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Introduction to "Municipalities addressing climate change: a case study of Norway"

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Abstract

Purpose – The purpose of this paper is to provide an introduction to and overview of this special issue titled "Municipalities addressing climate change: a case study of Norway". It provides the rationale for the project leading to the special issue while summarizing the issue's contents and outcomes.

Design/methodology/approach – Seven research institutes in Norway were brought together for a five-year project examining adaptation to extreme weather in Norway at the municipal level.

Findings – The project led to individual and collaborative research linked to policy advice for Norwegian municipalities. Barriers and opportunities to act locally regarding extreme weather were identified, giving ways forward through more science along with policy and action possibilities.

Research limitations/implications – Only three main sectors were covered: drinking water supply, cultural heritage, and flood risk reduction. Extreme weather affects other sectors too, but no advice is given regarding those areas.

Practical implications – The project led to fact sheets, a web site, and engagement with practitioners at the municipal level in two ways. First, providing science-based advice that can be used by those working for municipalities. Second, providing practical advice to scientists regarding what practitioners seek from research.

Social implications – The work will contribute to improving how Norwegian municipalities consider and address extreme weather, in the context of climate change amongst other hazards, along with further social and environmental changes affecting municipalities.

Originality/value – This special issue represents an interdisciplinary, cross-sectoral approach towards useable science. It is also relatively original in providing an interdisciplinary approach for the case study of Norway.

Keywords Norway, Climate change, Floods, Water supply, Cities, Extreme weather, Municipalities

Paper type General review

1. Adapting to extreme weather in Norwegian municipalities

Extreme weather has always affected humanity, bringing advantages and disadvantages for society. If a location experiences more water than has been experienced in the recent past, a flood has the potential for killing people and damaging property including crops. Floodwaters across agricultural land also bring nutrients, revitalising the soil, along with the threat of soil erosion. Meanwhile, a dearth of water might mean a drought, also harming crops and agricultural land but perhaps inspiring advances in water efficiency technologies and behaviour. High winds and wildfires damage forests and can kill trees, also threatening lives and properties, while opening up space in the forest ecosystem for younger trees and revitalisation.

Sleet, fog, ice storms, and blizzards amongst other extreme weather provide problems and opportunities for humanity. How humanity deals with that extreme

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weather – before, while, and after it is experienced – often has much more effect on the resulting consequences than many parameters of the extreme weather itself (Wisner *et al.*, 2011). That is becoming more evident as climate change starts to impact extreme weather.

Around the globe and at all scales from local to global, climate change is influencing how society experiences weather (IPCC, 2007). Extreme weather's frequencies, intensities, and magnitudes seem to be following a trend that in some locations could take weather beyond most of humanity's collective recent experiences in those locations.

For some circumstances, it might turn out to be easier to cope with the new set of weather extremes. In Scandinavia, increasing precipitation is expected to reduce the extent of wildfires across the region (Flannigan *et al.*, 1998) even if local variations increase fire risk (Hanssen-Bauer *et al.*, 2009). On the other hand, the increasing precipitation must be dealt with in terms of floods. Yet, increasing precipitation has the potential for increasing the availability of hydropower, permitting a reduction in fossil fuel use if energy supply and demand is managed appropriately. Meanwhile, increasing precipitation could reduce snow cover, badly affecting snow-related recreation.

For many other situations, extreme weather difficulties are expected to be exacerbated by climate change if society fails to take action to deal with the challenges. It is certainly possible that in a specific locations, overall averages of weather parameters such as temperature and precipitation change little, but extremes become more extreme with higher frequency. That could lead to more floods and more droughts in the same place along with more heat waves and more cold waves.

Longer term climate challenges will also be affected by climate change. Higher absolute humidity is likely to increase on average due to higher average air temperatures, since hotter air can hold more water. Higher absolute humidity increases the potential for infrastructure to experience damage from mould, fungus, and water which also affects human health (Comrie, 2007). Meanwhile, ecosystems will change to adjust to the new climate regime, so new species can move in, displacing or reducing the numbers of local species and upsetting the ecosystems (Mooney and Hobbs, 2000).

Within all these complex changes, what options should be explored for dealing with the effects on extreme weather from climate change, including assessing gradual weather-related changes over the long term? What can and should be done without causing more problems than are solved and without bypassing other societal challenges, not linked to climate change, that must also be addressed?

This special issue provides some answers to these questions for the case study of municipalities in Norway. Norway consistently receives high scores on indices covering human development, transparency, democracy, and wealth per capita amongst others (EIU, 2010; TI, 2010; UNDP, 2010). In theory, Norway should be successfully tackling challenges emerging from extreme weather, including due to climate change, across many time scales. Norway's governance structure is set up so that the municipal governments have much of the responsibility for and control of dealing with this topic. Within it, limited study has so far been completed of specific sector strengths or room for improvement.

In order to fill in parts of this gap and to contribute original science towards understanding the topic, seven research institutes in Norway were funded by the Norwegian Research Council to study how the municipal level could and should manage extreme weather given climate change. The programme lasted from 2006 to 2011 and was called Klima SIP. In Norwegian, "klima" means "climate" while "SIP" stands

for strategic institute programme, referring to a programme across institutes that is meant to provide strategic direction to society. Klima SIP was subtitled "Adapting to extreme weather in municipalities: what, how and why?", thereby setting out the framing for more specific research questions to be answered over short and long-term time scales.

The programme's main objective was to conduct original scientific research in order to aid municipalities in facing the challenges of climate-driven extreme weather, over the short term and the long term. Three specific sectors were highlighted leading to the sub-objectives:

(1) to improve the knowledge and to provide an overview of the challenges facing Norwegian municipalities in terms of extreme precipitation and flooding and the possible effects on drinking water supply, cultural heritage, and flood risk reduction;

(2) to analyse to what degree new and updated knowledge about climate change and increased risks of extreme weather has an impact on policy formation at the municipal level in Norway; and

(3) to investigate whether Norwegian municipalities have adaptation policies and actions to deal with extreme precipitation and flooding for drinking water supply, cultural heritage, and flood risk reduction.

The institutes involved in the programme were:

- Center for International Climate and Environmental Research – Oslo (CICERO) as the programme leader (www.cicero.uio.no).
- Bioforsk (Norwegian Institute for Agricultural and Environmental Research) (www.bioforsk.no).
- Norwegian Institute for Urban and Regional Research (www.nibr.no).
- Norwegian Institute for Cultural Heritage Research (www.niku.no).
- Norwegian Institute for Air Research (www.nilu.no).
- Norwegian Institute for Nature Research (www.nina.no).
- Norwegian Institute for Water Research (www.niva.no).

For Klima SIP, each institute was involved in original scientific research within their sector of speciality, resulting in peer-reviewed scientific papers such as those in this special issue. The scientific questions to address were decided principally by the interests of the researchers, but also linked to feedback received from a reference group that expects to use the science for municipal operations. As part of that, within the programme, the scientists in the project have been working directly with local government workers in order to see what form of information they need from the science. The science should be useable (Glantz, 1997) which means understanding what people need in order to make the science useful to and used by them.

Part of the request from the municipalities was simple, straightforward material that provides advice for municipal policies and actions. One venue was created for that: the web site in Norwegian www.klimakommune.no providing fact sheets that outline the challenges facing municipalities regarding extreme weather under climate change.

The fact sheets also cover material regarding policies and actions to take for addressing those challenges, over the short term and long term.

Notwithstanding the increasing use of online translation tools, providing the material in Norwegian limits those who would find and access it. Since the material produced through Klima SIP would be of interest outside of Norway, this special issue is published in English aiming for an international, scientific readership. Norway's lessons are described for scientists working with municipalities in other areas, so that they could determine what is and what is not transferable while seeking to build on what the Norwegian scientists present.

2. This issue's contents

Six peer-reviewed papers follow this introduction, providing information and direction regarding adaptation at the local level to extreme weather under climate change, including assessment of gradual changes over the long term. The focus is the three sectors of drinking water supply, cultural heritage, and flood risk reduction. "What" is described in terms of the challenges faced while "how and why" are detailed in terms of action that could be taken, thereby answering the questions posed by the Klima SIP programme's subtitle.

In the first paper, Deelstra and colleagues examine how predicted climate change affects runoff, nutrient, and soil loss in agricultural areas. Using a set of four diverse catchments around Norway, being part of the Agricultural Environmental Monitoring Programme in Norway (JOVA), they evaluate the potential challenges due to climate change. The study indicates that under similar land use and tillage methods, the predicted effects of climate change result in an increase in runoff, nutrient, and soil loss.

Then, Tryland and colleagues focus on two case studies for illustrating how precipitation under climate change will impact surface waters containing faecal indicator bacteria along with two parasitic protozoa, *Cryptosporidium* and *Giardia*. The implications are with regard to water treatment plants. The two case studies represent different geographical situations to provide advice for different contexts on how municipal managers responsible for water treatment should adjust their treatment techniques to account for climate change's potential impacts.

Next, Grøntoft calculates how climate change combined with potential air pollution reductions might affect the cost of maintaining building facades. Metals and stone are used as the materials to which available functions of dose-corrosion response are applied. The calculations show a balance in temperature, humidity, and precipitation changes increasing maintenance costs while cost reductions could be seen if air pollution is tackled.

The fourth paper sees Haugen and Mattsson investigating the monitoring and maintenance of cultural heritage experiencing climate change. Catastrophic impacts are likely only if heritage owners and managers are not aware of the possible challenges or how to handle them. Consequently, this paper provides a theoretical framework and practical procedures, along with specific examples, regarding the climate change challenges to be aware of regarding cultural heritage and how to monitor and respond to observations.

As the penultimate paper, Museth and colleagues identify the importance of floodplains for biodiversity and flood risk reduction, indicating possible challenges for Norwegian floodplains due to climate change. They investigated 20 floodplain sites

around the town of Flisa along the River Glomma, seeking crustacean zooplankton and water beetle species. A remarkably high diversity was found, but this diversity is expected to be detrimentally affected by climate change. Preservation and management of floodplains can ensure that their important ecosystem and societal roles can continue.

To close this issue, Orderud examines the thoughts of municipal decision makers regarding climate change. A survey of Norwegian mayors and environmental officers is quantitatively analysed to determine the information sources that help to shape their views and actions regarding climate change mitigation and adaptation. Science plays a dominant role in the information sources for many of those surveyed. The results are interpreted in the context of variables such as job, gender, education, and political leanings.

This collection of papers represents cutting-edge, original science emerging from the Klima SIP programme, while highlighting wider contexts – geographic, temporal, and scientific – in which the work should be interpreted and applied. Now that the Klima SIP project has ended, what could be done with this science to ensure that it continues to serve the society that funded it?

3. Where to go next?

The Klima SIP programme achieved many scientific publications, popular science outputs, and media appearances along with communication and exchange with municipal workers who will use the science. That includes a web site www.klimakommune.no that will last – at least, for the length of time that web sites would normally be expected to last. Longevity of the information produced is certainly a concern, considering that Klima SIP stops at the end of 2011, having no further funds, meaning that no updates will be completed for the web site.

Will an older web site continue to be useful and relevant? To some extent, media newer than static web sites are taking over information dissemination. For instance, Klima SIP never used either facebook or twitter. Additionally, municipal elections across Norway will bring new municipal leaders to power who might shift the priorities which the municipal employees should be addressing.

In any case, the continuing governance problem to overcome is the usual over-reaction after an extreme event has occurred, when it is too late to prevent detrimental consequences, contrasted with the usual under-reaction before an extreme event has occurred, when detrimental consequences could be averted. Despite ample evidence that exists regarding the savings in money and lives that accrue when implementing adaptation before measures are absolutely necessary (BTRE, 2002; FEMA, 1998), too much emphasis tends to be placed on after-the-fact measures (Lewis, 1999).

How can a short-term research programme support municipalities in the long term? The Klima SIP researchers would prefer to build on the results from Klima SIP through similar work after 2011, but new projects and programmes must be found to support their time. Those new projects and programmes might or might not have any link to Klima SIP. Without strategic thinking regarding how science can best serve municipalities with continuity and longevity, the gains from Klima SIP might end up being much less than they should be.

Within such contexts, Klima SIP at least provides a baseline of science and scientist-municipality collaboration that has the potential to be available in the future. In particular, before Klima SIP, some of the authors on papers in this special issue

had had only limited contact with the detailed aspects of climate change affecting their sector. Capacity to address climate change has been created with them, so that they are likely to continue to incorporate climate change aspects into their future work, within the context of other challenges affecting their sector. Additionally, the publications – scientific and non-scientific, English and Norwegian – remain for anyone in the future to read and build on.

Does referring to built capacity and available publications justify the time and money that went into Klima SIP without any other form of continuity? Just because a baseline of knowledge exists, that does not necessarily mean that it will be used. And how many links have been made internationally with other work that assists municipalities in dealing with climate change, such as for Australia (ICLEI, 2008; SCCG, 2008) as well as ongoing, unpublished endeavours in, for example, India? Work in Norway can teach other countries, but should learn from others as well.

Humanity has always had to deal with extreme weather and changing regimes of extreme weather. The challenge continues with contemporary climate change which has a significant human-caused component (IPCC, 2007). Examples and case studies are emerging of good practices where people are able to deal with extreme weather over different times scales. By publishing aspects of Norwegian experience through this special issue, the knowledge and action base can continue to be built so that science can continue to serve humanity.

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