to provide tailored knowledge to decision-makers, by preventing climate-related losses and promoting benefits (Vaughan and Dessai, 2014). They are designed to convey information in a way that serves user needs. The importance of adaptation of buildings and infrastructure through making use of emerging knowledge is ever-increasing, as the changing climate is leading to changes in the intensity, frequency, duration, and timing of climate extremes (Intergovernmental Panel on Climate Change, 2021).

This research study was conducted in Norway, where CCA has high priority (Norwegian Environment Agency, 2015; Seljom et al., 2021). More than one-third of the Norwegian population lives in the five largest cities, a number which is expected to increase even more (Frauenfelder et al., 2016). Worldwide, a common side effect of urbanization and population growth is denser and more complex city systems and more vulnerable infrastructure. This has led to the situation where single extreme events have generated widespread damage to seemingly modern city infrastructure (Baklanov et al., 2018). A Scandinavian example is the extreme rainfall in Copenhagen in July 2011, which paralyzed the city infrastructure for several days, and resulted in 6 billion DKK worth (over 800 million euros) of damages (Bjerkholt et al., 2013). With the expectations of more extreme weather in the future due to the changing climate, natural hazards and extreme weather events are likely to increase as well (Intergovernmental Panel on Climate Change, 2021).

The Knowledge Bank

The Knowledge Bank (https://kunnskapsbanken.dsb.no/[1]) developed by the Norwegian Directorate for Civil Protection (DSB) is an attempt to create a common web portal for all data relevant to municipal decision processes to reduce risk and vulnerability to natural hazards and weather events. The data are obtained from both public and private sources, such as The Norwegian Water Resources and Energy Directorate (NVE), Norwegian Meteorological Institute, and Finance Norway. (See the results section for more information on the Knowledge Bank.)

Although the use of insurance incentives to encourage CCA has been discussed in the literature for the last 10 years, in practice insurers seldom offer such incentives (Lucas et al., 2021; Serje, 2017). Unique in a global context, asset-level loss data from Norwegian insurance companies are included in the Knowledge Bank (Hauge et al., 2020; Hauge et al., 2018). These data display localized (address-level) insurance adjustments after natural hazard events, from the ten largest insurance companies in Norway, covering more than 90% of the insurance market. Figs. 1 and 2 show geographical illustrations of the difference between the water damage data records from the municipality in Oslo (Fig. 1), compared to the water damage data the insurance companies could provide in 2016 (Fig. 2). As Fig. 2 shows, the data from the insurance companies give a more complete picture of the water damages in Oslo, than the municipality records do. This illustrates the value of providing access to the insurance loss data in the Knowledge Bank and explain the interest for these type of data among employees working with CCA in the municipalities.

The insurance data are only available to municipal employees with responsibility for CCA. The incorporation of insurance data is the result of a public–private partnership between Finance Norway and the Norwegian Directorate for Civil Protection, driven by research results.

[1] Because of internal prioritization in DSB, and the challenging security policy situation in Europe from 2022, the Knowledge bank has restricted functionality. However, the most central part of it, the map solution with nature events and the insurance loss data, is running, Kunnskapsbankkart (dsb.no), and is available through log in for municipality employees working with climate change adaptation.

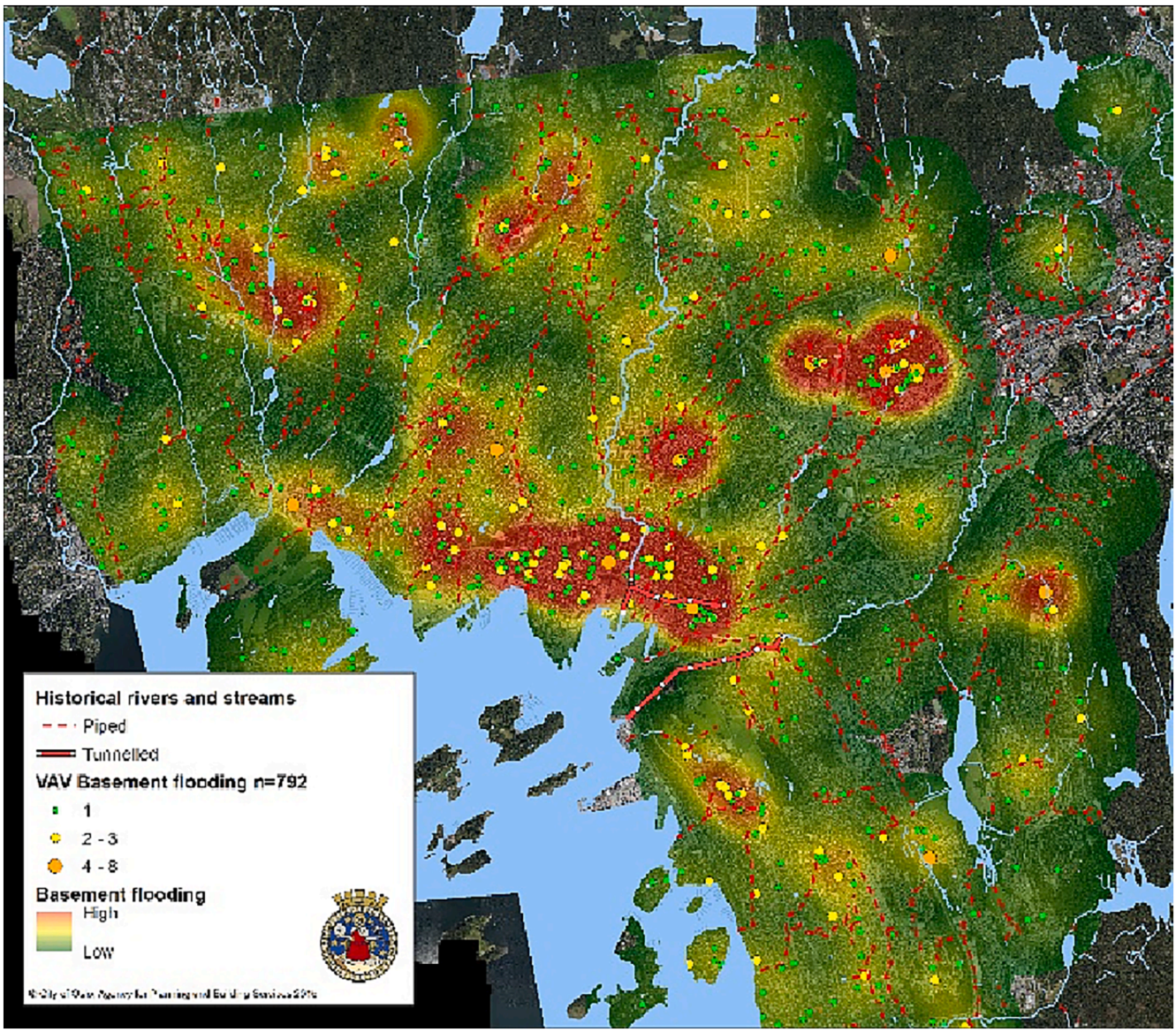

Fig. 1. Damage data from the municipality damage records. Oslo municipality, Agency for Planning and Building Services.

Research demonstrated that the municipal use of insurance loss data improved the understanding of climate risks and the ability to prevent and adapt to such risks, but that data quality and completeness (including the precise time and place for damage occurrence) are critical factors (Hauge et al., 2020; Thomassen and Hauge, 2022).

Research question and limitations

The study addresses the research question: What are the major drivers for municipal decision-makers for using a national web portal containing a collection of all relevant data for climate change adaptation in Norway?

In this context, the users of the portal are municipal employees who make decisions that are relevant to CCA. This includes a broad range of professions ranging from utilities, and engineering (including storm, surface, and wastewater), to spatial planning, preparedness, and vulnerability. The term "drivers" refers to aspects that may lead or motivate users to use the tool.

The results are based on an explorative user evaluation carried out during testing of the Knowledge Bank in the fall of 2020. The user evaluation focused on aspects that promote utilization. Although considered relevant, this paper does not address more technical aspects, such as the user interface and user experience (UX) design, which were evaluated but are not included here. This article focuses on the aspects of the web portal and context that are possible to transfer to attempts to create similar web portals in other countries.

Theory and relevant research

The literature section will first explain the relevant definitions and understandings of climate services and climate platforms, as a starting point for this research. The following literature sections were structured during and after the data analysis, as a recursive process (Braun and Clarke, 2021). The literature we found necessary for the in-depth understanding of the results, were reviews on research on user participation and user expectations, evaluation of efficiency and quality of climate service platforms, and behaviour change related to CCA.

Climate services and platforms

The term *climate service* describes services that aim to help users in the decision-making processes related to CCA (Vaughan and Dessai,

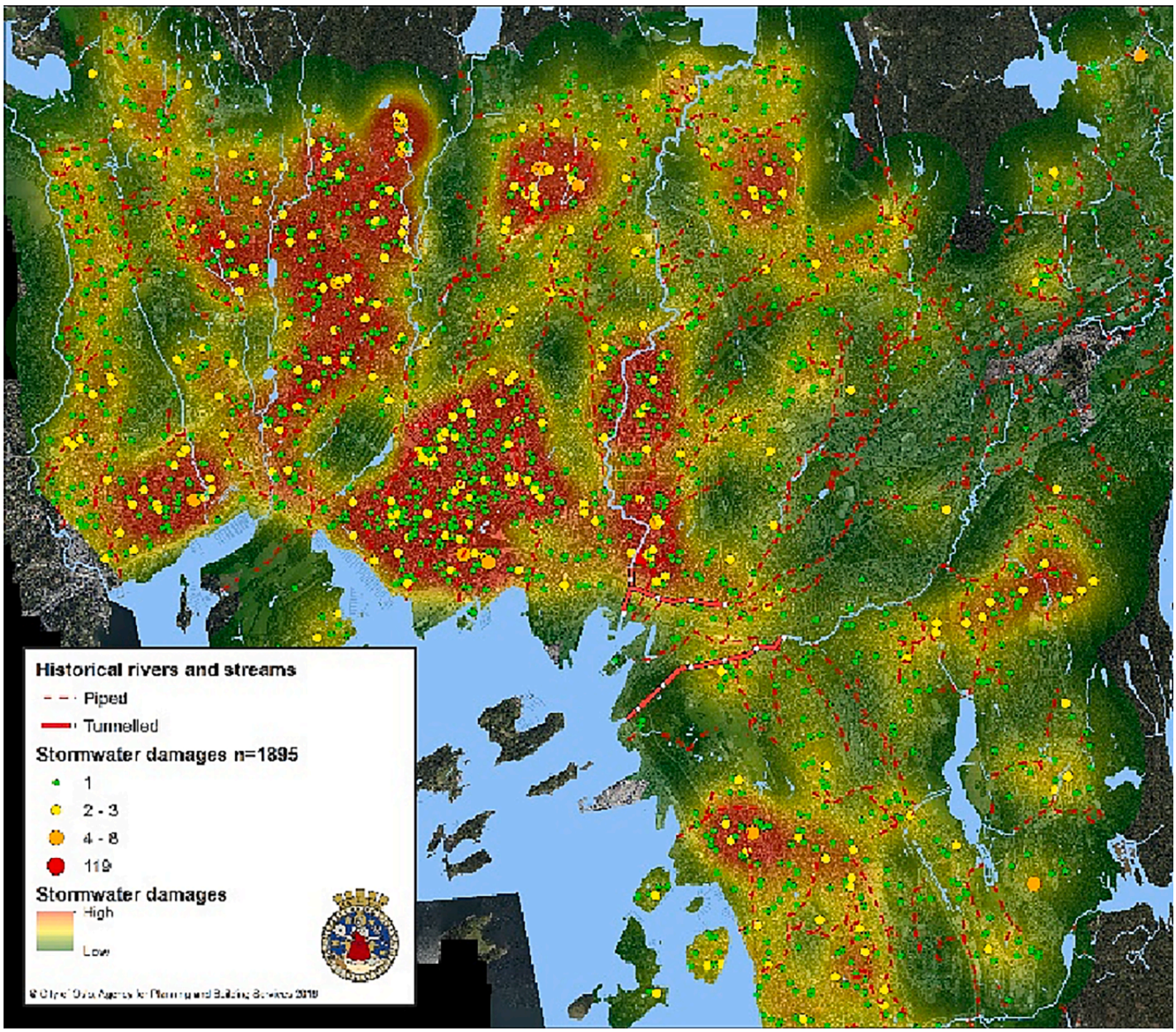

Fig. 2. Loss data from the insurance companies. Oslo municipality, Agency for Planning and Building Services.

2014). The term collectively refers to how experience is used to develop knowledge-based products and services (Filho and Jacob, 2020).

Climate services are typically web-based information platforms, designed to facilitate access to climate-related data (Swart et al., 2017). Decision support platforms are enabling environments, equipping decision-makers with data, tools, guidance, and information, that may facilitate knowledge and capacity building through networking and peer-to-peer learning opportunities (Palutikof et al., 2019). These platforms often include sharing of data between organizations, with autonomous and interacting actors consuming, producing, and providing data and other related resources which implies the need for data governance (Lis and Otto, 2021). Critical data governance factors include the definition of data ownership and access, definition criteria, an estimation of contribution, data use cases, conformance, monitoring, and data provenance (Lee et al., 2017).

To ensure that climate platform benefits are realised, a set of preconditions should be met. Palutikof et al. (2019) state that independent, long-term evaluation needs to be in place. There also need to be extrinsic factors to motivate use, such as policy, financing, or social pressure. According to the National Research Council (2009), social networks and education are important for a climate service product to be used, taking advantage of social mechanisms that affect our values and attitudes (Hauge et al., 2017; Hauge et al., 2018). Initiator agencies must also realize that these platforms require long-term funding (Palutikof et al., 2019).

User participation in climate services

Research has observed a 'usability gap', that is attributed to a tendency towards science-driven, as opposed to demand-driven, climate services (Brasseur and Gallardo, 2016; Lemos et al., 2012; Raaphorst et al., 2020). To overcome such challenges, more collaboration between users, providers, and knowledge producers is recommended (Alexander and Dessai, 2019). Research continues to produce evidence for the importance of user involvement in the design process (Romsdahl, 2011; Swart et al., 2017; Vincent et al., 2018). Ongoing user engagement and evaluation can contribute to understanding the users, tasks, and environments, and informed service development (Christel et al., 2018). Dialogue between providers and users of climate services can also strengthen the trust and legitimacy of the services (Lemos and Morehouse, 2005; Otto et al., 2016).

Raaphorst et al. (2020) present a framework for detecting usability

gaps for climate services. Both the information and the way the information is visualized may be unsuitable for the users. The framework presents a set of usability gaps, related to the validity, readability, and interactivity of the content, at different levels including stakeholder, purpose, information, and visual format. In addition, several contextual dimensions may affect implementation and use of climate services, including for instance audience characteristics, resources, and capacity to engage (Guido et al., 2019). Daniels et al. (2019) also summarize a broader set of reasons for the climate service usability gap to be: Lack of demand for climate services, limited capacity for providers and users, mismatch between research and decision-making needs, weak interaction and engagement, lack of trust and meaningful communication, poor data availability and access, and lack of funding.

Cooperating with users during the design process is more challenging, but it ultimately reduces the risk of unaligned agendas between decision-makers and climate service providers (Daniels et al., 2020). Such collaboration promotes the innovative thinking that is needed to create efficient climate services (Blome et al., 2017). Researchers, therefore, stress the importance to establish relationships between providers and users and take user diversity into account including considerations of who the users are, their objectives, interests, and skills, and how they are best engaged (Brasseur and Gallardo, 2016; Swart et al., 2017).

There have been several studies describing ideal approaches to user participation in the design process of climate services (Bremer et al., 2019; Daniels et al., 2020; Leitch et al., 2019; Wall et al., 2017). The "Tandem framework" suggests a seven-step approach to user participation in climate services, to avoid usability gaps. It supports a holistic approach, represented through collaboration and integration of different perspectives and knowledge (Daniels et al., 2020). The framework emphasizes identifying the adaptation challenges and engaging with potential users in the first steps, to build a shared understanding of the challenge that climate information could address and identify actors with a decision-making role. Further, the process should aim at understanding objectives and identifying actions. Together the stakeholders can build an understanding of institutional and decision context, to embed the climate service for long-term use. The framework emphasizes co-exploring issues related to data and information. This established understanding of user objectives, priorities, and decision-making will underpin the selection of decision-support methods (Daniels et al., 2020). The framework's last step is to maintain, upgrade and evaluate the service. Although user requirements are considered, it is rare for the effectiveness of user engagement or the usefulness of climate service platforms to be evaluated (Swart et al., 2017). A continued long-term focus on user participation is therefore important (Hoffmann et al., 2020; Palutikof et al., 2019).

User expectations

Finding credible, legitimate, and innovative solutions to manage the expectations of the users of products is a challenge (Jacobs and Street, 2020). User expectations affect their perceptions of tools, with unrealistic (positive or negative) user expectations leading to altered perceptions of performance (Petter, 2008; Szajna and Scamell, 1993). There is a risk associated with "overselling" a product, as the confirmation or disconfirmation of expectations is not easily predicted (Szajna and Scamell, 1993). It can also potentially affect subsequent user evaluations, as the evaluations might be coloured by users' prior expectations. User involvement and trust building can be useful tactics to manage user expectations, with trust reinforced through honest communication about shortcomings and realistic impressions of what the product can offer (Petter, 2008). There are often differences in expectations between users and providers as to what the decision support service can and cannot provide, with practitioners often expecting immediate solutions from CCA platforms (Palutikof et al., 2019).

Evaluating effectiveness and quality

An effective platform encompasses information that is tailored to the needs of the user in terms of content, style, and presentation and is legitimised to ensure confidence by users (Palutikof et al., 2019). The effectiveness of a decision-support product can be grouped into three categories (National Research Council, 2009). First, one can look at the increase in usefulness of the information. Then, one can evaluate whether it leads to improved relationships between providers and users. Lastly, one could look at whether the product contributes to better decisions. The effectiveness of the tool can be considered a process that both the providers and the users take part in. The tool must be well-made to be effective (Benyon, 2014), but it is the eventual transformation into action that defines the effectiveness of the tool. In addition, the quality of the data is found to be crucial for the use of climate services (Schwab and Storch, 2018; Vaughan and Dessai, 2014; Zahid et al., 2020).

Behaviour change

Lack of information is a barrier to behaviour, but is generally not a motive in itself (Schultz, 2002). That effective information alone is unable to promote pro-environmental behavior is a well-documented phenomenon. To lead to climate action, information has to be combined with other environmental interventions (Klöckner, 2015; Schultz and Kaiser, 2012). Werg et al. (2021) show that motivation for municipal actors for CCA is the perceived feasibility of adaptation measures and knowledge of risk, however, motivation and implementation are only partially related. Based on this, the presentation of information through a web portal for CCA may require a combination of interventions to achieve intended goals for utilisation.

Osbaldiston and Schott (2012) reviewed 253 experimental treatments measuring observed, not self-reported, outcomes of sustainable behavior. They found that the most effective pro-environmental interventions were cognitive dissonance (reminding people of inconsistent environmental attitudes), goal setting (especially public commitment), social modeling (following other people's examples), and prompts (reminders of the most sustainable behavior). Most of these interventions show the importance of social settings for affecting behaviour. A review by Farrow et al. (2017) also states that social norms are effective in encouraging pro-environmental behaviour, and Werg et al. (2021) found that among other things, social norms within the municipality are a key factor in the implementation of CCA measures. This implies that social learning may be crucial also for implementing a web portal for CCA. Learning about CCA in networks takes advantage of the ingrained social and cultural mechanisms influencing behaviour (Hauge et al., 2018). Recognition and attention to CCA is of significance for behaviour change, and climate change networks can contribute to this, through exposure to stronger social norms for the climate issue (Stoknes, 2015). Learning is deeper when people engage with each other and share perspectives and experiences in a social setting. Social networks are also important for co-producing climate services, both for users to develop a feeling of ownership towards the services or products, and for spreading awareness of the new tools (Hauge et al., 2018; Lemos et al., 2014; Owen et al., 2019). Peer-group collaboration and shared learning can help users overcome barriers related to the adoption of CCA platforms, by sharing their own experiences and knowledge and by using familiar language and examples from familiar settings. Even though these needs are recognized, networking initiatives for knowledge and experience sharing as a part of adaptation platforms can be challenging (Palutikof et al., 2019).

Method

Data collection

A qualitative interview study was selected to gain an in-depth

evaluation of the Knowledge Bank web portal. The interviews were conducted with 12 participants, 11 of which were employees in three Norwegian municipalities,[2] while one was an employee from the DSB, the initiating organisation for the Knowledge Bank (see Table 1). The interview with the DSB employee was done mainly to get an overview of the development process and the content of the web portal, as context information is central to analysing qualitative data (Braun and Clarke, 2021). The DSB representative had worked with the development and implementation of the web portal for several years, and this provided a better understanding of the background of the web portal.

The user interviews were done in groups, one municipality at a time, with 3 or 4 interviewees each. The 11 municipal employees were in professions related to CCA, such as spatial planning, water and sewage, and planning and construction. The municipalities were chosen due to differences in population, with two examples of larger cities and one example of a smaller town, to be able to collect data from different types of municipalities. Urban municipalities representing larger cities often have a larger professional environment on CCA than small municipalities, something we anticipated would influence the way the employees evaluated the web portal. The municipal interviewees were recruited by contacting municipalities that DSB had been in contact with through research projects, with an invitation to a user evaluation of the web portal. The chosen municipalities were some of the first municipalities to sign up for the evaluation. This also means that these municipalities probably had a special interest in the web portal. This was a valuable reason for selection because the study needed employees with enough interest in the web portal to be willing to spend time trying it.

The interview guide was sent by e-mail to participants before the interview, as some of the questions needed some consideration and time to reflect upon. The interview guide was clearly reviewed by some participants, who had written down several detailed comments about different aspects of the web portal that they felt could be improved.

The interview guide had the following topics: 1) Participant background (work, responsibility), 2) Testing the Knowledge Bank – evaluation of use and utility, 3) Expectations to future use of the Knowledge Bank, 4) Communication and spreading of the Knowledge Bank, and 5) Details on evaluations of the insurance loss data. Interviewees were also asked about their expectations prior to their testing of the web portal, to provide insights into what extent the tests of the web portal had met expectations.

Due to the Covid-19-pandemic, the interviews were carried out online with Microsoft Teams. The group interviews lasted from 1.5 to 2 h, while the interview with the participant from DSB lasted about 45 min. Depending on whether the participants were working from home due to Covid-19, some groups chose to be partially in the same room at their office, while others joined from home. As much as possible, it was ensured that every participant received ample time to answer every question. The participants often took turns talking, but sometimes had discussions regarding the answers if they disagreed. The fact that the interviews were carried out as a video conference might have played a role in how much they discussed. Nevertheless, their discussions several times led to topics that were not related to the interview guide. If particularly relevant information came up, they were also asked further about the subject.

Table 1
Participants.

Organization	Size of municipality	Number of participants	Participant professions/ areas
Municipality 1	Population < 5,000	3	Spatial planning, water, and sewage, coordination
Municipality 2	Population > 200,000	4	Surface water, water, and sewage, planning and construction
Municipality 3	Population > 200,000	4	Environmental counselling, CCA, engineering
DSB	–	1	Initiator, working in the DSB

The data collection was approved by the Norwegian Center for Research Data (NSD), and NSD guidelines for securing personal data were followed. All participants provided written informed consent before the study.

Thematic data analysis

The methodological approach was based on *reflexive* thematic analysis, with a social constructionist perspective on the data material, allowing the researchers to look for latent meanings and context interpretations (Braun and Clarke, 2021). The analysis was conducted according to the steps described by Terry et al. (2017). The software MAXQDA (VERBI, 2022) was used as a tool for the empirically driven analysis. The analytic process started with familiarization with the data through thorough listening and subsequent transcription of interviews. Initial codes were then generated, with the aim to capture the latent meanings behind statements and interpreted according to relevant climate service and environmental psychology research. Based on the generated codes, a set of main themes were then created and defined. The process involved an iterative approach involving review of previous steps. The themes were quality-checked using Braun and Clarke's (2012) criteria, which include; (a) having a singular focus, (b) avoiding overlap, but maintaining connection, and (c) directly addressing the research question.

Reflexive thematic analysis requires self-reflection on how our background influences the understanding of the results (Braun and Clarke, 2021). In this case, the extensive knowledge about the process of developing the Knowledge Bank and the insurance data (Hauge et al., 2020; Thomassen and Hauge, 2022), has been used actively to understand the findings from the interviews and look for latent meanings. The authors have no economic or personal interest in the success of the Knowledge Bank.

Results and discussion

The first part of the results contains a case description of the establishment of the tool, based on the interview with an initiator for the project. The second part contains the results from the users. Thus, the results are based on a single case, including several voices with different backgrounds and roles.

The establishment of the tool

The impetus for creating the national Knowledge Bank for data on natural disasters and extreme weather events arose from within the municipalities and the expressed needs of municipal employees in DSB's yearly municipality survey.[3] This survey goes to all 356 Norwegian municipalities and has a response rate around 85 %. The survey showed that obtaining the relevant information about civil safety was considered challenging and time-consuming by the employees. Motivations to create the tool included increased availability of data the decision-makers already use, as well as the addition and utilization of the directorate's own, unique data.

The process of creating the tool was initiated by asking a selection of

[2] Norway has 11 counties (fylker) with 356 municipalities (kommuner). Norske fylke og kommunar | Kartverket.no.

[3] Kommuneundersøkelsen | Direktoratet for samfunnssikkerhet og beredskap (dsb.no).

municipal employees about their current use and future wishes for data sources, in two different questionaries (one with 200 respondents, and one with 360 respondents). The results were used in combination with scientific research and previous work done by the DSB, to create a prototype. The prototype was then used in three rounds of user testing, in a group of five dedicated users. The users were interviewed about what parts differed from their expectations, as well as whether they thought a similar solution to the prototype would be useful and easy to use. They were also given specific tasks to solve through the data provided. In addition, ca 40 municipal employees and 25 county governor employees were interviewed in settings such as networks, seminars, and courses. The potential users were presented with the concept of the tool and subsequently gave feedback.

The process of developing the web portal has many similarities with the ideal Tandem framework (Daniels et al., 2020). The first steps of this framework concern the framing of challenges and engagement with potential users. Based on the descriptions from the DSB representative, these steps seem to be completed because user needs were part of the background for the initiative, contributing to the understanding of the CCA challenges the users' experience. The directorate further investigated the CCA challenges through questionnaires and interviews. Further, the framework emphasizes the importance of building a shared understanding of the context, the objectives, and the possible solutions. Several rounds of interviews with different potential user groups, can contribute to a comprehensive understanding of such aspects. In addition, the mutual understanding was supported through the user testing of prototypes, task solving, and discussion.

The users involved in the earlier stages of the development of this web portal, are *not* the same as the users in this evaluation study. Therefore, we do not have a user perspective on the process up until the present study. The co-exploration of issues related to data and information (Daniels et al., 2020) seems to be the current stage of the project development. A common understanding of these issues is currently being established through the user evaluation conducted.

The DSB participant emphasizes that *the work has just begun*, in terms of tailoring the tool to user needs. Creating tools aimed at decision-makers nationwide is a challenging task, particularly in a country with vast domestic differences in climate. With 356 Norwegian municipalities, representative user participation can be a difficult and resource-demanding process. The threshold for how much user collaboration is needed to satisfy the requirements can be considered a balancing act.

User results: the municipal participants

Based upon the thematic data analysis of the interviews with users, five main themes were defined including expectations, efficiency, trust, multiple data systems, and engaging users (see Table 2). The table also has a column giving examples of how the propositions are relevant to municipality size. The following sections present and discuss the themes from the thematic analysis (main themes are written in bold and sub-themes in italics).

Expectations for quality

The first theme refers to what users initially expected from the web portal. It also captures expectations of what the web portal can become over time, based on their initial impressions.

Users had varied expectations of the tool before trying it, ranging from clearly defined expectations to no expectations at all. Some expected a high-quality, finished product. Especially users from the largest city municipality seemed to share such expectations.

Users across interviews report that they initially expected the web portal to contribute to *improved decision support*. However, the web portal would need to have some adaptations to be able to contribute to that. Most users agree that the idea itself is positive, given that it would be improved with time. One participant says:

Table 2
Results of the thematic analysis.

Main themes	Drivers for uptake and use	Propositions regarding relevance to municipality size (S = small, L = large)
Expectations for quality	*The expectation of new contributions, and differentiation compared to existing services*	Experience with existing services S: experience with less advanced services L: experience with more advanced services
	Alignment of expectations to meet needs	Degree of advanced needs S: resources with broad general competence L: resources with specialized expertise
Efficiency of communication and sharing	*Contribution to improved interdisciplinary work and communication*	Degree of work specialization S: support employees across multiple areas of responsibility L: support collaboration between specialized employees
	Sharing information across organizations [both sharing and accessing can be a driver]	Amounts of information relevant for sharing S/L: share relevant information with others, access to information generated by others [amounts of sharing may be higher in large municipalities, and amounts of accessing in small municipalities]
Trust in data and web portal developers	*Ensured quality of data*	Degree of scepticism towards data S: Express trust in the quality of data L: Express more scepticism towards the quality of data
	Clear purpose and target group	No examples of variation between small and large municipalities identified
Multiple data systems	*Combination of national and local data*	Amounts of available local data S: low dependency, limited amounts of relevant local data L: high dependency, large amounts of relevant local data
Engaging users	*Collective training activities arranged by existing networks*	No examples of variation between small and large municipalities identified
	Dedicated super-user roles to create engagement	No examples of variation between small and large municipalities identified

> *Firstly, I would like to say that the potential of this becoming a super-web page, with the access to everything is… great, or is there. But I also have some things I thought were missing, as it is right now.*

The advantage of having large amounts of data compiled in one place is also something users expect to help them, by giving a comprehensive overview. It makes it easier to communicate in meetings and through reports. One participant expresses it this way:

> *I think it is a huge advantage that everything is in one place, as the chances of [the data] being used is much, much greater, than if you have to use several different databases or maps.*

The expectations of the participants seem directly related to what other pages already offer. It is mentioned across the interviews that they expect some form of *innovation* from the web portal. Users expect novelty, that will draw them to prioritize using it. One participant also

reflects upon why resources are being used to launch yet another web page, as the government already offers and manages several different web pages. Another participant says:

> *I would expect to get something I did not have already. I would not want to go into The Knowledge Bank to use data that another web page, that I already use, has.*

Users from the largest city municipality seemed to have higher expectations than the other two and express the highest degree of scepticism to the web portal. Both large city municipalities had professional CCA departments, however, the largest city also had developed an extensive CCA information and user guides themselves. In line with the research presented concerning the realism of expectations, this finding could be explained by the misalignment of expectations (Petter, 2008). Users from the municipalities with lower expectations seemed to have fewer negative remarks and were generally perceived as being more at ease with their experience.

Municipalities have different needs, which also could also help explain the different experiences. As mentioned, the municipalities vary greatly in their access to resources and strategies for solving issues. Nevertheless, user expectations can affect the user experience (Petter, 2008), and clear, honest communication about what to expect and potential problems is a step to manage this. The process of user participation can potentially contribute to this, as it leads to increased alignment of future visions for the tool between the users and providers (Daniels et al., 2020).

Efficiency of communication and sharing

Efficiency refers in this context to the ability to produce desired results and simultaneously minimize the time and energy spent in the process. The theme covers how the tool could contribute to users' efficiency in the future if they implemented it in their workday.

The users appreciate a platform that *streamlines interdisciplinary work*. The users from the smaller municipality specifically noted that they could benefit from a common, more interdisciplinary database. Users in smaller municipalities often have broader responsibilities and less specialized roles, due to fewer resources. Interdisciplinary processes can be optimized by a common platform. Employees in the larger municipalities have more specialized roles. Providing a common platform for these users could have positive effects on cooperation, as they would benefit from a more interdisciplinary overlook. One participant says:

> *In a large municipality such as ours, with thousands of employees, few have the full overview.*

Another participant from the same municipality says, *"it is always easier when we have a common ground to base decisions on."*

Time-consuming tasks can be eased by *access to work prepared by others*. Users mention that they would like checklists for how to perform risk analyses and the systematisation of reports to increase accessibility. The availability of previous work can save time. One participant from one of the bigger municipalities says:

> *A lot of what we produce is decision support… If something that was already produced by someone else existed, we would be able to put less work into that (…). Similarly, I hope our work is used, so we do not waste time-solving the same issues in all the municipalities. A lot of our work is general or could be adapted locally.*

A participant from the smaller municipality address some of the same issues:

> *We spend a lot of time looking for reports and assessments that have been done for us. If that was made easier, we would be more effective.*

Given that the tool was very recently launched at the time of the interviews, it is too early to evaluate its actual effectiveness. This is also apparent in the results, as the answers often seem related to more hypothetical scenarios. However, most users believe that the effectiveness of the tool would improve in the future, especially if it is improved based on user evaluations.

In light of the criteria for effectiveness mentioned (National Research Council, 2009), at least two of the three criteria mentioned can be considered as nearly being met. Most users find that the tool offers increased usability of information, as it supports interdisciplinary work and improves interdisciplinary communication. This also applies to the increased use of reports across municipalities, as they can adapt others' work found in the tool to their own municipality. This also plays into the next criterion, better decisions. The tool can support better decisions in smaller municipalities by providing different resources, as well as in the bigger municipalities by contributing to a more comprehensive overview. These effectiveness criteria should be revisited and reconsidered when the users have had time to implement the tool into their work.

Trust in data and web portal developers

This theme refers to the subjective trust in the web portal, such as the perceived credibility and trustworthiness of the tool and the data. The main issues seemed especially related to the insurance data. As access to these data is novel both to the initiators and users of the web portal, the insurance loss data was a natural focus of the conversation.

Several users *question the quality of the insurance data*. The process of quality checking the data is difficult, and the option to do this is central to the users trusting what they find. In addition, users found errors in the insurance data, which made them reluctant to trust it. One respondent from one of the large municipalities addressed some of the issues:

> *When you start looking into the data, you cannot differentiate between what is actually due to too low a capacity of the network of pipelines, and what is due to a broken washing machine (…). If you dig into it, it does not make sense. What it says in one column, does not match the other column. (…) There are enormous levels of error.*

Generally, the insurance data is also too aggregated for utility and does not give detailed enough information. Users expect it will be improved with time. At the time of the study, the quality was considered by many to be too low. One user says:

> *I also talked to someone in water and sewage, that had seen the page, and they … As of today, you cannot use the data to do anything. Because it is not detailed enough, as we have talked quite a bit about. We need more detail.*

The problem related to the data seems to not only be a practical issue, but also influences the general perception of credibility and trustworthiness. The additive effects of finding errors in the data, the data being overly aggregated, and not being able to check the data source, lead to unease amongst users. Nevertheless, users recognize that the process of making the categorizations and bringing the overall quality up to their standards is time-consuming and resource intensive. Some users suggest that insurance companies should be further pressured into categorizing the data. Users across interviews believe that providers have made great efforts in creating the tool, and are hopeful that improvements will be made with time:

> *We need more details. And I know that they have plans to do that and that they want more detail, they want to have information available.*

The challenges with the insurance loss data, and the need for details for the value of these data in planning and decision-making, are well-known (Hauge et al., 2020). Increasing the consistency of how these data are reported from the insurance companies' side is in progress, and measures for improvements are in focus in the public–private cooperation between the DSB and Finance Norway. However, these improvements will apply only from 2022. Trust and credibility, crucial for the use of climate services (Schwab and Storch, 2018), can be further enforced through dialogue between users and providers (Lemos and Morehouse, 2005).

A few users wonder about the *target group and purpose of the web*

portal. Some users conclude that the lack of clarity is due to their lack of information about the web portal, while others express that they are unsure of whether the initiators themselves have decided on a clear purpose for the web portal. They mention that they struggle to see who the tool's main target group is, as it covers a vast range of data. These findings can potentially be attributed to a lack of common understanding established through collaboration in the early stages of designing the tool, such as described in the Tandem framework (Daniels et al., 2020). Stakeholder validity and information validity (if the information is trustworthy) are usability gaps described by Raaphorst et al. (2020). A tool with such a broad target audience and versatility is novel to the users, compared to other relevant tools. It might require further explanation and training to be fully understood.

Multiple data systems

Users usually utilize multiple data systems – a combination of local data and national data systems. Local data is often referred to as being more detailed and of better quality, and users still depend upon using these. This creates a need to download data from the tool and upload it to their own systems to combine the two sources:

> *I wonder if you can download data, I did not find that function. Because you would want to put things on top of each other. For example, when it comes to landslide risk assessments, I would want to add a layer where I can see where the water will go (…). But that is data that I have, and not the web page.*

Users from the largest city have access to twice as many reports in their own municipal data systems compared to what is available within the tool. They therefore still depend on their local data. Users need the web address of the underlying data to merge data from different sources, which also serves the purpose of controlling the quality of the data. This would help instruct others, as errors have been made due to the divided data systems:

> *How you could merge or overlap the data [in the Knowledge Bank], and show that it exists both local and national data… I am unsure about it. But I have seen that very many, especially consultants that work in several municipalities, struggle with it. They use the national data sets, and when it is more detailed data locally, they make errors because of it.*

If the tool offered the ability to combine data sources, it could make users more inclined to choose it. Conversely, if a user has access to a lot of local data of better quality in their own systems, it could make the tool redundant, and thereby be a barrier to its use. The technical solutions users choose are often based on convenience. If users perceive it as difficult, time-demanding, or otherwise inconvenient to get the desired results, they often give up (Benyon, 2014, p. 144). If the tool offers an easy solution to the issues discussed, this could be a driver for utilization. There is a usability gap connected to the possibilities for interactivity with the web page and modifying the content (Raaphorst et al., 2020), and this study demonstrates the importance of it. At the time being, this usability gap is unsolved.

Engaging users

This theme refers to recruitment methods for users of the web portal. The users encourage the use of relevant social *networks*, such as seeking out relevant networks and physically showing up when they meet. Users prefer short presentations in network meetings:

> *I think it is important to make it known in the networks that exist. Actively seeking out those networks and presenting them. Showing it, what it contains, and how easy it is to use, I think that is the most effective measure. If the municipalities just send out information by email… It will be quickly overlooked, I think.*

The fact that networks may be used to add a social dimension to the learning process, based upon the social norms and behaviour established within groups, is also emphasized in previous research (e.g. Hauge et al., 2018). Using existing networks is thus a possible strategy to utilize such effects, and affect social norms for CCA (Farrow et al., 2017).

Users also would like "super-users" or *pilot users*, that have expert knowledge of the tool. These users should receive special training in using it. In addition, they want to *avoid time-consuming events*. Invitations to time-consuming events will likely lead to the invitation being ignored. Users suggest instead that different seminars they already attend are a suitable arena, as this is something they already have reserved time for.

Challenges and implications

The drivers we found for the uptake of this web portal were variations of expectation, efficiency, trust, multiple data systems, and recruiting. These drivers can be seen as different levels of prerequisites for the use of climate services web pages. Many climate service evaluations focus mainly on the details in content and user interface to detect usability gaps. The results in this study are a reminder that drivers for use are also dependent on a wider context of expectations and data trust, confirming results from other studies (Daniels et al., 2020; Guido et al., 2019; Raaphorst et al., 2020).

The drivers detected in this study also reflect different usability gaps described by Raaphorst et al. (2020), on stakeholder and information validity, and digital interactivity with the web portal. In addition, the study shows that even with good intentions for user interaction in the development of a tool like this, the successful implementation and uptake of the tool depends in a large part on the quality (and perceived quality) of the background data. Interest in the insurance loss data dominated many of the interviews. At the same time, the uncertain quality of the insurance data collected by the insurance companies over decades, makes the municipality employees doubt the quality of the web portal in total. They say they discover incorrect or confusing information in the insurance loss data, and they state that they need to see the original document files. According to Thomassen and Hauge (2022), the historic insurance data will remain in the format the insurance companies collected them. However, through digitalization and close cooperation with insurance companies, the data from 2022 will drastically improve.

The interviewees want the web portal to be presented and demonstrated in network meetings. They do not talk much about why they suggest this, however, the need for social arenas for engaging web portal users, is acknowledged by the interviewees in this study. We know from environmental psychology research that uptake of pro-environmental behaviour in a social context is stronger than reading information alone (Stoknes, 2015). Uptake of a climate web portal depends on additional measures exploiting social norms for change (Hauge et al., 2018; Osbaldiston and Schott, 2012; Werg et al., 2021). Exposure to social norms in a network is an example of an extrinsic factor leading to "social pressure" to motivate use (Palutikof et al., 2019). Further, in this case, the social arenas for promoting the web portal will be important not only for uptake, but also in establishing the right expectations for the insurance loss data. This process should begin at an early stage through co-exploration (early and continued exploration of knowledge, skills and practices for a common understanding) and co-production (combining these understandings) (Daniels et al., 2019).

Transferability

The study uses a single case and qualitative interviews. The findings described are therefore specific to this Norwegian case. However, it can be *analytically* generalized to similar cases and contexts. Adapting existing web portals for use in different countries can be challenging (Street et al., 2019). However, the findings from this study could be used as examples of critical aspects for governmental attempts to establish national web portals for CCA data, especially web portals containing insurance loss data. Further, some of the findings, such as the value of co-production and management of expectations for a web portal, can

potentially have value for the establishment of other tools as well. The study is conducted in an early phase of the establishment of the web portal.

Conclusions and further research

The aim of the study was to identify major drivers to the utilization of a web portal containing national data relevant to CCA. The findings imply that users' 1) expectations for quality affect the experience and motivation to use the web portal and that these expectations should be carefully managed to be realistic. Unrealistically high or low user expectations can lead to effects on perceived performance. Another driver to the utilization of the tool is the users' 2) trust in the product, the data and web portal developers. This can be improved by co-exploring and co-producing and communicating with the users. If the tool is optimized it can also contribute to the users' 3) efficiency of communication and sharing, which could be a driver. The support for interdisciplinary work and access to previous work is especially important for this, as well as the access to 4) multiple data systems. In this case, many practical issues, such as those concerning multiple data systems, remains to be solved. In addition, the users describe different efficient and social ways of 5) engaging users as a drive to use the web portal.

This qualitative case study of two large city municipalities and one smaller municipality, provides examples on how employees in large municipalities are much more critical and demanding of the content of a web portal on CCA than employees in a small municipality. Multiple data systems would provide the possibilities to transfer local data to the portal and interact with the web portal in different ways. This would make the web portal relevant and useful for large municipalities, while, at the same time, useful also for smaller municipalities without the same resources.

Many CCA-responsible employees in Norwegian municipalities have high expectations for the insurance loss data, but the quality gap between expectations and reality makes its inclusion challenging. Especially large city municipalities have high expectations of the old insurance loss data. The challenge is how to communicate trust in the web portal with all its content, and at the same time make the users interpret and use the insurance data with caution.

Further, a challenge for a national web portal with many potential users with different needs and qualifications is to ensure user involvement in the evaluation stages. The development of such a web portal is not linear, but an iterative process that will need to continue if the web portal is expected to be in use.

Continuing the findings from this paper, a natural focus for further research on the Knowledge Bank would be evaluations over time, with surveys based on the interview results. The themes identified in this research may also be used as a starting point for further research on user-related issues for building trust and increasing utilization of new and existing climate services. This study especially highlights aspects of the implementation of insurance loss data for CCA web portals. Even though data quality issues are recognized in existing literature, there is a need for research on data quality in future climate services, and evaluation of the use of insurance loss data for CCA.

CRediT authorship contribution statement

Fredrikke Lien Jevne: Writing – original draft, Conceptualization. **Åshild Lappegard Hauge:** Conceptualization, Methodology, Validation, Writing – review & editing, Supervision. **Maria Kollberg Thomassen:** Validation, Writing – review & editing, Project administration.

Declaration of Competing Interest

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

Data availability

The authors do not have permission to share data.

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