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User guides for the climate adaptation of buildings and infrastructure in Norway – Characteristics and impact

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ABSTRACT

To reduce future damages on buildings and infrastructure, and prepare society for the coming climate challenges, in recent years numerous user guides have been developed. The objective of this study is to provide the first overview and analysis of, the characteristics of the existing guidance material for the climate adaptation of the built environment in Norway. 84 user guides and web portals are mapped and analysed, focusing on target groups and topics. The results are viewed in relation to qualitative interviews with experts responsible for promoting climate adaptation. A large share of the guidance material communicates climate adaptation at a general level rather than in-depth practical measures. The interviews confirm that there is an overwhelming amount of guidance material, and it is suggested that this may cause confusion and uncertainty among users. The study and its findings are placed within a context of the climate services literature, and "user guides" are understood as a type of "climate services product". A main conclusion is that the abundance of user guides does not automatically lead to better climate adaptation. Too few user guides for climate adaptation sufficiently secure easily accessible information on practical measures. The guides are not broadly utilised, the language and length of the texts are sometimes problematic, and the target groups are often wide or not specified. The results presented may be used in order to develop improved user guides for climate adaptation in societies with similar climate and societal challenges to those in Norway.

Practical Implications

This study provides the first overview, and analysis of, the characteristics of the existing guidance material for climate adaptation of the built environment in Norway. 84 user guides and web portals have been mapped and analysed, according to user target groups and topics. The user guides typically contain a large amount of background information concerning climate changes, consequences, risks and uncertainty. The users are however more in need of descriptions of practical measures for easy implementation in plans, contracts, and other documents. The research findings may be used strategically by governmental departments/ directorates responsible for *climate adaptation in the built environment*, agencies with particular responsibilities within building- and infrastructure sectors, as well as other institutions and organisations involved in developing climate adaptation guides. Several measures are necessary to meet the most critical issues raised in the findings and conclusions. We recommend that:

- Future user guides should communicate concrete technical measures as efficiently as possible. Concrete measures about the decision making process are also needed; information about the coordination between sectors, which stakeholders should be part of which meetings, and how to plan a decision making process on specific subjects.

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- Web based user guides should be given a form which enables the instant and intuitive location of definite measures, instead of imputing the reading of several guides in order to find what you are looking for. Background information on climate changes should rather be organised as supporting literature. Interactive, web based guidance may provide such possibilities.
- Greater use of interactive webpages, with ideal examples of adaptation measures, the exchange of ideas, suppliers and products, are recommended as a follow-up strategy.
- User guides should also be adapted to the tools and working methods that the users already possess.
- One finding is that web pages dealing with specific subject areas are often used more frequently than general web pages on climate adaptation.
- Texts should be short and academic language should be avoided.
- Target groups for the user guides should be specified.

The results of the study show how to decrease user uncertainty through more target group-oriented and measure-specific guides. User involvement in guideline development could improve the accuracy of scope, contents, and target group.

Users are confused by the diverse array of guidance documents available on the climate adaptation of buildings and infrastructure. To diminish the confusion, the following measures can be considered; public authorities who keep track of the development of new user guides, a duty to report new user guides, publishers routinely exploring existing user guides before developing new guides, and a national expert panel evaluating user guides and removing the outdated ones.

Other types of climate services, social networking and education, are of great relevance for guidance documents to be disseminated, known and used. The information is by itself insufficient to translate abstract knowledge into local action. In order for user guides to be actively adopted, the stakeholders must have an experienced a genuine need for the information. Thus, the stakeholders must feel a responsibility for the consequences of their decisions.

1. Introduction

Projected future climate changes will with high probability lead to increased climate stress on buildings and infrastructure. The built environment is especially vulnerable to climate changes (Almås et al., 2011). Society's ability to handle the consequences of climate change depends on the availability of resources, tools, cooperation, and information – and particularly the level of knowledge. To provide necessary knowledge, identifying methods and tools for implementing sustainable solutions are of utmost importance. The focus on climate adaptation is not yet particularly strong in the legal framework in Western European countries (Hanssen et al., 2013; Weis et al., 2014). Climate adaptation guidelines and other tools are therefore necessary to support planning and other decision making processes. Effective climate adaptation consequently depends as much on structures and processes as on technical concepts and solutions. To prepare society for coming changes, in recent years numerous guidance documents have been developed by an array of actors. The research founding the basis for this paper is aiming at Norwegian public policy makers and municipal administration and management. However, the general conclusions in this paper are also relevant for other Western European countries with similar climate and societal challenges.

Climate services – informing stakeholders concerning decisions related to climate adaptation – is a term that recently has come into favour. Climate services are relevant for all activity involving climate related issues, e.g. municipal planning, building process activities, emergency preparedness, and other areas vulnerable to climate strain and climate change impacts. However, there has been relatively little evaluation of the performance of such services (Vaughan and Dessai, 2014). Some studies can be found on experiences with developing climate services in cooperation with users on different levels (Meadow et al., 2016; Goosen et al., 2014; Swart et al., 2016). These studies are typically concerned with subjects such as climate forecasting, to inform decision making, and the projecting of long-term trends to guide policymaking.

The present study addresses what the authors of this paper consider to be the next step in climate services. Early forms of climate services focused mainly on projections of climate change, while this "next step" focuses on how to translate climate forecasting into specific measures and technical solutions, as well as what measures to prioritise. *The "next step of climate services" is the interpretation of raw climate data and climate scenarios into decision support for practical measures and processes.*

A large number of web sites and documents are framed to help inform decision makers about practical measures to increase the resilience of buildings and infrastructure to the impacts of climate change. Vaughan and Dessai (2014) point to the fact that users are confused by the diverse array of products available. The literature study presented in this paper revealed very little research about the characteristics and impacts of such products, nor on how this information can be transferred in the best manner.

The study presented in this paper was conducted within the general framework of *Klima 2050 – Risk reduction through climate adaptation of buildings and infrastructure.* Klima 2050 is a Norwegian-based Centre for Research-based Innovation (SFI) with 20 partners from public, private, research and educational sectors (www.klima2050.no). The aim of the centre is to reduce the societal risks associated with climate changes, most notably enhanced precipitation and floodwater exposure within the built environment.

In this paper, an analysis of available user guides on climate adaptation for buildings and infrastructure within the Norwegian context is presented. The research has revealed a large amount of guidance material for climate adaptation. 74 guidance documents and 10 web portals have been categorised. Guidance documents, or user guides, are here defined as user-oriented internet publications (in Norway, net-based publications are prevalent) that briefly give introductions and education in practical (and organisational) climate adaptation in selected areas (for details, see the method Section 3.1). The main objective of the research has been to provide an overview over existing guidance material for climate adaptation in the built environment in light of the following research questions:

a) What characterises the analysed user guides?
b) What topics, target groups and publishers are represented?
c) How is the promotion of the guidance material experienced by experts working to introduce climate adaptation?
d) What can be done to improve user guides on climate adaptation?

2. Theoretical framework and relevant research

2.1. Basis for the choice of theoretical framework

The study will initially be seen according to the climate services literature, and relevant research within this framework (Vaughan and Dessai, 2014; Meadow et al., 2016; McNie, 2013; Lucio and Grasso, 2016). The term "climate services" has come into favour fairly recently, and some cornerstones in the historical development of the framework are described in Vaughan and Dessai (2014). The climate service framework sets user guides – "climate service products" in relation to other types of climate services. This framework provides concepts and categories for the research.

Then the Norwegian climate adaptation challenges and the climate services already existing within society will be explained. In qualitative research, the analytic generalisation of results depends on a comparison of cases, and the contextual information makes is possible for the reader to judge the generalisation of results with other situations and societies (Brinkman and Kvale, 2014). Some of the existing research on experiences with user guides about climate adaptation for the built environment in Norway will be described.

Lastly, an environmental psychology perspective is introduced. The field of psychology is uniquely equipped to identify the human dimensions associated with environmental problems on both local and global scales – the problems of *interaction between humans and their environment*. The psychological approach offers valuable insight into typical challenges found with human behaviours, perceptions, motivations and abilities when meeting climate change (Clayton et al., 2016). The psychological approach is a valuable framework for the research question on the promotion of user guides, and may help to explain the lack of utilisation and understanding of the information provided.

2.2. Climate services

In general, the term "climate services" denotes services helping stakeholders in decision making processes related to climate adaptation. This covers most forms of knowledge distribution and information about climate change (tools, documents, maps, webpages, social networks etc.), targeting decision-makers at all levels. (Vaughan and Dessai, 2014; Meadow et al., 2016). All these different types of climate services and tools are aiming at inspiring users to improve their decisions about adaptation. Main types include (NRC, 2009):

- *Decision support products:* Products as data, maps, scenarios, models, documents etc. that contain information to support decision processes;
- *Decision support services:* Consultations, teaching or interactions making the users more capable of using decision support products. These services are less visible, but are as important as the products;
- *Decision support systems:* Networks between individuals, municipalities, and organisations supporting how to use products and services.

The literature argues that climate service providers should work with users to contextualise scientific knowledge, enabling climate information to be both created and tailored to specific decision making situations (Meadow et al., 2016; Goosen et al., 2014; Swart et al., 2016; Vaughan and Dessai, 2014; Hygen et al., 2016; Lucio and Grasso, 2016). The dialog between users and providers of climate services contributes to legitimacy, and encourages trust in the services (Lemos and Morehouse, 2005). McNie (2013) concludes that the obtaining of climate-science information that is contextual, credible, trusted, and understood by users, requires an alignment between climate services' information and the users' needs. Vaughan and Dessai (2014) argue for the "co-production" of climate services, with scientists, users and policy makers working closely together in a process of joint problem solving.

Næss et al. (2011) studied the internalisation of knowledge (making the knowledge one's own) on climate adaptation in municipalities. Interviews with employees in several municipalities in Norway revealed that in general, the available climate research and climate knowledge was regarded as not being very useful. The interviewees found climate research in many cases, to be abstract and general, and not fitting the practical, local challenges that the decision-makers in the municipalities faced. The employees interviewed had little time for reading and based their measures more on political signals rather than on research results. The informants also maintained that the climate research results were too abstruse and general. The knowledge presented appeared as too academic and difficult to understand, and was therefore not accessible to many of the municipal employees. Similar results are documented in Lemos and Morehouse (2005). Furthermore, Næss et al. (2005) found that the knowledge provided was not sufficiently practically aligned, i.e. the same municipal employees lacked knowledge about how to employ climate research in practice. Furthermore, the interviewees wanted more locally adapted knowledge. They demanded specific alternative measures and standards. Correspondingly, a study of water management in local and county municipalities in Norway by Barkved and Hanssen (2015) revealed a need for more practically aligned user guides.

Specifying the target groups for user guides' and the channels that they are available through will have an impact on the accuracy when targeting the audience addressed. NRC (2009) summarises the identified impact on communication research by maintaining that communication is much more effective when targeted at specific groups, rather than at a general audience. Different groups of users will have confidence in different sources and require different types of details and information.

Evaluation is crucial to improving climate adaptation. Without a proper evaluation of actually implemented measures, learning across projects is notoriously difficult. Pahl-Wostl (2009) describes three different loops of learning through evaluation: Single-loop is to fix errors from routines and refining actions to improve performance, but without questioning established routines. Dooble-loop is correcting errors and questioning established routines, and adjusting values and policies. Triple-loop equals designing governance norms and protocols, and transforming the structural context. Orderud and Winsvold (2012) argue that learning in groups and networks, reflecting on incidents and its consequences together, creates a greater chance of double- or triple loop learning, especially if the networks are politically influential. Social learning is defined as group-based iterative reflections facilitated by shared experiences, ideas and environments with others (Keen et al., 2005). Learning climate adaptation occurs through all three kinds of learning loops, however the theories about learning loops show how essential it is to develop and use climate adaptation guides in group settings.

The need for climate services is still strong. Tompkins et al. (2010) elaborates on how sectors in the UK that require high investments in infrastructure, have done significantly more in preparing for potential impacts and adaptations than sectors without the same needs for investments. Moser (2009) and Repetto (2008) both underline how knowledge, capacity and resources to undertake adaptation do not necessarily guarantee that adaptation takes place. Adger et al. (2009) highlight that vague distribution of responsibilities is another factor limiting adaptation. Klein and Juhola (2014) have made a comparison between climate

adaptation research and policy development in the Nordic countries. They conclude that even if the Nordic countries have been at the forefront of adaptation research, the implementation of adaptation activities has been slow.

2.3. The Norwegian context

The present annual precipitation average in Norway is 20% higher than 100 years ago. Furthermore, at the end of this century, an additional 20% increase is expected. Scenarios for climate change in Norway also indicate an increase in the number of extreme weather events. This will further intensify already heavy loads/strain on drainage and surface water systems, water damage to buildings and infrastructure, and add to even more landslides and flooding damage (Hanssen-Bauer et al., 2015).

Climate forecasts and climate profiles for the municipalities are provided mainly by the Norwegian Climate service centre, https://klimaservicesenter.no/. This is a co-operative project between the Norwegian Meteorological Institute, The Norwegian Water Resources and Energy Directorate, and UNI Research. In addition, the web portal www.klimatipasning.no – The Norwegian Climate Change Adaptation Portal – is intended to support Norwegian society in preparing for the impacts of climate change. The portal offers comprehensive information about ongoing work on climate change adaptation, lessons learned and relevant research, developments and publications. This web portal is operated by the Norwegian Environment Agency.

In a study from 2007, a lack of knowledge and competence about climate change, and the inability to link experience from former incidents to future climate adaptation, were found to constitute the most significant barriers to climate adaptation within the Norwegian context (Vevatne and Westskog, 2007). 90 percent of the representatives from the participating Norwegian municipalities expressed that there was a need for more knowledge on climate adaptation. This overall picture is confirmed in more recent studies; municipalities lack the right kind of competence and expertise to succeed with climate adaptation (Hovelsrud, 2011; Hanssen et al., 2015).

Rambøll and Kaupang (2016) found in their study that climate adaptation and urban densification in cities were the largest future technical challenges being faced by municipalities. They uphold that there is a need for more interdisciplinary competence across strategy and planning, procurement, law and project management, ICT, and technology. Larger municipalities tend to have a greater chance of succeeding in this work than smaller municipalities. The study suggests that smaller municipalities should cooperate closely with larger municipalities to create competent specialist environments, and that municipalities should have a close dialogue with universities and colleges of higher education (Rambøll and Kaupang, 2016). However, adaptation activities differ greatly between municipalities. The municipalities engaged in climate adaptation networks such as Cities of the Future have done far more adaptive planning and adaptive measures than municipalities outside such networks (Rambøll, 2014). Other research reveals that the superior legislation and guidelines should be adequate to safeguard climate adaptation in Norway, but that the municipal implementation often fails when put to the test (Flyen et al., 2014).

Klaussen et al. (2015) found that in urban planning, climate adaptation occurs randomly. This is typically due to long-standing, conventional routines, policies or strategies. The introduction of adaptation measures is often arbitrary, and depends upon whether a climate enthusiast is involved in the project where such adaptation is appropriate. Learning therefore seems to be more individual than organisational (Klaussen et al., 2015). In the study by Næss et al. (2011), results showed that in many municipalities the recruiting of highly qualified personnel was problematic and hindered the domestication of climate knowledge.

2.4. Psychological approaches relevant to climate services

Psychological research reveals that our brain reacts quickly to sudden dangers, but when it comes to slowly encroaching crises, particularly at a distance, our capacity to detect risk deteriorates (Weber, 2006). This can be explained by the evolution and development of the human brain, still characterised by the type of dangers that people were exposed to in prehistoric times. Survival demanded vigilance against sudden dangers (Gifford, 2011). Our cognitive capacity in the area of climate adaptation (slow process) is limited, and we seem to have a limited pool-of-worry (Weber, 2006). Such factors can explain why climate adaptation measures are often undertaken after a devastating storm or flood (Wolf and Moser, 2011). If there is fear or confusion about what to do, this justifies doing nothing (Hamilton and Kasser, 2009). This phenomenon underscores the importance that information and guidance on adaptation is specific and clear. The uncertainty connected to predicting future climate change is therefore a problem, because uncertain estimates can prevent people from doing something active to adapt to climate change (Gifford, 2011; Stoknes, 2015).

People look to others to find out how to behave (Schultz et al., 2007). Therefore, if others are doing a lot for the environment, it is easy to follow their example (Nolan et al., 2008). Other people's actions are among the strongest influences for environmentally friendly behaviour when it comes to recycling and energy use. At the same time, people need to be seen and praised for the good that they do (Cialdini and Goldstein, 2004). Stoknes (2015) recommends focusing on *social strategies* for climate communication, which harnesses the power of social networks and norms. Municipalities and businesses are expected to act on climate change and take advantage of information made for users. Professional networks can contribute to building a corporate identity, saying that "our organisation is committed to adapting buildings and infrastructure to climate change." Such an organisational identity will encourage employees in municipalities or companies to more effectively absorb the information and guidance material. Investing in networking for climate adaptation responds to the importance of focusing on social strategies to get users to obtain information and guidance in a community. Networks can be referred to as a type of "climate service", they represent decision support systems for climate services (NRC, 2009). Social networks appear to be central to ensuring that climate services and guidance materials are being used (Hanssen et al., 2013; Klaussen et al., 2015; Flyen et al., 2016).

3. Method

3.1. Climate adaptation user guides and websites – appraisal

The quantitative thematic analysis of user guides categorised only "decision support products" (NRC, 2009), while in the qualitative interviews a broader approach to climate services was taken, including networks and consultations (see Section 3.2). The reason for choosing only decision support *products* for the quantitative analysis, was because this type of climate service was concrete and easy to count, it would be too difficult to get an overview of all other types of "oral" climate services. The qualitative interviews cover a broader area, and make it possible to see the different climate services in connection with each other. Climate services – decision support products – can be all types of data, maps, projections, models, documents etc. (Vaughan and Dessai, 2014; Meadow

et al., 2016). The present analysis examines the guides, typically pdf-documents developed by directorates or public organisations to give guidelines on how to solve specific climate adaptation measures. It does not include services such as data or maps, which will require further interpretation and knowledge to be of use. A goal of this study was to gain an overview of the most relevant user guides and web portals within climate adaptation, and their characteristics. It was desirable to have an overview of:

- Norwegian national-level guides;
- Concise and practical adaptation documents (technical or process);
- User-oriented guides (for public or private decision makers for climate adaptation at various levels);
- Guides dealing with climate adaptation of buildings and infrastructure to avoid water damage and landslides ("Klima 2050"-related). Guides and webpages that did not have climate adaptation as a central message were excluded;
- Particularly the newer guides, i.e. after 1990.

Within the Norwegian context, net-based publications are prevalent. To the knowledge of the authors, no relevant publications exist only in paper format. This may be different in other countries, and similar studies in other countries would have to consider if there are relevant user guides in paper format.

Some websites also have guidance material, not only in documents that are linked, but also directly on the website. Most of these are then categorised as a "portal", since they cover several topics (for example www.klimatilpasning.no). Internal user guides located on websites that are not accessible for non-employees of the company/agency are not included in the outline, since these services are not available for people in general. Relevant public user guides that must be paid for are included.

Legal requirements, guidelines and laws that *must* be followed are not included in the analysis, but guidance material that explains how challenges *can* be solved in order to achieve positive outcomes or be able to fulfil the requirements this includes. The reason for this distinction was that the scope of this study was not laws and regulations for climate adaptation, but user guides that give different answers on how to fulfil the governmental requirements and obtain climate adapted environments. However, some user guides are on the borderline, they include both an overview of legal requirements and are user guides explaining how to achieve these demands. This applies in particular to user guides in the directorates, Norwegian Public Roads Administration (NPRA), and the Norwegian government's Agency for Railway Services.

The research procedure was designed to discover which user guides on climate adaptation could be found using well-known search engines (e.g. www.google.no) and web portals (e.g. www.klimatilpasning.no) on the Internet. The search should be representative of what anyone could find when in need of Norwegian user guides for the climate adaptation of buildings and infrastructure. Rather than seeking full coverage including all expert databases, the research procedure wanted to find what the common professional, public (state/municipal) and private stakeholders in the building/construction process, meets as part of an (extensive) search. The searches were conducted in the period from April 15th 2016 to May 15th 2016. The table of guidance material and categories were discussed in several meetings, both with partners from Klima 2050, and external groups/ organisations that had a particular interest in this work. Some of the information in the guidance material table about surface water and water quality is provided by Barkved and Hanssen (2015).

3.1.1. Analysis and taxonomy

The user guides and websites were categorised by topic, target group, and publisher. The guidance material and websites were sorted and categorised in MS Excel™, and no guidance material was represented in more than one category, even though some of the user guides could have been sorted into several categories. All guides were put in the most prevailingly appropriate category. Further sub taxonomy within the three top categories (themes, target group and publisher) was tested and discussed in internal and external project meetings.

Categorising user guide topics is challenging because typical category names do not belong to the same type or level. Some topics would commonly be categorised as natural hazards, some by sector, and others by type of measure. Concepts that decision makers naturally would use when searching for information were given preference.

Topics:

1. Comprehensive planning/general
2. Transport
3. Storm water run-off, water quality, sewage and drainage
4. Land – and zoning plans
5. Building
6. Flooding
7. Sea level
8. Landslides
9. Portal (web site with links to information on climate adaptation)

During the review, an insight into what degree of practicality the user guides had, was gained. This was not quantified, because that would require a more thorough review methodology.

For the main category "target group", various public and private decision-making levels were retrieved. The target group subcategory "general" contains guidance material that is aimed at multiple target groups or guidance material where no special target group is described. The "local and regional authorities" subcategory applies to employees such as building officers, employees in technical departments or planners. The target groups "spatial planners" and "road planners" were separated because it was clear that some of these user guides were aimed at the private sector. Many of these would, none the less, be very relevant to municipalities.

Target groups:

1. General (integrated planning)
2. Municipal and county authorities
3. Consultants
4. Land planners, transport planners
5. Contractors/developers
6. Contractors, private developers (e.g. house owners, building owners)
7. Public organisations/state agencies

For the category "publisher", we looked at the bodies behind the guidance material.

Publishers:

1. Departments, ministry, directorate, county governor
2. Public organisations/State agencies
3. Municipalities, municipality organisations
4. Research
5. Consultants

3.2. Qualitative interviews

User guides were one of many topics in the expert interviews on barriers for climate adaptation. The interviews were conducted with people in positions within governmental agencies and organisations with overall responsibility for providing climate adaptation-related information. The experts that were interviewed represent organisations that provide public user guides, it was therefore implicit that the user guides discussed were public. However, also other types of climate services were addressed, decision support services and systems (such as networks and teaching) (NRC, 2009). The chosen representatives were typically those who have *contact with users* in municipalities or private enterprises. Seven semi-structured in-depth expert interviews with nine actors, and one group interview with 11 participants were conducted in line with the prescriptions of Yin (2013), Brinkman and Kvale (2014). The majority of the interviews were performed face to face. The interviews lasted from one, to one and a half hours. In some of the interviews, there were two informants. In addition, one focus group interview was conducted on climate adaptation in municipalities. Here, one municipality was strongly represented. The 11 external participants had different roles: four of them worked in government agencies, primarily with climate change. One was an architect, five representatives were from municipality A (from the Planning and Building Department, and from water and sewerage), and one was a representative from city municipality B (water and sewerage).

The interviews were recorded and later transcribed. The transcribed interviews were entered into the program NVivo (QSR, 2016). The material was coded on basis of the topics visible in the material. Some quotes contained more than one subject, and were placed in several categories and at various levels. Only interview quotes involving guidance material and information were included in this report. The participants had the opportunity to review the quotations that were used. The interviews are referred to in the text by the following numbers:

1) Government agency
2) Government Directorate
3) Private Organisation
4) Public interest group
5) Private Organisation
6) Government Directorate (2 participants)
7) Focus Group Interview (11 participants)
8) County Governors (2 participants)

4. Results and discussion

4.1. Main results from the thematic analysis of user guides/web pages

4.1.1. Category 1, topics

As shown in Table 1, 10 web portals and 74 guidance documents were included in this study. The web portals function as gateways for further information on climate adaptation, or they contain guidance on the webpage (not in separate documents). The largest share of user guides are about the climate adaptation of buildings (22%) (See Fig. 1). 19% concern storm water run-off, water quality, and drainage. 14% are about landslides. 9% are about flooding. 12% are on land- and zoning plans. Only two percent of the material is mainly about transport (road and railway). However, some of the user guides on transport have been otherwise categorised, when e.g. flooding and landslides are the main topics. Climate adaptation might be more integrated in other handbooks and documents in the field of transport – these are not covered by the analysis. Only 8% of the user guides cover overall/general planning. The number of documents covering different practical and technical challenges are naturally higher. None of the user guides explore decision processes and cooperation in depth. The topic "decision process" is found to be lacking; this means that guides on coordination between sectors, how to plan a decision process, which stakeholders should be part of which meetings are missing altogether. The analysis reveals that a high share of the guidance documents communicate climate adaptation merely at a general level, focusing on background information on climate adaptation rather than in-depth on practical measures.

For more information on the user guides, see the Norwegian report by Hauge et al. (2016).

Table 1
User guides sorted by topic.

Topic: Web portals	**Publisher**	**Target group**
SINTEF Building Research Design guides	SINTEF B&I[1]	General
DiBK Klimatilpasning	DiBK[2]	General
Norwegian Directorate for Civil Protection (DSB)	DSB	General
Klimatilpasning.no	Norwegian Environment Agency	General
Norwegian Meteorological Institute (MET)	MET	General
Norwegian Water Resources and Energy Directorate (NVE)	NVE	General
Naturfare – NIFS project	NIFS project[3]	General
Norsk klimaservicesenter	MET, NVE, Uni Research and Bjerknessenteret	General
Norwegian Water	Norwegian Water	General
Ovase – Overvannsenteret	Students	General
Topic: General planning	**Publisher**	**Target group**
Klimahjelperen	DSB	Municipalities
Helhetlig risiko og sårbarhetsanalyse i kommunen	DSB	Municipalities
Planlegging av grønnstruktur i byer og tettsteder	Norwegian Environment Agency	Municipalities
Startpakke for klimatilpasning	County administrator of Vestfold, Larvik municipality and Norwegian environment agency	Municipalities
Utbygging i fareområder	DiBK	Municipalities
Topic: Transport	**Publisher**	**Target group**
V137 – Veier og drivsnø	NPRA	NPRA
Lokal tilpasning til et klima i endring	KS [4]	Municipalities
Topic: Sea level	**Publisher**	**Target group**
Håndtering av havnivåstigning i kommunal planlegging	DSB	General

Table 1 (*continued*)

Topic: Stormwater, water quality, run-off and drainage	Publisher	Target group
Drenering for veg og jernbane	NIFS project	General
Eksempel på dreneringstiltak i små nedbørsfelt	NIFS-prosjektet	State agencies
Grønne tak og styrtregn	NVE (NIFS project)	State agencies
Blågrønn faktor – Veileder byggesak	Fremtidens byer a.o.	Executive officers, developers, municipalities
Klimatilpasningstiltak innen vann og avløp i kommunale planer	Norwegian Water	Municipalities
Overvannshåndtering – en veileder for utbygger	City of Oslo	Developers
På lag med regnet – veileder for lokal overvannshåndtering	Cowi	General
R200 – Håndtering av overvann fra urbane veger	Norwegian Water a.o.	Municipalities and land planners
Veileder 01:2011a – Karakterisering og analyse. Metodikk for karakterisering og risikovurdering av vannforekomster etter vannforskriftens §15	WFD[5]	General
Veileder 01:2013 Regional vannforvaltningsplan. Etter vannforskriften og plan- og bygningsloven	WDF	Municipalities
Veileder 02: 2009 – Overvåking av miljøtilstand i vann Ver. 1.5 30.10.2010	Norwegian Environment Agency	General
Veileder 02:2010 – Planprogram. Veiledning til arbeid med regionale vannforvaltningsplaner etter vannforskriften	WDF	General
Veileder 02:2011 Veiledning og mal. Vesentlige vannforvaltningsspørsmål. Veiledning til vannforskriftens §28b om vesentlige vannforvaltningsspørsmål, med forslag til mal	WDF	General
Veileder 02:2013 – Klassifisering av miljøtilstand i vann	NIVA[6]/NIBR[7]	General
Veiledning i klimatilpasset overvannshåndtering	Norwegian Water	General
Veiledning om mulige tiltak i avløpsanlegg	Norwegian Environment Agency	Municipalities
Topic: Land planning and zoning plans	**Publisher**	**Target group**
GIS i samfunnssikkerhet og arealplanlegging	Norwegian Mapping Authority /DSB	Municipalities
Grønn by – arealplanlegging og grønnstruktur	Norwegian Environment Agency	Municipalities
Hvordan ta hensyn til klimaendringer i arealplanleggingen – Faktaark 3–15	NVE	Land planners
Nasjonale forventninger til regional og kommunal planlegging	Ministry of Local Government and Modernisation (KMD)	Municipalities and counties
Nasjonale jernbaneinteresser i arealplanlegging etter plan- og bygningsloven	Jernbaneverket	Municipalities
Planlegging av grønnstruktur i byer og tettsteder	Norwegian Environment Agency	Municipalities
Retningslinjer for fylkesmannens bruk av innsigelse	DSB	County administrator
Rundskriv – T5/97 Fareområder Arealplanlegging og utbygging i fareområder	KMD	Municipalities and counties
Samfunnssikkerhet i arealplanleggingen	DSB	Municipalities
Sjekkliste for reguleringsplan	NVE	Municipalities
Topic: Buildings	**Publisher**	**Target group**
Arealdisponering og vernetiltak i værharde utbyggingsområder	SINTEF B&I	Consultants
Beregning av sol-, skygge- og horisontforhold	SINTEF B&I	Consultants
Bygg i snørike områder – en veileder i klimatilpassing	SINTEF B&I/ Norwegian State Housing Bank	General
Forebygging av flom- og skredskader. Lovgivning og ansvar	SINTEF B&I	Consultants
Klimadata for dimensjonering mot regnpåkjenning	SINTEF B&I	Consultants
Klimadata for termisk dimensjonering og frostsikring	SINTEF B&I	Consultants
Klimaundersøkelser	SINTEF B&I	Consultants
Kulturminner og klimaendringer	Directorate for Cultural Heritage	Municipalities and proprietors
Leirskred – Sikringstiltak	SINTEF B&I	Consultants
Leirskred. Skredmekanismer og farevurderinger	SINTEF B&I	Consultants
Løsning for lokal håndtering av overvann i bebygde områder	SINTEF B&I	Consultants
Plassering og utforming av mindre bygninger på værharde steder	SINTEF B&I	Consultants
Råd om snø på tak	DiBK	General
Snøskred. Skredfare og sikring	SINTEF B&I	Consultants
Steinsprang og steinskred. Farevurdering og sikringstiltak	SINTEF B&I	Consultants
Sørpeskred. Skredfare og sikring	SINTEF B&I	Consultants
Vann i by – Håndtering av overvann i bebygde områder	SINTEF B&I	Consultants
Veileder til Byggteknisk forskrift	DiBK	General
Visadapt	University of Linköping a.o.	House owners
Topic: Flooding	**Publisher**	**Target group**
Felthåndbok ved flom og skred	NIFS project	General
Flaum- og skredfare i arealplanar	NVE	Municipalities
Flaumfare langs bekker	NVE	Municipalities
Kvistdammer – Flomdemping, sedimentsamling og stabilisering i små nedbørsfelt	NIFS project	General
NVEs flomsonekartlegging -retningslinjer for flomberegninger	NVE	Municipalities and hydrologists
R204 -Åpne flomveger i bebygde områder	Norwegian Water	Land planners
Retningslinjer for flomberegning	NVE	Flooding hydrologists
Veileder for flomberegninger i små uregulerte felt	NVE (NIFS project)	State agencies
Topic: Landslides	**Publisher**	**Target group**
Dynamiske påkjenninger og skredfare	NIFS project	State agencies
Identifisering av skredvifter – Faktaark 2–13	NVE	Municipalities

(*continued on next page*)

Table 1 (*continued*)

Topic: Landslides	Publisher	Target group
Sikkerhet mot kvikkleireskred	NVE	Municipalities
Sikkerhet mot skred i bratt terreng – Kartlegging av skredfare i arealplanlegging og byggesak	NVE	Municipalities
Sikring av veger mot steinskred (rapportgrunnlag for veileder)	NPRA	State agencies
V138 – Veger og snøskred	NPRA	NPRA
V139 – Flom og sørpeskred	NPRA	NPRA
Veileder skogsveger og skredfare	NVE	General
Veiledning ved små inngrep i kvikkleiresoner	NVE a.o.	Municipalities
Verktøy for kvikkleirekartlegging	NIFS project	State agencies
Metode for vurdering av løsne – ogutløpsområder for områdeskredNaturfareprosjektet: Delprosjekt 6 Kvikkleire	NVE (NIFS project)	State agencies
Sikkerhetsfilosofi for vurdering av områdestabilitet i naturlige skråninger	NIFS project	State agencies

[1] SINTEF Building and Infrastructure.
[2] Norwegian Building Authority.
[3] Joint project between Norwegian Public Roads Administration (NPRA), Norwegian government's agency for railway services (Jernbaneverket) and NVE.
[4] Norwegian Association of Local and Regional Authorities.
[5] Norwegian National group for implementation of the Water Framework Directive.
[6] Norwegian Institute for Water Research.
[7] Norwegian Institute for Urban and Regional Research.

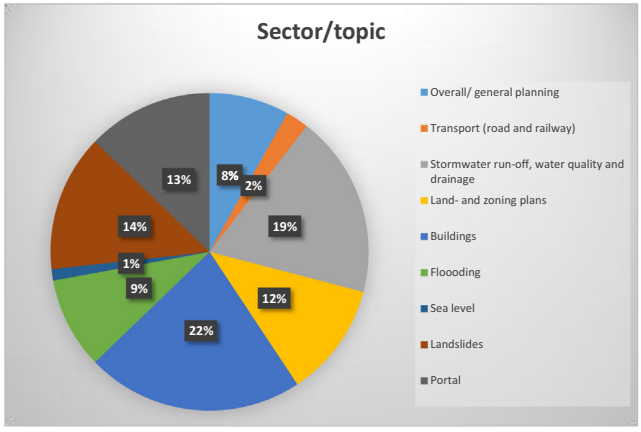

Fig. 1. Sector/topic.

4.1.2. Category 2, target groups

A general finding is that in many of the user guides, specifications about the target group are lacking. This makes it inherently it difficult to know which groups are being addressed. Research on communication strategies indicate that the narrower a communication is, the more likely it is to reach the target group (NRC, 2009). The largest share of the user guides address; a general target group (24%), or users in the municipality (31%) (See Fig. 2). 17% are targeting employees in public organisations (e.g. the Norwegian Public Road Administration or the Norwegian government Agency for Railway Services). Seven percent are mainly addressing land- and road planners. 19% of the user guides are targeting private actors in the building sector. This is the "Byggforskserien", the SINTEF Building and Infrastructure Design Sheet Series, with consultants as its primary target group. These documents have a paywall that affects the availability. Some documents in the group, land- and road planners, are for private actors, and a small number are for developers. Private developers are behind 80% of the zoning proposals in Norwegian municipalities (Klaussen et al., 2015). Thus, user guides addressing private developers are needed. Some of the user guides written for specialist target groups may also be relevant for other groups. A simple form of information dissemination would be to adapt existing guidance documents to new target groups.

4.1.3. Category 3, publishers

Departments, directorates and county governors are behind most of the user guides (43%) (See Fig. 3). Public organisations and agencies have published 22%; research communities have published 24% of the material, while municipalities and municipal organisations have published 9%. It is also worth noting that most of the guidance documents have been published during the last five years. A small number of user guides are developed by the consultant sector.

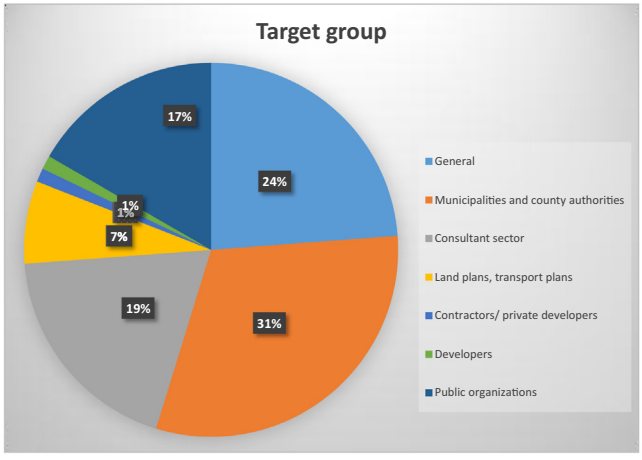

Fig. 2. Target group.

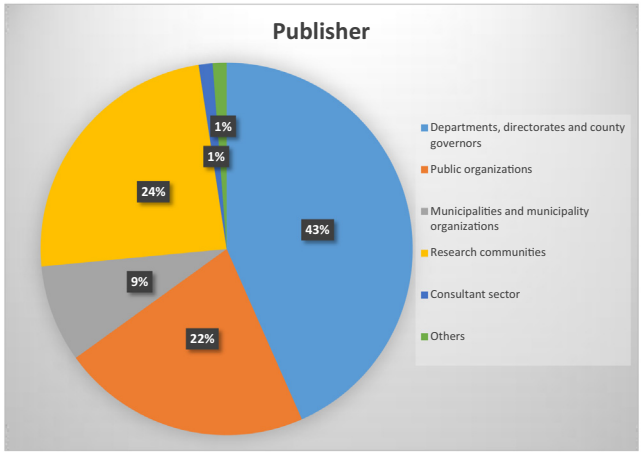

Fig. 3. Publisher.

4.1.4. Inevitable weaknesses

A complete table of all user guides on climate adaptation is unachievable. There will always be borderline cases and user guides that we are unaware of. Still, when planning new user guides, it is important to attempt to make this overview. Too often, user guides that are similar to existing guides are developed and distributed, creating confusion among the users (McNie, 2013).

This study has focused on externally available guidance documents. There is a chance that internal guidance documents cover the need for information about climate adaptation for some stakeholders.

Furthermore, all categorisation of user guides has its advantages and disadvantages. It became clear that the more detailed the subcategories were, the more difficult the categorisation was. Broad categories visualised the main tendencies.

4.2. Qualitative interview results and discussion

4.2.1. Abundance of guidance material

It was expressed in several expert interviews that there is an abundance of user guides on climate adaptation. These findings correspond to the large amount (84) of user guides and web portals documented and counted in the thematic analysis of climate service products. There is an impression among the interviewees that this may make it difficult to know what information to use and where to look for guidance.

> *What we often hear from municipalities in regards to the information base, it that it is so big that they do not know where to look. This is correct, an incredible amount of guidance material is developed, and everyone responds to a need by creating a brand new guide, it's a knee-jerk reaction. (Expert Interview 6)*

> *(User guides) . . . it is a big challenge! It easily gets out-of-hand. But there is no quick fix. There's a plethora of guidance material. And there are also many websites that deal with various bits of complexity here. And it's certainly not just one place and one scheme of things either, but it is the translation that is the problem. (. . .) Homepages alone are not the solution. It requires more detailed follow up – guidance – if you will – in the various theme areas. As it is today, the knowledge is not detailed enough for practical use. It is often too fragmented. We need to look at least at 34 different websites covering various bits of the climate adaptation puzzle. This could possibly be improved through the new klimatilpasning.no. (A new web page on climate adaptation in Norway). (Expert Interview 4)*

The confusion and uncertainty over the abundance of guidance material can lead to paralysis. Psychological research on decision making shows that uncertainty can justify the decision to do nothing (Gifford, 2011). This is a challenge caused by the growing amount of guidance material on climate adaptation. The last quotation also illustrates that producing a user guide is not enough, the publication have to be followed up with other strategies for climate services (NRC, 2009).

4.2.2. The impact of the user guides

Some municipalities have requested that all user guides on climate adaptation should be collected in one web portal, and the portal www.klimatilpasning.no arose as an answer to these needs. However, some of the experts interviewed have the impression that the user guides are barely used. It was also pointed out that although most user guides were collected under www.klimatilpasning.no, the website was barely used. The same was the case with the best-practice examples that municipalities requested.

> *They (employees in the municipalities) want things easy and accessible. Therefore, klimatilpasning.no was created, that was part of the idea. But we saw that it was rarely used. There was the desire to create a database with good examples, so that people could learn from what others had done before them. But we experienced that they were not adequately used (Ref. Statistics and user surveys we conducted). (Expert Interview 6)*

The website www.klimatilpasning.no is under revision and has since spring 2016 been re-launched with a different structure and new texts. It remains to be seen how much impact this will have on the use of the web portal.

However, from the state agencies' side, they have the impression that the guidance material is being used. This applies to, for example, guidance material for landslides and avalanches:

> *Yes, the guidance material is used. We go through them at the seminars. They ought to know them by now. I believe they are used. If they are not, it is generally picked up on by our caseworkers. The guidance material give answers to most issues. The design has changed over time. It is maturing, it is now more step by step thinking. It becomes a form of evaluation through active use. They are then changed regularly and irregularly. There are pdf files. They are not set in stone, they must be changed. (Interviewer: are they checklist based?) Yes, if the guidance material can be used directly in implementation, then it is a good channel. (Expert Interview 2)*

The interviews give another two examples of web portals for specific climate adaptation topics that are in use. From this, it is suggested that websites that are more theme-specific have a higher frequency of use than the more general websites on climate adaptation. In the expert interviews two of the participants reflect over whether the web portal www.klimatilpasning.no is becoming too large and extensive, taking the form of an "over-webpage", which is so broad that it is irrelevant for those looking for specific knowledge. When a website contains too much, it becomes time consuming to navigate your way to the right document. Other authorities who make factsheets and user guides are also struggling to find channels to get them out to the public. It is problematic to find websites where these can be posted:

> *There are fifteen factsheets coming, finished very soon actually. There are just no places to put them online. (Group Interview 7)*

These quotes also show that seminars and interactive training are employed to introduce the user guides to new users. This relates to the social strategies for climate change (Stoknes, 2015), as professional networks or networks between cities and municipalities, have an impact on the application of information materials (Flyen et al., 2016; Hanssen et al., 2013). It also includes theories on social learning, and the way social learning increases the chances of double- and triple-loop learning (Orderud and Winsvold, 2012). In in elucidation of social learning theories, the findings demonstrate the importance of developing and using web portals and guides in *social settings* to increase their impact. These findings from the qualitative part of the study show that the abundance of user guides demonstrated in the quantitative analysis does not automatically lead to better climate adaptation, and is dependent on supplementary climate service strategies.

4.2.3. Insufficient capacity?

Part of the reason for not using available guides, could be a lack of capacity. Executives with climate adaptation responsibility have received feedback that municipal employees lack the time to research and read what they need.

> *We see that there has been an awful lot which has been pointed at the municipal sector telling them that they should solve this. And the knowledge dimension from the state's side has been a concern.*

However, skills development, capacity building and capital, such as subsidies, have all been virtually absent. And it is of course a poor base to be able to build such a comprehensive and complex area such as climate change upon. (Expert Interview 4)

Climate adaptation is just one of many tasks for the municipalities, and as long as it does not follow task earmarked funds, it has a tendency to be disregarded. This corresponds with the results of the research by Næss et al. (2011), which found that a lack of capacity was a major barrier to using guidance material and information. It is difficult to allocate time and resources for learning. The quotations also illustrate the need for quick access to the relevant solutions and measures, and this should be reflected in the way user guides on climate adaptation are developed. These findings correspond well with the quantitative thematic analysis; the abundance of user guides, the long introduction texts on climate changes in general, and the difficulties in finding information on concrete measures. Further research should document which user guides are used the most, and why.

4.2.4. Academic level – practical knowledge

Another aspect that is highlighted in the interviews, that may be one reason why many guides are little used, is the translation between academic and practical knowledge (Vaughan and Dessai, 2014; Næss et al., 2011). How the guidance material is appreciated depends on experience. Small municipalities may struggle to hire people with higher education and the appropriate competence. It was emphasized that in small municipalities there are many generalists – employees who must be able to perform within a broad field. Larger municipalities have the opportunity to acquire several specialists and thus have a larger professional environment. In addition, one of the interviewees believed that in many user guides there is a gap between the knowledge presented, and knowledge that can be used directly. The natural science foundation needs a lot of processing in order to become understandable measures for climate adaptation in each municipality.

Yes, it is the scientific foundation, but ... and this is a very important point that I want to stress right away: Who are the translators in Norway who take it from the scientific knowledge base to what this means for municipality A, B and C ? For example: yes, we get three weeks more of ice flows in rivers in Troms – but what does that mean for the municipality? There are so many different disciplines involved, one must have a relatively large number of different translators. (Expert Interview 4)

How the information in a user guide is received, largely depends on the competence of the user. With user guides that are too detailed and prescriptive about specific solutions for climate adaptation, one can also risk provoking those who are competent enough to develop new solutions themselves. It is therefore important that a user guide is detailed and practical, but also allows for creativity, and is not too strict about how the measures should be done. A challenge, considering that user guides should focus on practical knowledge, is that the technology development happens fast. It is thus difficult to keep the guidance material updated. The practical form of the guidance material, is also dependent on the target audience. The farther down in the decision hierarchy the audience is, the more practical the content will need to be.

5. Conclusions and further research

What characterises the guidance identified documents? There is a huge amount of guidance material for climate adaptation in Norway, 74 guidance documents, and 10 web portals are categorised. The interviews confirm the general perception of an overwhelming amount of guidance documents. The largest share of the mapped material concerns the climate adaptation of buildings, storm water run-off, water quality, and drainage. None of the guidance documents describe decision processes and cooperation in depth. A large share of the guidance material communicates climate adaptation at a general level, focusing on background information rather than in-depth practical measures. In many of the guidance documents, no target groups are specified, thus it is difficult to know which group they address.

How is the promotion of the guidance material experienced by some of the experts working to introduce climate adaptation in the Norwegian society? The qualitative part of the study gives explanations as to why the large amount of user guides do not close the knowledge gap on climate adaptation among public and private stakeholders at different levels. A main conclusion is that the abundance of user guides will not automatically lead to better climate adaptation. Too few user guides for climate adaptation sufficiently secure easily accessible information on *practical measures*. Informants express a need for a greater number of descriptions about practical measures, especially for employees in small municipalities who are often generalists. The guides are not broadly utilised, the language and length of the texts are sometimes problematic. The interviews also revealed that topic-specific web-sites seem to be more often employed than general webpages for climate adaptation. The impression is that the sheer volume of user guides may lead to confusion and insecurity among the users, something that according to environmental psychology theories may lead to indecision and non-responsiveness (Gifford, 2011). The large number of user guides may therefore be a barrier against effective climate adaptation.

The results can be used in order to develop better user guides for climate adaptation by answering the weaknesses found within existing user guides when developing new guides (see the practical implication part for details). The deficiencies might be overcome with more user involvement in guideline development. This would probably improve the accuracy of scope, contents, and target group. Keeping track (public tables) of the national climate adaptation user guides and how much they are used would provide easily available overviews of user guide characteristics for those responsible for developing new guides. The possibility of comparing user guides tables from different countries would also provide useful information, and show which user guides are especially relevant for translation. The overviews of user guides would be valuable impressions of periods of time or a development stage in the climate adaptation advancement process in a country. The research founding the basis of this paper is directed towards Norwegian governmental departments and municipal administration and management. However, the general conclusions are also relevant for countries with similar climate and societal challenges. There is reason to believe that the user guide situation in climate adaptation is similar in other western countries. Vaughan and Dessai (2014) describes how the field is marked by relative fragmentation, and users that are confused by the diverse array of products. Norwegian laws and regulations for climate adaptation are wide and dependent on interpretation. It is up to the municipalities to decide how, and to what degree, to carry out measures for climate adaptation. National climate services therefore become important, ensuring that climate adaptation happens. This situation correspond to how climate adaptation is treated in many other Nordic and European countries (Hanssen et al., 2013; Weis et al., 2014).

The study is conducted as a basis for further case studies in municipalities and companies within the research program Klima 2050, where guidance material and decision processes will be studied from a *user perspective* in the next phase.

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