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Adaptation to sea level rise in spatial planning – Experiences from coastal towns in Norway

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ABSTRACT

Rising sea level has become a spatial planning challenge in Norway, as in many other coastal countries. This article focuses on how some selected Norwegian coastal towns adapt to this challenge in their spatial planning, and identifies potential barriers and opportunities for adaptation. Hammerfest in northern Norway is of particular interest since it is one of the few municipalities in Norway that addresses the future rise in sea level in its current municipal master plan. The main conclusion is that although sea level rise has scarcely been acknowledged as a challenge to spatial planning, there is increasing awareness and knowledge of the issues and impacts it presents. An important barrier to adaptation is the lack of authoritative signals from the national government. In Hammerfest there are enthusiasts in the municipal administration, and their ability to build networks with other relevant parties – including both the Planning Section in the municipality and other actors outside the municipality – which is a major reason for the consideration of sea level rise being integrated into the master plan.

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1. Introduction

Combined with more frequent spring tides and storm tides, rising sea level is one of the expected impacts of climate change in the future. Although Norway has a relatively rugged coastline, with hard rocks that are resistant to erosion and a relatively steep coastline that makes the country less vulnerable to marine flooding compared to many other coastal nations (Aunan and Romstad, 2008), many of the Norwegian towns are located in close proximity to the open ocean and are thus vulnerable to a rising sea level. Furthermore, a massive development has occurred along the waterfront in several Norwegian towns (Klausen et al., 2012), which further increases their vulnerability. This article focuses on how some selected Norwegian coastal towns adapt to this challenge and on highlighting barriers and opportunities when attempts are made to integrate sea level rise into spatial plans. The town of Hammerfest in northern Norway will be particularly in focus since it is one of the few municipalities in Norway that addresses the future rise in sea level in its current municipal master plan.

The capacity to adapt to climate change can be defined as the ability or the potential of a system to respond successfully to climate variability and climate change, and includes changes in actions, resources and technology (Brooks and Adger, 2005). Successful adaptation to climate change requires strategies and measures to be integrated into the ordinary planning decisions (Smit and Wandel, 2005). Evidence shows that spatial planning plays an important role when developing robust cities (Wilson, 2006). Moreover, it is important to have reliable knowledge when action on adaptation is required. This is particularly a challenge regarding sea level rise because of the lack of previous experience.

By downscaling results from global climate models, a report compiled in 2009 shows the expected relative sea level rise for all the Norwegian coastal municipalities in 2050 and in 2 100 (Vasskog et al., 2009), as is shown in the figures for some towns in Table 1. These estimates also include expected storm tide at the same time. The report was prepared by the Bjerknes Centre for Climate Change at the University in Bergen, and is published by the Norwegian Directorate for Civil Protection. The relative sea level rise is estimated, and takes into account the ongoing post-glacial rebound. It emphasises that the figures are estimates only and hence should function as a guide for planning. However, the report presents the best available evidence of this phenomenon at the present time.

In Norway, the municipalities are the primary planning authority and they adopt binding spatial plans according to the Planning and Building Act (PBA) from 2008. However, the plans must be in accordance with national and regional policies, and a variety of national and regional actors have the right and obligation

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Table 1
Estimated figures for sea level rise in some of the largest towns along the Norwegian coast in 2050 and in 2100, including the case towns in this study (in bold) (Source: Vasskog et al., 2009).

Norwegian cities	Year 2050			Year 2100		
	Rebound (cm)	Sea level rise (cm)[a]	Storm tide (cm)[a]	Rebound (cm)	Sea level tide (cm)[a]	Storm tide (cm)[a]
Hammerfest	13	19 (11–33)	236 (228–250)	25	65 (45–100)	287 (267–322)
Tromsø	13	18 (10–32)	237 (229–251)	27	63 (43–98)	287 (267–327)
Bodø	18	13 (5–27)	257 (249–271)	36	54 (34–89)	303 (283–338)
Trondheim	24	7 (−1–21)	254 (243–265)	48	42 (22–77)	294 (274–329)
Ålesund	9	22 (14–36)	220 (212–234)	19	71 (51–106)	274 (254–305)
Bergen	8	23 (15–37)	186 (178–200)	17	73 (53–108)	241 (221–276)
Oslo	25	7 (−2–21)	197 (189–211)	49	41 (21–76)	236 (216–271)
Fredrikstad	19	12 (4–26)	172 (164–186)	38	52 (32–87)	217 (197–252)

[a] Uncertainty intervals in ( ).

to participate in municipal planning processes to ensure that these requirements are met. In addition, detailed planning of urban areas is conducted in close cooperation with private developers, where private actors and their consultants currently account for much of the planning process and thus set many of the premises for the final decision (Falleth et al., 2010). The PBA also requires broad participation from the local communities in the planning processes. Thus, many different actors – often with diverse and conflicting interests – are involved in the planning process, resulting in major coordination challenges. Hence, how this is handled is of crucial importance for how municipalities are able to adapt to climate change, such as increased sea level.

Rising sea level is a new challenge in municipal planning in Norway, and there is no formal approach regarding how to deal with such long-term scenarios that are associated with such a degree of uncertainty. At the same time, urban development planning also has a long-term horizon (Dessay et al., 2007), and handling different types of uncertainty is therefore embedded in the nature of planning. Adapting to rising sea level within an existing urban structure can be difficult since neighbouring buildings and piers may be at levels that are at the risk of flooding, and the incorporation of new buildings can be demanding. The fact that the issue of climate change adaptation in urban development is a relatively new topic does not make the situation easier. To date the focus has been more on how to reduce energy consumption and CO2 emissions (Owens, 1986; Næss, 2006).

2. Adaptation, organisational learning and governance modes

In this article we draw upon theories of organisational learning and governance modes to understand adaptation and adaptation capacity. A starting point was the work of Berkhaut et al. (2004), and the model was first presented in Winsvold et al. (2009). Adaptation to climate change requires organisational learning, which means that learning is involved in the organisational routines. The model in Fig. 1 is a generalised approach to describing how organisations respond to changes in their environments – in this case information about sea level rise. Four stages are identified in the model. First, it is assumed that the learning process starts when organisations receive and interpret *signals* about incipient changes in their environments and eventually acknowledges them as a problem (see Fig. 1), cf. the first research question in this paper. Second, the organisation initiates a *search* for viable solutions as a response to the problems posed by the signals and knowledge. Third, these solutions are *articulated* into specific, implementable measures, for instance as strategies and efforts in the plans, cf. the second research question. Fourth, there is a *feedback* stage.

All four stages of the learning process in Fig. 1, which make the adaptation space, are profoundly affected by the governance mode that characterises the organisation and its environment. However, these four phases will rarely occur in a tidy, linear sequence as listed in this model. A guiding assumption of the empirical research has been that hierarchies, markets and networks provide quite different preconditions for learning and adaptation.

In a hierarchical governance mode, learning and adaptation take place in the form of command and control from above. The key prerequisite for achieving adaptation is the existence of centrist authority with legitimate power of decision making and means to ensure compliance, including control over funding and means of coercion. Based upon this understanding of hierarchies, signals and knowledge about climate change impacts must be received and interpreted by the top level of the system. This is because the top level is in charge of decision making – in other words the "articulation" of actual adaptation measures. In line with the hierarchical model, these decisions would need to be made in the form of binding directives to the appropriate subordinate levels. This could, for instance, be a decision made by a municipal council on the minimal height above sea level of new buildings, which would have a binding influence on the town's planning department.

The market is a governance mode devoid of the centrist authority found in hierarchies. Adaptation has to be achieved through the autonomous self-adjustment of numerous operationally independent actors. The sole means of communication between the actors is the price mechanism. In perfect markets no single actor is able to affect prices. Instead, a product price will emerge that balances supply and demand, and the actors have to adjust their behaviour accordingly. For instance, if homebuyers became aware of the risks associated with future sea level rise, there would be an increasing demand for buildings far away from the waterfront. Growing demand would increase the price of such houses, and this signal would be interpreted by private developers. The search for measures would most likely result in the "articulation" of the decreasing supply of waterfront houses.

Networks represent, in several ways, a point between hierarchies and markets. Contrary to hierarchies, there is no centrist authority. The participants in networks are operationally autonomous, but contrary to market actors they are mutually interdependent and require direct communication. Neither hierarchies nor markets leave room for arguing and bargaining, which represent the key mode of governance in networks.

The different governance modes are ideal types, and will hardly be found alone. Instead, in urban planning and development, a mix of them – 'governance arrangements' – will usually be in play (Heinelt et al., 2006). The hypothesis is that the governance mode, or governance arrangements, will influence the learning process

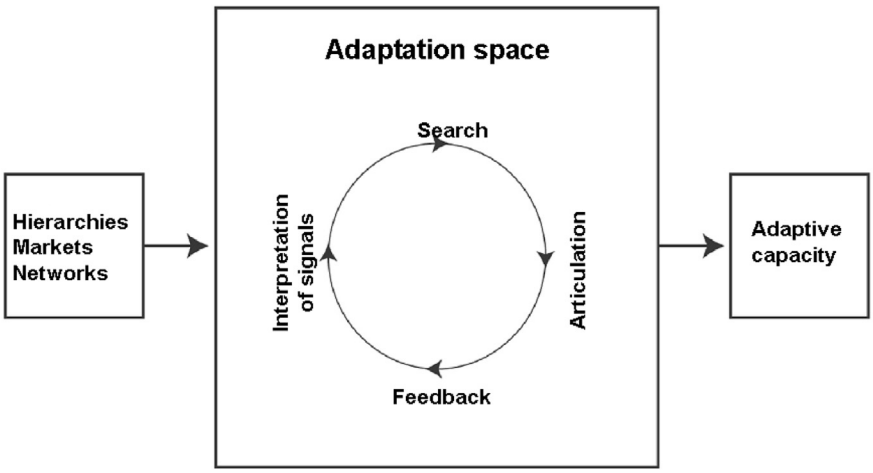

Fig. 1. A conceptual model of adaptation, combining organisational learning and governance modes.

and hence the actual adaptation to rising sea level in spatial planning.

Adapting to rising sea level in the future depends on capturing and recognising this challenge as an issue in the planning process. The first research question in this article is how rising sea level is perceived as a spatial planning challenge and is relevant among planners, politicians and developers in the selected coastal towns. Furthermore, the adjustments are subject to the same actors' search for possible solutions to meet the challenges that rising sea levels pose to urban development, as well as the selected solutions being articulated and implemented within the on-going planning processes. The second research question is therefore to what extent the coastal towns have adopted policies and measures in their plans according to the PBA. Moreover, potential barriers to and opportunities for adapting to sea level rise will be identified. In this context it will be argued how the three different coordination mechanisms: the hierarchy, the market and the network – all of which are present in urban development and planning (Winsvold et al., 2009) – promote or prevent adaptation. Then the town of Hammerfest will be addressed, and focus will be placed on why Hammerfest is the town among our cases that has made the most progress when it comes to integrating the concern of rising sea level into their spatial planning.

3. Method and data

The empirical material in this article was gathered in the PLAN project[1] in Norway. We obtained additional information about Hammerfest from the Interreg project CoastAdapt,[2] which was the Norwegian site in the project. In the PLAN project, case studies were conducted in four small and medium-sized coastal towns: Fredrikstad, Ålesund, Bodø and Hammerfest (see Fig. 2). The towns were selected on the basis of a number of criteria. First, we wanted to have a geographical variation along the Norwegian coast to secure different climate change vulnerabilities, i.e. regarding sea level change (see Table 1). Second, all the case towns have experienced a significant population growth. The ensuing demand for urban development was expected to provide fertile ground for identifying relevant planning projects for empirical study. Third, the towns were selected partially based on size, a factor which could potentially affect the capacity to adapt to climate change. The towns vary substantially in this sense, from approximately 73 000 inhabitants in Fredrikstad to 46 000 in Bodø, 42 000 in Ålesund, and 9 000 in Hammerfest. Finally, it was seen as appropriate to include some towns involved in networking activities concerning climate change adaptation, and some that were not. While Ålesund and Bodø have not been involved in such networks, Fredrikstad is a

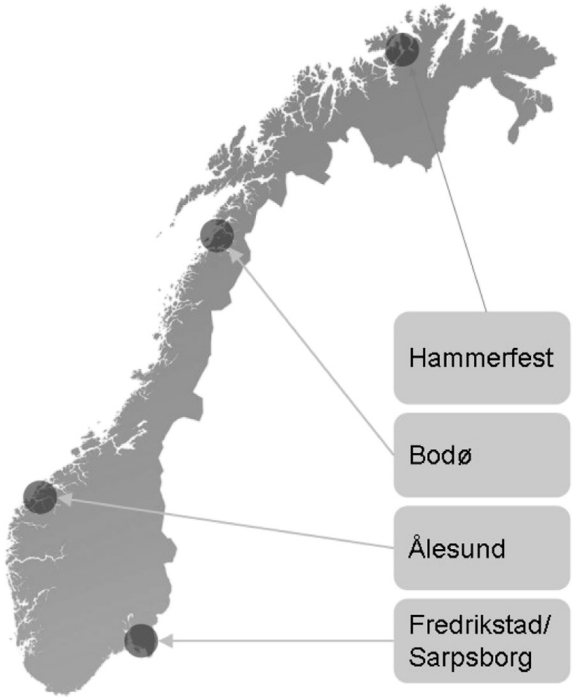

Fig. 2. Geographical location of the five case study towns.

[1] The research project Potentials and Limits to Adaptation to climate change in Norway (PLAN) was funded by the Norwegian Research Council and the programme NORKLIMA. The project was led by the University of Oslo with a number of partners. One of the work packages focused on adaptation in urban planning and in waterfront development, led by the Norwegian Institute for Urban and Regional Research, to which the data in this article is related.

[2] CoastAdapt: The Sea as Our Neighbour. Adaptation to Climate Change in Coastal Communities and Habitats on Europe's Northern Periphery. The project was a partnership of administrative bodies and research institutes from Scotland, Ireland, Northern Ireland, Iceland and Norway. For more information see www.coastadapt.org.

member of the national network Cities of the Future.[3] Fredrikstad has also participated with Hammerfest in the research project NORADAPT.[4] As mentioned, Hammerfest was a partner in the CoastAdapt project.

In total 23 in-depth interviews were conducted with planners in local administrations, and with local politicians, private developers and consultants. Each interview lasted between one and two hours. In all 44 persons in the case towns were interviewed. The interviews were conducted in two stages between autumn 2008 and spring 2010. In the first stage the town planners were interviewed as well as other representatives from the local administration and local politicians. Here a couple of relevant waterfront development projects and zoning plans in the towns were selected for more in-depth studies. The urban development projects were chosen based on the public list of new zoning plans and in dialogue with the town planner and other representatives from the local administration, who identified vulnerable geographical areas that are in urban transition.

In the second stage of the interviews in 2010, the responsible developers and consultants for the selected urban development projects were interviewed, together with follow-up interviews with town planners and other key informants. A semi-structured interview guide was used in all the interviews (Kvale, 2006), where the research questions of the study were made into more specific questions about the informants' perception of impacts and vulnerability relating to climate change, how they handle the knowledge and the uncertainty, and how adaptation has been integrated into the planning processes. The master plan for the case towns and related documents were analysed, in addition to documents related to the selected urban development projects in each case town.

In Hammerfest we obtained additional empirical data from the CoastAdapt project. Through CoastAdapt a total of three workshops were organised at each site, including in Hammerfest. The objective of the workshops was to strengthen adaptation capacity and identify adaptation strategies and efforts. The participants were primarily administrative staff from different parts of the Hammerfest municipality and the Finnmark office of the Norwegian State Housing Bank.[5] The workshops were organised as plenum sessions and group discussions. In the first workshop in 2009 the issue of climate change adaptation was put on the agenda, and its possible impacts for Hammerfest were discussed with regard to livelihood and businesses, infrastructure and housing. In the next two workshops in 2010 and 2011 relevant strategies and measures to face the possible impacts were addressed. Minutes were taken of the discussions from all three workshops.

4. Local awareness of rising sea level in urban planning

The primary impression from the interviews in the selected case towns (cf. Fig. 2) is that there is generally little knowledge and awareness of the scenarios for rising sea levels among planners and other public and private actors in urban development. Generally we find that plans for new developments along the waterfront in the towns rarely take sea level rise into account. The measures for emission reduction have dominated the urban debate in recent years, while climate adaptation has received little attention. We also find that it is easier for politicians and other actors responsible for urban development to relate to known climate phenomena such as landslides, flooding and wind than to expected rising sea level in the future. Rising sea level is a new challenge in planning and one which Norwegian towns have not yet experienced – contrary to strong winds, landslides and flooding. This is in line with other studies that show that local level adaptation to climate change in Norway is to a large extent a reactive phenomenon, defined as responses to weather- and climate-related events in the past (Næss et al., 2005; Dannevig et al., 2012; Amundsen et al., 2010).

We do however find a slight increase in awareness of the need for climate adaptation from the first round of interviews in 2008 to the second round of interviews in 2010 in all the four case towns, particularly among municipal planners and private planning consultants. It may be related to the report on rising sea level in Norwegian coastal municipalities that was published in 2009 (Vasskog et al., 2009). However, even in 2010 several of our interviewees did not know about this report. Among those who were familiar with it and had read it, there was considerable uncertainty regarding how to handle this in practical planning, i.e. how planners should translate such scientific knowledge into practical knowledge (Schön, 1983). A survey of Norwegian municipalities (questionnaire sent to the mayors and administrations responsible for climate and environment in 2007 and 2011 respectively) confirmed that professionals in municipalities have increasingly become aware of climate change and have progressively introduced the issue on the public agenda. However, at the same time Norwegian mayors have become more sceptical about the veracity linked to man-made climate change in the same period (Harvold, 2011).

Who actually promotes the issue of climate adaptation in general, and increased sea level in particular, in urban planning processes seems to vary. In some cases it is the municipal planners, while in others it is the private planning consultants. In addition, we find examples of state actors at the regional level who have a right and obligation to participate in local planning that addresses the issue of sea level rise in waterfront development plans. However, the signals did not come in an authoritative manner that these actors had the opportunity to use by raising formal objections to local plans that increase vulnerability to climate change. In addition, there is no consistency regarding who actually raises this issue. The sector that is formally responsible for climate change at the regional level, the County Governor's emergency department, had not set requirements for increased awareness to rising sea levels in local planning processes in our four case towns. Whoever it is who takes the responsibility for putting the issue of sea level rise on the agenda in spatial planning thus seems to be rather incidental.

There are also considerable variations regarding from where knowledge about adaptation comes and how proactive the actors are in seeking updated information. We note that the will to build on the most updated knowledge is largely inherent in the planning profession in both municipal planners and private planning consultants. We find an example of a proactive search for knowledge about rising sea level among municipal planners linked to ongoing planning in Bodø. In this case, it was an employee in the Planning Department who on his own initiative contacted the nation's leading researchers on climate change in the middle of a project planning process related to a larger building on the waterfront. A 100-year perspective that the building was to endure was assumed (cf. Table 1), and with a safety margin it was decided that the new buildings in the area should endure a sea level rise of 0.9 m.

Regarding the second research question, if municipalities have adopted strategies and measures to adapt to rising sea levels in the future, this is a form of articulation of knowledge that is dependent

[3] The Cities of the Future network is a collaboration between the Government and the 13 largest cities and towns in Norway to reduce greenhouse gas emissions, strengthen local adaptation and improve quality of life in the cities.

[4] NORADAPT – Community Adaptation and Vulnerability in Norway – was a collaborative research project between ten municipalities and research organisations funded by the Research Council of Norway.

[5] The Norwegian State Housing Bank is the main agency that implements the national housing policy in Norway, and its primary aim is to supply adequate and secure housing for everyone.

upon awareness of increased sea level and acceptance of this as a reality, and hence to begin searching for specific solutions in response to the identified problems (see Fig. 1). The general impression from the interviews and review of the planning documents in our case towns was that sea level rise was of little concern in urban plans and strategies. The fact that adaptation is rarely addressed in municipal plans is confirmed in the two surveys of Norwegian municipalities conducted in 2007 and 2010 (Berglund and Nergaard, 2008; Harvold, 2011). The municipalities are encouraged to make climate and energy plans, among other tasks, but there are still relatively few municipalities that have drawn up such plans. Among those municipalities that have made plans, the primary focus is on measures to reduce greenhouse gas emissions. These plans rarely focus on strategies and measures to adapt to climate change.

However, we find some examples of actual adaptation to scenarios of increased sea level in some urban development plans in our case towns, as the example above shows. Another example is in Ålesund, where in connection with a complex regulatory plan for the urban waterfront in the town centre a provision was added regarding minimum heights for the new development:

> Minimum heights of buildings, street and quay level: Before the development of the area commences, with new docks, squares, streets and residential areas and other buildings close to and directly above the current sea level, ROS[6] assessments of sea level rise and increased frequency of extreme weather will be conducted. Based on the ROS analysis, a common minimum height of one floor level of buildings, quay and street level will be set. For the present recommendation of the DSB,[7] minimum height will be higher than the current quota of +2.7 m − 3.2 m. As this is a greater long-term perspective in the town centre, a perspective up to 2 100 must be assumed (author's translation).

The decision on the wording of this provision to the plan was determined through an e-mail discussion between the town councillor, the environment manager, the emergency preparedness manager, the harbourmaster and the municipality's head architect. The initiative for the condition came from the heads of environmental protection and of emergency preparedness, which meant that the municipality should be more specific on buildings' heights in order to be prepared for future sea level rise and the tide. However, the neighbouring property also adopted a regulation at about the same time, but it did not set any corresponding conditions on height of buildings. Nor does the municipal master plan, which is the municipality's top management tool, address the concern about increased sea level. The concern of sea level rise is therefore not fully articulated and has not become an integrated part of the planning. The municipality that has progressed furthest in our study is Hammerfest, which we will return to later in this article.

5. Obstacles and opportunities for adapting to rising sea level

The three coordination mechanisms hierarchy, market and network are used to discuss the obstacles and opportunities for municipalities when it comes to adapting to rising sea levels (cf. research question three). Within *hierarchy* in the documents examined related to local plans in the four case towns, there were few or no authoritative signals from the national government to local authorities on climate adaptation in general and adaptation to rising sea levels in particular. The municipalities use this as justification for the lack of focus in developing and implementing adaptation measures. According to the interviews, the national government assumes that adaptation is primarily a municipal responsibility. Moreover, there is an unclear division of responsibility within the national government regarding climate adaptation, and as mentioned this is reflected in who displays concern for rising sea levels in their statement regarding the municipal plans. We also find that the four case municipalities rarely use their formal authority over private developers to set conditions on adapting to rising sea levels in specific development projects along the waterfront. We are thus witnessing a type of hierarchical apathy in which all parties are waiting for others to take action (Klausen et al., 2012).

The estimates of expected sea level rise in 2050 and 2100, which were published in 2009, have to a certain extent contributed to placing the issue on the municipal agenda, but there is uncertainty about how to apply them in practical planning. These are not authoritative signals, but are intended to act as guidelines for municipal planning. The PBA was revised in 2009, and the need to assess possible risks during development was then tightened. More formal remedies in the law involving taking the risk areas into account were also provided. Moreover, it was also emphasised that risk and vulnerability analyses had to be conducted, and that these should form the basis for planning. Climate change is not mentioned explicitly in the new guidelines of the law, but the severity of the regulations together with the specific knowledge base through the estimates of sea issues seem to have contributed to the need for greater concern about the sea level on the agenda of municipal plans.

The ambiguous governmental responsibility for climate change in general and particularly the rising sea level has also been pointed out in recent times, including in an NOU 2010 (Official Norwegian Report) entitled "Adaptation to a changing climate", which was published on 15 November 2010. This report pointed out that flooding of rivers/surface water management and rising sea level should be seen in connection with the implementation of the EU Flood Directive and that assessments should be made, with the Norwegian Water Resources and Energy Directorate being responsible for both of these areas. The goal is to identify a clearer division of responsibility and hierarchical structure for flooding of both freshwater and saltwater.

We find that the *market* is to only a small extent a force to adapting to rising sea levels in spatial planning and urban development. The demand for seaside plots remains strong, with high and rising prices. A slight tendency in climate adaptation thinking may be traced in the market actors' anticipation of a possible future demand for climate-adapted housing. Whether such anticipation exercises control depends upon the time horizon of these projects: the developers who are to sell immediately after the house has been built have fewer concerns about climate adaptation's potential profitability than those who will own and administer what they are building for some time to come.

Many of the actors in urban planning and urban development in the case towns are parts of different *networks.* This may be a professional network such as architects or engineers, an administration network with employees in various municipalities within specific sectors, networks between municipalities and research/R&D institutes, or a government-initiated network such as Cities for the Future lead by the Ministry of Environment.[8] Participation in these networks where climate change is on the agenda appears to have an awareness-raising effect. Specifically, professional

[6] Risk and Vulnerability Analysis.
[7] The Directorate for Civil Protection and Emergency Planning.
[8] Among our case towns both Fredrikstad and Hammerfest are involved in Cities for the Future.

networks appear to be important for adding adaptation to climate change to the agenda in our case towns. However, these networks are often isolated from each other, and the extent to which the participants in the networks are able to bring awareness and new knowledge back to their own business or municipality varies. In addition, the networks themselves have no implementing authority, and solutions must therefore be embedded either in the hierarchical structures in the municipal plans or in the market in order for climate adaptation to actually take place.

Lack of hierarchical control allows committed individuals to play a significant role. In those cases where adaptation occurs, it is not because of orders from the superior through the hierarchy and not as a result of market demand, but because committed individuals are placed in key positions and at the same time have the ability to put climate adaptation on the agenda of their networks and organisation. We find these individuals in Hammerfest, which is discussed more thoroughly below.

6. Climate change adaptation and planning strategies in Hammerfest

Hammerfest municipality comprises an area of 863 km2 west of Finnmark County. Over 90% of the total population of about 9 700 lives in Hammerfest town and the suburb Rypefjord. Hammerfest town has the harbour as its focal point and it is characterised by a concentrated urban settlement. The proximity to fishing grounds and the fishing industry has been the key foundation for settlement in the municipality, but its relative importance has declined in recent years. For the last ten years the petroleum industry has been significant for Hammerfest, which escalated with the construction of the LNG plant[9] in 2002. The plant transforms gas to liquid form. This has been an important force in the development of Hammerfest through new jobs and increased income for Hammerfest municipality. Over the past few years the town has experienced a substantial growth in population, especially among the age group 20–40 years of age. Housing development and the value of houses have increased, and the young people have greater faith in the future (Eikeland et al., 2009). The positive growth has contributed to the development of a number of new residential areas and new urban development projects. The topography and climate mean that there is limited space to build on.

> The property's location between the mountains and the sea adds natural limitations for the further development of key areas[10].

As one of the world's northernmost towns and with the arctic climate there is little vegetation, and the town is therefore fairly exposed to the wind and weather as it is located between the Barents Sea and the steep slopes of the mountain. One of the challenges is the winter avalanches and rock falls in summer from the steep mountain slopes down to the town and many of the residential buildings. Snow screens and large structures designed to protect the buildings are bolted along the mountain slopes and are well visible in the town.

As mentioned, the town is one of the few municipalities in Norway, and the only one of our case study towns, that incorporates the consideration of future rising sea level into its overall master plan. The municipal master plan for Hammerfest was adopted in December 2010, and the plan contains the following provision[11]:

> Upon completion of building projects in seaside areas that are lower than +3 m contour, necessary measures shall be implemented against water ingress. The floor level in living rooms must be above the contour +3 m (author's translation).

According to representatives of the municipal administration, action was taken in accordance with this provision several years before the plan was formally adopted in 2010. The administration has chosen to act on existing knowledge in spite of all the uncertainties in the estimates of future sea level rise and despite the lack of standards and signals from the national government. As part of the planning process, vulnerable areas in Hammerfest related to estimated sea level rise in the future were also surveyed, and these are presented using GIS. In addition, the municipality has decided that all private development projects promoting plans for housing and urban development shall prepare a climate analysis where all climate conditions related to the project should be considered, including rising sea levels and tides/storm surges. Hammerfest has chosen to adopt and follow these signals in spite of the fact that the signals have not been given as statutory requirements.

An important factor in explaining Hammerfest's implementation of these strategies for rising sea levels in their planning are enthusiastic individuals in the municipal administration and their networks. The impression from the study is that a great amount of learning and awareness has been raised through collaboration and networking within the municipal administration and in collaboration with external research institutions, consultancies and the Norwegian State Housing Bank. The collaboration with the Norwegian State Housing Bank's regional office in Finnmark (located in Hammerfest) is particularly emphasised in the interviews. Ever since the 1980s there has been collaboration on developing climate-customised homes, which have helped place climate change high on the agenda for several years. The primary focus, however, has been on the current climate rather than on the climate changes of the future.

Regarding awareness of the challenges of the future climate, this first appeared on the agenda when the municipality joined the research project NORDADAPT in 2006. This project facilitated learning from other municipalities and participation in new knowledge from leading research on climate, including downscaled effects of global climate change related to temperature, precipitation and sea level at the municipal level (Engen Skaugen et al., 2009). According to one of the informants in the community, this was not before time as the municipality was then (and still is) also in the middle of a large development and transformation phase and it is important to adapt to climate change in urban development.

> Since we shall build an entirely new town for the next 100 years, we must have knowledge of the future climate in the planning.[12]

In addition, municipalities' participation in the Interreg project CoastAdapt from 2008 has meant that the topic has been a strong item on the agenda. Enthusiasts in municipal administration have managed to involve key people in this administration in these networks so that more people have taken part in raising knowledge and awareness – particularly employees working with planning, property and business, as well as key parties in the Norwegian State Housing Bank's regional office in Hammerfest. Under the auspices of CoastAdapt, three workshops were held in Hammerfest, all aimed at increasing the local capacity to adapt to climate change. The first

[9] Liquefied Natural Gas.

[10] www.hammerfest.kommune.no, author's translation.

[11] A provision to the municipal master plan (the land use part) is in Norway legally binding.

[12] Representative of the administrative staff in Hammerfest municipality, author's translation.

workshop was held in September 2009, the second in February 2010 and the last in June 2011. Basically, it was employees from various parts of Hammerfest municipality and the Norwegian State Housing Bank's regional office who attended. Local politicians and representatives of NGOs and civil society were not at the meetings, even though they were initially open to everyone. At the meetings, current and future climate changes were on the agenda, as well as discussions of possible strategies and actions to meet the challenges. As a professional background, CoastAdapt prepared a climate vulnerability analysis of Hammerfest, built upon the model that was used for the communities involved in Coast Adapt (Angell and Stokke, 2012).

Besides the importance of enthusiastic individuals and internal and external networks, the actual context is also a major explanation as to why Hammerfest has integrated adaptation strategies into their plan. First, the municipality is used to adapting to extreme weather conditions. Hammerfest has a long history of thinking about the climate in planning and administration, which has diminished the steps to take into account future climate changes. In addition, experience of extreme weather is emphasised in the NORDADAPT project as one of the factors affecting the implementation of climate change measures (Dannevig et al., 2012). However, other case towns have found that experience of extreme weather conditions can turn both ways, even towards an attitude that is more reserved when it comes to the future climate. Another contextual explanation is that the petroleum industry has contributed to the municipality's administrative resources, providing the municipality with the capacity to think beyond its minimum tasks and operations.

The Hammerfest municipality is currently working on a comprehensive adaptation strategy to be developed as part of the climate and energy plan. This plan has not yet been decided politically, and it may seem as if politicians in Hammerfest do not currently prioritise this issue at the moment. An important challenge is therefore to involve local politicians to a greater extent in the networks where climate change is the theme, so that they too can take part in learning and raising awareness. Another challenge is to involve private developers, business and civil society in the work of climate adaptation. Currently, networks and processes where climate change is the topic are generally restricted to administrative staff in the municipality and Housing State Bank employees in Hammerfest.

7. Conclusion

In the initial research question we asked to what extent the coastal towns in our case consider scenarios of future sea level rise as a relevant planning challenge, and whether strategies in urban planning have been developed to meet these challenges. The main conclusion is that this has scarcely been acknowledged as a challenge to planning, but there is an increasing awareness and knowledge – in particular among municipal planners and private planning consultants. The towns have, to a lesser degree, come so far in the learning circle, cf. Fig. 1, that they have expressed this concern through strategies and actions in the municipal plans for urban development. The only municipality among our cases that has integrated the consideration of future sea level rise in their overall municipal master plan is Hammerfest.

An important barrier to adaptation is the lack of authoritative signals from the national government. So far, what comes in the form of consultative statements to municipal plans from national and regional agents is incidental and uncoordinated. The Norwegian planning system is hierarchical, and despite its relative decentralised structure we see a type of hierarchical apathy. Nor has the need to adapt to the rising sea level reached the market, where the demand for seaside land is still rising.

It is in the form of networks that we find most signs of climate adaptation and, more specifically, adaptation to rising sea level, although for this issue we find mostly small and isolated networks. In Hammerfest there are enthusiasts in the municipal administration who are able to build networks with other relevant sections in the municipality, including the Planning Section. This is a major reason for the consideration of sea level rise being integrated into their master plan. In addition, the network with the Norwegian State Housing Bank's regional office in Hammerfest since the 1980s regarding climate-adapted housing has been important and has contributed for some time to raising awareness of this topic. When it comes to adapting to the future climate, participation in ongoing research and governmental projects have had an enlightening effect. This finding is in line with the experience from the NORDADAPT project, where enthusiasts in the municipalities and their use of external expertise and networks is also emphasised as an important force for implementing adaptation measures despite the lack of signals from the national level (Dannevig et al., 2012).

Hammerfest municipality has been able to use its formal opportunity as planning authority to include adaptation to sea level rise in the municipal master plan, which is to work to control new development projects in Hammerfest. However, it has only been possible to a lesser extent to involve local politicians, private developers and others representing the local community in networks and processes where learning and raising awareness of the need and opportunities to adapt to climate change has taken place. It may be important for local authorities to facilitate appropriate venues with a variety of stakeholders in the local community to strengthen the capacity of local adaptation to climate change on a wider front. Spatial planning and urban development involves many different actors, and there is a need to establish a common understanding about climate change and its impacts in order to implement effective adaptation measures. This study supports the conclusion of Saglie (2009) that broad participation and learning networks are particularly suitable in relation to climate change due to the need for long-term strategic planning, the uncertainties of climate change scenarios and the challenges of implementing measures in urban development that involves a multitude of interdependent actors.

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