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Table of contents

TABLE OF CONTENTS ..... **I**

LIST OF FIGURES AND TABLES ..... **III**

ACKNOWLEDGEMENT ..... **IV**

ABSTRACT ..... **V**

1 INTRODUCTION **1**

2 LITERATURE REVIEW **3**

2.1 INSTITUTIONAL CHANGE 4
2.2 INSTITUTIONAL ENTREPRENEURSHIP 5
2.3 INTERORGANIZATIONAL COLLABORATION 8
2.4 KNOWLEDGE SHARING AND LEARNING 11
2.5 SUMMARY OF KEY DRIVERS OF INSTITUTIONAL CHANGE 14

3 METHODOLOGY **16**

3.1 RESEARCH STRATEGY 16
3.2 RESEARCH DESIGN 17
3.2.1 Selecting a case study *17*
3.2.2 Case boundaries *17*
3.3 RESEARCH SETTING 18
3.4 DATA COLLECTION 18
3.4.1 Documents *19*
3.4.2 Interviews *20*
3.5 DATA ANALYSIS 21
3.6 RESEARCH QUALITY 23
3.6.1 Trustworthiness *23*
3.6.2 Authenticity *24*
3.6.3 Reflexivity *25*
3.7 ETHICAL CONSIDERATIONS 25

4 FINDINGS **26**

4.1 BACKGROUND 26
4.2 INCIDENTS AND EXTERNAL PRESSURES 28
4.3 ENTREPRENEURSHIP AND INTERORGANIZATIONAL COLLABORATION 31
4.4 KNOWLEDGE SHARING AND LEARNING 36
4.4.1 Development of mapping *36*
4.4.2 Development of methodology and technology *39*
4.4.3 Creation of guidelines and regulations *41*
4.5 IMPLEMENTING FIELD-LEVEL CHANGE 42
4.5.1 Mapping of quick clay zones *43*

4.5.2 Enforcement of guidelines and laws ... *43*
4.5.3 Establishing joint databases ... *46*
4.5.4 Application of new tools and technology ... *47*

5 DISCUSSION ... **50**

5.1 INCIDENTS AND PRESSURES AS DRIVERS FOR CHANGE ... 51
5.2 ENTREPRENEURSHIP AND INTERORGANIZATIONAL COLLABORATION AS DRIVERS OF CHANGE ... 54
5.2.1 Creation of collaborative initiatives ... *54*
5.2.2 Mapping and pooling resources and knowledge ... *58*
5.3 KNOWLEDGE SHARING AND LEARNING AS DRIVERS FOR CHANGE ... 61
5.4 KEY DRIVERS OF INSTITUTIONAL CHANGE IN NATURAL HAZARD FIELDS ... 65

6 CONCLUSION ... **69**

6.1 KEY IMPLICATIONS ... 69
6.2 IMPLICATIONS FOR THE NATURAL HAZARD FIELDS ... 71
6.3 LIMITATIONS AND FUTURE RESEARCH ... 71

7 BIBLIOGRAPHY ... **73**

8 APPENDICES ... **95**

LIST OF APPENDICES ... 95
APPENDIX 1 – DESCRIPTION OF RELEVANT AGENCIES ... 96
APPENDIX 2 – DOCUMENTS ... 99
APPENDIX 3 - INTERVIEW GUIDE WITH EXPERTS ... 103
APPENDIX 4 – DEVELOPMENT IN SCANNED AREAS IN DIGITAL 3D-MODEL ... 107
APPENDIX 5 – NUMBER OF MAPPED QUICK CLAY ZONES ... 108

List of figures and tables

Figure 1 - Drivers of institutional change 15
Figure 2 - Timeline of important events 28
Figure 3 - Key drivers of institutional change in the quick clay field 50

Table 1 - Data table 19
Table 2 - Excerpt of the coded analysis in Excel 23

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Hope you find this thesis interesting, enjoy the reading!

Oslo, 22nd of July 2020

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Abstract

The objective of this master thesis is to contribute to literature on institutional change, by investigating the key drivers for change in the natural hazard fields. We have conducted a qualitative case study, and by using documents as our main source of data we have looked into the changes in the quick clay field since 1978 and up until today. In addition, we interviewed three experts within the quick clay field to get a holistic perspective. Our findings present multiple drivers for field-level change within the natural hazard field of quick clay, and by systematically analysing the key drivers we suggest the following:

The identified changes in the quick clay field have occurred due to incidents, pressure, entrepreneurship and interorganizational collaboration, and knowledge sharing and learning. These drivers are important prerequisites for field-level change and have positively affected how the field deals with and manages the occurrence of quick clay in Norway. Further, the drivers impact change individually, however, in some cases, they affect and drive one another. Through this study we establish that incidents lead to increasing pressure on the field, increasing degree of collaboration, and knowledge sharing and learning in and between the relevant organizations which has led the field to be better equipped to deal with future occurrences and mitigate them from happening, as compared to in 1978.

1 Introduction

Natural recurring phenomena, such as floods, landslides and earthquakes, are events known as natural hazards (Godschalk, Beatly, Berke, Brower & Kaiser, 1998). Over the last centuries there has been an increase in natural hazards, which in some cases has been found to have a connection to global warming and climate change (Haddow, Bullock & Haddow, 2017). Natural hazards are considered a catastrophe when humans are exposed to the threat and are unable to completely absorb the impact without causing harm to property or life (Paul, 2011; Schwab, Brower & Eschelbac, 2007). Further, the significance of a natural hazard depends on the intensity of the event, the number of structures and people exposed to it, and the effectiveness of mitigation measures made to protect people and property from the natural forces (Godschalk et al., 1998). The adaption of protective measures to reduce risk are important in areas exposed to natural hazards, because it decreases the negative impact such force events may entail (Pation, 2007).

Natural hazards can be considered as complex problems as it requires many associations and interactions, nonlinear dynamics and emergent awareness (Ferraro, Etzion & Gehman, 2015). This means that when organizations are faced with complex problems it may prove difficult to manage, as the situation often is unpredictable without a set way to solve it. Natural hazards are also considered to be complex problems as they usually have unknown solutions, in addition to intertwined social and technical aspects, which requires innovative ideas and unorthodox approaches to be solved (Eisenhardt, Graebner & Sonenshein, 2016).

In many countries, including Norway, the government holds the obligation to protect its citizens from unreasonable harm. The threats posed by natural hazards call for the use of public funds in adaptation activities, such as investment in national security, social programs and infrastructure (Tompkins & Eakin, 2012). In addition, it is argued that the capacities needed to adapt to grand challenges, such as natural hazards, are directly linked to the ability to collaborate and act collectively (Adger, 2003). Ultimately, the increasing number of natural hazards occurring poses risks to most institutions, and under such circumstances,

collaborative solutions are the only reasonable way to realize change (Wijen & Ansari, 2007; Gray, 1989).

Although research has been conducted on complex problems, there is a gap in literature on what drives institutional change within climate change and natural hazards (Greenwood, Raynard, Kodeih, Micelotta & Lounsbury, 2011; Ferrarro et al., 2015; George, Howard-Grenville, Joshi & Tihanyi, 2016). Climate change and natural hazards pose great threats to lives and properties, and as there is call for more research on this topic from a managerial and strategic perspective (Howard-Grenville, Buckle, Hoskins & George, 2014; George et al., 2016), we want to investigate it further and explore what drives change within the natural hazards field. This leads us to the research question;

"What are key drivers of field-level change in dealing with natural hazards?"

To study this question, we draw upon a case study of quick clay management in Norway, which includes several public and private organizations. Quick clay landslides are considered to be a natural hazard and has led to major destruction of both infrastructure and lives. Even through quick clay also is considered a problem in other northern countries, such as Sweden and Finland (NGI, n.d.a), we in this study only focus on the drivers of field-level change in Norway, due to the complexity associated with natural hazard fields.

Further in this thesis we start by looking into existing literature in chapter 2. There is a wide range of literature on institutional change, and for this thesis we focus on institutional entrepreneurship, interorganizational collaboration, and knowledge sharing and learning, resulting in a model illustrating the drivers of institutional change identified in the literature. Next, we describe and justify the chosen research methodology in chapter 3. Thereafter, in chapter 4, we systematically present and analyse our findings, consisting of key events and work that has been done within the quick clay field and investigate the what kind of change has occurred since 1978, in order to determine the key drivers of field-level change. Following, in chapter 5 we compare the findings with existing literature through a discussion. Finally, we conclude with practical and theoretical implications, discuss the limitations of our study and suggest directions for future research in chapter 6.

2 Literature Review

Natural hazards can be considered as complex problems as they present considerable implications, have uncertain approaches and involve evolving and intertwined technical and social interactions (George et al., 2016). Therefore, addressing complex problems calls for "big and new" thinking (Eisenhardt et al., 2016). As described by Greenwood et al. (2011), if a field is working on a complex problem, the responses created by the organizations, whether they are coordinated or not, have important effects on the field structure. According to Trist (1983), an organizational population becomes a field when they collectively engage with an area or set of problems, which constitutes a domain of common concern for its members. Hence, in an organizational field the set of organizations is directly correlated through the problem area (Trist, 1983).

Due to the uncertainty associated with the consequences of the increasing degree of natural hazards, it is important to understand how the field is able to deal with and adapt to the threatening, but also shifting, circumstances. As natural hazards, similar to climate adaptation, is local, the role of local institutions is important as they are the actors shaping the adaptation and improving the situations for the affected social groups (Agrawal, McSweeney & Perrin, 2008). Institutions may decrease the impact of natural hazards through different functions such as mobilization and allocation of resources, gathering and distribution of information, development of skills and networking with other institutions, which may result in institutional change. Following Scott (2001; 2014), we define institutions as the normative, regulative and cultural-cognitive elements that, in combination with activities and resources, establish guidelines for social behavior (see also North, 1990; Powell & DiMaggio, 1991).

To address the research question, we start by looking into literature on institutional change and investigate why and how natural hazards create pressures leading to changes in institutional fields' processes and practices. Further, we examine how institutional entrepreneurship may lead to the creation of new institutions and altering of the status quo, before we turn our attention to the discursive dynamics and its contribution to the creation of field change. Next, we look into how interorganizational collaboration drives field change, through the

process of sharing knowledge and combining resources. Then, we explore how institutional learning and knowledge sharing may ease the management of complex problems through the development of new knowledge and resources. After the literature has been investigated, we develop a model with the identified key drivers for institutional change.

2.1 Institutional change

Organizational fields' ability to cope and adapt to compound and changing forces is a determining factor for creation of value and organizational survival (Greenwood and Hinings, 1996). Institutional change is closely related to the evolution of organizational change, since they reciprocally form one another (Haveman & Rao, 1997). According to Reay and Hinings (2009), institutional change is frequently considered to be the outcome of change in one institution of an organizational field. Consequently, it can be elucidated as an evolving process from one institution to another and can also lead to a transformation of organizational fields (DiMaggio, 1991).

Institutional theory looks at organizational transformations and institutional processes as critical precursors of institutional change. Lee and Pennings (2002) argue that there is a need for adoption of new organizational forms due to a changing environment that will induce changes in norms, beliefs and practices (i.e. institutional change). For an institution to be created, transformed or diffused there is a need for legitimacy, which means that other alternatives are less desirable, viable or appropriate (Dacin, Goodstein & Scott, 2002). Hence, introduction of new practices, technologies, and rules create institutional change, and if diffused throughout a field it has the potential to constitute field-level change (Lawrence, Hardy & Phillips, 2002).

Oliver (1992) found three sources that create pressure on institutionalized norms and practices which induce institutional change. The first being functional pressures, which are connected to issues related to the perception of organizational performance and of the utility of the institutionalized practices. The second identified pressure are political pressures, which are a result of changing interests and power distributions, that may change existing institutional arrangements due to environmental changes or other factors that induce firms to

question the legitimacy of an institutional factor (Oliver, 1992; Dacin, Goodstein and Scott, 2002). The third set of pressures identified by Oliver (1992) is social pressures, which includes disruptions or changes that discourage the continuation of an institutional practice. Berkhout, Hertin and Gann (2006) found that many of the pressures to change or adapt are indirect, and often outside of the organizational boundaries. Peng (2003) argues that in response to such institutional pressure actors will make strategic choices such as cooperation, compliance and defiance.

Hargrave and Van De Ven (2006) present a model for examining the construction of new institutions through collaboration, claiming that the generative mechanism is that several actors recognize an institutional problem, barrier or injustice. The focal actors can be seen as a network of different and partisan actors who are embedded in a collective process of mobilizing, structuring and promoting their mutual interests. The outcome of collective action is an institutional precedent, a new or changed working rule or an innovation (Hargrave & Van De Ven, 2006). Collective institutional change may be caused or initiated by external shocks (e.g. scientific breakthroughs or natural disasters) or by internal factors (e.g. manipulation of power configurations), and can help us understand how dispersed actors "attain and sustain cooperation in complex domains" (Wijen & Ansari, 2007, p. 1084).

2.2 Institutional entrepreneurship

Integrating movements into institutionalism has been found to have parallels to the key aspects of institutional entrepreneurship (Hardy & Maguire, 2008). Institutional entrepreneurship places a greater focus on collective mobilization and politics as drivers for change and additionally address the relations between existing institutional contexts, collective organizations and activities (Schneiberg & Lounsbury, 2017). According to DiMaggio (1988) new institutions will arise when organized actors (i.e. institutional entrepreneurs) with adequate resources discover an opportunity to realize interests that are of high value to them. Maguire, Hardy and Lawrence (2004) argue that new institutions arise through institutional entrepreneurship which is "the activities of actors who have an interest in particular institutional arrangements and who leverage resources to create new institutions or to transform existing ones" (p. 657). Thus, institutional

entrepreneurs will create collective action through the framing of desired changes (Hardy & Maguire, 2017). In light of this, institutions are "the very fabric to be used for collective transformational action by a range of actors" (Jolly & Raven, 2015, p. 1000). Through a new system of meaning the functions of the different institutions are tied together (Garud, Jain & Kumaraswamy, 2002).

Institutional entrepreneurship requires actors to eject existing practices, introduce new practices and further ensure that these practices become widely adopted. This involves interventions as there is a need for actors to communicate and construct reasons or rationales as to why other actors or field members should support the institutionalization project. By legitimating the project, institutional entrepreneurship may "theorise institutional change by specifying problems associated with existing practices and justifying new ones as a solution" (Hardy & Maguire, 2017, p. 271). In order to succeed and create change the institutional entrepreneur needs to "influence legislative or regulatory frameworks, affect cultural norms or values, or establish some structures or processes as taken-for-granted" (Lawrence, 1999, p. 168). Institutional entrepreneurship can therefore be seen as a structure that undertakes three tasks in a collective action frame: (1) the identification of a problem and deeming it important; (2) diagnosing the problem through the identification of who or what is responsible; (3) motivating actors to participate in change (Hardy & Maguire, 2017).

Most literature emphasizes the individual institutional entrepreneur and the unilateral relationship where the entrepreneur promotes own interests by persuading other actors, affecting preferences and building consensus, rather than the role of other actors (Garud, Hardy & Maguire, 2002; Emil & Benesdrine 2005; Fligsten 2001; Dew, 2006; Greenwood, Oliver, Suddaby & Sahlin-Anderson, 2008). Although institutional entrepreneurship usually is based on profit-oriented objectives, it may also create value for society as a whole through the resolution of externalities (Meek, Pacheco & York, 2010). However, as dealing with natural hazards requires investments in public goods throughout jurisdictional dispersed areas, it is not appropriate for individual entrepreneurs to make such investments. Boxenbaum and Battilana (2005) argue that institutional entrepreneurship entails sharing of ideas. Further, Edelman and Suchman (1997) found that it involves collective sense-making activities by the involved actors. According to Ferrarro et

al. (2015), “institutional change is not the result of individual entrepreneurial action, but rather, the efforts of multiple individuals and organizations that purposefully spearhead change and mobilize cooperation (p. 368). Hardy and Maguire (2008) assert that this body of literature looks at institutional entrepreneurship as discursive interventions where the desired outcomes are designed to be achieved in relation with the targeted actors through a reciprocal relationship.

This body of literature claims that change in an institutional field is based upon the use of discursive processes (Hardy & Maguire, 2010). Discourse is the practices of writing, talking, or illustrating something to make it accessible for others. In light of the institutional fields it can be seen as a system of statements which constructs a field (Phillips, Lawrence & Hardy, 2004). Discourse directs the way a topic is talked and written about, by defining what is deemed normal and acceptable, while at the same time excluding, restricting or limiting what is not, thereby institutionalizing practices and behavior (Hall, 2001; Hardy & Maguire, 2010). Discourse may be in the form of different types of written documents, but also in the form of verbal reports, speeches or informal communication, where all are defined as texts (Phillips et al., 2004; Hardy and Maguire, 2010). As text is created and distributed by actors, it is consumed by other field representatives. Hearing, reading, interpreting, reproducing and acting upon the text may initiate or create field change (Zilber, 2007). Hence, the consumption, distribution and production of texts may disrupt the discourse already existing within institutions, thereby creating change in institutional fields (Maguire & Hardy, 2009).

The discursive view “expands the notion of institutional entrepreneurship by highlighting its power dimensions; by shifting the emphasis from individuals and their entrepreneurial enterprises to collectives; by attending to the ongoing work involved in institutional entrepreneurship” (Zilber, 2007, p. 1037). The consumption, production and dissemination of texts are collective processes that are developed and distributed by and among various actors (Phillips et al., 2004). Hence, the inclusion of discourse allows for a collective view on institutional entrepreneurship. Further, as emphasized by Zilber (2007) literature on institutional entrepreneurship often portrays it as a one-time act, while the

inclusion of discourse expands the perspective by viewing it as a continuous process as "institutions require constant "work"" (p. 1037).

In many cases institutional entrepreneurship includes the establishment of new interorganizational relations to enable change (Wijen & Ansari, 2007; Dew, 2006; Hardy & Maguire, 2008). Since institutional entrepreneurship, as previously described, is to change already existing values, practices, or norms, both the mobilization of resources and the rationales for change in most cases includes the development of new relations, such as alliances, partnerships or collaborations. The actors engaging in institutional entrepreneurship therefore undertake a number of interventions aiming to change or create interorganizational relations and thereby establish collective action (Hardy & Maguire, 2008). However, Zilberman, Zhao and Heiman (2012) argued that the adoption of institutional entrepreneurial measures is more challenging when done by the public sector or through collective action.

2.3 Interorganizational collaboration

Complex problems involve issues that are "too extensive and too many sided to be coped with by any single organization" and require an interorganizational approach in order to be dealt with (Trist, 1983, p. 270). Dealing with complex problems, such as natural hazards, entail interaction among several actors and nonlinear dynamics, and confront organizations with uncertainty (Ferraro, Etzion & Gehman, 2015). Further, it involves the interdependence of actors through their relationships with each other, including the institutions they are a part of and with the resources they depend on (Adger, 2003). Collaborative solutions are the only plausible way of achieving change when a group of stakeholders are worried about a common problem or issue (Wijen & Ansari, 2007; Gray, 1989). Interorganizational collaboration shares similarities with institutional entrepreneurship at a collective level, as they both include interaction among several actors.

Doh et al. (2019) proposes collective environmental entrepreneurship as a method for adapting to climate changes as it is based on the idea of cross-sectoral partnerships. Cross-sectoral partnerships enable the actors to leverage resource complementarities or recombination to develop adaptation approaches. Cross-

sectoral partnerships provide the actors from different sectors tools for dealing with common challenges by combining resources and leveraging cost advantages by combining public and private sectors (Doh et al., 2019; Rangan, Samii & Van Wassenhove, 2006). By pooling resources, the different actors are better able to collectively generate responses to cope with natural hazards (Doh et al., 2019). Doh et al. (2019) suggests, through a process model, that responses are initiated by the formation of partnerships (i.e. interorganizational collaboration) between actors in the private, public and non-profit sectors, where governance mechanisms are established, and knowledge is pooled. Further, as resources are shared and combined, and the actors start to generate responses. The pilot responses are tested and if successful certain measures are selected and scaled up, contributing to institutional change and improved responsiveness for the actors. However, if the results from the pilot responses are not favourable the actors will try to learn from the failures and go back to pooling knowledge and further develop other responses.

Organizations are often able to obtain added value by sharing knowledge and combining resources (Doz & Hamel, 1998). Due to the complexity, new concerns or issues may be identified or revealed as the actors are tackling the complex problem (Ferraro, Etzion & Gehman, 2015). Institutional theory suggests that interorganizational collaboration (e.g. alliances and networks) may help the involved actors solve economic, technical and strategic problems, as they may contribute to enhanced development and production of knowledge, services or products that the actors need to survive (Osborn & Hagedoorn, 1997; Freeman & Hannan, 1989). Hence, embeddedness of institutions through collaborative initiatives may represent solutions that institutions would not be able to obtain individually.

Agrawal et al. (2008) study of local institutions' importance in climate-related adaptation found that when dealing with complex problems institutional collaboration or partnerships may enhance the informal institutional processes which enable more efficient adaptation. In other words, the issues connected to natural hazards generate the need to act collectively, which in turn acts as a "driver" for collaborative measures and for the development of new knowledge and resources. Social interaction between different institutions or actors has been

found to ease collective action, as social capital is an important factor contributing to adaptive capacity especially when dealing with unpredictable and periodic natural hazards (Adger, 2003). Ostrom (1990) describes that previous cooperation and experience working directly together is one of the drivers for collaboration. Further, Gerlak and Heikkila (2007) in their study of collective action in water management systems in the U.S. found that previous cooperation between the different agencies prior to the inception of collaborative programs and collective action had beneficial effects.

Complex problems require responses from all relevant sectors, however, each sector has the challenge of realizing the potential of their contribution (Doh et al., 2019). The U.S. Office of Science and Technology Policy (n.d.) describes that grand challenges can serve as a helper for collaboration between the public and private sector. However, the objectives of the public sector may not conform to the private sector, vice versa. Differences in organizational cultures, missions and structures may limit the effectiveness of interorganizational collaboration (Doh et al., 2019). Additionally, firms operating in the private sector face different stakeholder groups than the public sector firms, which may lead to goal conflicts (Googins & Rochlin, 2000). In the disruptions caused by natural hazards the public sector focuses on ensuring the prosperity of public goods, making investments in national security and infrastructure, as well as the establishment of environmental regulations. However, there may be issues in the public sector due to the often slow and incremental bureaucratic processes and lack of coordination among the agents (Brooks & Adger, 2005; Tompkins & Eakin, 2012; Urwin & Jordan, 2008; Doh et al., 2019). Further, the efforts provided by the public has been found to be reactive rather than proactive (Brooks and Adger, 2005). Contrastingly, firms in the private sector focus on protecting their core business, value chains and creating profits, which includes making their business models less vulnerable. However, such institutions often have a narrower business focus that does not match the scale of the complex problem (Scott & McBoule, 2007; Tashman & Rivera, 2016; Doh et al., 2019).

To optimize interorganizational collaboration, both between similar sector firms and those that are not, the focal agents should integrate their interests and establish governance mechanisms prior or early in the process of the collaboration

(Selsky & Parker, 2005). Doh et al. (2019) propose several governance mechanisms that coordinate and harmonize potential conflicts in goals and expectations when establishing interorganizational collaborations. Firstly, there is a need to set objectives and structural specifications for the partnership to create an overall purpose and set boundaries. Secondly, partners should formulate rules and regulations for the partnership, so that the operating mechanisms and procedures are clear. Thirdly, Doh et al. (2019) proposes to codify the scope, responsibilities and roles through a memorandum. Agrawal et al. (2008) also found that it is important that local institutions understand their responsibilities and the linkage with other institutions. Fourthly, one should establish the leadership positions in the partnership (Doh et al., 2019).

Previous studies have emphasized the importance of core leaders and the ability to keep diverse actors focused on shared problems, and has found that leadership can be especially important when dealing with complex challenges such as natural hazards (Gerlak & Heikkila, 2011; DeWitt, 2004). Fifthly, one should ensure that the partners control structures, which allow them to add and integrate value, are coordinated properly through the decision of specific organizational structures. Lastly, it is important to ensure that the partners have an influence in their sectors and possess competencies, and that these are given the appropriate emphasis through agreeing on the management of the collaboration (Doh et al., 2019). However, the establishment of rules, processes, structures, and meanings may also disable actors with a wider variety of positions to influence events (Maguire et al., 2004).

2.4 Knowledge sharing and learning

As natural hazards pose risks to society, there is a need to learn from past events and identify future methods (Adger, 2003). The action needed to adopt to climate change is often "constrained by a general lack of knowledge about or experience in how to best operationalise the concept" (Rickards, Wiseman, Edwards & Biggs, 2014, p. 643). The actors and groups responsible for managing climate change adaptation are often required to generate huge amounts of work through which they learn and create knowledge (Rickards, Wiseman, Edwards & Biggs, 2014; Carlsson-Kanyama, Carlsen & Dreborg; 2013). The motive for creating interorganizational relations is often connected to the partnering institutions

seeing an opportunity to learn how to improve their operations through cooperation in different ways (Larsson, Bengtsson, Henriksson & Sparks, 1998).

Because dealing with natural hazards is a continuous process that always requires development of new knowledge regarding effective adaptation, it is not possible to create blueprints for all future events. Therefore, institutions should rather adopt an adaptive perspective on institutional development and learning (Agrawal et al., 2008). This requires institutions to develop a greater adaptive capacity, which calls for social learning, willingness to experiment and tolerance of mistakes (Agrawal et al., 2008). Balancing efficiency, effectiveness and equity through structures that promote learning is often the goal when actors collaborate (Adger, Arnell & Tompkins, 2005).

Scholars have argued that learning can appear at several levels, ranging from individuals to organizations and networks, and that it is a process linked by the social dynamics of sharing and producing knowledge (Heikkila & Gerlak, 2013; Levinthal & March, 1993; Bendar, 2000). Hence, "individuals may not only learn on their own but also in "conjunction" with each other" (Heikkila & Gerlak, 2013, p. 486; Salomon, 1993). Following Siebenhünerp and Suplie (2005) we define institutional learning as the "… process in which individual or collective actors acquire knowledge that leads to a change in their behavior and results in changed institutional arrangements" (p. 511). Thus, for learning to be characterized as institutional it has to appear at a collective level that surpasses the domain of individual decision making (Siebenhünerp & Suplie, 2005). Through a collective learning process of acquiring, assessing and translating information and disseminating knowledge between actors, new ideas, rules or strategies may emerge as collective products (Gerlak & Heikkila, 2011).

One stream of literature within organizational learning focuses on intraorganizational learning processes, e.g. by looking at how individuals learn from each other, how groups and teams share experiences and learn or by paying special attention to the role of social interaction or work practices within organizations (Holmquist, 2003; Brown & Duguid, 2001; Edmondson, 1999). Another stream of organizational learning focuses on interorganizational learning, by looking into the processes that occurs in interorganizational collaborations

such as alliances or joint ventures (Gulati, Wohlgezogen & Zhelyazkov, 2012; Larsson et al., 1998; Liebeskind, Oliver, Zucker & Brewer, 1996). According to Larsson et al. (1998) one of the key motives for forming interorganizational relations is the learning process. Interorganizational learning can be seen as collective acquisition of knowledge among a set of organizations (Larsson et al., 1998). As compared to intraorganizational learning, interorganizational learning includes learning synergies or interaction effects between the organizations "that would not have occurred if there had not been any interaction" (Larsson et al., 1998, p. 287).

Knowledge can be divided into two main types, depending on its properties in terms of ability to be structured, codified, diffused and shared with others (Haldin-Herrgard, 2000). On the one hand, there is explicit knowledge, or "know-what", which is tangible knowledge that can be described though formal language, print or electronic media, and is often based upon established work processes. On the other hand, there is tacit knowledge, or "know-how", which is practical and action-oriented knowledge based on practice, that is acquired by personal experience, and often resembles intuition and is rarely openly expressed (Smith, 2001). Borial (2002) emphasize the importance of tacit knowledge, as it is particularly useful when dealing with environmental issues such as management of natural hazards or creation of preventative solutions.

The process of sharing tacit knowledge is more difficult than sharing explicit knowledge, as it cannot be thought, trained or educated (Brockmann & Anthony, 1998). Tacit knowledge is semiconscious or unconscious knowledge that "produces insight, intuition or decisions" based on personal experience (Leonard & Sensiper, 1998, p. 113), and can only be learned through an active contribution of the individual possessing the knowledge, which is time-consuming (Haldin-Herrgard, 2000). As explicit knowledge can be expressed through formal language, in the form of manuals, handbooks or e-mails, it is more easily transferred to other individuals or groups. It does, however, require the recipient of the knowledge to invest time in order to understand the knowledge at hand (Smith, 2001). The transfer of tacit knowledge is more challenging as it can only be done by observing, imitating or practicing, thereby "socializing into a specific way of doing things" (Smith, 2001, p. 316). The active involvement of actors

when dealing with natural hazard incidents can contribute to ease the transfer of tacit knowledge as it encourages the actors to share their "know-how" in order to deal with the complex problem (Borial, 2002). As found by Leonard & Sensiper (1998), tacit knowledge is a highly valuable resource, especially for innovation, as it does not only derive from visible and obvious knowledge, but from the accumulation of experiences.

2.5 Summary of key drivers of institutional change

Through the above-mentioned literature we have identified several drivers that have been found to contribute to institutional change (see Figure 1). As literature suggests, pressure, such as changing interests and power distributions in the form of new regulations, policies or areas of responsibilities, social disruptions from society, or identifications of functional flaws or opportunities both internally in organizations or externally from society, is a driver for institutional change. As such pressures put constraints on the existing institutional practices, norms and beliefs, actors are likely to conduct strategic choices, which may alter the status quo and lead institutional change. Additionally, literature points to that entrepreneurship by individuals or groups can be a driver for change as the actors conduct activities in order to achieve particular institutional modifications or alterations. Thereby, the entrepreneurs use discursive processes to encourage institutional change by influencing existing institutional structures through the ejection of existing practices, introduction of new ones and attempting to ensure that these practices become widely adopted. Institutional entrepreneurship could also be a result of external pressures as this may make the actors aware that change is needed.

Establishing interorganizational collaborations is also identified as a key driver for institutional change, as such initiatives contribute to new and improved relationships among the actors. Through interorganizational relationships the actors may be able to identify and develop measures that pose opportunities to improve the management of natural hazards, thereby creating institutional change. As the motive for interorganizational collaboration often is connected to actors seeing an opportunity to learn and improve their operations, knowledge sharing and learning, and interorganizational collaboration are drivers that are closely linked. Through collaborative structures the actors collectively learn by acquiring

knowledge which can result in new ideas, rules or strategies. As institutional learning is the process of acquiring knowledge, which leads to changes in behaviour or institutional arrangements, it can be seen as a driver towards institutional change as it is the underlying process contributing to change. Thereby, through pressures, entrepreneurship and collaboration the actors engage in activities that contribute to changing norms, beliefs and practices by implementing new technologies, rules and practices.

According to existing literature pressures, institutional entrepreneurship, interorganizational collaboration, and knowledge sharing and learning acts as drivers of field-level change. Although these drivers individually have an impact on institutional change, literature points to that these can influence each other. As external pressure may lead to institutional change at the field-level because relevant actors see a need to change their practices, norms and beliefs, it may also contribute to institutional entrepreneurship which again may lead to the establishment of collaborative structures. However, institutional entrepreneurship may also occur without the occurrence of external pressures. Additionally, as learning and knowledge sharing can take place in the individual organizations, the output in the form of institutional change is likely to have a bigger impact in the natural hazards field if done through collaboration.

Based on the literature we present a model (Figure 1), where the darker boxes illustrate the main drivers for field-level change. The lighter boxes offer a description of how the drivers contribute to the creation of change.

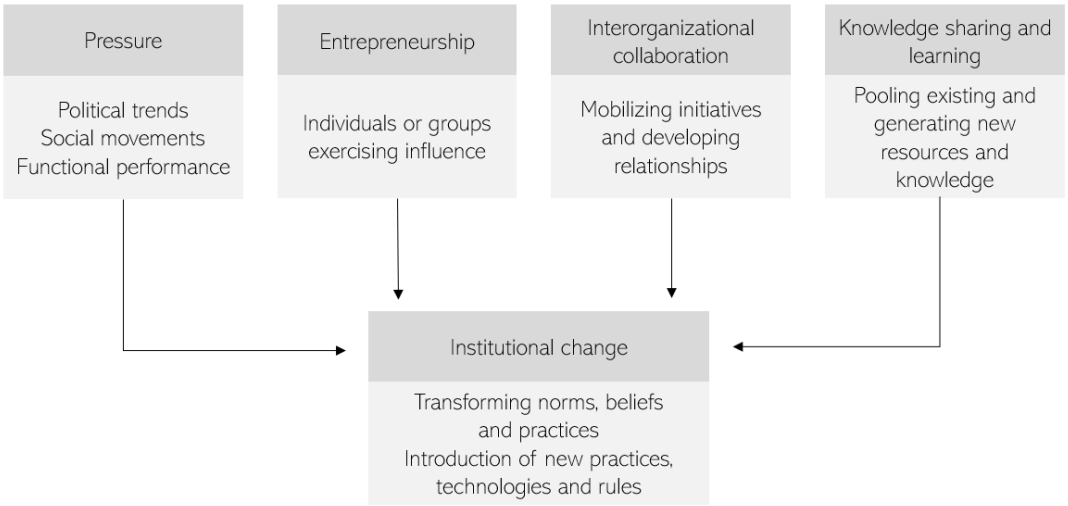

Figure 1 - Drivers of institutional change

3 Methodology

3.1 Research Strategy

The research strategy chosen for this thesis is based upon the research question, namely "What are key drivers of field-level change in dealing with natural hazards?". Quantitative research mainly involves the collection of numerical data, whereas qualitative research usually entails images and words in the collection and analysis of data (Bell, Bryman & Harley, 2019). In order to answer our research question, we have identified a qualitative research approach as most relevant for our study as it allows us to investigate, in-depth, the phenomenon of dealing with natural hazards. This allows us to capture the processes and complexity that is involved in managing such a convoluted phenomenon, through collection of information in social form. We believe we will gain better insight through a qualitative approach rather than a quantitative approach, as our research question is closely connected with existing theory and depend on complex social processes. Hence, we believe a qualitative research design will give us in-depth information from several actors working on quick clay related problems, as qualitative data can help improve our understandings and interpretations of how individuals and institutions act and interact (Bell et al., 2019).

We are using an inductive method as the approach in this study, as we are seeking to generate theory from data (Eisenhardt, Graebner & Sonenshein, 2016). Our research is inductive as we are building on theory and the process of this study has been iterative where we have been going back and forth between existing theory and collected data (Bell et al., 2019). To take a naturalist view of the fact that both knowledge and understanding are socially constructed, is what characterize interpretivist studies (Gephart, 2004; Eisenhardt et al., 2016). In addition, researching natural hazards is complex, and inducive methods will provide the opportunity to select cases based on their capability to highlight and develop a profound understanding of processes (Eisenhardt et al., 2016). According to Eisenhardt et al. (2016), inductive researchers often review and collect data from archival data. As this study mostly uses documents to collect data, it is also crucial that the interviews generate an authentic and trustworthy representation of the interviewees experience and expertise.

3.2 Research design

3.2.1 Selecting a case study

A case study design is suitable for a study when: (a) the study focuses on "why" and "how" questions; (b) when the researcher(s) cannot control the actions of those involved in the study; or (c) the researcher(s) want to cover contextual circumstances, since it is believed to be important for the phenomenon being studied (Yin, 2003; Baxter & Jack, 2008). A case study is especially relevant for investigating phenomena in-depth within a real-world context (Yin, 2014). For our thesis, we consider a qualitative research design to be the right choice for our study, based on the rationale provided by single-case studies, that a specific phenomenon of interest can be investigated in depth (Eisenhardt & Graebner, 2007).

We have carried out our research through a case study of quick clay management in Norway, with focus on the relevant agencies contributing within this field (See Appendix 1). We believe a qualitative case study is the most beneficial for our thesis because it gives us, as researchers, tools to be able to study a complex phenomenon within its context. According to Baxter and Jack (2008), a case study provides researchers with opportunities to explore a phenomenon or describe it in context using different data sources. Further, it has been stated that a case study is best described as an in-depth study of a single unit with the objective to generalize across a larger set of units (Gerring, 2004). Therefore, we will investigate the concept of the research question by looking at the independent work and collaboration of multiple agencies within the case of quick clay management in Norway.

3.2.2 Case boundaries

Quick clay is considered a problem primarily in Norway and Sweden, but also occurs in countries such as Finland and Canada (NGI, n.d.a). Since quick clay is limited to a small amount of countries, there is no global strategies for mitigating, managing, or adapting to the occurrence of such landslides. This indicates that exposed countries have to make their own strategies to better manage such incidents. Risk management, in the form of assessment of potential for or occurrence of quick clay landslides are actively pursued in Norway, Sweden and

Quebec (Torrance, 2012). However, in our study we investigate the quick clay management in Norway, and do not focus on changes in the quick clay field in other countries.

The first quick clay landslides occurred in Norway in the Medieval Period and since this quick clay landslides have happened on a regular basis without any noticeable change in frequency (NGI, n.d.b). Although quick clay landslides have occurred for several centuries, it is not before more recent time that incidents have been thoroughly documented and actors have actively pursued solutions as to how to deal with it. Therefore, we have chosen to limit the timespan of our study, and only include important events occurring after 1978 and up until today, as these is more data available.

3.3 Research Setting

Natural hazards have caused great destruction in Norway over the last decades and it is important to understand how organizations adapt, manage and mitigate the occurrence of natural hazards. Due to its massive consequences, it is interesting to look into the changes that have occurred because this can provide a better understanding of what has driven natural hazard fields to improve the management of such occurrences. By using quick clay as our empirical setting, we wish to investigate what the key drivers of field-level change in dealing with natural hazards are. There have been several organizations working on quick clay problems in Norway and various collaborations have been initiated with the goal to mitigate or avoid quick clay landslides (See Appendix 1). Overall, the agencies within this field work both separately and through collaboration. The purpose of collaborations has been to contribute to professional development and advice regarding management practices related to professional problems in areas exposed to quick clay. In addition, they propose development measures and provide advice and recommendations in relevant areas such as mapping of the zones exposed to quick clay landslides and follow-up of incidents (Naturfareforum, n.d.).

3.4 Data collection

Bryman et al. (2019) suggest that the relation between qualitative research and theory is more complex than quantitative research, and that data collection is therefore made up of greater uncertainty. For this thesis we chose an approach of documents as the main source of data, in addition to three expert interviews, to get

more insight than what only one method of data collection would provide us with (see Table 1). According to Flick (2004), the term triangulation "is used to refer to the observation of the research issue from (at least) two different points" (p. 178). Hence, the use of triangulation for this study can contribute to gaining a more comprehensive and balanced insight to the situation. The documents will provide us with in-depth information about the situation of quick clay management in Norway and how the field has changed over the last decades, whereas interviews will give us a deeper understanding for how some relevant actors have learned to deal with such problems over the same period of time.

	Archival data					
	Preparation, midway and final reports	Minutes from meetings and workshops	News and media coverage	Legislative and policy documents	Online webpages and press releases	Interviews
Data items	26	5	8	9	7	3
Pages	1,989	148	About 19	752	About 14	31
Timing	2011-2020	2012-2017	1996-2020	2011-2019	2016-2020	April 2020 – June 2020
Data description	Published reports by individual agencies and collaborations.	PowerPoint slides and summary reports of what was discussed	News articles on events	Parliamentary propositions, white papers, formal policy documents	Relevant agencies webpages etc.	Field experts from central agencies with large responsibilities
Type of information provided	Current status and progress in the field, R&D and results.	Description of different opinions, progress of research, recommendations.	Time, date, triggering reasons and consequences for landslides. Public statements from agencies and opinions	Priorities and allocation of funds, enactment of laws and regulations	Company information, historical landslide events and description of collaborations	Overview of key events, activities, learning processes and collaborative structures

Table 1 - Data table

3.4.1 Documents

Documents will be our main source of data in order to gain in-depth knowledge about the key drivers for field-level change in dealing with natural hazards. According to Merriam (1988), all types of documents can enable the researcher to discover meaning, gain understanding and uncover insights related to the research problem. As we are researching the drivers for change within natural hazards, it is appropriate to use documents as many of them have registered development and change over time within the field (Bowen, 2009; See Appendix 2).

We found that the most relevant documents for this study is retrieved from NVE's (Norges vassdrags- og energidirektorat; The Norwegian Water Resources and Energy Directorate) publications, as well as media outputs such as newspaper articles and other descriptive reports containing information about quick clay management in Norway (Bryman et al., 2019). A list and description of the documents used can be found in Table 1. As many of the documents we retrieved

bear witness to former occurrences, means that they will be able to provide us with background information, historical insights and change over time (Bowen, 2009). Therefore, we found the NIFS' final report and articles concerning quick clay landslides and the aftermath of these to be especially relevant. Such information and insights will benefit us in the sense that we can understand the historical background of particular problems as well as it can indicate the conditions that affect the phenomena we investigate. To ensure the quality of the information we have collected, we will determine the trustworthiness, authenticity and reflexivity of the documents we have selected for this study (Halldórsson & Aastrup, 2003; Bryman et al., 2019).

3.4.2 Interviews

We have used two sources of data, namely documents and interviews, with the intend to find corroboration and convergence between them (Bowen, 2009). We chose to conduct three interviews with experts within the quick clay field, which will contribute to insight and validation of the findings from the document analysis. The aim of an interview is to figure out how people interpret an object or event, as well as the importance they assign to it (Owen, 2014). We found it necessary to conduct interviews, in addition to analyzing documents, as the information we retrieved from the documents revealed that there were some questions that needed to be asked as a part of our study (Bowen, 2009).

We decided to construct a theme-centered interview guide (Appendix 3), which was somewhat adjusted to each of the three interviews we conducted. This was to be able to focus on the expert's opinions and experiences of the topic of quick clay, in addition to providing the interviewees with the opportunity to explain and unfold what they considered to be of importance within the field (Schorn, 2000). Hence, each interview consisted of the same theme, namely the quick clay field, but some questions were added or removed depending on what was suitable. Further, we deemed that semi-structured interviews would be the most appropriate, as it gives us the flexibility to gain insight to the processes, routines and experiences of the interviewee. Semi-structured interviews are based upon prewritten questions in the more general form which usually is open ended, and provides latitude to ask further questions (Bryman et al., 2019). This method was chosen to be able to retrieve all important information, in addition to other

relevant aspects and information that was not accounted for before the interview was conducted. We constructed the interview guide to start off with simpler, informative questions before moving over to more detailed, insightful questions towards the end. As we had open-ended questions, it allowed us to ask follow-up questions through the interview.

We conducted the interviews through online video calls, due to the restrictions posed by Covid-19 which limited the possibility of meeting the interviewees in person. We do not consider this to have been an impediment for collecting information and data from the interviewees, as we attained a lot of valuable input. In addition, our supervisor also joined the online interviews, where they asked follow-up questions which helped us gain more insight and information.

The interview questions were composed with the purpose of investigating the phenomenon of our research question. It was important that topics such as the development within the quick clay field, collaboration, routines and the participants' roles was touched upon, because this was not easily disclosed in the documents we retrieved. The most important subject for us, was to establish the key-driver in the quick clay field, how they were managing potential landslides and if there had been some major changes in the field. Although this is not an interview-based thesis, we found it helpful to conduct three interviews to get more insight to the field. For this thesis, we chose to interview three actors who are relevant in the field of quick clay management in Norway. The actors will be anonymous for this study and referred to as Expert 1, Expert 2 and Expert 3 further in this thesis. The three actors we interviewed works at three relevant agencies within quick clay management in Norway, and they were able to elaborate some important aspects for this thesis. In addition, the actors we interviewed has specific knowledge about the field, as well as large responsibilities.

3.5 Data analysis

The process of analyzing qualitative data is not limited by specific processes or rules on how one should conduct it, because the source of the method is entrenched in interviews, documents and observations (Bryman et al., 2019). To

be able to manage the considerable quantity of data collected, we used the tool Microsoft Excel.

Although Excel is often considered to be more relevant for quantitative research, it has great potential for qualitative data analysis due to its display futures, data manipulation and most importantly its structure (Meyer & Avery, 2009). Firstly, we chose to create a narrative from all relevant documents (i.e. reports, media and news articles and legislative and policy documents) to establish a timeline for the important events and major changes within the field in an Excel document (see Table 1 and Figure 2). Secondly, we evaluated the data for occurring topics which we coded into concepts and classifications that would help clarify how the actors and agencies both act(ed) and interact(ed) in these projects and events to assemble and generate change. Lastly, we saw some repeating patterns as to what was focused on after an incident had occurred or after a report had been released and coded these again in Excel to establish what had been focused on and how the issue had been dealt with. This part of our analysis affirmed that large incidents initiated change in the field, and generated more attention to quick clay as well as how the work should proceed to manage such natural hazards. When performing such an analysis, we understood that it enables us to link one part of the qualitative data to another (Meyer & Avery, 2009).

After analyzing the documents, we started to prepare interview guides, which is based on questions we believed could clarify and add to some aspects. After transcribing the interviews, we coded the data in Excel by piecing it together with the already coded document analysis, to gain a more holistic evaluation of the data (See Table 2). Conducting interviews strengthened the data established from analyzing documents. As the interviewees on several occasions confirmed and improved our understanding of the findings from the document analysis, this proved to be valuable in terms of validating our findings. One example is the insights we gained on why and on what basis the guidelines for the field were updated, as the documents only provided us with information on the fact that the guidelines were updated. Although this type of analysis has its limitation, it enabled us to identify which parts of the narrative facilitated learning, both independently or through collaboration, and thereby created a broader pattern of meaning. The results of our findings are presented in section 4, and we made sure

that nothing of interest has been ignored as we went back and forth to the documents and interviews to ensure this (Bowen, 2009).

Year	Events that occurred	Documents	Interviews
2012	The NIFS program started. This is considered to be the first cross-sectoral collaboration between multiple organizations in the quick clay field	The NIFS project was established as a consensus between several actors. The overall objective of the project was to develop knowledge and good, effective and future oriented solutions for handling natural hazards, and contribute to increased societal security. (NIFS report 2016-43)	The establishment of such a cross-sectoral collaborative initiative can be considered exceptional for the field and was a game changer for further development. (Expert 3) It was crucial to collaborate, such as in the NIFS project, and to allocate resources, to be able to develop results which are valid for everyone in the quick clay field. (Expert 2)

Table 2 - Excerpt of the coded analysis in Excel

3.6 Research quality

It is our responsibility, as the researchers, to decide the relevance of the documents used in this study (Bowen, 2009). There has been discussed that there are three criteria for assessing the quality of documents, which is also highly relevant for this thesis. As the researchers, we have to verify whether or not the content of the documents corresponds with the theoretical framework of our study. Therefore, it is imperative for us to discuss the trustworthiness, authenticity and reflexivity of this qualitative study, to be able to determine the quality (Halldórsson & Aastrup, 2003; Guba & Lincoln, 1994; King, 2004; Bryman et al., 2019).

3.6.1 Trustworthiness

Researchers suggests that trustworthiness consists of the four qualities; credibility, transferability, dependability and confirmability (Halldórsson & Aastrup, 2003; Erlandson, Harris, Skipper & Allen, 1993). The criterion credibility is established on the idea that there is “no single objective reality” (Halldórsson & Aastrup, 2003, p. 327). In other words, the findings need to be believable. As mentioned, this study has been using two approaches to gather insight from more than one angle, i.e. documents and interviews. Most of the documents that have been retrieved for this study are reports from acknowledged agencies, e.g. consultancy firms, universities and agencies subject to different ministries. Furthermore, the field expert’s we interviewed were able to elaborate on some important aspect, and the answers they provided harmonized with each other and the documents we had retrieved. Transferability refers to the degree the findings are capable of making general claims of the world (Halldórsson & Aastrup, 2003). Even though

both space and time is considered a constraint when generalizing findings, we do suppose that our study will be generalizable for more than one natural hazard. However, the purpose of our study is not to generalize the findings, although we do believe that future studies can explore our research in the future.

Dependability ensures that the data have stability over time (Guba & Lincoln, 1989; Halldórsson & Aastrup, 2003). This means that the researchers should permit the data to be audited to make sure of its trustworthiness. Firstly, we have given our supervisor full insight to our work throughout the whole process and have in this matter they have functioned as auditors. Secondly, the data we have gathered from documents, although written by professional actors, are mostly written in Norwegian. We are aware that we might misinterpret something when translating documents from Norwegian to English, but we are confident that the translation illustrates the proper meaning as we have translated it to the best of our abilities. Thirdly, the interviews we conducted have been taped and transcribed to guarantee as much transparency and accountability as possible. Lastly, two out of three of the interviews were also conducted in Norwegian, but we have taken the same measures as we did with the documents and have translated the content to the best of our ability. The last quality, confirmability, referrers to the fact that the findings itself should represent the results of the study, instead of the researcher(s) own beliefs (Halldórsson & Aastrup, 2003). To make sure of this we have conducted our research, to the best of our abilities, without letting any interferences from our own personal beliefs and theoretical inclinations.

3.6.2 Authenticity

According to Lincoln and Guba (1989), authenticity positions the researcher to have the responsibility to objectively represent contrasting aspects of social settings, to facilitate the research participants to gain a more comprehensive understanding of their situation, in addition to enable them to engage in processes to change their circumstances (Bryman et al., 2019). Our research paper's intention is to see the key-drivers towards change in dealing within the natural hazards field, and the research contains several papers from different actors as well as three expert interviews from different agencies. All the information we have gathered seems to coincide, and we have not stumbled upon anything we believe is wrongly perceived by us or any of the data. Additionally, we have acted as objectively as possible when both retrieving the data and analyzed it.

3.6.3 Reflexivity

According to Bryman et al. (2019), reflexivity regards the involvement of the researcher(s) in a study, as well as how this affects the development of obtaining findings and insight. There are multiple ways to guarantee reflexivity in a thesis, and as an example, we have made sure to document the thought process we have had throughout this semester and discussed what each document we have went through could provide for our thesis. Additionally, we have been able to guarantee a greater reflexivity by regularly reviewing the process, content creation and progress. Since we are two authors on this thesis, we have both contributed with different perspectives, in addition to being able to discuss with our supervisor to gain more insight. For our study, we aim to have unexpected findings and results retrieved from the document analysis, as well as we have been transparent and defined our objective throughout the whole process.

3.7 Ethical considerations

To ensure that no challenges of ethical problems intervened in our research development, we ascertained to pursue a set of principles, which were considered before, during and after retrieving the relevant documents and when conducting the interviews for our study, and continuously evaluating the importance of them during the whole process of our thesis. We chose to follow Diener and Crandalls (1978) four ethical principles in business research, which is whether there is harm to participants, lack of informed consent, invasion of privacy and if deception is involved (Bryman et al., 2019, p. 114). We have also considered issues such as anonymity, confidentiality and that the participation is voluntary, in regard to the interviews that was conducted.

Throughout our study we have had close contact with our supervisor, and we established early that our interviewees were to be anonymous. Although we do not quote the participants directly in the study, we still made sure that what they expressed should not be traceable back to them. We made sure that the interviewees were sure of this and ensured that we had a mutual understanding of the purpose of our study and their role in it. In addition, the interviewees also accepted our request to record the interviews which gave us the opportunity to reassess our interpretation of their statement if uncertainty arose later in the research process.

4 Findings

To study the drivers of field-level change in dealing with natural hazards, we first present an overall description of the case, looking at the key events that have happened since 1978 up and till today. Further, we present the findings according to our analytical model derived from the iteration between the literature and empirical study. First, we look into the background of the quick clay field and present a timeline of important events that have had an impact on the field. Second, we describe how pressure has driven the field to identify problems or opportunities that call for institutional change. Third, we investigate how entrepreneurship and interorganizational collaboration has led to the creation of collaborative initiatives contributing to institutional change. Fourth, we look into how knowledge sharing and learning has led to generation of responses contributing to institutional change. Lastly, we present the institutional changes that have occurred within the quick clay field since 1978.

4.1 Background

Quick clay is a naturally occurring and fine-grained sediment with high sensitivity, that behaves as a liquid when its structure breaks down (Torrance, 2012). Quick clay occurs below the marine boarder, which is classified as where the sea level was during the last ice age. At this time, about 20 000 years ago, Norway was covered by a 3,000-meter layer of ice (NGI, n.d.a). When the ice melted, particles of clay were carried away with the water from the melted ice and sedimented in what then was the beach zone close to the salty sea water. The clay acquired an internal grid structure in the marine environment because of the salt from the seawater. Since the last ice age, the land has risen, and the salt in this clay has been washed out with fresh groundwater, which leads the mechanical properties of the clay to dissolve, thereby creating quick clay (NGI, 2016).

Quick clay landslides are natural hazards that poses a major risk of damage to infrastructure, households and lives in Norway (Torrance, 2012; Regjeringen, 2012; NVE, 2016a). As of 2020, about 2,500 quick clay zones have been identified in Norway, and about 90,000 people live in these exposed areas (NVE, 2020a; Mordt, 2019). Quick clay is originally steady, and it is therefore not dangerous to live in these areas, however, if the clay becomes overloaded the structure could collapse which causes quick clay landslides. Quick clay landslides

can occur due to different reasons, but the two main reasons are natural causes such as digging from rivers or streams (erosion), or human activities such as excavations at the bottom of slopes or fillings on top of terrain loads which both worsen the stability of the clay (NVE, 2016a). According to Expert 1, there has been a shift in which of these reasons caused the most quick clay landslides in Norway. In the period before 1960, most quick clay landslides happened due to natural causes, and in the period after this most landslides occurred because of human activities such as construction activities.

Although human activities have trigged approximately 75% of all quick clay landslides in the past 50 years, climate change may entail larger amounts of waterflow in watercourses, which increases the risk for naturally caused quick clay landslides (Expert 1; Statens vegvesen, 2013). The largest quick clay zones in Norway are in the areas around Oslo and Trøndelag (NVE, 2016b). Several incidents have been reported in these areas, some with major consequences, such as the largest landslide in the 20th century at Rissa and a recent one in Sørum, which will be further described (NGI, n.d.b). Many of the quick clay landslides in Norway have caused people to die and lose their homes, as well as severely destroyed the infrastructure. Since 2010 there have been several registered landslides in Norway, where 80 percent of them occurred because of human activities (Mordt, 2019). Since changes in the climate entails a significant need for investment in planning, construction and maintenance of infrastructure, the possession and development of research-based knowledge about quick clay landslides is important (Næss, Solli & Sørensen, 2011). Nevertheless, networks that collaborate and focus on how to organize adaptation is essential when dealing with natural hazards such as quick clay landslides (Time, 2017).

Within the quick clay field, there are several factors that have contributed to drive actors and agencies towards creating field enhancement. Through the occurrence of events, actors have identified problems or opportunities that have constituted the need for institutional change. There have been several landslides and changes in the quick clay field since 1978. Figure 2 provides an overview of important events, in terms of accidents, new guidelines and regulations, and changes in practices and technologies. These aspects will be further elaborated on in the following sections.

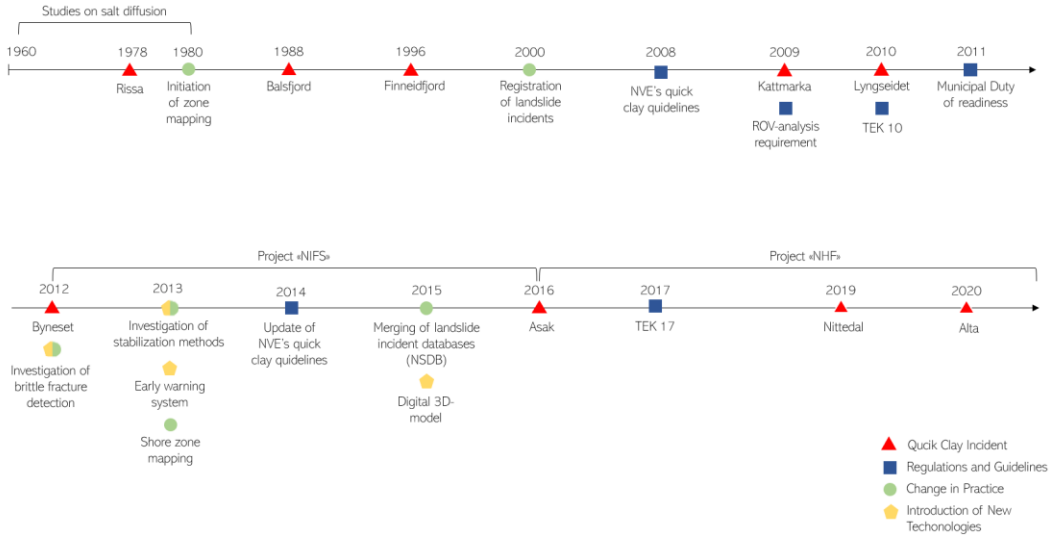

Figure 2 - Timeline of important events

4.2 Incidents and external pressures

The largest quick clay landslide in Norway in the 20th century occurred in Rissa in April 1978. In addition to taking one life and destroying over 20 houses and farms, the quick clay landslide resulted in a tsunami which reached 6.8 meters above the surface level (Issler, Cepeda, Luna & Venditti, 2012). As a consequence of this massive landslide, several actors saw the need to identify potential areas exposed to quick clay in Norway, and this incident is therefore considered as an enabler for the nationwide mapping program initiated in 1980 (Olje- og energidepartementet, 2012; L'Heureux, 2012a; Wiig et al., 2011; Aunaas et al., 2016). This was also seen as an opportunity to provide municipalities and the management of construction projects an important tool in the planning for new buildings and infrastructure (NVE, 2019a).

Another landslide that brought attention to the need for a nationwide mapping of potential quick clay zones in Norway occurred in Finneidfjord in 1996. The well-known landslide ended up taking four lives and destroying two houses, including the municipality's school and community centre (Issler et al., 2012; NGI, n.d.b; NTB, 1996). In addition, around 400 meters of the highway (E6) ended up in a fjord nearby (NGI, n.d.b). After the incident, the mayor of Finneidfjord emphasized the importance of mapping quick clay zones in Norway, as the reconstruction costs and consequences of such events are immense to the affected communities (NTB, 1996).

During the 1980's, it became clear that quick clay landslides posed threats to both lives and infrastructure in large parts of Norway. Although the geotechnical competence in Norway is among the best in the world, NGI (Norges Geotekniske Institutt; The Norwegian Geotechnical Institute) (n.d.b) pointed to the fact that there is a lack of applying these skills, after a landslide occurred in Balsfjord in 1988. The landslide resulted in the loss of two human lives and a variety of livestock (NGI, n.d.b). It is reasonable to believe that relevant agencies and governmental bodies became more aware that human activities can initiate such natural hazards, as the incident was triggered by nearby roadwork. Many of the incidents that occur are not due to poor geotechnical feasibility studies, but rather to the lack of them, according to an NGI representative (Nordlys, 1988). Hence, the absence of executing feasibility studies before construction work in potential quick clay areas was considered to be an issue.

There is a need to learn from previous incidents to be able to prevent, to the degree possible, the damage on infrastructure, lives, and property (Expert 1). In 2009, twenty-one years after the landslide in Balsfjord, another landslide occurred in Kattmarka in Namsos due to similar reasons. The landslide happened because of blasting work in connection with the construction of a new road, and resulted in the destruction of nine houses and one hundred people were directly affected, but luckily no lives were taken (NGI, n.d.b; Dalløkken, 2009). The leader of the commission committee pointed to that one should not only figure out what and why an event occurs, but additionally make thorough assessments of the planning phase of construction projects and provide advice on new procedures for such work. In other words, it became clear that there is a need for guidance on how roads should be planned and built in the future, which is part of the broad mandate that the commission was assigned by the ministry of transportation (Dalløkken, 2009; Nordal, Alén, Emdal, Jendeby, Lyche & Madshus, 2009).

Although large quick clay landslides were considered a driver for mapping potential quick clay areas, there was no particular focus on coastal areas, as the prioritization of the mapping focused on areas where people live, and ignored the potential consequences of infrastructure, cultural heritage, industry, and roads (Wiig et al., 2011). The consequences of not mapping coastal areas were demonstrated when a large quick clay landslide occurred in Lyngseidet in Troms in 2010, due to masses of fillings being dumped near the shore zone. Although no

lives were taken, several residential buildings and the main road going through Lyngseidet were destroyed because of the landslide (NGI, n.d.b). This indicates that the scope of the nationwide mapping was inadequate and should be widened in order to cover all areas that have the potential to face great loss, if a landslide occurs. Although the knowledge regarding quick clay landslides in the shore zone had improved over the past decades, there was no established methodology for preventative landslide mapping in the shore zones as of 2013 (Expert 2).

In a report published by NVE, it was, through a municipal survey from 2010, identified that multiple municipalities saw the need for a detailed mapping of quick clay occurrences to ease the work in planning and construction proceedings (Wiig et al., 2011; Hansen, L'Heureux, Solberg & Longva, 2012). Among these, the county governor in Oslo and Akershus saw the need for more thorough mapping of the potential quick clay zones in Nittedal municipality, even though the municipality is located in an area that had previously been mapped (Wiig et al., 2011). Despite this, a 40-meter-wide quick clay landslide occurred in Nittedal in September 2019. No people or buildings were harmed due to the landslide, but a big amount of infrastructure such as water pipes, sewage pipes, roads and cables were destroyed and residents from close to thirty houses were evacuated. Additionally, there were negative consequences for businesses who had production and storage facilities in the evacuated areas (Aftenposten, 2019; Nittedal Kommune, n.d.). Although there had been a need for more thorough mapping of potential quick clay zones in Norway for several years, this incident proved that there was still a lack of information and more work needs to be done in order to avoid similar events in the future.

Even though most quick clay landslides, in recent times, have occurred due to human interaction, a several hundred meters long quick clay landslide occurred at Byneset in Trondheim municipality in 2012, due to natural erosion in a stream close by. No lives were lost, but around 50 people were evacuated for several days (NGI, n.d.b). Although the area had been mapped for quick clay (Wiig et al., 2011), there was no risk associated with the probability of a landslide occurring since there was no construction work being done in this period of time. It was therefore identified a need to define which events trigger brittle fractions and what the likelihood of these events occurring within a given period is, as well as possible measures to reduce the possibility of them occurring (NIFS, 2014a).

In 2016, a large quick clay landslide occurred in Asak in Sørum in a forestrial area and resulted in the loss of three forestry workers lives (NGI, n.d.b). The landslide was triggered by the deposition of filling loads on a slope, which was a violation of the permit provided by the municipality in regard to doing measures in the area. It was clear that those who did the ground planning in the area went beyond their permission. However, the municipality misinterpreted the quick clay map over the area and wrote in the permit that the area was not in danger as it was placed outside of a mapped quick clay zone (Fjellberg & Gedde-Dahl, 2020). As pointed to by Expert 3, landslides occurring due to human activities are in most cases unintentional and rather a result of lacking knowledge about quick clay. Immediately after the incident a crisis management team was created which assisted the search and rescue team and conducted investigation to secure the surrounding area. The landslide received a lot of attention from the media and resulted in a police investigation that recently was dismissed. The attention given to this landslide made the municipalities more aware that it differs how actors follow the set guidelines, which according to Expert 1, acted as a driver for improved clarification of such measures in the future.

In retrospect to this event it became clear that one of the challenges when dealing with quick clay is the different actors' interpretations of the already existing quick clay zone maps. According to Expert 1, a lot of misunderstandings have occurred in the past due to how different actors view these maps. This proved the importance of conveying the existing competence to the municipalities, as this may prevent landslides from occurring due to human activities (Expert 2). As the maps are created, lines are put down on the map to indicate where there is a potential risk for quick clay, but this does not mean that the area outside the lines are safe. Hence, if construction work is being conducted in an area outside of such a mapped zone there is still a risk of quick clay landslides occurring (Expert 1). In many cases the areas outside of the zones are yet to be mapped. Additionally, there was no established system for registration of quick clay identified outside of the mapped zones, which was considered negative, as this type of information is valuable (Wiig et al., 2011).

4.3 Entrepreneurship and interorganizational collaboration

In the quick clay field, there is an increasing trend towards establishing collaborative initiatives to deal with natural hazards. The nature of such

collaborative initiatives began with distributing responsibility to some agencies, before moving over to collaboration among several actors and agencies (Wiig et al., 2011). According to Expert 2, the establishment of such initiatives drives the organizations to collaboratively create new solutions to improve the preparedness and management of quick clay landslides and reduce the associated consequences. Compared to Figure 1, we have chosen to gather both entrepreneurship and interorganizational collaboration in this section as we have not been able to identify many acts of entrepreneurship in the quick clay field. In the following section we describe the establishment of key collaborative initiatives and how roles and responsibilities change within the quick clay field, and how this acts as a driver for institutional change within the field.

After the identification of the need for creating quick clay zone maps of Norway, it was clear that the overall responsibility should be given to one relevant agency, to ensure proper development of the mapping. The main responsibility for the initiation of the nationwide mapping program of quick clay hazard zones was handed to KV (Kartverket; The Norwegian Mapping and Cadastre Authority). The responsibility was later transferred to NGU (Norges Geologiske Undersøkelse; The Geological Survey of Norway) in 2004, before NVE took over in 2009 (Wiig et al., 2011).

Even though only one agency was given the overall responsibility, a number of other players also contributed in the massive project of mapping quick clay zones in Norway, through inquiries from the responsible agency. A field expert states that almost all of the mapping was completed by NGI (Expert 1). However, in 2005, the task of mapping potential quick clay zones was made accessible for all relevant actors through public tenders (Doffin, n.d.). This opened opportunities for other actors and NGI was no longer alone in the mapping of potential quick clay areas. This enabled the field to leverage the competence of relevant consulting firms, which led to the possibility of mapping larger areas simultaneously due to increased capacity (Expert 2). According to Expert 1, the initiation of public tenders created, to some degree, competition between NGI and large consulting firms (e.g. Multiconsult and Rambøll) as they were competing on price and quality. Although these agencies also cooperate on many projects, this is one example where they act as competitors.

As previously identified, there was a lack of focus on mapping coastal areas exposed to quick clay, and no established methodology for conducting such investigations. As the responsible agency, NVE recommended to focus on this in their national mapping plan for 2013, as there was a need to map such areas. Further, NVE emphasised the importance of distributing the results to the society and started to create a plan on how to proceed (Wiig et al., 2011; Hansen et al., 2012).

Prior to 2009, the responsibility for prevention of landslide incidents was distributed among several actors, however, in 2009, NVE became the agency responsible for safeguarding the state's administrative responsibility regarding prevention of landslide incidents (Wiig et al., 2011). This responsibility also includes contributing to coordination and stimulating cooperation between actors who have sector responsibility or professional expertise (Olje- og Energidepartementet, 2012). Furthermore, to build up competence and capacity the budget for landslide prevention was increased with 10 million NOK from 2009, when NVE took over the administrative responsibility (Olje- og Energidepartementet, 2008). Collecting all administrative responsibility under one agency was considered an important factor for the management of landslides in Norway (Expert 1).

Prior to 2012, there was little collaboration between the organizations within the quick clay field. However, dealing with natural hazards are a complex process requiring the competence of several agencies. The different agencies affected by quick clay in their operations had different guidelines and safety requirements for conduction of work in areas with quick clay. According to Expert 3, this created obstacles especially for SVV (Statens vegvesen; The Norwegian Public Roads Administration), as scheduled work was not approved by the municipalities because they followed a different set of guidelines. This created disagreements between the different agencies working in the field over longer periods of time, which led SVV to initiate conversations with other actors on how to improve the current situation in the field in 2011. By discussing the problem with others, several agencies came together and agreed that the overall issue was that they had different regulations and guidelines, but that they ultimately were working on a common challenge (Expert 2; Expert 3).

As consensus was created SVV, JBV (Jernbaneverket; The Norwegian National Rail Administration) and NVE established a collaboration in 2012, namely NIFS (Naturfare, Infrastruktur, Flom, Skred: Natural Hazards, Infrastructure, Floods, Landslides), for dealing with natural hazards (Berggren, Erichson & Larsen, 2015). According to Expert 3, the establishment of such a cross-sectoral collaborative initiative can be considered exceptional for the field and was a game changer for further development. The overall objective of the project was to develop knowledge and good, effective and future oriented solutions for handling natural hazards, and contribute to increased societal security (Dolva, 2016). The project, which received resources from the Research Council of Norway, involved focusing on several natural hazards, where collaboration is crucial for improved preparedness and management of risk and incidents, as well as reduction of the associated consequences for infrastructure and buildings (Miljøverndepartementet, 2013; Expert 2).

It was decided that quick clay management should be a separate sub-project due to the importance and consequences of the phenomenon. Several other agencies participated in the project (e.g. NGI, Multiconsult and NTNU (Norges Teknisk-Naturvitenskapelige Universitet: Norwegian University of Science and Technology)), in addition to JBV, NVE and SVV. The actors working on quick clay management within NIFS were chosen as a part of the workforce due their high level of competence, experience, and involvement in the field. According to the final report of the NIFS project, the research conducted in connection to quick clay was in most cases published as reports and made available for all, e.g. through NVE's publications, providing opportunities for sharing knowledge and experiences with other relevant parties (Dolva, 2016). According to Expert 3, the research was focused on producing results, however, implementing created measures was not a part a part of the project. Expert 3 further pointed to that towards the end of the NIFS project the actors started to create implementation notes on what results could be implemented.

According to Expert 2, prior to the NIFS project, close to every report that had been produced in the quick clay field was developed independently by the agencies. Through the establishment of the NIFS project, working groups were established with representatives from the different agencies, encouraging them to work together on the formalization of knowledge and creation of reports.

However, the work was still characterized by the fact that the agencies shared their reports with each other rather than producing it together. As the different actors began to form relationships, the tendency shifted, and reports were written in collaboration between multiple agencies. As knowledge resides within independent actors, and not the organization as a whole, it proved to be beneficial to collaborate on the reports as combining the knowledge increased the expertise and thereby the value of outcome. This contributed to a more equal distribution of ownership and concrete results that could be applied by all the participating actors (Expert 2). According to Expert 3, it was important to collaborate, and to be allocated resources, to be able to develop results which are valid for everyone in the field. In addition, exchanging experiences and information within the collaboration is essential because it has the potential to improve practice (Expert 3).

After the NIFS project ended in 2016, SVV, JBV and NVE decided to carry on with the collaboration, through a new project called NHF (Naturfareforum: Natural Hazards Forum). NHF was established to further strengthen the collaboration between national, regional and local actors to reduce the vulnerability connected to undesired natural hazards, by identifying deficiencies or potential for improvement in society's prevention and management of natural hazards and propose measures to address this. Compared to NIFS, NHF is structured more like a forum, where the participating actors meet and discuss issues and opportunities. The idea was to create a permanent center, which could act as a platform where all agencies could discuss issues, share knowledge and resources, and learn from and with each other. Through creating an arena for sharing experiences, the interaction between the actors in the field becomes more transparent (Expert 3). Despite the fact that implementation notes were created during the final period of the NIFS project, there does not seem to have been any changes with regards to this. According to Expert 3, the NHF does not have any authority to implement measures into the field, as such authority still belongs to the respective organizations.

In total, there are ten agencies involved in the NHF, whereas eight of them were a part of the workforce dedicated to working with quick clay problems (Naturfareforum, n.d.). According to Expert 2, the different agencies have varying resources, priorities, experiences, and strategies, which makes them able to

positively contribute to the forum in distinctive ways. As pointed to by Expert 1, the results of such collaborations benefit the involved actors. However, it is often such that the developed competence does not adequately reach relevant stakeholders outside of the close circle of agencies (Expert 1).

4.4 Knowledge sharing and learning

The quick clay field have worked on developing several new measures to better manage quick clay since 1978. In order to develop such measures, we have identified that sharing of resources and knowledge has been an important driver toward institutional change as it generates learning. By sharing knowledge and resources the actors have become better equipped to deal with the challenges ahead of them. Further, by combining, leveraging, learning and developing knowledge and resources the agencies alone or in conjunction with each have developed new methods, techniques and guidelines which has driven the field towards change. As new measures are created, we have identified that it may lead to revelation of additional flaws that need further investigation.

4.4.1 Development of mapping

Although zone mapping of potential quick clay areas had been an active process since 1980, NVE acknowledged a need to further develop the efforts related to mitigation of quick clay landslides (Olje- og energidepartementet, 2012). This caused NVE to establish a program to increase the safety against quick clay landslides in 2000 (Program for økt sikkerhet mot leirskred). In relation to this, they needed a tool to prioritize which hazard zones that needed to be assessed and secured (Wiig et al., 2011). NVE started with creating hazard (assessment of the possibility of a landslide occurring), consequence (assessing the danger of loss of life and value) and risk maps (combining information about the possibility of a landslide occurring with the possible consequences) for the already mapped quick clay zones in Norway (Wiig et al., 2011; NVE, 2011a). The creation of such maps also provides possibilities to improve the quality and characterization of previous landslides registered in NSDB.

In 2012, several areas of Norway had not been investigated and mapped for quick clay. Through the NIFS project, the different actors summarized and shared previous experiences in order to generate an overview over what has been done and to provide recommendations for future mapping of unmapped zones (Hansen

et al., 2012). In addition, several methods have been proposed to map shore zones, and it was recommended in a NIFS report to establish a system for prioritizing mapping of coastal areas, and that existing information and data regarding these areas are made publicly available through online portals (Hansen et al., 2012). However, before such methods are put into use it is important that the maps are in the same format as the existing maps, because it is important to be able to compare and link them together in order to get a unified evaluation of the danger in such areas (L'Heureux, 2012b).

In a NIFS report from 2012, a suggestion for a methodology was presented (L'Heureux, 2012b). Reports have proven to be an effective way to generate learning within NIFS, especially due to the project's ability to gather and compile knowledge (Expert 1). The methodology was further worked on in the following year, when NIFS started by reassessing the degree of danger for a representative selection of quick clay areas in Norway. In addition, the methodology was tested, and different quick clay landslide factors were assessed in a hazard matrix specified for the shore zone, classifying the areas to a low, medium or high degree of danger. The project made the participating actors (SVV, JBV, NVE, NGI and NGU) both gather and share information to be able to gain satisfactory results, and it was identified that there was a good distribution of zones in each degree (low, medium and high) in the representative selection. Further, the project proved the need for mapping danger and risk areas for land planning, and for assessing safety needs in relation to existing buildings and infrastructure in the shore zone (L'Heureux, 2013).

In 2013, NIFS held a workshop assessing the mapping of the shore zone, where they, after the production of several reports, shared their experiences and recommendations on this matter. It was established that it is especially important to map out areas where a landslide could propagate onto land and potentially affect populated areas (Jensen & Nyheim, 2013). According to Expert 2, the occurrence of several landslides in the shore zone the past years have led to increased attention on the topic, forcing the agencies to work on developing new knowledge. In June 2020, an additional landslide occurred in Alta in the shore zone, where eight buildings were destroyed and one person evacuated. This led to great attention in the media, which is likely to further increase the pressure to

create measures on prevention and handling of such landslides (Dimmen, Rostad, Rasmussen & Tronsen, 2020).

According to Expert 1, the occurrence of large quick clay landslides poses a great opportunity to learn from, as such incidents do not happen frequently, and many of the cases where the process of creating new or updated ways of dealing with quick clay, is initiated in connection to the occurrences of landslides. Additionally, it is desirable for the relevant actors to be present when and after a landslide occurs, because of the high learning potential, both for the experienced and inexperienced workforce (Expert 1; Expert 3). Therefore, it is important to evaluate what has been done to be able to formalize and integrate new aspects (e.g. techniques) that worked well during the management of the landslide. Such evaluations are reserved for incidents where more thorough documentation and analyses can provide new and better knowledge about prevention and at the same time provide society with a basis for the events and its causes (Expert 1; Expert2). Although internal learning within the agencies, such as lectures, course offerings and presentations, also is an important aspect driving the field forward, learning directly from incidents and projects is considered to be the most important arena (Expert 1; Expert 2).

As the NIFS project seeks efficient solutions for monitoring, mapping and warning of natural hazards, the group wanted to develop a knowledge base on the use of drone-based solutions to investigate the potential use of the technology. On behalf of NIFS, SINTEF in 2014, carried out a mapping of the current status and potential of drone-based technology, especially with regard to applications in the field of natural hazards and infrastructure. The report identified that in regard to quick clay landslides the technology could be especially helpful in the process of inspection after a landslide. This is because manual inspection often cannot be done due to the uncertainty related to the possible occurrence of additional landslides and the use of ground based laser scanning may not be feasible in challenging terrain (Grøtli, Transeth, Gylland, Risholm & Bergh, 2014).

When identifying quick clay there are multiple field methods that can be applied (e.g. R-CPTU). Several NIFS reports have been produced on the detection of brittle fracture materials, describing the current industry practice and summarizing previous knowledge and experiences, from relevant agencies (Sandven, Vik,

Rønning, Tørum, Christensen & Gylland, 2012; Montafia & Sandven, 2013). As a result, from pooling the knowledge through the production of these reports it was clear that the agencies used different field methods when detecting brittle fracture materials, in terms of equipment, field procedures and interpretation of results. Therefore, the agencies saw a need to collaboratively evaluate the methods and detection practices with previous experiences in order to gain a better understanding and create further development, both in terms of interpretation and execution methods in the field (Sandven et al., 2012). Hence, it was agreed upon that there was a need for establishing quality requirements and a common methodology, which all actors operating within the field should use.

4.4.2 Development of methodology and technology

In 2009, NVE initiated research on the establishment of a surveillance and warning system for landslides on a regional level, due to its potential for minimizing consequences of landslides and quicker be able to initiate emergency responses (Colleuille & Engen, 2009). As a part of this a seminar was held, where the participating actors provided input and discussed practicalities and the potential of such a system. After the seminar several agencies (NVE, SVV, NGU, NGI, JBV, Norwegian Meteorological Institute and municipal representatives) contributed to the creation of a report recommending how and why the project should be executed (Colleuille & Engen, 2009; Colleuille & Humstad, 2016).

In 2012, several stabilization methods for quick clay were investigated by multiple actors, as a response to the government requirements. This is considered an important measure to prevent and minimize the consequences of quick clay landslides. One of these projects was initiated by NIFS to investigate how salt diffusion could serve as ground reinforcement for quick clay, by actualizing the method and creating guidelines for the use of the method for stabilizing measures in quick clay slopes (NIFS, 2012). Prior to this pilot project, NGI conducted several studies in the 60s, 70s and 80s to identify how salt diffusion may serve as ground reinforcement for quick clay, which NIFS incorporated in their research. Hence, the project relied upon previous literature in the field, as well as calculations and cost assessments, to develop the method for commercial use (NIFS, 2012). Another stabilization method that was investigated by NGI, on behalf of NIFS, was the use of gentle installation methods for lime piles and the use of slurry. The project found that to increase competence and knowledge on the

application of lime pile stabilization in natural slopes, there is a need for conducting experimental field tests (Eggen, 2012). According to Expert 3, being able to develop and accept new technologies has become much better, and faster, since the agencies started to collaborate. Additionally, Expert 3 pointed to that through collaboration actors share their experiences with each other and are able to implement the good experiences from others into their own practices, even though this process may not always be easy to pinpoint or identify.

In addition to the investigation of stabilization methods, the NIFS project identified a need to establish joint guidelines in regards to the use of anisotropy ratios in stability calculations for the planning, projecting and engineering environment as consultants had different practises when it comes to this. After a workshop in 2013 on the use of anisotropy in stability assessment in brittle materials, key actors in the professional environment (e.g. SVV, JBV, NVE, NGU and NGI) collaboratively developed a unified recommendation on how to move forward (NIFS, 2014b; Oset, Statens Vegvesen & Vegdirektoratet, 2013). However, no further work seems to have been done on the topic.

In terms of establishing quality requirement and common methodology for the detection of brittle fracture, NGI conducted R&D on how to collect, analyse and characterize quick clay, and found that the variation in the quick clay's characterization is larger than previously assumed (Karlsrud, Otter & Gjelsvik, 2012). Further, the agencies involved in the NIFS project proposed that 3-4 national experimental fields should be established, with different types of quick clay, where at least one should be in Trøndelag and one in the east of Norway (Sandven et al., 2012). It was also found promising to contact Sweden (SGI) and Finland (TUT Tampere), which has performed or planned field activities using certain field detection methods for brittle fracture (Montafia & Sandven, 2013). The objective is to collaboratively evaluate the methods and practices for the detection of quick clay in order to establish quality requirements and a common methodology on how the different methods should be used. Creating such field standards would make it easier for the different agencies to interpret and use the work previously conducted by other agencies.

When brittle fracture material is detected, it is often necessary to calculate the probability of a landslide occurring and implement stabilizing measures. During a

seminar on this topic, arranged by NHF in March 2018, the participating actors pooled together and reflected on their views on the different methods and approaches related to both theory and practice. In the aftermath of the seminar it seemed clear that this subject engages the agencies and scientific community, and that the seminar contributed to elucidate relevant issues related to the use of probability calculations and methodology related to geotechnical issues (Dolva, 2020). Moreover, a recommendation for further R&D on the use of probabilistic methods to complement and enhance traditional geotechnical standards was proposed. A report summarising the background documentation and reflections that emerged after and during the seminar was created and made publicly available two years later (Dolva, 2020).

Up until 2013, the nationwide mapping program of potential quick clay areas was limited to the identification of exposed areas and did not take the mechanisms (i.e. spread, distance and retrogression) of the landslides into consideration. Due to increased social awareness, the tool Q-Bing was developed and included in the mapping program because of its potential to calculate the distance of a potential quick clay landslide (L'Heureux, 2012a). However, it is not easy to accurately calculate and simulate the run-out distance of quick clay landslides, which is pointed to in several reports. To be able to calculate it more accurately, researchers also attempted using other models meant for other types of landslides but did not succeed in simulating any of the previous quick clay landslide events in Norway satisfactory. Therefore, suggestions were made for future improvements of Q-Bing as this was considered to be the most promising tool (L'Heureux, 2012a; Issler, Cepeda, Luna & Venditti, 2012).

4.4.3 Creation of guidelines and regulations

NVE wanted to improve the society's ability to meet the complicated problems related to dealing with landslides. Therefore, in 2010, NVE organized "Exercise Quick Clay", in Trøndelag, in collaboration with all relevant government agencies, power grid companies and municipalities, to apply the established systems and make sure that everything is working properly, as well as assessing the distribution of roles and responsibilities. The scenario for the exercise was a large quick clay landslide in central Norway, which also had consequences for the power supply, and the aim was to improve society's ability to meet complex, sector-wide issues related to a major quick clay landslide accident. The exercise

had a wide range of participation and was perceived as a good arena for testing the ability for interaction and coordination. Based on this, it was concluded that NVE should be a driving force for conducting such exercises (Olje- og energidepartementet, 2012). However, the agencies generate most learning from real life events, as it is difficult to make exercises realistic due to the time frame (Expert 2).

As of May 2013, the Ministry of Climate and Environment reported that 64,000 people live in exposed quick clay zones. In addition, 17,000 properties exist in these exposed areas (Miljøverndepartementet, 2013). It is clear that the municipalities have a desire to keep its citizens safe and prevent and minimize, to the degree possible, the occurrence and consequences of natural hazards. The same year, it was established that the Transport and Communication authorities will be responsible for ensuring that knowledge and experiences from previous projects are systematized and communicated to the responsible authorities at all administrative levels, and that the increased level of knowledge will be followed by specific measures (Miljøverndepartementet, 2013). In addition, the Ministry of Climate and Environment in collaboration with the Ministry of Local Government and Modernisation and the Ministry of Petroleum and Energy agreed on the need to develop recommendations, and if necessary guidelines, on how the effects of future climate change on landslides and floods should be incorporated in municipal planning (Miljøverndepartementet, 2013). Therefore, it was concluded that assessments of the probability and consequences of landslides occurring, prioritization of areas with increased risk and the creation of measures to deal with such events was necessary. Further, in a white paper presented in 2012, the most central research and government institutions expressed the need for improved models and calculative tools, increased multidisciplinary research on the consequences of floods and landslides, as well as creation and evaluation of different measures. Additionally, the research communities pointed to the need for prioritization of the development of research infrastructure (Olje- og Energidepartementet, 2012).

4.5 Implementing field-level change

As different measures, such as technology, tools, guidelines, and knowledge, are developed it needs to be incorporated and implemented into the operation of the agencies working in the field, in order to create change. Additionally,

implementation of new measures may lead to the identification of a need for further enhancement of the focal measure, or to the identification of a need for developing other measures, through the application of the measure or feedback from the agencies using it. On this basis, we in the following section describe the implementation of new measures in the quick clay field.

4.5.1 Mapping of quick clay zones

One important change in the quick clay field is the establishment of the nationwide quick clay zone maps, as previously described. Since its initiation in 1980, it is clear that the number of mapped areas has gradually increased, providing the municipalities and agencies with an increasing amount of data (See Appendix 5). As of 2012, about 1,750 quick clay zones had been mapped, mainly in eastern Norway and in Trøndelag, and hazard and risk maps for these zones have been prepared (Olje- og energidepartementet, 2012; Expert 1). In a parliamentary proposition from the Ministry of Petroleum and Energy, it was suggested that for these already mapped quick clay zones, future work will prioritize updating the maps through compilation of available data and information from recent investigations and basic studies (Olje- og energidepartementet, 2012). This can be viewed as an evaluation of the already established zone mapping program, as incorporating such information could contribute to improving the available data and information. Since then, the number of zones mapped have increased even further, and as of June 2020 2,512 quick clay zones have been mapped out (NVE, 2020a).

4.5.2 Enforcement of guidelines and laws

As a result of NVE prioritizing their efforts related to the mitigation of quick clay landslides in the 2000, they started to work on the creation of guidelines in collaboration with a selection of representatives from the geotechnical field (e.g. NGI, Multiconsult and SVV) (Olje- og energidepartementet, 2012). Such collaborations provide a holistic perspective, as knowledge and resources from several agencies are included. These guidelines were published in 2008, and dealt with the assessment of area stability when working in areas with detected quick clay and other soils with brittle fracture properties. According to Expert 2, the new guidelines met some resistance from senior individuals who had been practising geotechnics for many years and created pressure on the geotechnical community, as the requirements were stricter and required more resources. In 2009,

adjustments were made in connection with a revision of the guidelines for planning and development in hazardous areas (NVE, 2011b). These were further revised in 2014, and several alterations were made as a result of input from a seminar in 2012, where all major geotechnical enterprises participated together with NVE, SVV and the Directorate of Building Quality, as well as selected municipalities and counties. Among the changes were increased requirements to the level of details regarding several measures, e.g. the assessment of the potential for quick clay landslides (Schanche & Haugen, 2014). The purpose of these guidelines were to act as a template for the conduction of activities connected to quick clay. According to Expert 2, the guidelines have been acting as the "bible" in the quick clay field, as it has been the basis for all actors when detecting, documenting, and securing areas with quick clay.

After the quick clay landslide in Kattmarka in 2009, which occurred due to blasting work in connection to road construction, SVVs guidelines were updated to include the conditions pointed to by the commission committee the following years. The updated guidelines were clarified and included specifications for blasting work in areas with quick clay, where direct pressure from blast to the masses may be a possible and undesirable consequence (Aabøe, 2014). However, blasting work is not only conducted in connection to road construction, and is therefore also relevant for other agencies working with quick clay related issues. Consequently, this was also included when NVE updated their guidelines for safety against quick clay landslides in 2014 (Schanche & Haugen, 2014).

Since the updated guidelines came into force in 2014, NVE has, in collaboration with relevant agencies, continuously worked on revising and keeping the guidelines up to date. A new version was put up for hearing in 2019 and includes new knowledge and best practises based on developments in the field and results from the NIFS and other research projects (NVE, 2019b). The new version will be published later in 2020, because the process got delayed due to some shortcomings that needed to be incorporated (Expert 2). According to Expert 1, the development of the guidelines from NVE is one of the most important factors contributing to learning in the field of quick clay. Additionally, keeping these guidelines up to date and incorporating new knowledge is considered important because it contributes to making new and relevant information available for all actors in the field and is the basis for how they deal with quick clay problems. In

the years that the guidelines have been present, the number of collaborations have increased and thereby improved the relations between the agencies working in the field. Through the contribution of several agencies, input and feedback has become more accessible, making it easier to update the guidelines in an optimal manner for the involved agencies (Expert 2).

As a lot of incidents have occurred due to construction work, the relevant agencies and the government have realized the importance of creating guidelines and regulations for quick clay management within construction work. A new legislation (TEK10) regarding regulation on technical requirements for construction work came into force in July 2010 and draws up the limit for the minimum features a building must have to be constructed legally in Norway (Direktoratet for Byggkvalitet, n.d.). Because of the consequences quick clay may have on the construction industry, it was decided that the principles and procedures on handling quick clay described in NVE's guidelines would be incorporated in TEK10, with effect from 2011 (NVE, 2011b). Therefore, by following the guidelines set by NVE, the agencies comply with the legal requirement for building and construction in areas with quick clay. In 2017, a newer version of legislation, namely TEK17, came into force, and is built on the same regulations as TEK10 (Direktoratet for byggkvalitet, 2019).

After the occurrence of several destructive landslides it became clear that the municipalities needed to take on a more active role in the prevention of such incidents, as they are the responsible party for issuing permits to conduct construction activities. In July 2009, municipalities were obligated to promote social security through the prevention of the risk of loss of lives, harm on health, environment and infrastructure, material goods etc., through the new Planning and Building Act. The new legal requirements required that the municipalities must ensure that a ROV-analysis is conducted before construction activities take place in potential quick clay areas (Olje- og Energidepartementet, 2008).

However, landslides may also occur in areas where no construction work is being conducted, and this is likely to be one of the reasons for the introduction of the Civil Protection Act in 2011. The act imposed the municipalities of Norway a duty of readiness, which included clearer and stricter requirements. These requirements involved a preparation of a comprehensive ROV-analysis covering

the whole risk profile, thereunder identification of possible undesirable events in local communities, assessment of likelihood of such occurrences and their consequences (Justis- og beredskapsdepartementet, 2013).

As this is a difficult task for the municipalities to do on their own, a manual to the regulations regarding municipal readiness was stipulated by DSB (Direktoratet for samfunnssikkerhet og beredskap; The Norwegian Directorate for Civil Protection) and FM (Fylkesmannen, The County Governor) to assist the municipalities to comply with the legal requirements and ensure the quality of the ROV-analysis in 2012 (Justis- og beredskapsdepartementet, 2013). A survey conducted by DSB in 2012 suggests that 8 out of 10 municipalities had completed a full ROV-analysis, however, a majority of the municipalities did not comply with the legal requirement of conducting this at least every fourth year (Justis- og beredskapsdepartementet, 2013). By the end of 2012, only 70 out of 429 (16 %) municipalities had received quick clay zone maps (Miljøverndepartementet, 2013).

Even though conducting ROV-analysis was made a requirement in area planning through the Planning and Building Act and a manual on its conduction had been created, a NIFS report published in 2015 revealed that there is a lack of a unified and standardized way to perform a ROV-analysis. As an example, even though both JBV and SVV used the same methodology based on the guidelines from DSB, the different agencies are imposed to different requirements and laws, and a need for a clearer definition of what should be included in a ROV-analysis was identified to better coordinate efforts. Additionally, a need for better adaptation to municipal and county needs and closer collaboration between the involved actors was identified (Berggren, Erichson & Larsen, 2015).

4.5.3 Establishing joint databases

The different agencies working on quick clay related manners had independent databases containing information and data on previous landslides, which resulted in the actors having different foundations for managing and analysing landslides (Sokalska, Devoli, Solberg, Hansen & Thakur, 2015). In the early 2000s the agencies NGU, JBV, SVV, NGI and NVE started to systematically register landslide incidents, by collaboratively gathering information about historic landslide incidents in a digital format. The different agencies established separate

databases, but also created a joint web-portal to visualise landslide incidents (www.skrednett.no) (Sokalska et al., 2015). The interest of analyzing data from the portal has increased over time which has revealed problems related to the quality of the registered data, as some of the registered landslide incidents have flaws related to type of landslide, date and/or location. In addition, some incidents are registered twice and lack technical details (Sokalska et al., 2015).

Through the NIFS project the agencies discussed the potential benefit of gathering all the information in one joint database and created NSDB (Nasjonal skredhendelsesdatabase: National Landslide Incident Database), which is accessible for everyone through the already existing web-portal. This led SVV, JBV and NVE to explore how to improve routines for registration, quality requirements and quality assurance of landslide incidents, which applies both to new events and those already registered in the database (Sokalska et al., 2015). Nevertheless, a discussion was initiated on how and which data from previous landslide incidents should be transferred to NSDB (Sokalska et al., 2015). Further, several reports had been published every year, at both regional and national levels, which potentially could supplement the existing documentation in NSDB. Such reports could also provide input for better characterization of landslides, be used in connection to hazard zone mapping, risk assessment and in planning and construction (e.g. safety measures).

The quality of the NSDB's database is an important tool for its users, such as SVV, NVE, JBV and NGU (Sokalska et al., 2015). An important aspect for the optimization of the database is to have consensus of the definitions and agreements regarding terminology, which has been established through collaboration for several years by NVE, NGU, SVV and JBV (Sokalska et al., 2015). However, as anyone can register landslides in the NSDB, a NIFS report identified that this in many cases lead to incorrect information and that the classification of information therefore should be conducted by professionals (Sokalska et al., 2015).

4.5.4 Application of new tools and technology

In October 2013, an early warning system for landslides developed by NVE, SVV, Bane NOR and Norwegian Meteorological Institute was operationalized. An important aspect of the early warning systems is the communication and

distribution of warning messages. The authority responsible for issuing an alert communicates the kind of threats which can be expected, in addition to where and when it is expected. The early warning systems publish digital warnings daily (at www.varsom.no) and distribute them to emergency authorities, municipalities and road and railway authorities, the media and the public (Devoli & Dahl, 2014).

The study on detection of brittle materials came to an end in 2015, and NIFS released a report documenting the results from previous field and laboratory tests conducted by the different agencies (NGI, SVV, NTNU, Rambølls & Multiconsult) in various areas of Norway using different tools (Long, 2016). Additionally, during the project, experiences were exchanged with agencies located in Sweden and Finland on the use of different detection methods (Sandven & Montafia, 2015). Later the same year, Multiconsult, on behalf of NIFS, interpreted and compared the results, and produced guidelines on recommended methods and their usage in the detection of quick clay (Sandven, Montafia, Gylland, Pfaffhuber, Kåsin & Long, 2015; Long, 2016).

The investigation of the drone-based technology that NIFS conducted in 2014 proved to be promising, and in the fall of 2015 the government initiated the creation of a digital 3D-model of Norway using this technology, in the fall of 2015. A representative from NGU stated that this would be of great help in the mapping of quick clay landslides (NGU, 2015). The 3D-model would be created through the use of air-based laser scanning (LiDAR) in combination with photogrammetry from airplane photos, and new and already existing data would be put into an online portal (www.kartverket.no but now https://hoydedata.no/LaserInnsyn/) available for all (Oppikofer, 2016). In 2015, it was identified that the coverage of laser scanned areas in Norway was far from complete, but that new areas would be scanned every year (Sokalska et al., 2015). As previously mentioned, there is a need for a high-resolution model as a reference in order to use ground-based laser scanning to get knowledge about quick clay landslide events. The nationwide 3D-model proved to be a great alternative for this, and therefore serves various functions, in addition to being cost effective (Oppikofer, 2016; Expert 3).

In 2018, an additional amount of 16 million NOK was allocated to the digital 3D-model of Norway, which provides value for the agencies working with quick clay

management (Regjeringen, 2018). The Minister of Local Government and Modernisation emphasized that the objective is to strengthen the readiness for natural hazards across the country and that such data can act as a tool for municipalities and other relevant agencies when dealing with climate change. Further, the 3D-model provides the municipalities with better data when carrying out the required risk and vulnerability analysis (ROV-analysis) and is also crucial to speed up the detailed planning of roads, railways, buildings and construction. As of November 2018, 71 % of mainland Norway was mapped out due to good weather conditions in 2018, but only 54% of the areas have been processed and made available online (Regjeringen, 2018). The mapping has continued, and larger areas are covered every year, which is illustrated in Appendix 4.

In order to implement and scale new measures there is a need for available funding and resources to do so. As a public agency, the amount of funding delegated from the state budget to NVE for managing floods and landslides vary from one year to another, thereby setting limits to what is achievable (Expert 2). According to NVE, the winter of 2020 has had the heaviest snowfall in over 60 years (Fossum, 2020). The increased amounts of snow melting and taking paths down the mountains entail larger amounts of waterflow in watercourses, thereby increasing the likelihood of naturally caused landslides to occur, proven by the recent quick clay landslide in Alta (Dimmen et al., 2020). As such occurrences are likely to bring increased attention to exposed areas and ongoing projects, it increases the need for collaborative measures and funding. In the spring of 2020, NVE was granted an additional 100 million NOK from the parament to be used for projects that can quickly be initiated against flood damage and landslides across the country. It is reasonable to assume that the increased likelihood for occurrences of landslides, is responsible for the increased funding, which was also pointed to by Expert 2. According to the director of NVE, the funds will be used on measures that can quickly be implemented, as well as to maintain progress on major ongoing projects. He points to that this is exciting as it provides the opportunity to prioritize several security measures with great social benefits that could not have been obtained as quickly without the additional funds (NVE, 2020c).

5 Discussion

In this section we will discuss our findings and compare it with previous research, and see how this study contributes to answering the research question; *"What are key drivers of field-level change in dealing with natural hazards?"*. When analysing the development in the quick clay field we have identified several drivers contributing to field-level change. Based on our findings, we have developed a new model (see Figure 3) that can be considered as an extension from Figure 1. There are some similarities between existing literature and our findings, however, there are some differences which is included in Figure 3.

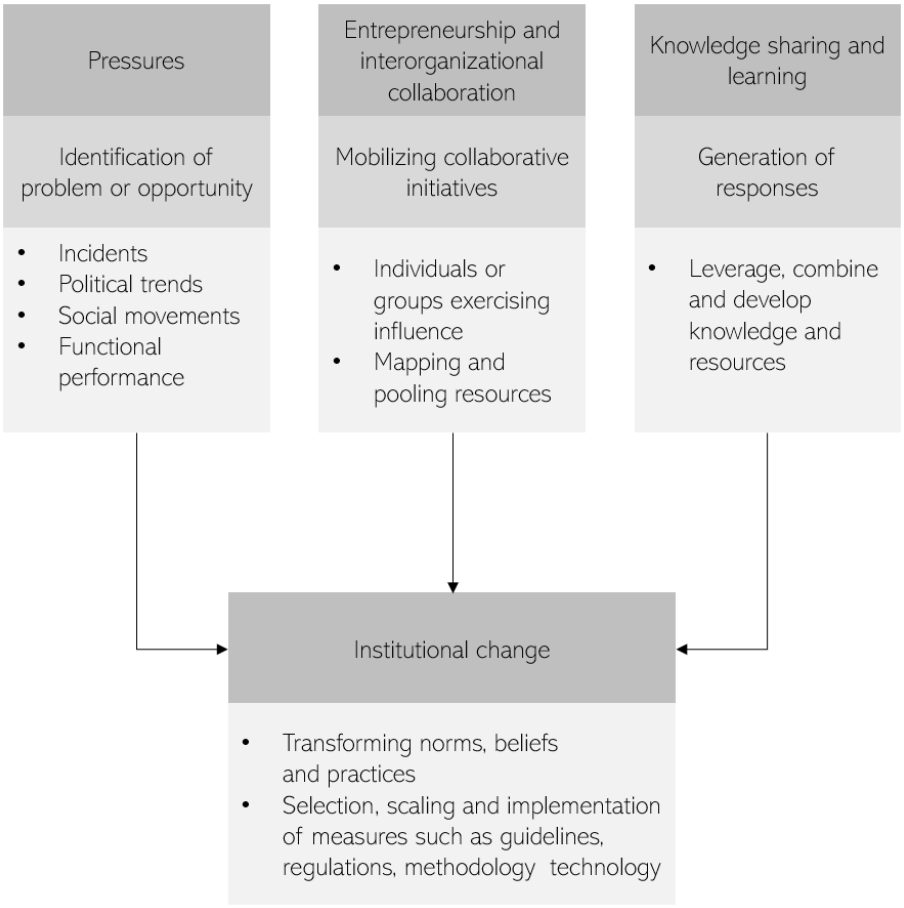

Figure 3 - Key drivers of institutional change in the quick clay field

Throughout our study we have identified that the key drivers of institutional change in the natural hazards field of quick clay are pressures, entrepreneurship and interorganizational collaboration, and knowledge sharing and learning (i.e. the darkest boxes in Figure 3). Similar to existing literature, we have identified that entrepreneurship and interorganizational collaboration can be interlinked. However, we have only identified one instance of entrepreneurship, and this event led to the creation of a collaborative initiative. Therefore, entrepreneurship and

interorganizational collaboration, which was previously classified as two separate drivers for institutional change, are now merged together. Additionally, we have identified that the occurrence of incidents has a big impact on driving field-level change. The medium boxes, which was added as an additional layer to the model, offer a description of how the drivers contribute to the creation of change. The lightest boxes present a more accurate description of the drivers and describe what makes change occur.

Some of the identified changes in the quick clay field can be seen as a result of a process of several drivers, rather than a result of a single driver. In some cases, it is the combination of pressures, entrepreneurship and interorganizational collaborations, and knowledge sharing and learning which has driven change, although we have also identified that these drivers individually lead to change. Institutional change ultimately occurs within single organizations, however, many of the identified changes has applied to, affected, and led to alterations in several organizations and can thereby be considered as field-level change. In the following we will discuss these drivers for change more thoroughly.

5.1 Incidents and pressures as drivers for change

As identified in the findings, the most important driver for development and change in the quick clay field is the occurrence of landslides, and the pressures that occur due to this. This corresponds with Wijen and Ansari (2007), who states that the occurrence of natural hazards and increased levels of experienced risks associated with this is one of the factors that motivate the need for institutional change. Additionally, it is evident that the occurrence of large landslides, with considerable consequences, has led to pressures from the government, organizations and local communities for better management of natural hazards. This indicates that motivation for field development is a result of both internal factors, such as seeing the need for change, and external factors, in the form of pressure from different actors to create change.

Over time, the occurrence of quick clay landslides and its consequences have made the society more aware and concerned. When the Rissa landslide happened in 1978, it seemed to trigger pressure from several sides of the society on the need for field change due to increased levels of experienced risk. The landslide raised concerns, due to its consequences and media attention, because the landslide occurred in a populated area, and led to the destruction of over 20 houses and the

loss of one life. This is also likely to have resulted in increased fear from the general population. Such worries generate social pressure, in the form of disruptions calling for change in institutional practices, with regards to preventions of such incidents recurring in the field (Oliver, 1992). Further, such responses by the general population may also create political pressures as it is the government's responsibility to protect its citizens, which again puts pressure on the field to develop new methods or create changes. Additionally, the fact that the agencies had not put in preventative measures in the area prior to the incident indicated flaws in their processes, which constitutes as a functional pressure (Oliver, 1992). It is likely that as a result of the social, political and functional pressure, the government and relevant agencies identified the need for mapping potential quick clay areas to be able to identify hazardous zones, and further development of measures to manage, mitigate and prevent such landslides from happening again.

The occurrence of the quick clay landslide in the shore zone in Lyngseidet in 2010 led to similar pressures as was experienced during the Rissa landslide, due to its consequences. This pressure drove the actors to identify that there was a need to include mapping of quick clay in the shore zones and develop methodologies for this. This again indicates that landslides and the pressure that follow, acts as a driver for the identification of problems or opportunities in the field that drives change. We see it as likely that without the occurrence of such incidents it would be difficult for the actors to identify the need for improving or creating e.g. preventive measures. On the one hand, a landslide can have massive negative consequences for infrastructure, properties and life, while on the other hand, it positively contributes to the identification of problems or opportunities which could contribute positively to further change in the field.

Several of the quick clay landslides that have occurred in the past decades has been triggered by construction work, and has led to the identification of the need to develop and enhance methods, measures and guidelines in order to avoid such incidents from recurring. An example of this is the landslide that occurred in Balsfjord in 1988 due to roadwork being conducted nearby, where it was identified that there is a need for conducting feasibility studies before doing construction work. However, as the landslide in Kattmarka occurred due to similar reasons 21 years later, it indicates that the work on improving the identified lacks

connected to measures such as area planning had not been sufficient. As previously identified, this is likely to have generated increased pressure on the responsible agencies for the creation of change, in order to avoid or minimize the chance of such incidents recurring. The fact that these landslides clearly were triggered by human activities, creates pressure on the field's ability to secure areas before construction work is being conducted. Such pressure can therefore be seen as a functional pressure, as it concerns the perception on how the field performs and deems it as insufficient (Oliver, 1992). Therefore, it is likely that this pressure contributed to the commission committee's identification of a need for better guidelines on how road construction should be planned and conducted in the future.

As described, all the relevant agencies had their own databases containing information and data of previous registered landslide incidents. When working on matters related to quick clay, such data and information is valuable when making assessments (Lawrence et al., 2002). As it is likely that the different agencies were aware of this, it constituted a functional pressure as the perception of the organizational performance and utility of the information and data available could be enhanced if combined (Oliver, 1992; Doh et al., 2019). We assume that this pressure led the agencies to identify that having separate databases was a problem, as the knowledge sharing and information flow was not optimal. Simultaneously, this pressure also led to the identification of an opportunity to enhance the organizational performance of the agencies. This proves that although a problem is identified, an opportunity may arise from it.

According to literature, pressure is an important driver for field change (Oliver, 1992; Dacin, Goodstein and Scott, 2002; Berkhout, Hertin & Gann, 2006; Peng, 2003) and we see that this corresponds with our findings. We found that the pressure increases after the occurrence of a large landslide, and that this is an important period of time for the identification of problems or opportunities that drives actors towards changing their practices and developing new measures. We have identified some trends in drivers, especially political, functional and social pressures, which are all considered important for the creation change. However, we found that if landslides lead to the identification of a need for change through opportunities or problems, but do not receive any social, functional or political pressure, it does not always drive the field towards change (e.g. Balsfjord).

Further, we identified that a functional pressure was present without the occurrence of a landslide, due to a lack of interorganizational measures that could enhance the information flow between the agencies. This indicates that when it comes to opportunities of enhancing the organizational performance, internal pressure (i.e. functional pressures) may arise, and lead to identifications and further changes in the field. This demonstrates that the motivation for field change is a result of both internal and external factors, although it seems like the external factor trigger change the most.

5.2 Entrepreneurship and interorganizational collaboration as drivers of change

When investigating the quick clay field, institutional entrepreneurship, interorganizational collaborations and pooling resources acts as drivers towards change. It seems like collaboration is an enabler towards pooling resources, as the agencies involved obtain added value in their work. On one side, by pooling resources the actor may become better equipped to dealing with the challenges ahead of them. On the other side, it may lead to the identification of missing knowledge or resources that needs to be further investigated. Further, by mapping and pooling knowledge and resources the agencies alone or in conjunction with each other generate responses to better manage the occurrence of quick clay.

5.2.1 Creation of collaborative initiatives

According to DiMaggio (1988), when actors with adequate resources have identified an issue or opportunity that can be solved by collaborative measures, new institutions will arise. In order to do so, the institutional entrepreneur needs to create consensus on the need for change, through engaging other field actors through discursive processes in the form of text (Phillips et al., 2004; Hardy and Maguire, 2010). One example where this is evident in the quick clay field is when SVV engages in the creation of collaborative initiatives, which resulted in the establishment of NIFS. By engaging with other actors in the field, SVV was able to create consensus on the need for improved preparedness and management of risk and incidents related to natural hazards. However, it is difficult to identify how this process was initiated as this often is not formally written down or formulated as official statements, but we were able to gain some insights as to how this consensus of a collaboration was initiated by the experts we interviewed.

It is likely that the process of creating consensus and agreement for the need of change is often conducted through personal communication between a few actors, and it can therefore be a complicated process to pinpoint exactly how this has been done and what happened. We mostly identified the occurrence of such processes through our expert interviews, and they expressed that when the institutional entrepreneur attempts to influence other actors to recognize the need for change, he or she will try to create a sense of affiliation for the other actors and does not take complete ownership of the idea (Expert 1; Expert 2; Expert 3). Presumably, this is because the institutional entrepreneur acknowledges that if the other engaged actors experience a type of ownership to the focal matter, they will to a higher degree participate in solving the issue at hand to their best ability. Based on this reasoning, it is believable that such discursive practices and the use of texts is more actively used in the field than what we have been able to identify.

According to literature, creating collaborative initiatives is seen as an opportunity for realizing and creating change within a field when a group of actors are worried about a common problem (Wijen & Ansari, 2007; Gray, 1989). The NIFS project is a clear example of the creation of a new collaborative institution within the quick clay field, with the objective to create change. Through our findings we have identified that the creation of such initiatives provides the actors with a better basis for managing the challenges they are facing. The establishment of collaborative initiatives in itself constitutes a change within the quick clay field as there had been little collaboration between organizations prior to 2012. Collaborative initiatives also act as a driver for change as it has led to the creation of institutional change in the participating organizations operations. According to Selsky and Parker (2005), it is important to establish governance mechanisms in order to optimize interorganizational collaboration and minimize the risk of conflicts. Consequently, it is reasonable to assume that the results of collaborations, in the form of changes in the field, will increase when governance mechanisms are in place.

As proposed by Doh et al. (2019), there are six factors that need to be considered when establishing governance structures. The objectives of the NIFS project were clearly formulated and agreed upon by the participating actors, even though the different agencies had their own independent priorities. Through the establishment of work groups focusing on specific matters, the institutional structure was to

some degree settled and responsibilities were given to the actors who possessed the most appropriate knowledge and expertise on the topic. In addition to NVE, SVV and JBV, there were several other agencies that contributed to the project when their knowledge was needed. As some of these agencies were public (e.g. JBV and SVV) and others were private (e.g. NGI and Multiconsult), literature points to that the differences in organizational culture, structure and missions may limit the effectiveness of the interorganizational initiative and lead to goal conflicts (Doh et al., 2019). However, the outcome of the project seemed to be of great interest to both sides, and we have not found any indications of conflicts among the agencies. This may be due to the clear establishment of roles, responsibilities and tasks, as well leadership structure, making it easy for the actors to understand their part in the project and what was expected of them. This was made apparent in several reports, as it is specified what kind of work has been done, and by whom, on behalf of the NIFS project. Further, the fact that it was established that the different actors had to formalize the knowledge and findings through the creation of reports which were made available for all, can be seen as a working rule or specification contributing to strengthening the governance mechanisms.

In addition to formally discussed or written down governance mechanisms, there are indications that some informal mechanisms were determined as the NIFS project evolved. As previously described, early in the project the participants of the different working groups produced reports independently on behalf of their agencies, before sharing it with the group. When collaboration is carried out over a longer period of time, literature suggests that the governance mechanisms need to be reconsidered at a later stage if the conditions shift (Doh et al., 2019). As the relationships in the working groups advanced over time, the practice changed towards a more collective approach on the production of reports, which indicates a development of the established governance mechanisms. This demonstrates that such mechanisms can evolve over time, even if it is not formally communicated. Hence, we believe that changes in the mechanisms guiding the project over time, have contributed to increasing the quality of what is produced in the collaborative initiative and increased the integration among the agencies.

As pointed to by Ostrom (1990), previous cooperation and experience of working with other actors is a driver for establishing future collaborative structures. This

corresponds with the agencies agreement of continuing the collaboration after the NIFS project ended, and we see it as likely that the success of the previous collaboration influenced the establishment of the new collaborative initiative, namely NHF. Further, the fact that the agencies decided to carry on with the collaboration through a new structure indicates that the participating actors considered the governance mechanisms in NIFS as sufficient and working well. Therefore, it is reasonable to assume that the governance mechanisms and relationships established during the NIFS project contributed to ease the collaboration in NHF. Further, it is likely that the NIFS collaboration has improved the relationship between the involved actors, thereby making it easier to focus on creating changes in e.g. practices and methodologies.

The practices and norms from the NIFS collaboration is likely to have affected the structure in NHF, however, the governance mechanisms and objectives are not as clearly stated. This may be due to the fact that NHF has a more open and flexible structure compared to NIFS, in addition to that the relationships already were somewhat established. This can be considered as positive, because it contributes to making the work within the collaboration more effective from the very beginning. It does, however, seem like the responsibilities and roles of the different actors are less defined, which according to literature can lead to goal conflicts (Doh et al., 2019). As the collaboration is structured more like a forum for discussing opportunities and issues, and as we have not identified that this has led to any challenges, this level of established governance mechanisms seems to be functional for NHF's purpose. It is challenging to determine whether the collaboration within NHF has been as good as in the NIFS project, as there are far less reports available, in addition to the structure being different. However, the experts have stated that the NHF is a well-functioning collaboration, and that it has led to changes in the quick clay field as the actors continuously share knowledge and resources, as well as learn from each other.

It is clear that the establishment of new collaborative institutions, such as NIFS and NHF, has led to increased interaction among the actors and contributed to improved relationships. Such changes in the relational aspect of the field is likely to contribute positively to how the actors respond to the occurrence of landslides, as they have developed a mutual understanding of each other's operations and practices. The development of governance mechanisms is likely to have increased

the performance of the collaborative institutions and resulted in less conflicts, which ultimately has contributed to the actors being able to focus on creating changes in the practices and methodologies in the field. There does not seem to have been any particular focus on interorganizational collaboration outside of the established structures described above. However, as the experts we interviewed for this study all pointed to the great value these collaborations have resulted in, it seems like collaborative initiatives are especially important for field change. Hence, the establishment of interorganizational collaborations seem to have acted as a driver for field change.

5.2.2 Mapping and pooling resources and knowledge

By combining resources and sharing knowledge the agencies participating in the collaborative initiatives are often able to obtain added value (Doz & Hamel, 1998). As the different actors in the quick clay field seem to have differing operational areas, and to some sense possess different types of competencies, knowledge and resources, literature points to that by pooling resources and existing knowledge, the collaborative initiative is left with an aggregated base for creating field level change and tackling the challenges related to complex problems (Osborn & Hagedoorn, 1997; Freeman & Hannan, 1989). While SVV specialize on transportation and road construction and has expertise related to the development of such infrastructure in areas with quick clay, NVE has the state administrative responsibility and possesses general competence on security measures and adaptation. Another important actor in the quick clay field, NGI, acquires a high level of technical knowledge and research competencies. Hence, these three examples only represent a selection of the agencies operating in the field and it clearly proves that the different actors possess various resources and knowledge, which has the potential to increase the field performance through generation of changes, if combined.

One example where we have identified that pooling resources and knowledge has led to increased value for the involved actors, is the establishment of common databases. Through our findings we identified that by pooling the data from independent databases into a collective one, namely NSDB, the information available became more accessible, accurate and helpful for all the actors. The knowledge being pooled in the database can be considered as explicit, due to the fact that it was codified and written down in independent databases prior to the

establishment of the joint one (Smith, 2001). It is likely to believe that pooling such information and data in between the actors and agencies enhances the relevant actors' knowledge and contributes to increased flow of information. Hence, this poses an opportunity for an increased knowledge base as the information the different agencies hold may be complementary and increase the general level of expertise in the field.

This type of knowledge transfer is considered to be relatively straightforward as it is easier to formulate and express such explicit knowledge to others (Brockmann & Anthony, 1998). By making such data available for all, it can contribute to help both the participating actors, but also organizations which did not possess such resources previously, and thereby make planning work easier. However, as pointed to by Smith (2001), the actors or agencies that intend to use the available knowledge need to invest time in order to understand it. Therefore, in order to optimize the database, it is important to establish a common terminology in order to make the input from one agency understandable for others, so that the actors are able to apply that knowledge provided in the database. As we have identified in the findings, improvement of this aspect was made collaboratively during the NIFS project.

When pooling the existing information and data residing in the individual databases, the actors are left with a better knowledge base for dealing with quick clay. However, as pointed to by literature, it is likely that the process of learning and acquiring knowledge still occurs in the individual agencies, and it is important that such information is continuously shared with the other actors (Siebenhünerp & Suplie, 2005). After the initial pooling of resources for the creation of NSDB, several reports have been produced by the actors, both collaboratively and independently. The fact that input from these reports has been incorporated into the database, has led to increased value and quality, as the information has been found to supplement the already established information in NSDB. This proves the importance of continuously pooling resources and knowledge, as it can contribute to creating a better basis for the field as a whole (Osborn & Hagedoorn, 1997; Freeman & Hannan, 1989). However, it is likely that it is important that the different actors have equal levels of involvement in the process of sharing knowledge, even though we have not directly made any findings on this (Larsson et al., 1998).

The pooling of resources may contribute to finding solutions to identified issues or opportunities or to the creation of what needs to be further investigated (Doh et al., 2019). Establishing databases containing the current state of knowledge and resources residing in the agencies provides a basis for future collaborative efforts and developments, as the agencies do not have to share their knowledge several times, given that the databases are continuously updated. Another example of such a database is the governmental initiated database where research and state administrative information and experiences from practical adaptation efforts was made publicly available. However, that all information can be made available and accessed through databases and applied by all actors is somewhat a utopia and cannot be obtained in real life, as there is a large amount of knowledge needed in order to deal with the complex problems related to quick clay.

Through the NIFS project, the current state of knowledge and resources have been mapped at several occurrences on several topics. The process of improving the mapping of quick clay zones, improving field methods for detection and stabilization of quick clay, and the development of different types of technology, are all examples of where previous experiences and knowledge were gathered in reports in order to create an overview of the different actors' current level of expertise (see e.g. Hansen et al., 2012). By analysing a large amount of reports, we have identified that production of such reports through pooling existing knowledge, to a large degree, contributes to the identification of what aspects need to be further worked on. This proves that pooling existing resources and knowledge through collaborative initiatives has been valuable for the actors, both in terms of individual agencies acquiring new knowledge and creating a common ground for the development of new measures.

It is reasonable to believe that the number of actors participating in pooling knowledge and resources affects what is being distributed. Since NVE got the state administrative responsibility for floods and landslides in 2009, the focus has shifted towards increased coordination and sharing of resources and knowledge. As pointed to by several experts, having one responsible agency was a change that was beneficial for the field as a whole as it provided better coordination of both knowledge and resources which again contributed to easing the work of pooling the current state.

Through mapping and pooling existing knowledge and resources, the actors create a basis for further work as the current knowledge base is established among all the participating actors. By pooling resources on a regular basis, the actors may be able to aggregate the interorganizational collaboration knowledge base even further. Additionally, through pooling resources and knowledge, the actors may acquire new resources which could lead to changes in the field. This will potentially provide an even better base for tackling the challenges connected to quick clay, as the actors are ultimately working together on dealing with complex problems, and are not direct competitors (Osborn & Hagedoorn, 1997; Freeman & Hannan, 1989).

5.3 Knowledge sharing and learning as drivers for change

According to literature, agents are often constrained by a lack of experience or knowledge on a concept and need to create new resources or practices to generate change (Rickards et al., 2014). In order to develop new measures, interorganizational collaboration has been found to have a positive effect on this creation as it can contribute to increased development of knowledge and tools (Osborn & Hagedoorn, 1997; Freeman & Hannan, 1989). In the quick clay field collaborative initiatives have been established with the objective to focus on research and development of methodology and technology, e.g. NIFS. We have identified that the NIFS project had several research projects and developed multiple methods and technologies, which included both knowledge sharing and learning.

One example is the investigation of methodology and quality requirements for detection of brittle fracture initiated in 2012 by NIFS, where NGI started by looking into the current knowledge on the topic, before sharing this information with other actors in the project. Further, field and laboratory tests were conducted, and the results of this in addition to experiences of field actors were shared. Overall, the methods investigated and developed in the NIFS project seem to be characterized by the amount of knowledge disclosed and absorbed by the individual actors within the interorganizational structure. As described by Larsson et al. (1998), this is an important aspect of a collaboration as it determines the level of new knowledge created. This was pointed to by Expert 3, who stated that the development and acceptance of new technologies and methodologies in the field has improved over time and through collaboration. Therefore, it is reasonable

to assume that a good relationship between the actors is essential to increase the amount of knowledge that is created, because the collaboration consists of and depends on the knowledge of the involved actors. Hence, the actors will share more of their knowledge on the topic, and thereby also receive more, when the relationship is well established.

Through collaborative initiatives the creation of new measures emerges as collective products (Gerlak & Heikkila, 2011). When new measures are created through collaborative relationships and learning, one may argue that the actors are more willing to incorporate the measures created, leading to institutional change, as they feel ownership and recognition in the developed measure, and want to share this with others. Additionally, as described by literature, by collectively generating responses, the actors may obtain synergy effects through combining their knowledge and resources (Larsson et al., 1998; Doz & Hamel, 1998). It has been established through our study that the actors involved in the NIFS project possess different kinds of knowledge and the collaboration has led to tremendous development in new and existing technologies, methods and practices (Gerlak & Heikkila, 2011). The new methods for mapping the shore zones and drone-based technology, are examples of this, which several experts have pointed to that they would not have been able to develop alone.

The process of sharing knowledge may alone lead to institutional change, as the different actors have potential to obtain new knowledge through intraorganizational learning (Siebenhünerp & Suplie, 2005; Holmquist, 2003; Brown & Duguid, 2001; Edmondson, 1999). If an actor shares knowledge and experiences, other actors may learn and absorb this knowledge and incorporate it into their agency’s operations, leading to changes in their behaviour or practices. The process of sharing experiences and knowledge of what has worked well in one agency, was described by Expert 3 as an important measure driving minor changes that when put together can have great impact on a field's overall performance. However, such changes are hard to identify through documents, as the changes may be difficult to pinpoint and may not be formally written down.

The scope of the change resulting from the creation of new knowledge or resources through knowledge sharing and learning can be constrained if it is not disseminated to the relevant actors, as the actors in the field ultimately are

working together on tackling the complex problem of dealing with quick clay. Through our findings we have identified several examples of research projects, seminars, and discussions where the actors in the field expressed their opinions and experiences and shared their knowledge with the other participating actors. This type of knowledge can be considered as explicit knowledge as the actors are able to diffuse and share it with others (Haldin-Herrgard, 2000). However, the change is limited to the actors being present during these events, and in the best case to the respective agencies of the participating actors, given that these actors choose to further share and incorporate it into their focal agencies.

Because the produced knowledge in the NIFS project was, to the degree possible, formulated in written reports and made publicly available, the knowledge has the potential to reach all relevant actors in the field, and not only the ones participating in the collaborative initiative. Such knowledge can therefore be considered as explicit knowledge, as it is more easily transferred to other actors (Smith, 2001). Through codifying the knowledge and making publicly available reports we suppose that the NIFS project and the NHF has contributed to an increased level of sharing explicit knowledge in the quick clay field, as there is a considerably lower number of reports available from the period before the NIFS initiation in 2012.

Dealing with quick clay is a practical manner and some knowledge may be acquired by the actors through personal experience and resembles intuition, and is more difficult to share with other actors as it is hard to express through formal language (Brockmann & Anthony, 1998; Smith, 2001). As described by Smith (2001) such tacit knowledge is often practical and action oriented. We consider the occurrence of landslides and the arrangement of exercises, such as "Exercise Quick Clay", to be events that can act as good platforms for the transfer of tacit knowledge, as the different actors can observe what other actors do and learn from it (Smith, 2001). As pointed to by Expert 1 and Expert 3, there is a massive learning potential from such events. It is reasonable to believe that this to some degree is due to the fact that such settings enable the actors to express their knowledge in more practical ways, as compared to participating in lectures and meetings, and writing reports. Further, as stated by Haldin-Herrgard (2000), it is important to work directly together with other actors in the field to be able to

transfer tacit knowledge. We have identified several occasions of this, and it is therefore likely that such processes are present in the quick clay field.

In the process of generating new resources and practices, we have identified that involvement by governmental authorities, and them being aware of the status quo of the field, contributes to earlier identification of which changes need to be made in order to drive the field forward by accelerating the creation of new initiatives, laws or regulations. One example of this is the collaborative agreement between three ministries on the need to develop future recommendations for assessing landslide hazards and measures to deal with such incidents. Two year after this, NVE initiated the creation of hazard, consequence and risk maps due to the need for better assessment of which areas to prioritize in the nationwide mapping program. Even though there is no clear evidence that this was a result of the ministries recommendations, it is likely that the ministries influenced NVE to prioritize development of knowledge for the initiation of such a measure.

NVE's development of hazard, consequence and risk maps proved to be valuable for the field as a whole, as it had the potential to contribute to increased quality and characterization in the commonly established database NSDB. Additionally, we see it as likely that such information also proves valuable in municipal planning and construction processes. Even though we have previously pointed to that collective development of new resources, knowledge and practices can lead to synergy effects, it is here demonstrated that efforts produced by individual actors can prove to be valuable for the field as a whole, as long as it is made available for everyone. Further, as mapping potential quick clay zones can be considered one of the most important efforts in the management and mitigation of landslides, the creation of such prioritization tools contributes to enhancing the fields future performance. Therefore, making information, resources and tools publicly available and actively sharing it with other relevant actors seems to be a vital aspect when individual agencies generate responses alone.

Contrastingly, although the governmental authorities have been involved in generating responses, literature points to the fact that the public sector often entail challenges due to its slow and bureaucratic nature (Brooks & Adger, 2005; Tompkins & Eakin, 2012; Urwin & Jordan, 2008; Doh et al., 2019). Within the quick clay field, there are tendencies towards the authorities acting as a subsidy, in

the sense that the agencies and the authorities work together, and several measures have been implemented due to this. As the Norwegian authorities seem to understand the importance of implementing security measures, it has led to an increased budget within the quick clay field. This, of course, contributes to the agencies being able to conduct e.g. more research on the topic, and thereby generate more responses and learning, which can lead to change. Literature points to the fact that the objectives of the private and public sector do not always correspond (Doh et al., 2019). The fact that governmental authorities are made responsible for ensuring knowledge sharing, could indicate that this is something the public agencies sees as an important measure for ensuring the prosperity of public goods and national security and infrastructure (Brooks & Adger, 2005; Tompkins & Eakin, 2012; Urwin & Jordan, 2008; Doh et al., 2019). We find our findings to contradict existing literature somewhat, as the public sector and private sector seem to collaborate in the management of quick clay. However, as the government seem to act only after a large incident has occurred, or more focus has been places to the field, we find Brooks and Agders (2005) findings to apply, namely that efforts provided by the public sector is reactive rather than proactive when to comes to learning and knowledge sharing, contributing to institutional change.

When it comes to knowledge sharing and learning in order to generate change, it seems like collaboration is a huge driver. We have identified that new methodology and techniques are established through collaboration, although we have discussed some measures being conducted by a single agency and later shared with other actors. Further, it seems like the governmental authorities also contribute to generating change in some sense. They act as a supporting actor for the quick clay field, as the push towards knowledge being shared and methodology and technology being developed. All of this together, seems to be driving the field towards change, as the relevant actors seek to manage the natural hazard quick clay.

5.4 Key drivers of institutional change in natural hazard fields

Through our findings and discussion we have identified several changes in the quick clay field in Norway. This includes introduction of new technology, methods and practices, as well as guidelines and regulations (Lawrence et al., 2002). As we have discussed above pressure, entrepreneurship and

interorganizational collaboration, and knowledge sharing and learning can all be seen as drivers for field-level change.

One of the most recognizable key drivers for change within the quick clay field has been the occurrence of landslides. The first change we have detected that resulted from an incident was the initiation of the nationwide mapping program of quick clay zones, after the Rissa landslide. This landslide can be considered as a turning point for the field, as several other changes have been initiated after this incident. It is clear that the occurrence of the Rissa landslide is what triggered this major change, however, it is likely that other previous landslides also have contributed to increased awareness and realization of the need for change (Dacin et al., 2002). As previously described, the occurrence of large landslides have in several cases led to functional, social and political pressures, which again drives change within the field. After the nationwide mapping program was initiated in 1980, several other landslides have occurred, which again have functioned as drivers for further changes and development in the field.

The fact that several incidents happened in the shore zone, acted as a driver towards including such areas in the mapping program. In relation to this there was a need to develop new safety measures in the form of techniques and methodology, which also can be considered as a result of the landslides and the pressure that followed. It is likely to believe that such changes would only have been developed and incorporated in the field if landslides in the shore zone with large consequences take place. Consequently, as such landslides have occurred, and it has led to pressures from several stakeholders, making the society, government and relevant agencies aware of the complex problem, it is clear that it is an important driver for field-level change (Berkhout et al., 2006).

Dealing with quick clay is something several actors are involved in, and the practices and methods used by the different actors in the field differed which created challenges in the field. The establishment of interorganizational collaborations, such as NIFS, has contributed to changes in the quick clay field. The driver for establishing NIFS was institutional entrepreneurship conducted by SVV, due to the fact that they experienced operational issues that could only be fixed through collaboration. The establishment of NIFS in itself constitutes a change in the quick clay field driven by institutional entrepreneurship, but the

interorganizational collaboration has also been a driver for several other changes in the field. After the establishment of interorganizational collaborations in the field, we have identified an increased degree of knowledge sharing and learning.

When it comes to the development of new tools and technologies, interorganizational collaborations seems to be an important driver for change. Through collaboration, the different actors pool knowledge which often leads to agencies learning something from each other. If actors incorporate the new knowledge or practice into their own agencies, this can constitute a change, which has the potential to be a field-level change if several agencies incorporate it. Additionally, by pooling resources and knowledge we have identified that the actors collaboratively are better able to identify measures that need to be further investigated and improved, which drives future work on creating new measures. Therefore, it is proven that collaborative initiatives act as drivers for field-level change as it in the quick clay field has led to development in e.g. guidelines, methodologies, technologies, that ultimately affects how the actors in the field operate.

One identified change with regards to the use of new technology is the use of drones in the creation of a digital 3D-model of Norway. NIFS, as an interorganizational collaboration can be seen as the driver for this change as it encouraged pooling existing knowledge and resources on the topic, and enabled the actors to identify the potential in the technology, that further led to the development of a measure that proved to be helpful for several aspects of the field. Hence, through interorganizational collaboration the actors together developed a new measure that constituted change in the field.

In 2008, NVE created guidelines which would act as a template for how to conduct construction work in areas with quick clay. This can be considered as a change resulting from functional pressures. After the initiation of the NIFS project, the guidelines have been updated on several occasions, however, this can be seen as a change resulting from other drivers, namely interorganizational collaboration and knowledge sharing and learning. The changes which were incorporated in the updated guidelines in 2014 was mainly driven by new knowledge acquired through interorganizational collaboration. Additionally, the arrangement of a seminar where several relevant actors in the quick clay field

participated and discussed what changes were needed through sharing experiences and knowledge, resulted in alterations. The actors in the quick clay field had developed new knowledge, in addition to learning from each other and shared knowledge over a longer period of time, which ultimately acted as drivers for the changes in the updated guidelines.

It is reasonable to believe that the changes made to the guidelines would not have occurred if the actors had not come together to collaboratively evaluate the current guidelines. At the same time, it is likely that the initiative for having a seminar discussing the guidelines was a result of functional pressures, as the guidelines from 2008 did not work in an optimal manner for the actors applying them in the field. The creation of the guidelines can be seen as a major change in the quick clay field, as they act as joint guidelines for all relevant actors operating in the field. In addition, the incorporation of NVE's guidelines in TEK10 and TEK17 is a change driven by an increase in occurrences of landslides due to construction work. Hence, the establishment and update of NVE's guidelines is a field-level change that occurred due to the driver's pressure, interorganizational collaboration and knowledge sharing and learning.

Another change in the quick clay field is the Planning and Building Act requiring the municipalities to conduct ROV-analysis before construction activities take place in potential quick clay exposed areas. It is likely that this new legal requirement was driven by the increasing number of quick clay landslides occurring due to conduction work. In addition, when several landslides had happened due to human activities this is likely to have created social, political and functional pressure on the responsible agencies. As it proved to be difficult for the municipalities to comply with the new requirements, it contributed to relevant agencies having to assist them. As it is likely that some type of collaboration or communication must have occurred for them to be able to identify this, interorganizational relations seems to have been a driver for future change through the creation of manuals in order to ease the work. This indicates that collaboration, knowledge sharing and learning contributed to field-level changes related to legal requirements.

6 Conclusion

In this study we have investigated how institutional change has occurred and what has driven changes within the quick clay field. Through our findings and discussion, we have identified the key drivers for field-level change in dealing with natural hazards. In this chapter we conclude with implications both for the quick clay field, and other natural hazard fields, and suggest directions for future research on this topic.

6.1 Key implications

Through our study we have identified that the key drivers for change in the quick clay field is pressures, entrepreneurship and interorganizational collaboration, and knowledge sharing and learning. Further, we have identified that the key drivers in itself are important for field-level change, but they also affect and can be a result of each other.

In the quick clay field, the role of pressure, resulting from incidents, political trends, social movements and functional performance, has clearly led to the identification of problems or opportunities. The identification of a problem or opportunity has often begun when a large landslide has occurred, and led to pressures from several stakeholders, which further has driven the actors to create institutional change. Increasing awareness and attention of the complex problem puts pressure on the government, relevant agencies and society for improving the management of such hazards. This often leads to increased funding from the government, and relevant agencies try to find solutions to be better able to manage the occurrence of quick clay, which drives field-level change.

Entrepreneurship and interorganizational collaboration are also drivers towards change in the quick clay field. Dealing with complex problems requires the efforts of several actors. Entrepreneurship influences the establishment of interorganizational collaboration in the quick clay field. Further, through interorganizational collaboration the actors map, pool and combine their resources which often leads to the identification of new measures that pose opportunities for added value, which drives field-level change. Therefore, interorganizational collaboration leads to the development of tools, guidelines or safety measures which changes the way the field manages the occurrence of quick clay.

Knowledge sharing and learning enables the field to generate new responses to manage the occurrence of quick clay, and thereby acts as a driver for field-level change. The process of learning and sharing knowledge can occur both in individual agencies and through interorganizational collaboration. Either way, leveraging, combining and developing new knowledge and resources drives change. An overall important aspect for knowledge sharing and learning to act as a driver for field-level change, is that if an individual agency learns or develops new knowledge or resources which leads to institutional change, the focal firm must share it with other relevant agencies.

The quick clay field has through the drivers; pressures, entrepreneurship and interorganizational collaborations, and knowledge sharing and learning, managed to create field-level change that positively has affected how the actors deal with and manage the occurrence of quick clay in Norway. Additionally, it is evident that these key drivers in some cases affect and drive one another. It was identified that pressures drive the entrepreneur to influence the establishment of interorganizational collaborations. Further, it is often such that the process of learning and sharing knowledge in the field occur within collaborative initiatives. Hence, collaborative initiatives can act as drivers for knowledge sharing and learning.

Increasing levels of awareness after landslides putting pressure on the field, increasing degree of collaboration, and knowledge sharing and learning in and between the relevant agencies has led the field to be better equipped to deal with future occurrences and mitigate them from happening, as compared to in 1978. The quick clay field has experienced a number of changes in the time period we have studied, but there is still room for improvement. More collaboration facilitated in the field would provide great opportunities for further enhancement, as we through this study have proven that collaboration has provided the field with valuable inputs that have driven field-level changes when dealing with quick clay. Additionally, an increase in available funding from the government could contribute to facilitate further change, as the activities related to driving change are constrained by this. However, it is evident that the field continuously attempts

to change the status quo, by creating field-level change in dealing with quick clay.

6.2 Implications for the natural hazard fields

Our study has set out to investigate the key drivers for field-level change in dealing with natural hazards. Through using the quick clay field as our empirical setting, we have identified several key drivers which have contributed to change. As there are several other natural hazard fields dealing with complex problems similar to quick clay, it is possible that our study could prove relevant and valuable for other natural hazard fields. Hence, our findings derived from the quick clay field may be applicable for other natural hazards, as it is likely that they require similar drivers to create change as they have comparable characteristics.

Natural hazards can be characterized as complex problems that are difficult to manage by a single organization, are often unpredictable and require innovation in order to be dealt with. This indicates that in order to create change in natural hazard fields there is a need for interorganizational collaboration, knowledge sharing and learning. Additionally, as natural hazards in many cases entails incidents, e.g. in the form of landslides and floods, it is likely that it creates pressure if the responses to deal with it are not sufficient. Therefore, our study may prove to be generalizable for dealing with other natural hazards.

6.3 Limitations and future research

There are some limitations related to our research design, which should be addressed. Our case study focused on the quick clay field, which is a relatively large and complex case. We are aware that we may not have been able to go into detail on every aspect of the field due to its complexity. However, if we would only have focused on a single agency or event within the field, we would not have been able to grasp the entire perspective of what drives field-level change. Even though it is a possibility that we have missed out on some aspects that would have been relevant to our case, we believe that we have been able to capture the most important events and changes that have occurred over time.

As our main source of data, we have relied upon documents. This poses some limitations as most of the documents we have retrieved are written by individuals

or small groups, which may indicate that there is some information left out from the texts. In addition, when a small working group writes documents together, it might be biased as the actors involved often are from the same agency and have the same agenda. However, by conducting interviews we tried to fill gaps and ensure that what was written in the documents corresponded with our interpretation.

Another limitation related to the use of documents in such a study, is the fact that there are numerous documents available and we have not been able to investigate every single one due to the time constraint of this thesis. Further, there may be additional documents that we have not been able to get access to. However, we believe that we have been able to cover a large amount of data that has provided us with a solid basis for our study. We have excluded some documents from our research as we had to select the ones we found most appropriate. There are also several documents relevant to the quick clay field that were very technically written, and we chose to exclude them as we do not have the technical abilities to fully understand the concept of the text. This could pose a limitation as there may have been some important aspects, which we could have included in our thesis, in such documents as well. Nevertheless, we believe that the selected documents have provided us with a lot of valuable insight for our study.

Since we have based our proposed model on a combination of existing literature and our findings, there may still be other drivers to institutional change that we have not been able to identify. There is a lack of research on complex problems and natural hazards in the business management literature, and we therefore considered this as a field that should be explored further in future research. To be able to see if our findings and model is generalizable to other natural hazard fields, we recommend future research to test our model in other empirical settings. Additionally, we have chosen not to focus on the mechanisms of learning in our study. As it is likely that learning, to a great degree, contributes to field-level change it would be interesting to further investigate these mechanisms in future research.

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8 Appendices

List of appendices

Appendix 1 – Description of relevant agencies

Appendix 2 – Documents

Appendix 3 – Interview guide with Experts

Appendix 4 – Development in scanned areas in digital 3D-model

Appendix 5 – Number of mapped quick clay zones

Appendix 1 – Description of relevant agencies

DSB (Direktoratet for samfunnssikkerhet og beredskap; The Norwegian Directorate for Civil Protection) is a Norwegian governmental agency under the Ministry of Justice and Emergency Management. Their overall aim is to protect Norway and its inhabitants from hazards, accidents, and other undesirable incidents, in addition to ensure preparedness and effective accident and crisis management. DSB also provides advice and guidance to municipalities regarding how they can integrate hazard management into different parts of the planning process to safeguard social security. The agency has approximately 700 employees (DSB, n.d.).

NVE (Norges vassdrags- og energidirektorat; The Norwegian Water Resources and Energy Directorate) is subject to the Ministry of Petroleum and Energy and is responsible for managing the water and energy resources in Norway. NVE is considered the most important state agency within quick clay management, and they have the state administrative responsibility. Further, they have a unit dealing with securing areas that are exposed to quick clay and flood, in addition to financing a lot of security measures in different municipalities in Norway (Expert 1). Hence, it is their responsibility to make the society better equipped to deal with flood and landslide hazards. NVE employs approximately 400 workers (NVE, 2020b).

SVV (Statens vegvesen; The Norwegian Public Roads Administration) is an administrative body subject to the Ministry of Transport and Communications. They are responsible for developing clear regulations and standards for smart transportation and modern road construction, which applies to all Norwegian roads. In addition, SVV provide professional advice to politicians on which national and major roads should be taken care of or rebuilt, as well as planning, building and maintaining these roads. In the case of serious accidents, SVV analyze the incident and the contributing causes, to learn from them and prevent new dangerous situations (Statens vegvesen, 2020). When it comes to quick clay management, SVV does most of their work independently, e.g. when building roads and thereby taking precautions in areas exposed to quick clay (Expert 1). As of 2019, SVV employed approximately 7,000 workers (Statens vegvesen, 2020).

Bane NOR is a state-owned company which are subject to the Ministry of Transport and Communications. Their purpose is to provide accessible railway infrastructure and efficient and user-friendly services. Their main responsibility is planning, development, management, operation and maintenance of the national rail network, traffic management and management and development of railway property. Bane NOR also has the operational coordination responsibility for security work and operational responsibility for coordination of emergency preparedness and crisis management (Bane NOR, 2018). Bane NOR does similar work as SVV when it comes to quick clay management, meaning that they work mostly independently and take precautions when e.g. building railways in quick clay exposed areas (Expert 1). The company employs around 4,400 workers (Bane NOR, 2018).

JBV (Jernbaneverket; The Norwegian National Rail Administration) is a formerly state-owned railway company, which was in operation from 1996 until 2016. When they closed down the company in 2016, Bane NOR took over the responsibility for the national railway infrastructure. JBV was subordinate to the Ministry of Transport and Communications and received allocations from the state budget, and had 4,000 employees at the most (Nordli, 2016).

KV's (Kartverket; The Norwegian Mapping and Cadastre Authority) main responsibility involve collecting, systematizing, managing and disseminating public geographical information. KV is an agency subject to the Ministry of Local Government and Modernization, and they are currently leading Norway's largest land mapping project, which includes that the entire country is being laser scanned and put into a new and detailed model. As of 2020, KV has 900 employees (Kartverket, 2020).

FM (Fylkesmannen, The County Governor) is the state representative in the county and is responsible for following up on decisions, goals and guidelines from the Parliament and Government. FM is also an important link between the municipalities and central governing authorities. In addition to performing various administrative tasks on behalf of the ministries, FM also controls the activities of the municipalities and acts as the appeal body for many municipal decisions. Hence, FM has special knowledge regarding superior social areas, while they also possess important local knowledge (Fylkesmannen, n.d.). It is also FM's

responsibility to take initiative and follow up on evaluations after exercises and incidents, to ensure learning and development of local and regional safety and preparedness (Kringen, 2017).

NGU (Norges Geologiske Undersøkelse; The Geological Survey of Norway) is Norway's central institution for knowledge regarding bedrock, mineral resources, soils and groundwater in Norway. NGU is subordinate to the Norwegian Ministry of Trade, Industry and Fisheries. They are responsible for conducting quaternary geological mapping in Norway, which is an important basis to be able to further map quick clay zones in Norway (NGU, 2020). Hence, NGU is an important agency within quick clay management as they produce important maps, in addition to doing development work in order to detect quick clay (Expert 1).

NGI (Norges Geotekniske Institutt; The Norwegian Geotechnical Institute) is a private organization, established in 1953, which means that they have no regulatory role nor administrative responsibility. However, NGI is considered to be an important agency within quick clay management. Even though dealing with quick clay is a big part of the organization, they also have some R&D projects related to quick clay, which is financed by their profit. NGI can be seen as the agency which is most important when considering research in the quick clay field (Expert 1).

NTNU (Norges Teknisk-Naturvitenskapelige Universitet: Norwegian University of Science and Technology) is an international oriented university which is specialized in technical and natural sciences. They teach a lot of courses which involve quick clay landslides, especially focusing on how to do calculations, how to conduct site investigations and how to detect quick clay. NTNU is the only group in Norway of geotechnical engineers who gives master's degrees and PhD scholarships within geotechnical engineering. Hence, NTNU plays a vital role in education in terms of quick clay (NTNU, n.d.).

Appendix 2 – Documents

This appendix consists of documents we have retrieved data from and used in the findings, and contains archival data such as reports, news articles, legislative and policy documents.

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Appendix 3 - Interview guide with Experts

The Norwegian version of the theme-based interview guide was used when conducting the interviews with the participants. Although the interview guide was specified to each actor, we chose to anonymize the actors in this appendix. We have also ruled out two questions, as this could identify anonymized actors.

Bakgrunn

Denne studien omhandler hvordan læring og samarbeid bidrar til institusjonell endring for å håndtere komplekse problemer slik som naturhendelser og klimaendringer. Vi bruker kvikkleireskred-feltet som empirisk eksempel for å studere dette. Metodisk baserer vi oss primært på dokumentanalyse av rapporter som omhandler temaet. I tillegg gjennomfører vi noen intervjuer med eksperter på området som kan bidra til innsikt og validering av funnene fra dokumentanalysen.

Intervjupersonen og organisasjonens rolle i forebygging og håndtering av kvikkleireskred

- Kan du fortelle kort om deg selv og din rolle i organisasjonen?
- Hvilken rolle (ansvar og oppgaver) spiller organisasjonen når det gjelder kvikkleireskred?
- Hvordan arbeider organisasjonen med kvikkleire, da tenker vi på internt men også i samarbeid med andre, og hvordan er dette organisert?
- Hvilken rolle har læring innad i organisasjonen, blir det lagt mye fokus på dette?

Kvikkleireskred og problemene man står overfor

- Hva er omfanget av kvikkleireskred i Norge og hvordan har utviklingen vært?
- Hvilken oppmerksomhet har problemet egentlig og fra hvem? Eks myndighetene, forskningsmiljøer, de med sektoransvar, etc.
- Hva er de viktigste tiltakene man har?
- Har det vært noen spesifikke hendelser som har bidratt til at dette har fått oppmerksomhet, og som har bidratt til endringer på feltet? Eksempler?
- Hvilke aktører vil du si er de viktigste når det gjelder håndtering av kvikkleire i Norge, og hvilken rolle spiller de?

Samarbeid

- Hvordan er samarbeidet mellom de ulike aktørene som er involvert, kan du gi eksempler? Hvilke aktører har vært drivkraften i slike samarbeid?
- Gjennom blant annet NIFS prosjektet har en rekke prosjekter blitt igangsatt, har du noen formening om på hvilken måte dette har bidratt til læring og endring på feltet?
- Har organisasjonen lært noe gjennom ulike samarbeid - i så fall, har du noen spesifikke eksempler på dette?

Utfordringer og forbedringspotensial

- Hva er utfordringene med arbeidet med kvikkleire?
- Kunne det blitt utført på en like god måte dersom det ikke var samarbeid mellom flere aktører slik det er i dag (for eksempel utvikling av metoder for detektering av kvikkleire som har blitt utført gjennom NIFS og NHF)?
- Er det andre ting som man burde gjøre?
- Hva vil du si har vært det de/den viktigste faktoren(e) når det kommer til utvikling og læring samt endring innad i feltet over tid? Er det noen spesifikke initiativer som har vært viktig?
- Hva tror du kommer til å skje i årene fremover?

We translated the interview guide from Norwegian to English to guarantee that all readers will understand the full meaning of it.

Background

This study addresses how learning and collaboration contribute to institutional change to address complex issues such as natural events and climate change. We use the field of quick clay landslides as an empirical example to study this. Methodically, we primarily rely on document analysis of reports that deal with the topic. In addition, we conduct some interviews with experts in the field that can contribute to insight and validation of the findings from the document analysis.

The interviewee and the agency's role in the prevention and management of quick clay landslides

- Can you tell us briefly about yourself and your role in the agency?
- What role (i.e. responsibilities and tasks) does the agency have in terms of quick clay landslides?
- How does the agency work with quick clay, meaning both internally and in collaboration with others, and how is this organized?
- What role does learning have within the agency, is a lot of focus on this?

Quick clay landslides and the problems that occur

- What is the extent of quick clay landslides in Norway and how has the development been?
- What kind of attention does the problem get, and from whom? For example authorities, research communities, those with sector responsibility, etc.
- What are the most important measures in this field? Has this changed over time?
- Has there been any specific events that have contributed to increased attention and changes in the field? Examples?
- Which agencies would you say are the most important when it comes to handling quick clay in Norway, and what role do they play?

Cooperation

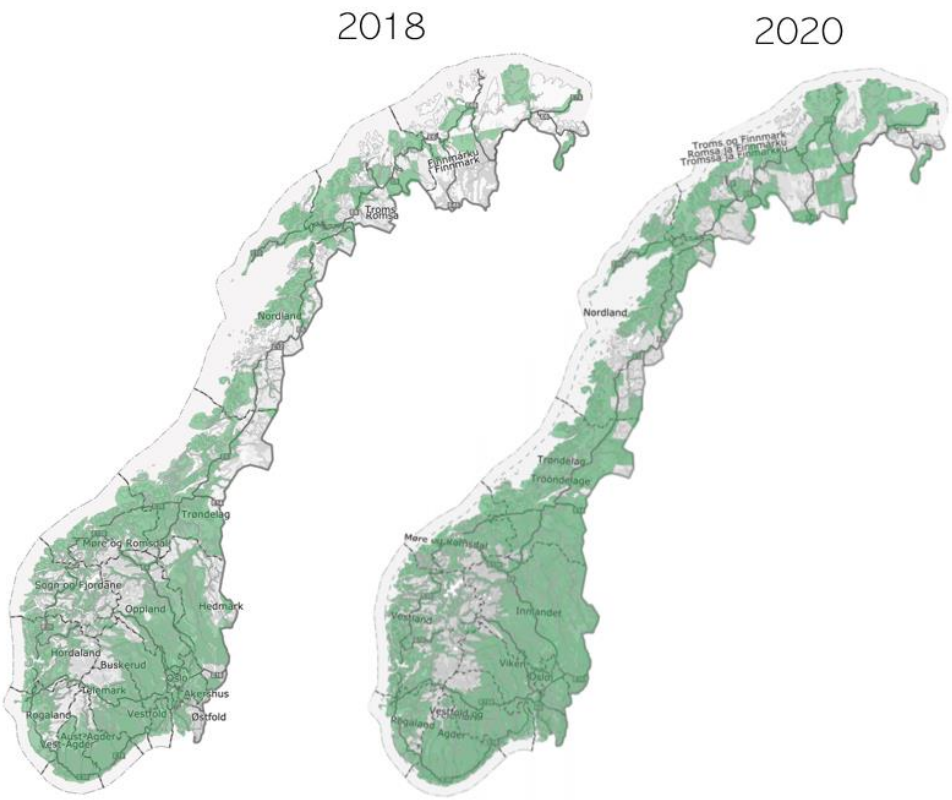
- Do you have any examples of how the collaboration between the various involved actors has been? Which actors have been the driving force in such collaborations?

- Through the NIFS project, among other things, a number of projects have been initiated, do you have a perception on how this has contributed to learning and change in the field?
- Has the agency learned something through various collaborations - if so, do you have any specific examples of this?

Challenges and potential for improvement

- What are the challenges of working with quick clay?
- Could the work that has been done have been carried out just as well if there was no collaboration between agencies, as it is today (for example, the development of methods for the detection of quick clay that has been carried out through NIFS and NHF)?
- Do you believe that there are other measures that could have been done in order to improve the field?
- What would you say has been the most important factor(s) when it comes to development and learning as well as change within the field over time? Are there any specific initiatives that have been important?
- What do you think will happen in the field in the future?

Appendix 4 – Development in scanned areas in digital 3D-model



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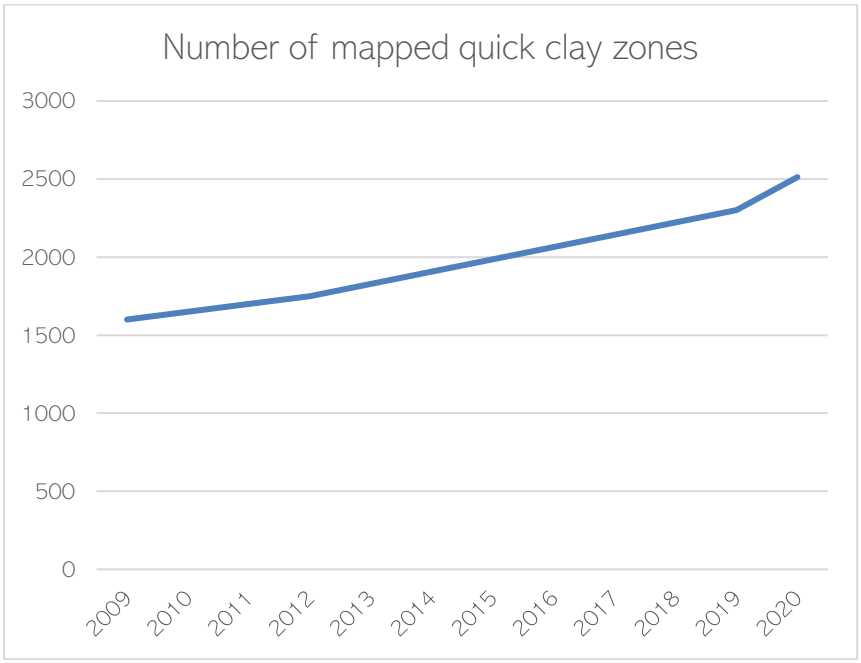
Appendix 5 – Number of mapped quick clay zones



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