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Resilience in crisis management at municipal level:

The case of the Synne storm in Norway

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Abstract

This paper focuses on the role resilience plays in flood crisis management at municipal level. Drawing from crisis management and the resilience literature, we outline a conceptual framework for crisis management that incorporates resilience abilities, namely the ability to respond, monitor, anticipate and learn. Then, through an in-depth analysis of a flood event, provoked by the Synne storm in Norway in 2015, we explore the extent to which Eigersund municipality succeeded in managing the flood. We conclude by outlining the importance of resilience abilities to cope with learning and coordination challenges and by proposing further research endeavours.

Keywords: Resilience, floods, crisis management, local response

1 INTRODUCTION

The increasing number of floods caused by natural hazards such as hurricanes, storms and heavy rain poses a serious challenge to societies in terms of human and economic losses and environmental damage. This global phenomenon affects rich and poor countries alike, causing similar devastating consequences. Months of heavy rains in Southern Thailand between November 2016 and January 2017 led to one of the most severe floods in that country in three decades. In March 2017, heavy rains caused Peru's worst floods in recent memory, with 67 people killed, thousands evacuated and the destruction of households and critical infrastructures. Three big hurricanes in 2017 - Harvey, Irma and Maria - brought widespread death and destruction to Texas, Florida, Puerto Rico and the US Virgin Islands. Europe, too, will experience an increase in the number of floods in the coming years (Bisselink et al., 2018).

Scientific evidence confirms that this increase is a direct consequence of climate change (Kundzewicz et al., 2014; Woodwar et al., 2014).

Knowledge on floods has been widely provided, in Europe especially after the implementation of the 2007/60/EC Directive on the Assessment and Management of Flood Risk (Nones and Pescaroli, 2016; Norén et al., 2016). Floods are usually natural crises triggered by natural hazards (Schneiderbauer, 2007). As such, floods should be more manageable and predictable, especially since states have put floods alerts and warning systems in place to mitigate their consequences. However, floods often have cascading effects and a transboundary character, thus putting crisis management under pressure each time they occur. In addition, floods are generally unintended events, compared to manmade crises, where there is the human intention to harm and damage (Perrow, 1984). Nonetheless, human behaviour, such as building in flood-endangered areas or neglecting the maintenance of rivers and basins can aggravate the consequences of floods. Rapid urbanisation (Chen et al., 2015; Slowik, 2015), land misuse (Smith and Petley, 2009), growing interdependence and the complexity of critical infrastructure systems (Zio, 2016) all exacerbate flood damages.

Floods are recurring events from which learning has become an important component. Communities and individuals can learn from and adapt to these events with the goal of increasing resilience through reflection, modification of former policies, and adoption of new policies (Albright and Crow, 2016). At the same time, organisations can learn by introducing organisational changes to improve their performance to better cope with the next flood (Kayes 2015). Generally, relevant literature has given much attention to the subject of learning in recent years, and on the considerable challenges involved in learning from crises (Boin and Bynander, 2015). Studies on floods have mainly emphasised the importance of strengthening societal resilience (see Alexander and Davis, 2012; Hutter et al., 2011) and critical infrastructure resilience (see Berariu et al., 2015; Doll et al., 2014) to manage these events. In general, despite the vast and varied literature in resilience, we believe that there are few studies (see, for instance, Carayannopoulos and McConnell, 2018; Boin and McConnell, 2007; Kruke and Morsut, 2015) that specifically address how we can incorporate resilience within the crisis management cycle (prevention/mitigation, preparedness, response and recovery). This paper aims at contributing to this research by developing a crisis management framework containing resilience abilities (the ability to anticipate, monitor, respond and learn). To illustrate the main characteristics of our suggested framework, we used the case of the 2015 flood, provoked by the Synne storm, which affected the Eigersund municipality in south-west of Norway.

The paper is organised as follows: firstly, we briefly present our theoretical background, including the concepts of crisis management and resilience. Then we move on by proposing a framework of resilience in crisis management and by explaining our method. Thirdly, we describe our case and analyse it through the lens of our framework. Finally, we draw some final remarks. Our investigation is based on several sources (public documents, previous research on this case, websites and interviews) analysed through content and document analysis.

2 THEORETICAL BACKGROUND

2.1 Crisis and crisis management

According to the International Organisation for Standardisation (ISO), a crisis is defined as “a situation with a high level of uncertainty that disrupts the core activities and/or credibility of an organization and requires urgent action” (ISO 22300:2011). Drennan et al. (2014) describe a crisis as a unique set of circumstances that threaten life, property, safety and security, with high levels of time pressure and uncertainty about the causes and the scope of the severity of its impacts. Crises usually have two main negative effects on systems and organisations, which can be described as “a multi-minded, sociocultural system, a voluntary association of purposeful members who have come together to serve themselves by serving a need in the environment” (Gharajedaghi 2011: 9). On the one hand, they may be stretched “to the limit, rendering standard operating procedures inapplicable” (Boin and Lodge, 2016: 292). On the other hand, they may be put under pressure by the demands of citizens looking for leaders able to safeguard them, manage the crisis and “bring things back to normal” (Boin and t’Hart, 2003: 545). However, a crisis can represent a chance for organisational changes in terms of policy reforms, institutional overhaul and even leadership revival, for instance (O’Donovan, 2017; Boin, 2009).

Crisis management depends on the characteristics of the crisis, such as its speed of development and termination. In this regard, Boin et al. (2017) distinguish four types of crises. First, fast-burning crises, which suddenly start and terminate after a relatively short time, such as flooding, hijackings and hostage taking. Second, cathartic crises, which develop slowly, but terminate abruptly (e.g., international confrontations during the Cold War). Third, are the long-shadow crises, which develop instantly and terminate gradually, such as climate change. Finally, there are slow-burning crises, which develop and terminate slowly, such as overpopulation and poverty.

The crisis-management literature divides crises into three phases: pre-crisis, acute crisis and post-crisis. For each phase of a crisis, crisis management foresees a set of activities and measures that are carried out to manage the crises and mitigate their consequences on the environment and on society (Coombs, 2015). According to Comfort et al. (2010), these activities and measures include prevention/mitigation, preparation, response, and recovery. The pre-crisis phase involves *prevention/mitigation* and *preparedness activities*, including identifying potential risks and preventive actions to be taken before the acute crisis phase occurs. The acute crisis phase deals with *responding* adequately to the crisis to minimise damage and negative consequences. Resource allocation and implementation of the preparedness emergency plans are as crucial here as cooperation and communication among the involved actors. In this phase, it is not unusual that the involved actors face uncertainty in terms of sharing responsibility, being able to work efficiently and choosing the appropriate response strategies. The post-crisis phase looks for ways to *recover* from the impacts of a crisis and identify necessary changes that need to be made in the pre-crisis and acute crisis phases to improve crisis management.

2.2 Resilience

Resilience has been defined and used in various ways and in several scientific and practical fields in recent decades. There is no single concept of resilience, but a plurality of concepts formulated, analysed and discussed within several disciplines. De Bruijne et al. (2010) made an attempt for a typology of resilience concepts along the three strands of engineering resilience, ecosystem resilience and social-ecological resilience. This typology underlines different ways to describe resilience, depending on which scholarship we consider. While this typology is very useful to categorise the resilience concepts in use, in the reality of resilience-based policies, we commonly are confronted with a mixture of various conceptual approaches.

Table 1 Resilience typology based on De Bruijne et al. (2010:19)

Resilience field	Characteristics	Focus	Context
Engineering resilience	Return time, efficiency	Recovery, constancy	Vicinity of a stable equilibrium
Ecological/ecosystem resilience	Ability to buffer capacity, withstand shock, maintain function	Persistence, robustness	Multiple equilibria, stability landscapes

Social-ecological resilience	Interplay disturbance and reorganization, sustaining and developing	Adaptive capacity, transformability, learning, innovation	Integrated system feedback, cross-scale dynamic interactions
Organizational Resilience (Sutcliffe & Vogus, 2003, p. 3).	Quality to respond productively to significant change that disrupts the expected pattern	Adaptive capacity and learning	Organizational theory
Socio-Technical Resilience (Hollnagel, 2014).	The ability to adjust its functioning prior to or following changes and disturbances	Adaptive capacity to sustain operations after a major mishap	In safety management

Since the endorsement of the Hyogo Framework for Action in the follow-up of the World Conference on Disaster Reduction in 2005, resilience has made its way into crisis and disaster management and disaster risk reduction. However, resilience has been mainly accompanied by the political pressure to operationalise it as quickly as possible, without a clear theoretical understanding.

In the field of disaster risk reduction, resilience is described as “the *ability* to prepare and plan for, absorb, recover from disasters, and adapt to new and diverse conditions” (Cutter et al., 2013: 27). In the crisis management field, resilience is “the *capacity* of the system to quickly resume critical functions that were affected by a shock to the system” (Boin and Lodge, 2016: 293).

In this paper, we consider resilience as a “*to have*” and “*to do*” quality of a system or an organisation. In other words, resilience for us is both a capacity, according to Boin and Lodge’s definition, and an ability, according to Cutter et al.’s (2013) definition. In general, capacity and ability are often used as synonyms. However, there is a difference between these words in the way we describe resilience in this paper. To understand this difference, consider a system that is designed with certain capacities (“*to have*” quality). Whenever the system is under stress, it shows the extent to which it is able (“*to do*” quality) to use its capacities to respond to a crisis and recover, as it should happen within crisis management, the system in focus in this paper.

Within crisis management, resilience capacities are related to:

1. Adaptation that reflects learning, flexibility to experiment, the adoption of novel solutions and the development of responses that may also divert from the planning (Walker et al., 2002).

2. Redundancy, which refers to the availability of substitutable elements or systems that can be activated when disruptions occur (Bruneau et al., 2003).
3. Resourcefulness, which refers to the capacity to mobilize and apply material and human resources to achieve goals in the event of disruptions (Bruneau et al., 2003).

Training activities, procedures, structures and plans are elements that reinforce these capacities.

As for resilience abilities, we borrow from Hollnagel's four criteria of resilience engineering, the so-called LARM (Hollnagel, 2014). A resilient system or organisation needs to have the following four abilities:

1. The ability to address the factual by knowing what has happened; that is, how *to learn* (L) from past experiences.
2. The ability to address potential outcomes by knowing what to expect; that is, how *to anticipate* (A) developments, threats, and opportunities, such as potential changes, disruptions, pressures and their consequences.
3. The ability to address the actual by knowing what to do; that is, to how *to respond* (R) to regular and irregular disruptions and disturbances.
4. The ability to address the critical by knowing what to look for; that, is how *to monitor* (M) what is or can become a threat or a risk in the short term.

3 RESILIENCE IN CRISIS MANAGEMENT

In this section, we propose a framework in which the activities within crisis management (prevention/mitigation, preparedness, response and recovery) include the four resilience abilities (LARM). Resilience capacities are a "to have" quality of crisis management and, thus, we posit that that they are already in the system. Figure 1 illustrates our framework:

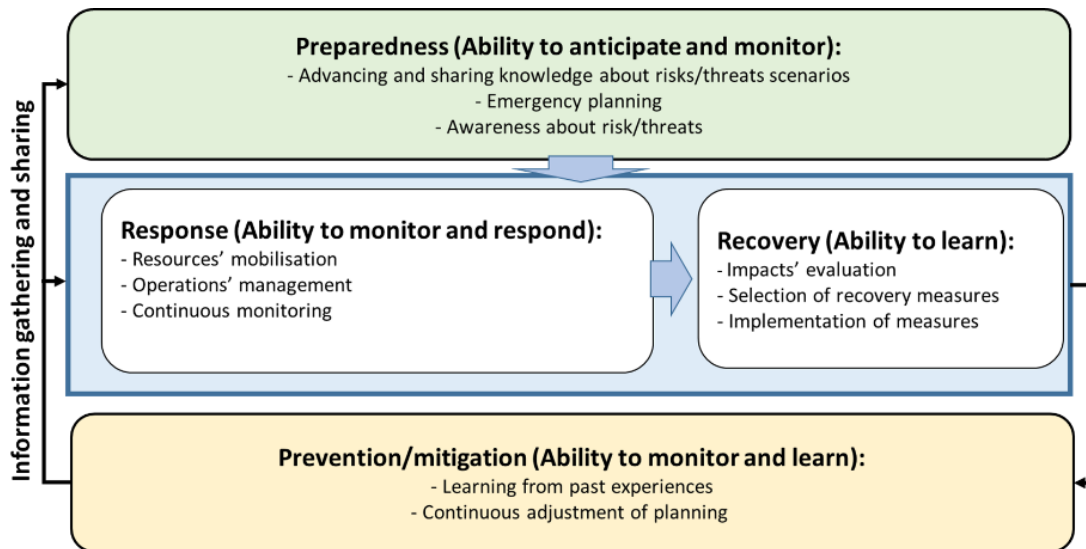


Figure 1: Resilience abilities in crisis management

Preparedness

Preparedness includes a wide range of proactive actions needed in case a crisis unfolds. Actions encompass, for instance, public support for planning initiatives, training, and the establishment of precautionary measures to lessen the consequences of the crisis. To be resilient, preparedness should include the ability to both anticipate and monitor risks/threats. An example of the ability to anticipate is represented by emergency or contingency plans. They usually contain information about the nature of the risks and threats, the likelihood of risks, who/what is exposed to the risks, and different scenarios. In addition, the emergency plan covers practices and procedures in terms of a division of responsibilities and roles for the involved actors. An example related to the ability to monitor a risk/threat is to have early warning systems. They should actively involve the communities at risk, facilitate public education and awareness of risks, effectively disseminate messages and warnings and ensure there is constant state of preparedness. It is crucial that preparedness has adaptive capacity, since crises, usually have a dynamic nature. Thus, periodical updates of the emergency plan, adoption of new solutions as for early warning systems, and flexibility in making changes should be part of preparedness.

Response

The response ability consists of the correct execution of emergency plans to protect lives and property from further harm when the crisis occurs. Public warning, evacuation, mobilisation of resources, such as building up fences, and search and rescue operations are all response abilities. The occurrence of a crisis is the ultimate opportunity to verify the validity of the emergency

plan from preparedness: response can follow the emergency plan, but in some cases, the response needs to be flexible by adopting ad hoc solutions (adaptation capacity). This is why we added the monitor ability here: a continuous monitoring helps adjustments of the response under way.

Redundancy and resourcefulness capabilities affect the quality of response. For instance, during a crisis caused by a flood, the likelihood of a power outage can be very high; accordingly, having extra power supplies is necessary. In addition, during an evacuation, several resources need to be mobilised, such as health and administrative personnel, as an effective distribution of evacuees to safe areas is required.

Recovery

In Figure 1, we have placed recovery in the same box as the response, since after a crisis, the focus should be shifted quite fast to bounce back to a normal situation. Indeed, recovery consist in the restoration of normal services and should begin immediately after the crisis has taken place. For example, when the acute phase of a flood ends, recovery starts by conducting an assessment of flood damage, the results of which provide insights about short-term activities, such as cleaning up, opening roads, going back home, restoring infrastructure, and responding immediately to social needs. A recovery that takes a long time usually consumes significant resources in terms of time as well as financial and organisational resources. Examples are improving infrastructures or introducing new regulations. To us, the ability to learn needs to guide the recovery to improve, in turn, the preparedness and the response, by considering the lesson learnt and by reflecting on how the preparedness and the response may have affected the recovery. Lessons learnt can enhance capacity-building to improve preparedness and response.

Prevention/mitigation

In general, prevention indicates the activities aimed at reducing the likelihood that a crisis will occur, while mitigation actions are steps that eliminate or reduce the loss of life or property damage for events that cannot be prevented. In the case of floods, examples of prevention/mitigation are stricter land use regulations close to rivers and seas or having alternative sources of electricity or alternative communication systems in place. In our framework, prevention/mitigation is strictly correlated to preparedness, response and recovery,

due to the ability to monitor and learn. Prevention/mitigation are characterised by a challenging process that is “neither simple nor mechanical; it requires an overall strategy” (Hollnagel, 2014: 191). This process consists of adjustments, updates and/or improvements of plans, modification of procedures and the enforcement of new norms, which need to be implemented in the other crisis management activities to enhance a more robust crisis management in its preparedness, response and recovery actions (Weick et al., 1999; Kruke and Morsut, 2015). New knowledge and competences and the acknowledgment of different perspectives (Fazey et al., 2007) should spread through the whole crisis management cycle.

In our framework, information gathering and sharing is an interactive process involving all the activities within crisis management. Two major issues confront this process in terms of complexity and uncertainty. Complexity relates to the number of involved actors and uncertainty to the characteristics of the crisis. The availability and quality of shared knowledge affect both these aspects, which, in turn, influence the coordination of the whole crisis management.

By considering resilience as a system’s capacity and ability, we designed a framework that incorporates resilience in crisis management. This is actually the ultimate goal of resilience engineering, namely, to bring resilience into management systems by enhancing the ability of an organisation to meet challenges (Nemeth, 2009; Steen and Aven, 2011). Capacity and ability can determine how crisis management responds to a crisis and address two main challenges of crisis management, such as learning and coordination.

During the post-crisis phase, besides recovery, learning is an important element, since the activities in the previous two phases need to be scrutinised and evaluated to improve the crisis management and make it better prepared for the next crisis. Several academic researchers have emphasised the so-called *crisis induced learning* (Boin, 2017; Elliott and Macpherson, 2010; Moynihan, 2008; Veil, 2011). However, it can happen that learning is not linear and easy since the involved actors can have different opinions, strategies, and political agendas on how the crisis was managed and how the organisation can be improved (Hood, 2007). We categorise four areas of learning from crisis where barriers may emerge, presented in table 2.

Table 2: Four areas of learning barriers

Area	Barrier
Information	Lack of “institutional memory” to maintain and share organisational experiences (Stern, 1997). Deficiencies in collecting relevant data and warning signals (Boin, et al., 2017; 132).

	Inadequate inter-organisational communication to share and understand information. “Over-learning”: rigid application of prematurely drawn inferences (successfully responding to previous crises) supported by the dominant coalition (Boin et al., 2017: 131). The potential lack of fit between lessons from the past and the demands of future events (Elliott and Macpherson, 2010).
Reforms	Difficulties in changing the organisational structure (e.g., hierarchy, routines, procedures, etc.) to implement lessons learnt (Boin et al., 2017: 133).
Power and politics	Tendencies towards centralisation, such as top-down and command-and-control (Boin et al., 2017:140 - 141)
Human behaviour	Fear to be exposed to negative reactions and publicity (Boin et al., 2017: 130). Strategic amnesia, such manipulation of organisational memory (Boin et al., 2017: 132).

Another crucial element in all the crisis management activities during the three phases is coordination. Coordination is referred to as “a descriptor of collaboration” (Boin and Bynander, 2015: 124), “a form of directive action” (ibid.) and as “the process of bringing together a set of differentiated activities into a unified arrangement” (Wolbers et al., 2017: 1521). Coordination revolves around two dimensions, vertical and horizontal. The first concerns different levels of governance, ranging from the international to the local levels. The second concerns actors who need to coordinate at the same level (Kruke and Olsen, 2011; Christensen and Lægheid, 2008). In the pre-crisis phase, the continuous, comprehensive and planning processes require coordination in order to establish the right conditions for cooperation across functional and hierarchical boundaries (Boin and McConnell, 2007). Moreover, coordination among different actors is a prerequisite for a common understanding of a crisis’ characteristics, and thus helps the relevant parties respond to the crisis according to simultaneous work and shared procedures and tasks. Under challenging or fast-response circumstances, coordination becomes critical to succeed and work effectively. Finally, in the post-crisis phase, coordination is the process that keeps the involved actors together in seeking proper strategies for recovery and for improving preparation and response when the next crisis occurs.

At the same time, coordination faces several challenges that can jeopardise the crisis management. For instance:

- time pressure, depending on crises typology (see Boin et al., 2017)
- involvement of several actors from different organisations and different working cultures, especially in case of complex crises

- difficulties in information gathering and sharing due to, for example, language barriers or misunderstandings, which may cause severe consequences for the management of a crisis.

These challenges touch upon two broad areas. The first area incorporates the characteristics of the crisis, as described by Boin et al. (2017). The second one refers to organisational issues, how crisis management is organised (who is involved, role and responsibility distribution, administrative assets, and skills).

4 METHOD

In this paper, we develop our qualitative research according to three phases. In the first phase, we reviewed the relevant literature on crisis management, resilience and flood crisis management. The main outcome of the review was to establish connections between the characteristics of crisis management and resilience, which were developed into our suggested crisis management framework.

In the second phase of our work, we used a triangulation of qualitative methods, consisting of content analysis, document analysis and semi-structured interviews to obtain reliable insights about our case. Triangulating provides “a confluence of evidence that breeds credibility” (Eisner, 2017: 110) by comparing and cross-checking the consistency of information derived within qualitative methods (Patton, 2002). Content analysis was applied to the data registered at CIM, which is a standard tool in a municipality’s management system for information sharing relating to a crisis/emergency situation and unwanted events, media inquiries as well as mobilisation of resources. We also used Eigersund municipality’s website to gather shared information about the flood. Furthermore, we scrutinized three MA dissertations on the Synne storm (Andreassen and Molde, 2017; Jacobsen Moum, 2017; Berge, 2016). Document analysis was applied to the study of two evaluation reports on the flood by the Eigersund municipality (2016) and the Rogaland County Governor (2016). We examined, as well, the Eigersund Municipality Emergency Plan (Eigersund Municipality, 2014).

Finally, we conducted five semi-structured interviews with five representatives from the Eigersund municipality. Four municipality representatives had a key role in the crisis management of the flood as members of the municipal Emergency Management Team. The

fifth representative was the municipality's chief executive officer who had a guest lecture about the different stages of crisis management during the Synne storm at [] in October 2016.

An interview guide was developed, consisting of a list of questions and topics of interest. The guide was divided according to the three crisis phases, within which we formulated questions according to the crisis management activities (prevention/mitigation, preparedness, response and recovery). For instance, regarding preparedness, anticipation, situational awareness and monitoring were issues we discussed to understand the pre-crisis phase. Questions related to the acute-crisis phase dealt with response management, procedures, plans and the distribution of roles and responsibilities. Questions on the post-crisis phase focused on which kind of immediate measures were taken to normalise the situation as fast as possible. The interviews' material was recorded and transcribed. The answers from the interviews were analysed as sensitizing concepts. According to Blumer, using sensitizing concepts allows us to have "a general sense of reference and guidance in approaching empirical instances" (Blumer, 2019: np). For example, a recurrent theme in the answers was the importance on learning from the ongoing operation during the acute and the post-crisis phase in order to improve the local emergency plans later. Moreover, we spotted out how learning from a successful operation, which resulted in desired and expected outcomes, positively affected the municipality's perception and response to future flood events.

5 THE CASE OF FLOOD CRISIS MANAGEMENT IN EIGERSUND, NORWAY

5.1 Crisis management of floods in Norway

Norway is extremely exposed to shifting weather conditions due to its coastline and wide mountain ranges, which extend right up to the Arctic. Over the past 100 years, the Norwegian climate has become warmer and precipitations have increased (Meld. St., 2013). These two trends, considered consequences of climate change, indicate that the risk of floods, landslides and avalanches will intensify in Norway (ibid). Indeed, in recent years, the country has experienced more frequent and more severe floods, typically caused by storms characterised by heavy precipitation and strong winds (Lillestøl and Rjkkja, 2016).

In general, the responsibility for natural risk and crisis management is distributed among three levels of government (national, regional and local). The Norwegian government shoulders the greatest responsibility by providing overarching plans and guidance on risk and crisis

management. At regional level, counties' administrative boards are responsible for coordination between levels, while municipalities are obliged to provide risk assessment of potential natural crises and the implementation of mitigation measures and interventions during a crisis. The following governmental bodies share responsibility in flood risk and crisis management, but they are crucial for other types of risks and crises, as well.

At national level:

- The Ministry of Justice and Public Security has overall responsibility for coordinating the government's policy for response and mitigation measures through the Directorate for Civil Protection (DSB), the leading civil protection agency (DSB, 2019).
- The Ministry of Petroleum and Energy is responsible for supervising water and energy resources through the Directorate for Water Resources and Energy (NVE), which is in charge of managing water resources and mapping flood risks (NVE, 2019).
- The Ministry of Local Government and Modernisation and its agency, the Building Quality Directorate, are the planning and building authorities.
- The Norwegian Environment Agency, under the Ministry of Climate and the Environment, has responsibilities within the area of climate change.
- The Norwegian Meteorological Institute, which answers to the Ministry of Education and Research, anticipates and forecasts weather, monitors the climate and conducts research.

At regional level, the counties are accountable mainly to the Ministry of Local Government and Modernisation. They constitute the bridge between the central government and the municipalities and are responsible for a significant part of the county's infrastructures, such as schools and the road system. They are also responsible for protecting these infrastructures from floods. The county supervises municipal emergency preparedness according to the Civil Protection Law (JBD, 2010). At local level, municipalities are obliged to provide regular risk and vulnerability analyses to the counties and to economically support the activities within the crisis management circle. In addition, municipalities are responsible for land planning (JBD, 2010). Municipalities are organised around an elected mayor, who has a political role during a crisis to keep information channels open with the media and local population. During a crisis, the chief executive officer, heading the local Council, leads the municipal Emergency Management Team in charge of emergency plans, warnings, evacuation and resource oversight.

5.2 The Synne storm

The Eigersund municipality is located on the coast of south-west of Norway in Rogaland County. According to Statistics Norway, the municipality has approximately 16 000 inhabitants, of which about 11 500 live in the largest urban area, the town of Eigersund, which developed around a bay. The town is famous for its Christmas market, which starts during the first weekend of December and attracts many tourists. There are two major rivers, Helleland and Bjerkreim, which can provide flood challenges for the municipality and for the town of Eigersund, in particular. Close to the town centre, Helleland River is divided in two by a small island. One branch of the river continues in the town centre, which is divided into two parts. The other branch meets the first one in in the town centre's inner harbour. Its waters are used by the company Dalane Energy. Bjerkreim River ends in the sea just outside the town. Both the municipality and NVE had mapped these two rivers due to several critical areas: floods can damage the road system, including the bridges crossing the rivers and the railway, which has been built parallel to the Helleland River. In addition, they can damage households around the harbour and close to the rivers' banks. The climate is mild throughout the year, especially in winter, when storms hit the municipality. The Synne storm was no exception in this sense. As a relatively short-lived, but extremely bad weather event, the storm was characterised by the heaviest rainfall since records began in 1897 (Figure 3) and violently hit the town of Eigersund between 5 and 6 December 2015. Synne caused a so-called 200-year flood, with more than 170 mm of rain falling in just two days.

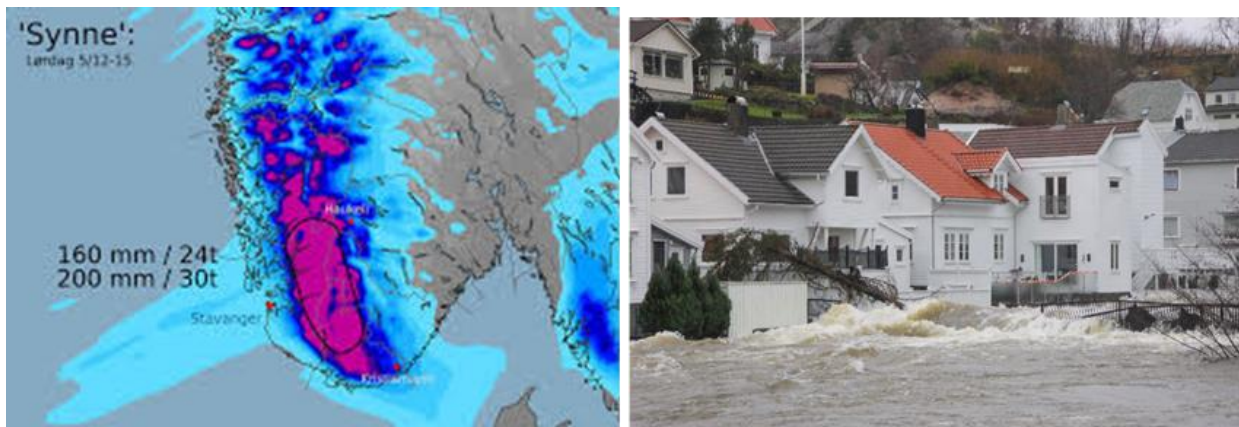


Figure 1: Synne storm map and its consequences (source: Eigersund municipality website)

Following Norwegian laws, the Eigersund municipality had its own Emergency Plan in place to cope with various crises (Eigersund Municipality, 2014). This plan includes the municipality's emergency management coordination, consisting of a senior municipal official

appointed by the Council and other municipal employees with crisis-management functions. The plan foresees that this municipal Emergency Management Team works together with other public and private actors. During the flood, several hundred people from over 80 houses were evacuated, while some institutions, such as Lundeane Housing and Service Centre and Tengs Riding Centre, had to provide temporary shelters for their guests. The flood destroyed a large area of farmland, damaged the town's infrastructure, disrupted road and rail traffic and cut off power supplies in several areas. The total impacted area was the Rogaland and Vest-Agder counties, which are 9 378 km² and 7 276 km², respectively. Losses were estimated at more than 1,5 million Norwegian Crowns (Westby, 2015).

Between 350-420 people were involved in different tasks during the Synne storm. In addition, local residents helped either by providing information about their area or by actively engaging in rescue operations (Eigersund Municipality, 2016). The municipality employed 114 personnel from the technical, health/care and central administration departments. The local police had a deputy leader participating in meetings of the Emergency Management Team and personnel dislocated in the most critical areas of the municipality from Saturday at 11:00 am until Sunday at 9:30 pm. The police made all the operational decisions, such as those relating to evacuation, while 38 Red Cross employees assisted with evacuation. The municipality made use of two ambulances from the local hospital. The Civil Defence (CD) took part with a total of 150 members and helped with evacuations, guarding, pumping capacities and filling sandbags. The local leader of CD was part of the Emergency Management Team. Twenty-one soldiers from the local quarters contributed with guards and the stuffing of sandbags. The NVE and the County Governor sent two employees to the Emergency Management Team respectively, while two employees from Dalane Energy were part of the team, thanks to their knowledge about water management. A helicopter was used during the crisis and Dalane Energy paid the expenses. The municipality kept constant contact with the local newspaper, Dalane Tidende, with Stavanger Aftenblad, the regional newspaper, and NRK, the national broadcaster, to keep the population of the whole county updated on proceedings.

Appendix B includes three tables to illustrate the main events and activities, organised according to the three phases of the crisis. The information was gathered mainly from evaluation reports, MA dissertations and registered data on CIM. Here, we present a short summary. Detailed list of events and activities during the three phases of CM is provided in Appendix B.

Pre-crisis phase: Friday 4 December 2015

During the pre-crisis phase, the main activities of crisis management are mitigation/prevention and preparedness. Before Synne provoked the flood, some prevention/mitigation measures were put in place to avoid a worst-case scenario, and to ensure a constant and updated flow of information to the local population. A series of meetings was held to coordinate responses in the acute phase.

Acute crisis phase: Saturday 5 and Sunday 6 December 2015

During 5 and 6 December, when the acute crisis phase manifested, an adequate response to the crisis was the main concern of the Eigersund authorities, who were joined by several external actors to manage the flood. These parties included the police, Red Cross, Civil Defence, and health and care services. Local residents were also involved in the response.

The Town Hall became the headquarters for coordinating the activities during this phase until evening, when the Lagård Youth School was considered a safer place to gather. The Town Hall was under threat of the flood, and a sudden electricity interruption would have caused critical consequences for the town, including the ICT system. The ICT office prepared for the relocation of critical ICT systems (servers) and an emergency room system, from the server room at the Town Hall to another location in the municipality. This was not implemented in the end. At the same time, a power shortage would have caused a breakdown in telephone communications, so the emergency phone number was switched through the municipality's telecommunications provider's shift function. The municipality provided an updated overview of the actual situation to the parties involved and the population. In the most critical moment, the municipality, with the help from the Police and the Red Cross, evacuated residents from inundated areas. The Civil Defence provided pumping equipment to assist individuals and companies with dewatering of cellars.

Post-crisis phase: late Sunday 6 – Monday 7 December 2015

The post-crisis phase is characterised by seeking how to recover from the crisis' impacts, and what changes are necessary to improve crisis management. The post-crisis phase began in the late afternoon of Sunday 6 December with normalisation of the situation and the gradual reopening of the roads, while the railway was closed for another week to evaluate the damage. The municipality asked the population for feedback on what and how to improve. To further discuss how to be better prepared to meet future challenges caused by extreme weather, the

Ministers of Local Government and Modernisation and of Petroleum and Energy visited the municipality.

6 MAIN FINDINGS

In this section, we present the extent to which the crisis management performed by Eigersund municipality contained resilience abilities and capacities by applying our framework. A flood is a typical example of a rapidly evolving crisis. This sudden adversity puts the crisis management under great pressure; in this context, we seek to enlighten resilience capacities and abilities according to the three phases of the crisis. The semi-structured interviews supported our findings from the data registered at CIM, Eigersund municipality's website, the three MA thesis and the two reports.

Pre-crisis phase: Friday 4 December 2015

During this phase, the main capacity Eigersund municipality displayed was resourcefulness in terms of organization (procedures, structures, plans were in place), technology (CIM, municipality's website, flood maps) and human resources (municipality Emergency Team). These capacities were embedded in functions, such as maps about the flood areas, the kind of risks from the Helleland and Bjerkreim rivers, and the Eigersund Municipality Emergency Plan. However, this Plan is a generic document that does not specify which actors are the most relevant in the event of a flood. Nonetheless, the municipality showed the ability to anticipate in the following circumstances: first, it identified a group of actual actors and, through the CIM, shared information with this group. In a relatively short time, about a half-an-hour window, the actors involved from the national to the local level, updated each other by sharing the information they owned via the CIM. Then, it sent the first warning to specific areas of the municipality, which were most exposed to an eventual flood (Hafsøyene and Lundeåne villages), basing this decision on the risk mapping. Furthermore, two meetings were held. In the first meeting, the municipal Emergency Management Team discussed an action plan to foresee a set of possible scenarios, based on information from the NVE. The second meeting was an inter-organizational meeting to discuss the action plan with external actors. In particular, one interviewed stated that this second meeting involved Dalane Energy, the NVE, and the County Governor, while contacts with the police department, road operators, and Norwegian

State Railways were established. Assistance was requested to the Civil Defence, through the police and Red Cross (Interview 4). According to the interviewees, these two meetings were crucial to clarify roles and responsibilities in a coordinated manner with the external involved actors and to enhance, as well, coordination internally within the municipal Emergency Management Team. A common feedback from the interviewees was that a good cooperation was already established in the pre-crisis phase thanks to these initiatives (Interviews 1 – 5).

The ability to monitor the development of the storm was to continuous meetings, not only at the Town Hall, but also organising phone meetings each time it was not possible to meet physically with all the concerned parties. Two principles were followed during these meetings: “Here and now” to update the relevant parties on the developing situation and “what will happen later” to plan ahead (Interview 1). By using this scheme, the Emergency Management Team established a good workflow, while ensuring that the Team was at the forefront of handling the crisis. According to the interviewees, telephone meetings were an important addition to the physical meetings, since they contributed to have a continuous real time report of the development of the crisis (Interviews 1 – 5). At the same time, one member of the Emergency Management Team we interviewed pointed out that these continuous meetings generated tacit knowledge that was not transferred into explicit information to be stored and used for future events (Interview 2). The continuous monitoring was useful for keeping the population updated via Facebook, Twitter and the municipality website: to keep the awareness of the population high about a possible deterioration of the situation, the municipality posted continuously information about decisions taken within the meetings.

According to our informants, the use of different channels of communication, both among the actors involved and the crisis management and with the local population, helped to increase a common understanding of the situation (Interview 1 – 5). For instance, those interviewed agreed that the use of a tool like CIM had a positive effect in establishing a common ground of situational understanding (Interviews 1 – 5).

The ability to learn, typical of prevention/mitigation, is visible in the different flood scenarios taken into consideration, all elaborated from data gathered from previous floods in the same area. In one interview, when we asked whether the same type of flood events had occurred in the past to provide some lessons learned, the subject confirmed that past events led to improvements in flood protection, but he added that he had never experienced such a magnitude

of water as during Synne storm (Interview 3). Another respondent emphasised that adjustment of local plans including prevention/mitigation measures are important to meet future challenges (Interview 2). A third informant underlined that investments in prevention were a long-term priority for the municipality (Interview 4).

Acute crisis phase: Saturday 5 and Sunday 6 December 2015

A flood often develops in unexpected directions. It creates challenges to responding organisations in terms of adaption and redundancy. During the acute phase, these two crucial capacities were evident: two buildings were made available to coordinate the response (the Town Hall and the Lagård Youth School, in case of evacuation from the Town Hall), and alternative ICT systems (servers) were allocated.

The acute phase consists mainly of the response activities. Here, our framework proposes two resilience abilities. The most obvious one is the ability to respond; the other is the ability to monitor. The municipal Emergency Management Team put in place a series of responses in the form of a mix of preventive and reactive measures. Preventive measures were taken just after a new flood alert: for instance, Protan Flood Protection was installed, while sandbags were provided to the population to protect their houses and belongings. In addition, to avoid an evacuation of residents at the Lundeåne Housing and Service Centre, mainly elderly people, their families were invited to pick them up. The municipal Emergency Management Team was aware that an evacuation of elderly would require time and the employment of several people, so they preferred to empty the building before an eventual flood would damage it or make the evacuation more challenging (Interview 2). Another important preventive measure was to consider the risk of a power outage as very high and to use an alternative, safer building to manage the response. Power outage and other related problems can have severe adverse effects on localised emergency operation management. The County Governor's report confirms that these preventive measures were successful in limiting the escalation of the flood towards more severe damage to people and households. In addition, the report remarks that close collaboration among the involved actors made the response process effective. This is confirmed by the interviewed as well (Interview 1-5).

Reactive measures consisted of the evacuation of Lundeåne village and the Tengs riding Centre; the closure of roads and the railway after roads and bridges were damaged by the flood; and the provision of pumping equipment to those houses under water. The scope of this paper does not

allow us to present the evacuation process in detail, but we can focus here on the coordination aspects. In general, some of the key elements inherent in an evacuation process are the emergency management's adaptive behaviour, trust-building, cooperation culture, solution seeking and the inclusion of different resources. Indeed, these aspects were present according to the evaluation reports from the Eigersund municipality and the Rogaland County Governor as all being present during the evacuation of Lundeåne village and the Tengs riding Centre. The evacuation process required considerable coordination efforts among several different actors, including the Emergency Team, the police, Civil Defence, the Red Cross and the Norwegian Public Roads Administration. Both evaluation reports concluded that such cooperation improved resource distribution. In total, about 80 houses were evacuated and individuals and families were offered food, beverages, and lodging at the facilities of a private company, Aker Solution AS. However, the interviewees revealed some aspects of the response that were not immediately evident from the analysis of the reports and data registered on CIM. All informants agreed that the understanding of roles in the pre-crisis phase was clear and that good cooperation among involved actors was a common feature in the response, as a whole. Nonetheless, it did not work properly during the evacuation (Interviews 1 – 5). The police was in charge of the operations related to evacuation, assisted by the Red Cross. Nonetheless, one informant underlined that there should be one person and one person only from the municipality Emergency Management Team in charge of giving information about the procedures of evacuation to the evacuated, while what happened was that the information came from several sources (the Municipality, the police, the Red Cross and so on). This generated confusion among the population about who was really in charge of the procedure. The informants concluded that it is necessary to have clearer responsibilities and better role clarifications during responses (Interviews 1 – 5). This may be interpreted in two ways: on the one hand, coordination works when time pressure is not high, while, when time becomes crucial, there is a higher probability that confusion of roles may emerge. On the other hand, coordination with external actors (such as the Red Cross) can be challenging if the same external actors are not properly involved in all phases of crisis management. A third interesting point refers to the involvement of actors from the local to the national level. One informant mentioned that poor knowledge about the local situation from national authorities, such as the Police Operation Centre and the Norwegian Public Roads Administration, led to traffic being directed into the hazardous flood area (Interview 4).

The ability to monitor is very much intertwined with the ability to respond in this phase. Without accurate monitoring, it is more difficult to respond properly. The ability to monitor during the response activities represents a continuum with the monitoring pursued during the pre-crisis phase. Two interviewees pointed out that competences, skills, knowledge and experiences shared during the pre-crisis phase guaranteed that the monitoring was constant also in this phase, in the form of ad-hoc meetings to assess the situation (Interview 2 and 3).

Post-crisis phase: Late Sunday 6 - Monday 7 December 2015

During this phase, adaptation is the most important capacity. Our empirical findings highlight that the Eigersund municipality, already in the early stages of recovery, was prone to seek new and different ways to be better equipped for future floods. This focus was reflected in the learning ability, which related mainly to the evaluation of the impacts, the selection of recovery measures, and their implementation. Learning, here, concerns how the municipality translated its experience during the flood into useful knowledge for future events, and which course of action the municipality would choose to take based on the new knowledge acquired. Two examples illustrate learning ability in short-term recovery: the coordination meeting held by the municipality with the NVE South Region and Dalane Energy to sum up the situation and make a plan for the way forward. This implies that these two actors were regarded as the most critical in taking the situation back to normal. The second example was the feedback from the population. Local experience was considered crucial in order to improve crisis management in the future, so the local population was invited to give feedback to the municipality, especially those evacuated (Interview 3).

One interviewed offered insights on the long-term recovery as well, which is worth mentioning (Interview 5). The informant emphasised the importance of continuous improvement in the response process, based on Eigersund municipality's focus on learning from previous emergency events. This focus has determined ongoing improvement initiatives to maintain the momentum. For instance, the Norwegian National Rail Administration, in cooperation with the Eigersund municipality, made an action plan (Jerbaneverket, 2016) in September 2016, which included several possible solutions to address the challenges posed by the floods. An example was to build a new, higher and longer bridge to reduce the vulnerability of the railway infrastructures.

According to the evaluation report from the Rogaland County Governor, the response and recovery processes were generally successful at the executive level, considering the size of the geographic area impacted, although matters for improvement were identified, such as a better role identification. In addition, the Governor expected an involvement of the Norwegian Public Roads Administration at a very early stage of the crisis since the flood impacted the road and railway system, but this was not the case, since this actor was not present in the main meetings.

The informants were asked about some learning barriers, presented in Table 2. In their answers, we did not find elements of being afraid to be exposed to negative reactions and publicity, as the municipality asked proactively for feedback from the local population. One informant pointed out that the experiences from Synne were mentioned wherever possible and relevant during municipality meeting (Interview 3). This indicates that the municipality sought to avoid the so called strategic amnesia to enhance organisational memory.

7 CONCLUSION AND FINAL REMARKS

In this paper, we developed a crisis management framework where we incorporated resilience abilities. By employing resilience abilities within the crisis management of the flood in Eigersund, we discussed the extent to which the municipality succeeded in managing the flood. We conclude this paper by reflecting on how these resilience abilities in crisis management are beneficial for lessening learning and coordination challenges.

Learning is a recurring element in the interviews. Among the four areas of learning where barriers may emerge (see table 2), we expected that information could have been the main concern in our case. On the contrary, information on previous floods was stored and became useful for proactive and reactive measures (institutional memory). The use of CIM helped to create a common ground for understanding the situation at hand and to ensure a good flow of information among response authorities, while the population was kept constantly informed. Two main learning points emerged from the interviews: a better clarification of roles during the response and the introduction of constant usage of several communication channels both within the crisis management and with the local population. In general, information flow between the different actors involved worked well.

Coordination was not a challenge in preparedness. The extent to which the municipality was able to monitor and anticipate critical issues to minimise the impact of the flood in the acute phase was guaranteed by having mainly human and institutional resources in preparedness ready to be operative. The municipality was well prepared and had established and practiced plans and procedures related to flood scenarios. In addition, communication among the involved actors played an important role to coordinate the response. On the other side, coordination became an issue during the evacuation of Lundeåne village and the Tengs riding Centre. However, a concrete solution (a precise person in charge belonging to the municipality Emergency Management Team) was suggested in the interviews.

Finally, we propose future research directions in studying resilience in crisis management. For instance, further research could examine other floods events by using our suggested crisis management framework. It could be interesting to apply the framework presented to other flood crises to understand eventual variations of crisis management in terms of resilience abilities. In addition, our framework could be applied in different events than floods to investigate possible differences raised by different contexts that influence resilience in crisis management.

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Appendix B

Pre-crisis phase: Friday 4 December 2015

Table 1: Pre-crisis phase, events and activities

11:23	The municipality receives the first alert from the NVE via the warning app Varsom (storm type: category 3): Internal coordination measures immediately implemented for different flood scenarios, in addition to implementation of a home security service for ICT and the opening of a municipal account to incorporate all the expenses related to the storm.
11:31	The municipality receives a warning from the Norwegian Meteorological Institute and the Rogaland County Governor.
12:52	Warning issued by Rogaland County Governor to all the municipalities in the county.
12:56	Information about the extreme weather shared on CIM and the establishment of contact (via CIM) with external actors, such as the local press, police, ambulance service, Dalane Energy, Civil Defence, the NVE, the Red Cross, Christmas City and some particularly vulnerable farmers.
13:00	First information sent to the population on the municipality's website.
13:00	The chief executive officer convenes the municipality's emergency team to discuss how to handle possible floods.
13:15	Message about the meeting on the municipality's website, newsletter, Facebook and Twitter.
14:30	First joint coordination meeting (municipality's emergency team + other involved actors): decision on plan of action.
15:45	The first population warning (text and voice announcement) is sent specifically to the Hafsøyene and Lundeåne villages.
16:00	A second coordination meeting with other involved actors is convened to provide an overview of the situation and discuss worst-case scenarios.
16:05	Continuous dissemination of information, warnings and advice to the population via newsletter, Facebook and Twitter.
20:49	Updated data from Met.no regarding extreme rainfall in the Rogaland and Agder Counties.

Acute crisis phase: Saturday 5 and Sunday 6 December, 2015

Table 2: Acute crisis phase, events and activities

06:00	Dalane Energy alerts sent out about the high level of water in the Helleland River.
08:00	The NVE increases alert to category 4 (red level) for eight municipalities (including Eigersund) in the county.
09:00	The municipality's Emergency Management Team meets with the police.
11:00	Coordination emergency planning meeting: full staff present at the Town Hall and coordination with external actors required, involving the Ministry of the Interior.
12:00	New flood alert.
13:00	Municipality personnel install Protan Flood Protection around the German bridge and the Lundeåne Housing and Service Centre to limit damage if the water should rise too high.
14:20	The municipality provides sandbags to those who need it to control the water level on their properties.
15:00	Secondary roads closed.
15:20	Residents at the Lundeåne Housing and Service Centre are retrieved by their families or accommodated in other centres to avoid evacuation in a hurry.
16:00	The fire department reports that there are some children and adults walking dangerously near the Helleland River.
17:15	The E-39 motorway is closed.
17:40	Evacuation alert to residents along the Helleland River, especially in Lundeåne, since the amount of water is increasing.
20:00	Meeting to give updates on the situation.
20:10	Evacuation in Lundeåne starts with the help of the police and Red Cross. Those who can be hosted by family and friends do so, while others are lodged in the building of a private company, Aker Solution AS.
20:37	Tengs Riding Centre is evacuated.
21:45	Municipality hires a local contractor to install concrete blocks to divert the water from the town into the river again.
23:45	Evacuation continues with the help of Red Cross representatives, who go from house to house to ensure residents are rescued. Residents ask to be hosted by family and friends, if possible.
Sunday 06:00	Damage to bridges forces the closure of the South Coast railway line (until December 16).
06:00	The municipality's Emergency Management Team holds a coordination meeting with the police, the NVE, Civil Defence, Dalane Energy, officials from the Ministry of Health and the Rogaland County Governor.
06:23	Other secondary roads are closed due to damaged bridges.
07:50	The M44 road and the Christmas market are closed.
08:00	The municipality provides an overview of the actual situation in cooperation with the police. Discussions are conducted to determine when to allow evacuees to return home, as some areas are declared safe.
11:30	The Civil Defence provides pumping equipment to assist individuals and companies with dewatering of cellars.
13:50	The municipality's Emergency Management Team holds another coordination meeting with the response authorities involved to decide the next steps.

Post-crisis phase: late Sunday 6 – Monday 7 December 2015

Table 3: Post-crisis phase, events and activities

17:00 Sunday	Start of normalisation of the situation: roads are gradually reopened and residents receive updated information via media and social media.
20:00	Last status meeting.
08:00 Monday	The Civil Defence provides a help phone number for residents to request pumping, technical assistance, etc. so they can move back to their evacuated houses and receive assistance with transportation of vital equipment.
10:00	Application for flood-control funds delivered.
10:00	Meetings with evacuated and other affected residents, businesses and municipal employees.
11:44	All evacuated people can return home. The main bridge in town reopens.
13:10	Norwegian public roads emergency staff monitor road conditions.
14:00	The municipality holds a coordination meeting with the NVE and Dalane Energy to sum up the situation and make a plan for the way forward.
14:40	The municipality's Emergency Management Team asks the population to give feedback on what and how to improve.
Tuesday 8 13:00	The Ministers of Local Government and Modernisation and of Petroleum and Energy visit the municipality.