Beneficial effects of improved ocean forecasting

How a more accurate fjord model can improve communication in an oil recovery operation

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SUMMARY

The idea of this thesis comes from the project FjordOs, whose goal is to develop an improved fjord model where one of the functionalities is to forecast oil drift orbits. How the forecasting is communicated, is crucial for how the forecasting is applied.
The purpose of this thesis is to investigate how communication in an oil recovery operation can be improved by a more accurate fjord model than the one in current use, and how the information is distributed from the Norwegian Meteorological Institute to the Coastal Administration and other users, and possibilities of improvement.

Qualitative research method will be used as the main research method. The main advantage with qualitative research methods is the possibility to get close and direct to the subjects studied. This is achieved by conducting in depth interviews which is a flexible way to collect information. Purposive sampling technique is used to select interview objects.

The organization established when conducting governmental oil recovery operations consists of several actors lead by the Norwegian Coastal Administration, which together with the Norwegian Coastguard and IUA (inter municipal organization responsible for preparedness against acute pollution) are the most central ones. If the oil drift forecast becomes more accurate than today, it can increase efficiency when conducting oil recovery operations.

To be a useful tool when planning an oil recovery operation, the accuracy of the oil drift orbit forecast has to be significantly better than today. It should also be possible to present the forecast in a chart with other information available, like the Coastal Administrations own chart “Kystinfo”.

PREFACE

One of several tools used by the Coastal Administration and other maritime institutions in an oil recovery operation is oil drift predications calculated by the Meteorological Institute. The quality of the predications is of significance for the recovery work. The project FjordOs plan to improve the accuracy of the oil drift predication. The basics in such a tool is an improved fjord model to forecast current, sea level, and hydrography with a sufficient solution to provide realistic environmental information in the Oslofjord including narrow sounds and routes.

I work today as a commanding officer on the Norwegian Coastguard vessel Nornen, and have done that for nearly three years. Nornen is responsible for patrolling the area from the Swedish boarder to Egersund including the Oslofjord. One of my duties as a commanding officer aboard Nornen, is to be prepared to attend the role as On Scene Commander at sea in an oil recovery operation. Therefore it was natural for me to choose a theme concerning oil recovery, when selecting subject to my master thesis.

I have been working in the Coastguard sine 1997 in different positions aboard different vessels and have completed the course the Coastal Administration is running for their effort leaders. During my duty I have taken part in several oil recovery exercises together with the Coastal Administration and other units including the Swedish Coastguard and the Danish Navy. I also have some experiences from real ship accidents where the oil recovery organization has been sat, but fortunately the ships have been saved before brakeage with following oil spill as a result.

It has been a pleasure for me to work together with the contributors to my work and to have the opportunity to immerse myself in this subject. I hope my findings will come in use, so the efficiency in oil recovery operations will be improved.

A lot of people in addition to the Vestfold University College, the Norwegian Coastal Administration, the Norwegian Coastguard, the Norwegian Meteorological Institute and Tønsberg Fire Department have contributed to my thesis, and I want to thank my supervisors Karina and Are for their really helpful advices, the informants who contributed to my research, my wife and our four kids for being very patient, my crew on Nornen for all support, my dear friend Kristina for great support, and my fellow students at VUC and especially my group teammates.

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INTRODUCTION

The Oslofjord region has the highest density of maritime traffic, including commercial and leisure crafts, compared to other Norwegian waters and fjords. Moreover, no other fjord has the same density of population. As a result, the environmental consequences in the Oslofjord and its coastline can be very severe, should an accident occur to the many vessels and crafts that traffic the fiord.

The Norwegian Coastal Administration has a duty on behalf of the government to maintain a national preparedness to, and capacity to respond to, major cases of acute pollution of Norway's coast. The coastal administration is responsible for spills that are not covered by municipal contingency plans or the contingency plans of private maritime companies. Most of the responses the Coastal Administration is taking action against, are directed at oil spills from ships and shipwrecks and unknown sources.

The Purpose of This Thesis

The purpose of this thesis is to investigate how communication in an oil recovery operation can be improved by a more accurate fjord model than the one in current use, and how the information is distributed from the Norwegian Meteorological Institute to the Coastal Administration and other users, and possibilities of improvement.

Chart 1 shows how the oil drift orbit forecast how it is presented today. The information available on the chart is very limited. There are no place names, navigational hazards, plot of observed oil, or other useful information when planning oil recovery operations shown on the chart. This causes the On Scene Commanders to run different chart system in parallel to have all the necessary information available when leading an oil recovery operation. This is less effective than operation one system with all the information needed available.

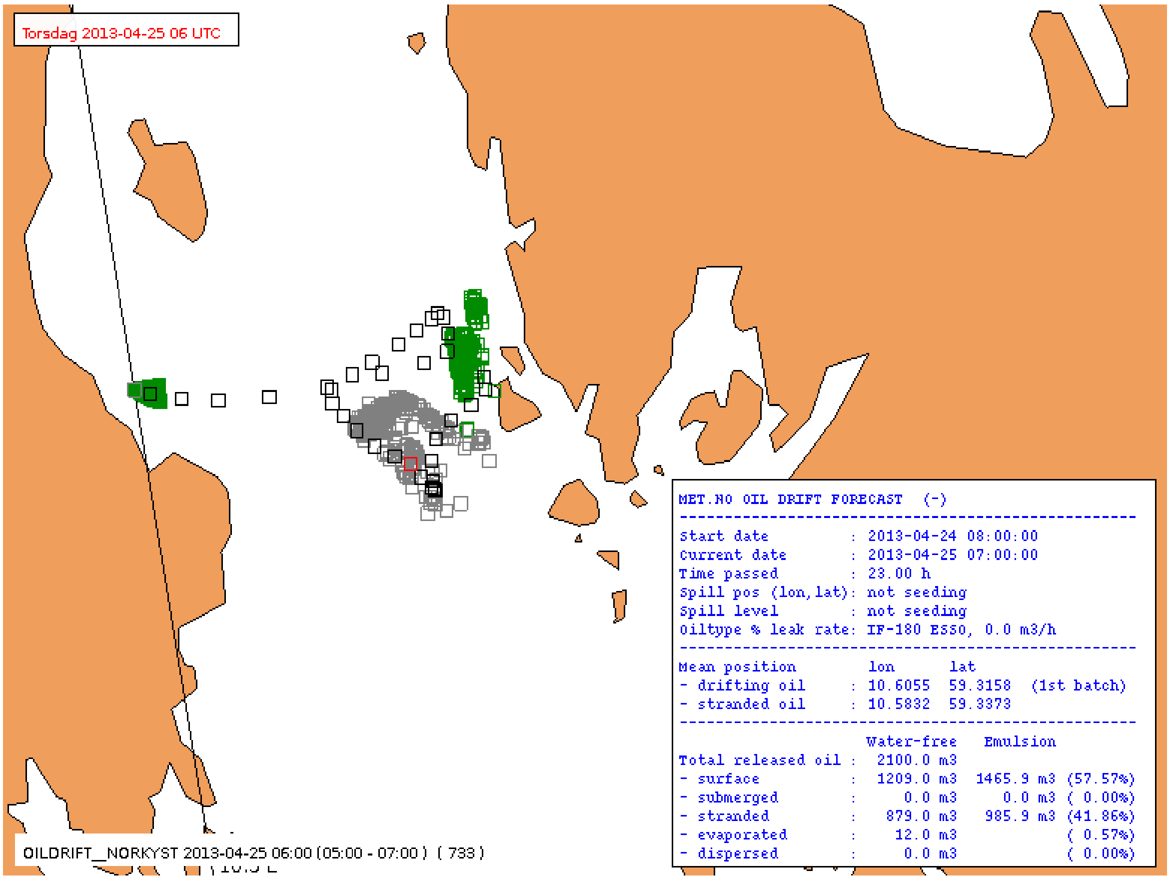


Chart 1: Presentation of oil drift orbit forecast, as available today.

This study focuses on oil recovery operations through the perspective of inter-organizational communication. In order to identify current communication practices between organizations involved in oil recovery operations, interviews are performed.

Research Question

The purpose of this thesis is to study how an improved fjord model can contribute to increase the efficiency when conducting oil recovery operations. This includes a study of the actors who take part, experiences with the fjord model available today, different ways to utilize oil drift orbit forecasts, and how the result of the oil drift orbit forecasts is presented to the users today.

It is significant to know the need for information at each level in the organization, and therefore I will ask what kind of information each level of the organizational structure need. In order to answer the purpose of the thesis, the following factors have to be investigated:

1. The cooperation within the *recovery organization.*
2. The oil drift orbit forecast’s contribution to the efficiency of an oil recovery operation.
3. The accuracy of the oil drift orbit forecast.
4. The oil drift orbit forecast’s contribution to the situational awareness in an oil recovery operation.
5. Requirements to the equipment needed to receive oil drift orbit forecasts.

INTER-ORGANIZATIONAL COMMUNICATION THEORY

Oil recovery operations are dependent of cooperation and communication between organizations in order to be successful. Thus, it is important to map factors which influence the communication process in an organization. Lack of good communication will impede management, and the workers might experience lack of cooperation, when conducting oil recovery operations.

Communication is a continuous and vital process to transaction, coordination, and cooperation. The traditional way to define communication is the exchange of information between people or groups. The communication process is usually described in a step by step model, see Figure 1.

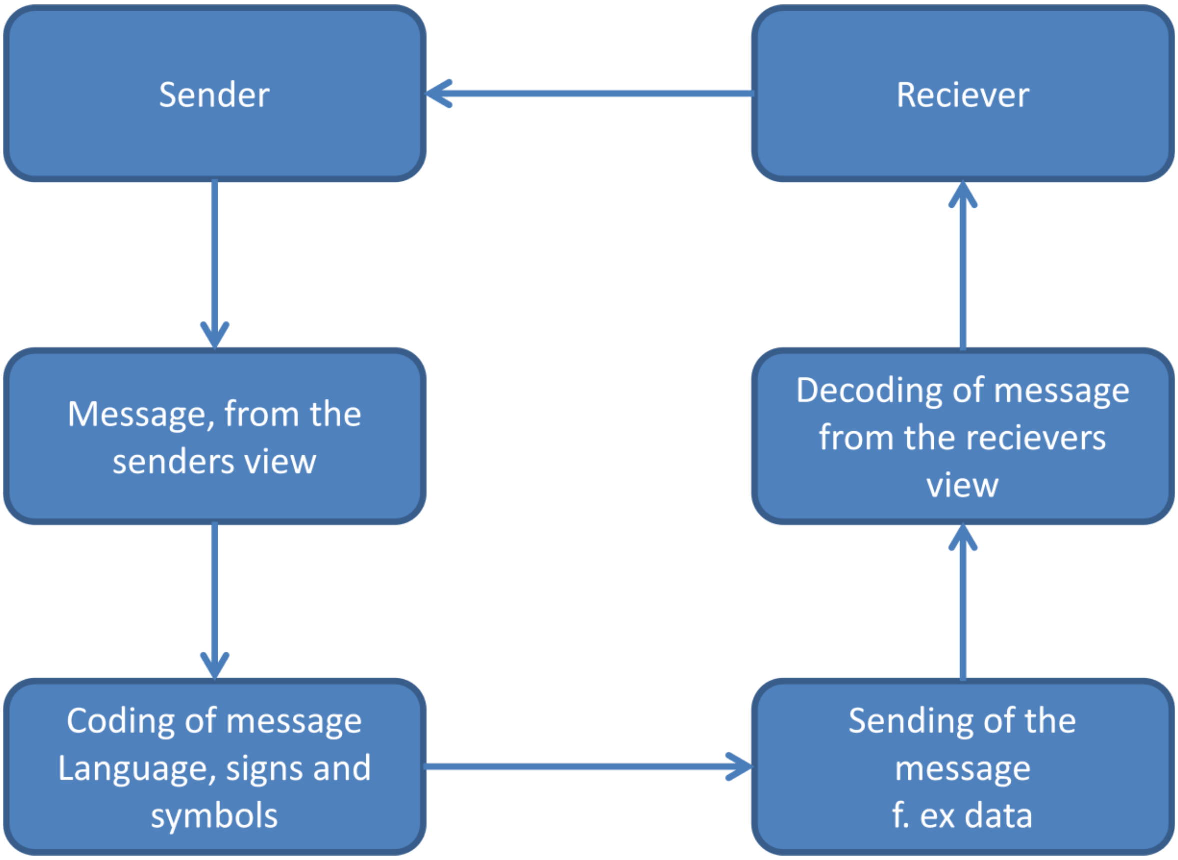


Figure 1. The communication process described in a step by step model, (Shulman, 1996)

The step by step model shows that the communication process takes place between the sender and the receiver. The sender has a message which he or she has to formulate and send. The receiver reads the message and interprets what he read. If any feedback is expected, the communication process is repeated. The step by step model can help us study important steps in the communication process can arise:

1. The sender needs to formulate the information he wants to communicate. This can be done by either words or other symbols and signs, like the oil drift orbit forecast on a chart.
2. The sender needs to select a communication channel. There are several possibilities: f. ex. formal reports, letters, e-mail, phone calls, video conference, and face to face talk.
3. The receiver needs to interpret the information he receives. The communication is often defined as good if the receiver interprets the message in a similar way as the sender's intention.
4. The final step in the communication process is the feedback, and the process is repeated.

Challenges can arise when the sender formulates the message. Preferably should the sender formulate the message as the sender imagines, and so the receiver interprets it like the sender imagine. Other factors that can cause challenges are the choice of words and phrases, communication based upon cultural and educational differences, and lack of confidence by the receiver caused by the way the sender express himself.

Communication is crucial for how organizations are functioning, and one of the key factors to reach organizations' goals. Trough communication, the management will inform subordinates about tasks and expectations concerning to achieve the mission.

Communication Challenges

Challenges in communication are not uncommon in organizations. In general, challenges in communication imply poorer exchange of information, and this can lead to insecurity among the employees and loss of efficiency in the work process.

Jacobsen and Thorsvik (2010), describes three different communication challenges which organizations may be exposed to:

- Challenges in the communication process between employees who want to share information.

- Challenges in the communication process associated to the communication channels.
- Challenges in the communication process caused by abuse of power where someone holds back or manipulates the information.

According to Jacobsen and Thorsvik (2010) there are three challenges related to the choice of communication channel. The channel can be unsuitable to the information the sender wants to communicate. Second, the channel limits the opportunity for feedback if a two way communication is preferred, and finally the communication channel can include several actors, and the information sent through the channel can be exposed to manipulating and change. This often happens in vertical organizations where the information goes through several organizational levels.

There are also challenges to the communication process when the receiver is interpreting the message. These challenges arise when the sender is formulating the message. The receivers' attention to the message and her perception of the sender will influence the way she interprets the message. Research shows the importance of confidence between the actors in the communication process (Haslam, 2004). If the receiver doubts the reliability of the sender, the receiver probably will be dismissive to the content of the message.

Challenges linked to overload of information

Communication challenges are often caused because the employees receive too little information, but too much information can also be a challenge. Moreover, Edmunds and Morris2000 and Eppler and Mengis 2004 show that the individual can be exposed to stress, lack of control, and the loss of overview when receiving too much information. The information has to be adapted to the needs and knowledge of the receiver. Eppler and Mengis (2004) shows three common reactions of receiving too much information:

- The receiver has a tendency to accept the first information which seems to be good enough. The search for information becomes more superficial.
- The receiver process the information more superficial. This entails a risk for interpreting the information wrong.
- The receiver fails to deal with the information. This can lead to a delay of important tasks.

Communication challenges caused by opportunistic behaviour

Opportunistic behaviour can cause communication challenges if someone holds back relevant information to take an advantage over a situation. The result will either be that someone knows something others could have use of, but keeps the information to promote their own interest, or that someone already have made a decision, but creates and impression of something different to secure own freedom of action to promote own interests.

Control over information is a factor of power for organizations. When the information is available, but unlikely distributed, it is called information asymmetry. Information asymmetry is often separated in two types; hidden information, that happens when someone are more informed about relevant matters than others and hidden action, meaning that the actors after making an agreement can chose to act in a different way (Douma and Schreuder, 1998).

Informal communication in organizations

Informal communication takes place everywhere people meets. Informal communication is communication which takes place when people meet at the start of the working day, they meet for a coffee break, on their way to a meeting or after a meeting. Stohl and Redding, (1987) showed that informal communication channels distributes information faster than formal communication channels. Other research shows that subordinates in general are more confident to information which is distributed in an informal way (Robbins, 1993) and (Burt and Knez, 1996). Therefore there has been a change in the way people think of informal communication, from unwanted and disturbing to a necessary and wanted process in the organizational life.

Some important functions of informal communication according to (Ekman, 2004) are:

- Social relations are developed through informal communication.
- Trust and mistrust between people are arising as people learn to know each other. Talk about others achievements can create trust or mistrust.
- Informal communication is an important supplement to formal communication.
- Informal communication promotes learning in organizations

Communication network

Several design options are available for working groups. Bolman and Deal (2008) illustrates five principles of different structural forms.

The first structure (see figure 2) is a configuration where the information flows from the top. The group members are communicating primarily with their boss and not with each other. This setup can be effective in simple situations. In complex tasks the boss can be overloaded with delays and bad decision making as a result.

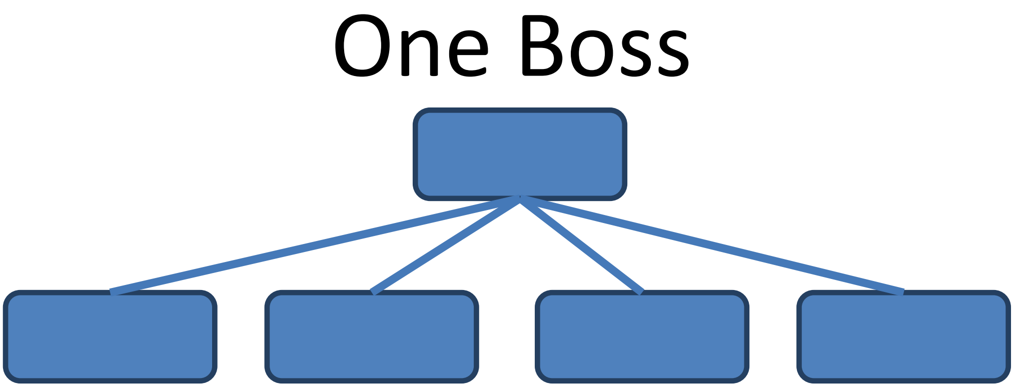
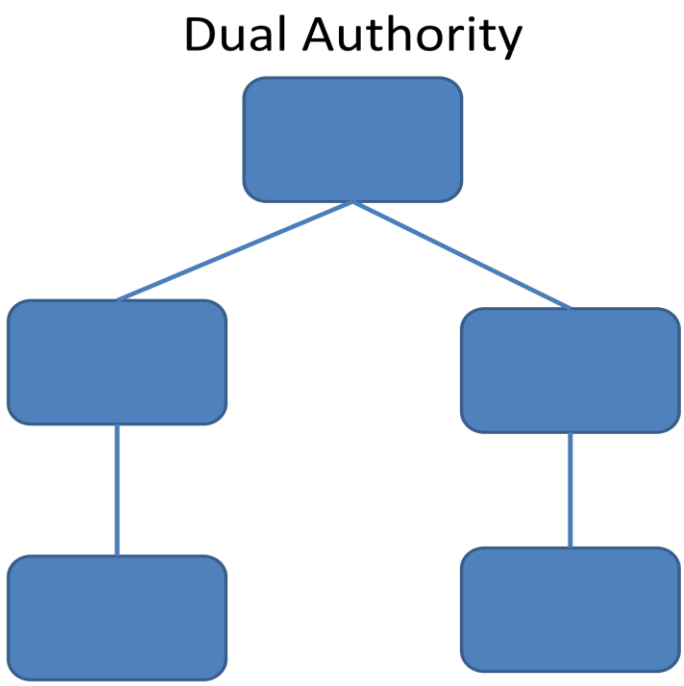


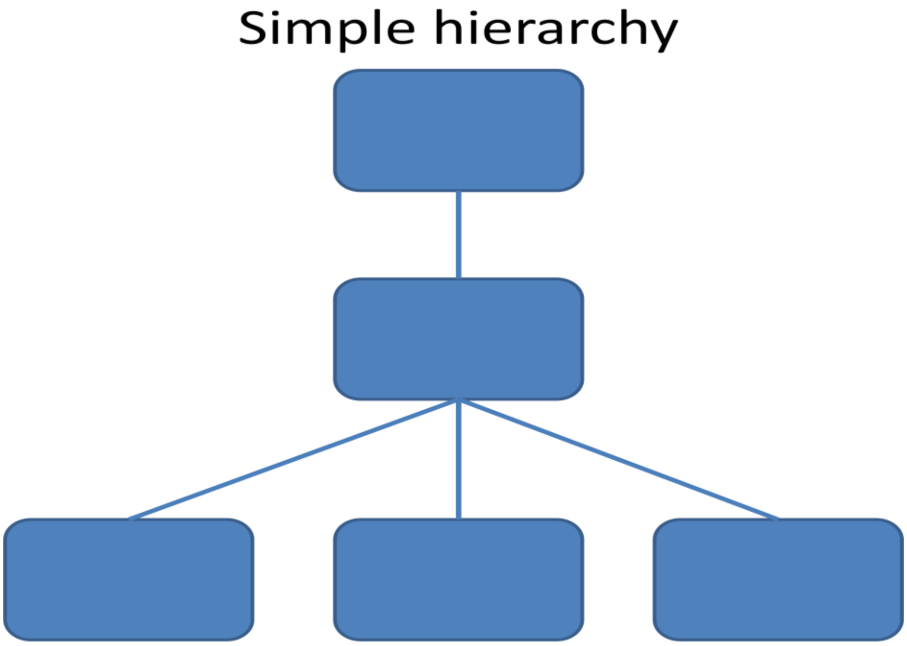
Figure 2: Illustration of communication network with one boss on top.

In the second alternative (see figure 3) another management level is created below the boss. Each of the two managers is given authority over different area of responsibility. This is a good solution if the mission is divisible. The boss will release time to focus on the overall mission and communication with higher levels. The new level will limit the communication from the lower level to boss.



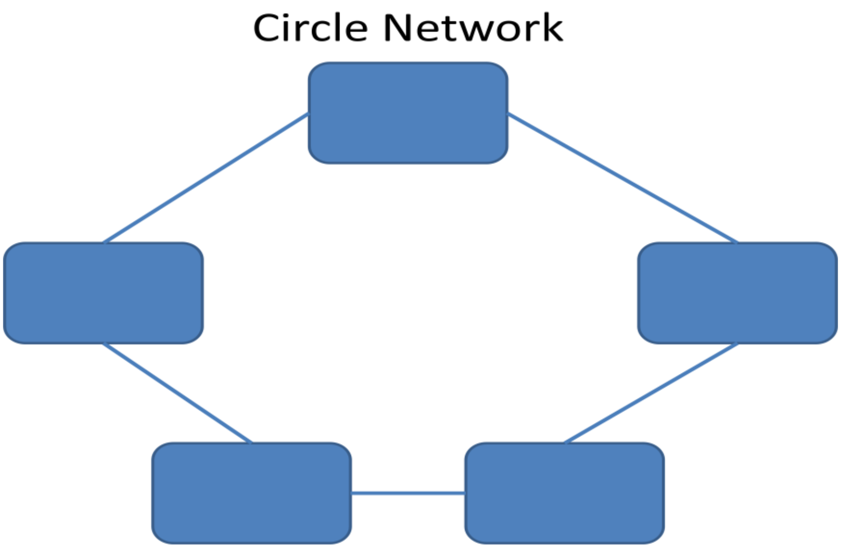
Figur 3: Illustration of communication network with two management levels under the boss.

The third option (see figure 4) is a simple hierarchy with a chief of staff under the boss. This can be effective because the boss can focus on mission and external communication while the chief of staff is taking care of operational details. Bolman and Deal (2008) claims this option to be more effective than a dual-manager configuration, although friction between the operational and top-level managers is normal.



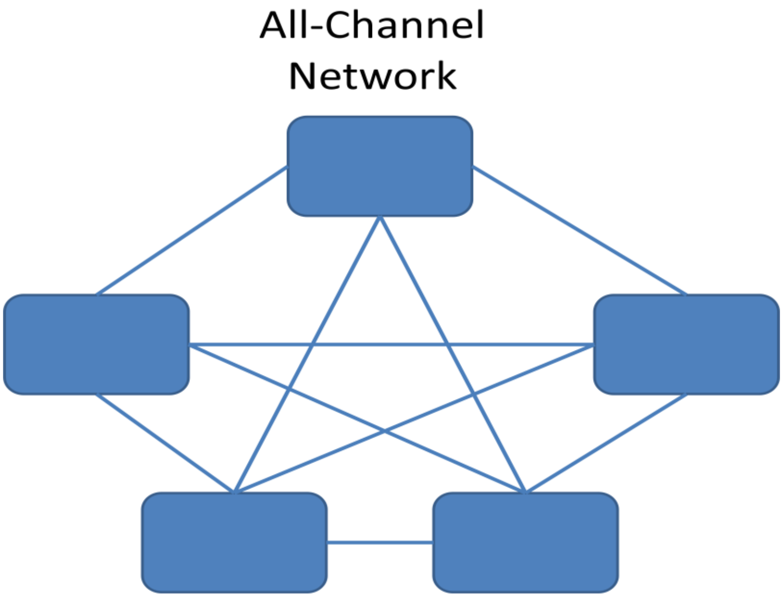
Figur 4: Illustration of communication network with a staff officer under the boss.

Circle network is the fourth option (see figure 5). Each group member communicates only with two others and can influence the information when the communication process is going on. The communication process is simple but the system is depending of all links in the chain. The circle can knee if the task requires reciprocity.



Figur 5: Illustration of a cirkle communication network.

The last option (see figure 6) is a configuration with multiple connections also called star network. Everyone can talk to whoever he wants and the information flows freely. This configuration often creates a very high morale and it works well if the task is challenging. For more simple tasks the all-channel network is inefficient. It also requires more from the team members, like good communication skills, tolerating ambiguity and embracing diversity, and ability to handle a conflict.



Figur 6: Illustration of a star communication network.

Information and communication technology (ICT) and communication

Information and communication technology (ICT) provides us the opportunity to communicate independent of time and space. Time independence means that two or more people can communicate without being present at the same time.

Jacobsen and Thorsvik (2010), distinguishes between synchronous and asynchronous communication channels. E-mail is a good example of an asynchronous communication channel. The e-mail can be read independent of when it was sent. A telephone call is an example of a synchronous communication channel. The persons communicating have to speak at the same time, but can be in different places. Most communication channels today are space independent. Face to face talk is the only communication channel which is space dependent.

The technology enables us to separate time and space today. Dennis and Valacich (1999) and Jessup and Valacich (2006) expand the analysis of communication channels to five dimensions to study how well groups function when they rarely meet each other:

1. How quick the receiver can give feedback to the sender?
2. To which extent the communication channel can convey different types of information.
3. To which extent the communication channel allow more calls at the same time.
4. To which extent the sender has to prepare the message before sending.
5. To which extent the communication channel allow to store and recall the information.

Jarvenpaa and Leidner (1999) argues that virtual groups, that is groups that are not working together at the same place, in some cases are not functioning as well as groups communicating face to face. This is significant for groups who don't know each other and do not have mutual trust. The information is often interpreted wrong and the actors are selective with respect the information which is distributed. If the participants know each other, and the responsibility is clear, it seems that virtual groups are working as good as traditional groups.

Summary of Communication Challenges

Communication is crucial for the information the decision makers base their decisions on. If the information base is poor, the analysis and the description of the situation can be wrong, and the decision makers can make bad decisions which are poorly adapted to the situation. Communication is also essential to succeed to put plans into life and realize the organizations goals (Kaplan and Norton, 2006).

For the management communication is a tool to coordinate and control the operations (Goldhaber, 1993). Any coordinating and control presupposes information about what is going on in the organization (Daft, 2004). This information is only present if the communication in the organization is good. At the same time effective management implies the decision makers are able to communicate the right message. In other words, the decision makers need to communicate the information so as the right people receives it and understands it in a way that matches the sender's intentions.

THE METHOD OF THIS STUDY

Qualitative research method will be used as the main research method. The reason to choose qualitative research method is the importance of the characteristics of decision making by use of drift orbit models in oil recovery operations. The main advantages with qualitative research methods are the possibility to get close and direct to the subjects studied. This is achieved by conducting in depth interviews. By carrying out in depth interviews it is possible to obtain as much information as possible by the limited time available, and to bring out the nuances that can be of vital importance. The flexibility is another characteristic of this method. It is possible to change the questions posed to the interview objects and it is possible to utilize the information one gets randomly when going further in the data collection (Repstad, 2004).

To study an operation in depth can be very time consuming. Thus, the time available to do the field work can be one of the limitations by using qualitative method as the research method. Another limitation can be the low number of respondents such a research allows me to contact. The sources of information are limited and there is a possibility the researcher can miss important information during the collection. In this thesis the organization established when an oil spill occur, is limited and straightforward, and thereby it is manageable to perform interviews of the most central persons in the organization. To conduct real time field study of an oil recovery operation would be quite impossible considered that this study is work assigned to the spring semester 2013, and conducting an governmental oil recovery operation is impossible to plan. By using in depth interviews the goal is to secure the collection of information to a high level even the limited time available (Repstad, 2004).

When I conducted the interviews and formulated the interview questions, I used experiences from a former oil recovery operation in addition to my own experiences as commanding officer on the Norwegian Coastguard vessel Nornen for nearly three years. This case study is of the recent grounding and oil spill of “Godafoss” in 2011. All the interview objects except from the respondents from the Meteorological Institute, took part in the “Godafoss” oil spill response.

Ethical guidelines developed by The Norwegian Research Ethics Committee in the Social Science and the Humanities (NESH) are followed during the work with my master thesis. The research project is reported to Norwegian Social Science Data Services (NSD) as required. Any personal data will be handled in accordance with ethical guidelines and the Personal Data Act. The requirements for storing information which can be used to identify individuals will be met.

Field Work

In a qualitative research, the researcher is active in the data collection process. Repstad (2004) suggests that it may be wise for the researcher to undertake some initial fieldwork before the start of the study in order to learn who has the relevant information and who to interview. Moreover you will be able to ask more relevant questions. Thus, qualitative research requires that the researcher has a broad background of the topic. Hammersly and Atkinson (1996) asserts that the method of field work implies the researcher to take part, openly or hidden, in the daily life of a community over a longer period. During this time the researcher observes, listens, and asks questions. The researcher will collect available data which will illustrate the research problems.

It is not possible to plan an oil recovery operation in a particular semester which is the time limit of this thesis. Therefore no field work has been done. Nevertheless has the researcher been able to take advantage of his long experience as a Coastguard officer, which includes three years as a commanding officer on the Norwegian Coastguard vessel Nornen.

Using Interviews as Data Collection Method

The qualitative interview model has been criticized for being idealistic and individualizing, to focus too much on the individual opinions and neglect social and material structures and frames (Repstad, 2004).

Another challenge with interviews as research method is the possibility that they can be out of the context. It is therefore good practice to ask specific questions related to the actual practice, and ask about what the persons are doing in concrete situations which is realistic for the persons asked. It is important that the questions are concerning the experience learned in its context (Repstad, 2004)

Flexible Interview Guides

Compared to a pre coded questionnaire where nuances can be omitted because of missing response categories a qualitative research, where there is an interview guide designed with some basic questions and some follow up questions, encourage the participants to elaborate and justify their answers. The interview guide is used as a guide to secure that all the important themes are covered. If the interview guide is made too detailed it is a risk that the respondent can be pacified. (Repstad, 2004). This risk has to be taken into account when performing interviews.

Another benefit of flexible interviews is that they can be adjusted during the conduct of the interviews. Both the possibility to drop unnecessary questions and ask new questions can be done in such a research (Repstad, 2004).

There is also a risk for asking delicate questions which may damage the communication, (Repstad, 2004), but in this research we do not expect any of the themes to be unpleasant for those surveyed.

Sampling Strategy

Often in social science a researcher seeks answers to important research questions that cannot be answered by a probability sampling technique. Probability sampling is based on the notion that one sample can represent subgroups of larger populations. Therefore nonprobability sampling is quite often used as a sampling strategy in qualitative research. In contrast to the probability sampling, in nonprobability sampling the researcher is not basing his sample selection on probability theory.

One of the non probability techniques is called purposive sampling technique. In purposive sampling technique the researcher can use his expertise or special knowledge to select respondents most suitable to answer his research questions (Berg, 2009).

In this thesis it has been vital to ask the relevant persons with knowledge and practical experience about the use of results from oil drift orbit calculations. Therefore purposive sampling technique is chosen as a sampling strategy for this thesis.

Selection Interview Objects

The main reason to select an interview object is that the researcher expects that the candidates have relevant information for the projects research question, either thoughts, knowledge, attitudes, experiences, or else which is called for. Within this framework the rule is that the respondents should be as diverse as possible, (Repstad, 2004). Factors that influence the selection of informants is according to Repstad (2004) that they must play a role which means they are exposed to the information the researcher seeks, the need to be cooperative, motivated to shear their knowledge, have the ability to express themselves, and finally have a certain impartiality in relation to the setting. Repstad (2004) claims that interviewing persons you know can provide an advantage because they can feel freer during the conversation and as an interviewer you can crack down on exaggerations. On the other hand there is a possibility that they play up to the interviewers thoughts.

Based on the organization established when a governmental oil recovery operation is conducted (see fig. 1), the interview objects were selected. Table 1 shows the interview objects individual positions, the location, and duration of the interviews.

Organization	Nr. of interview objects	Positions	Location of the interveiw	Interview duration
Coastal Administration	3	• Management • Operational • Plan, environment	• Coastal administration • Nocgv Nornen • Nocgv Nornen	• 36 min • 35 min • 38 min
Coastguard	1	Captain	Nocgv Nornen	21 min
IUA	1	Management	Tønsberg Fire Station	20 min
Meteorological Institute	2	Research and development (one professor)	Vestfold University College	32 min One interview, two respondents

Table 1: Interview objects, individual positions and duration of the interviews

The Completion of the Interviews

The interviews were conducted as conversations in undisturbed conditions. The interview guides (see the appendix section) were used as an aid to ensure that all relevant themes were discussed.

The respondents were all positive to contribute to the thesis' research question, and they all showed willingness and flexibility to find time to be interviewed. The respondent from the IUA organization was in my opinion not as concerned with the oil drift orbit calculation as the rest of the respondents. The representative from IUA was also a bit busy. Anyway, that did not inhibit the collecting of relevant information.

I experienced strong commitment from most of the respondents and all saw the importance and showed enthusiasm for an improved fjord model. All the respondents did their best to shear their knowledge.

The composition of the interview objects was well suited to answer the research questions.

Some of the informants I knew from before. This was an advantage because a very useful dialog quickly was established because we did trust each other. Those of the respondents I knew from before did not play up my thoughts. On the contrary I had very constructive conversations with them.

Although the interview guides where relatively detailed, I received information I did not ask for. The use of oil drift orbit calculations to document the spreading of oil after a recovery operation and the usefulness the environmental researchers can have when they plan their positions to take samples, is examples of that. The discussions I had with some of the informants about the information displayed in the chart, is an example of one of the benefit a qualitative research method provide. I also made benefit from the flexibility of the qualitative research method, by calling three of the interview objects after the interview to ask clarifying questions.

EMPIRICAL RESULTS

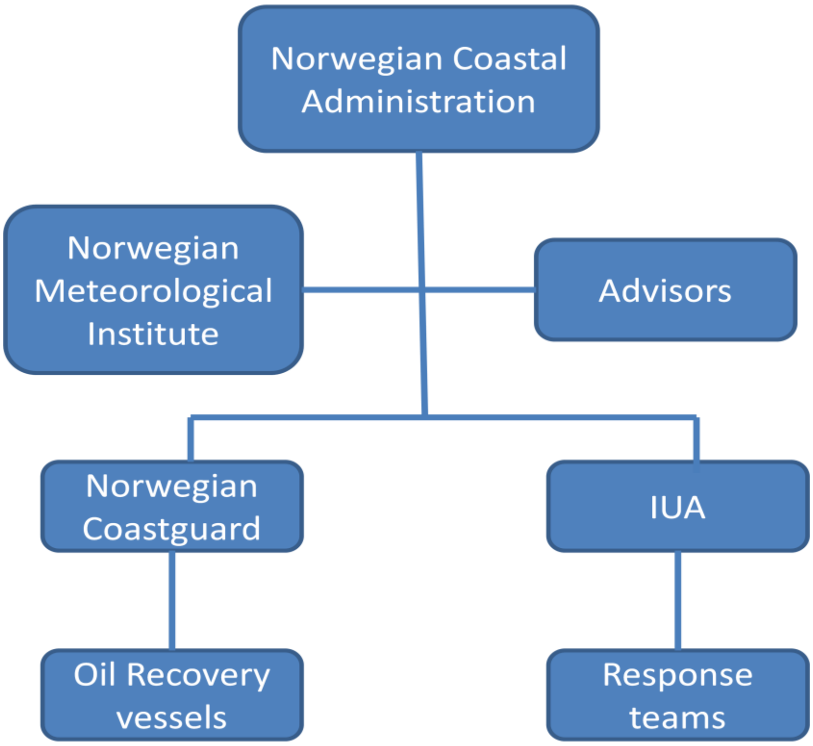
This chapter describes the main results from the series of studies that were conducted in this research. Initially the oil recovery organization created during an oil spill is described, including how it distributes the information from oil drift orbit forecasts. Then, a case from a real life oil spill event, the grounding of "Godafoss" in February 2011 is presented in order to explain how the organizational actors work and organize during an oil recovery operation. Finally, the informants' most essential information needs and especially the importance of oil drift orbit forecasts are described.

The Oil Recovery Organization

The Coastal Administration's Department of Emergency Response has the overall responsibility to organize and lead a governmental oil recovery operation. Most operations concern oil spills from ships and shipwrecks or unknown sources. When an oil spill occurs and the responsible polluter is incapable of taking action, a temporary *recovery organization* is established. This organization will be described in this section, based on interviews, documents, and reports from previous operations.

The *recovery organization* as described in figure 7, consists of experts from the Coastal Administration, the Norwegian Coastguard, IUA (Interkommunalt Utvalg mot Akuttforurensning), and oil recovery workers. IUA is an inter-municipal organization which is responsible the preparedness against pollution from oil and chemicals in watercourses, on land and along the shoreline. IUA consist of the port captain, chief of the fire department, chief of police, representatives from the county's environmental department, and representatives from industry who are mandatory to keep and emergency preparedness. IUA has assigned response teams from the fire department, port authorities, and the archipelago service. The Coastal Administration can also mobilize resources from private and municipal actors if necessary in a major governmental response operation. Through international agreements, international assistance can be requested. Examples of possible partaking units in the Oslofjord are vessels from the Norwegian Coastguard, the Swedish Coastguard, the Danish Navy, the Coastal Administration's own units, Exxon Slagentangen's units, vessels in costal preparedness, private salvage companies, Norwegian Sea Rescue, the Archipelago Service, and the port authorities units. The size of the *recovery organization*, which is similar to the dual authority organization described in figure 3, and the total numbers of actors is depending on the size and extent of the oil spill.

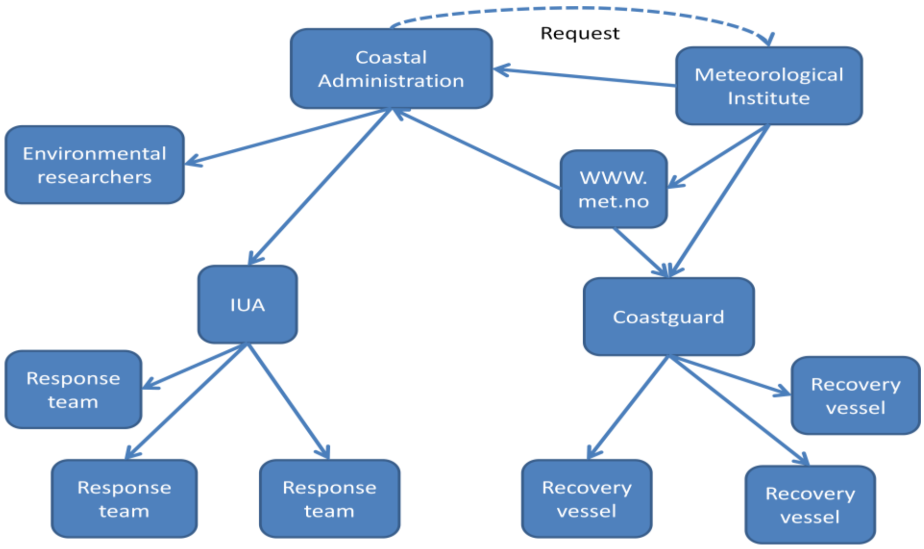
The Coastal Administration is responsible for maintaining a suitable organization. The Coastguard takes the responsibility at sea to recover as much oil as possible, with assistance from other available vessels, and the IUA takes the responsibility on shore and at sea close to the shore. Shore based recovery personnel will operate under the lead of IUA. The respondent from the IUA tells this is mainly people from the fire department, the archipelago service, and the port authority. This informant further says their remit is protecting and recovering the beaches and that the Coastguard takes the responsibility for the area at sea. This is confirmed by the respondent from the Coastguard. Both the informant from the IUA and the Coastguard confirm that there are no conflicts in the intersections of their areas of responsibility.



Figur 7: The r*ecovery organization* established when a governmental oil recovery operation is conducted.

One of the respondents from the Coastal Administration with leader responsibility states the following: "The Coastal Administration is making a general long term strategic operation plan and operation order (see appendix 1). These documents contain overall information about priority areas, like geographical areas of special interest, distribution of oil and participating units. The Coastal Administration then assigns effort leaders, which whom they keep a tactical dialog on a daily basis. Both the respondent from the Coastguard and IUA find the information received with the operational plan for adequate and satisfactory (see chapter Inter-Organizational Communication). Where to send the partaking units is in general decided by the On Scene Commanders. Sometimes it is more efficient to divide the vessels into several groups and assign one suitable unit as a group leader.

One of the respondents has background from both the Coastguard and the Coastal Administration. This informant tells that the different actors know each other very well. Moreover the Costal Administration keeps a record over the capacities of most of the available resources in the different areas in Norway. This can be distributed to the different units in an oil recovery operation so all the participants are familiar with their capacities. Furthermore the Coastal Administration is running a course for On Scene Commanders for the coast guard, and also visits the IUA's every 3rd years. On these visits the Coastal Administration conducts teaching and run exercises. Teaching subjects content of organization, economy, missions, and tasks, writing of orders and maintaining a good log and the use of tools like results from oil drift orbit models. He further informs that the Coastal Administration each year arrange exercises where the Coastguard and other units from the emergency plans take part. This includes the annual Nordic oil recovery exercise. An important tool used in planning where to deploy available units is an oil drift orbit forecast from the Meteorological Institute. The Meteorological Institute then has a time limit of one hour to calculate the oil drift orbit. This model can predict where the oil will drift, and is a tool to decide where to deploy recovery units and protection systems. Figure 8 shows how the oil drift orbit forecasts are distributed within the *recovery organization*. When the calculation is ready, it represents a simulation of the most probable moving direction of the spilled oil with a minimum of other information like place names and navigational hazards provided on a chart (see chart 1). The Meteorological Institute e-mails it to the Coastal Administration and the Coastguard and publishes the results on their website where authenticated users can read them. The Coastal Administration then sends the result to the IUA as an e-mail attachment to the operational plan.



Figur 8: Distribution of oil drift orbit information in the *recovery organization.*

Both the Coastal Administration and the Coastguard are authenticated users, and has the opportunity to get the results directly from the Meteorological Institute's web site. The result from the drift orbit calculation is one of the sources to make use of to decide where to start the oil spill recovery. The Coastguard and the IUA will use the information from the drift orbit calculations when they give tasks to assigned units.

The “Godafoss” Case

To illustrate the flow of information including information about oil drift orbit forecast is communicated when conducting an oil recovery operation, a study of the grounding of Godafoss has been done. At 20:00 Thursday the 17th of February 2011, the effectiveness of the information distribution between the organizations responsible for oil recovery operations was put to a test, when the container vessel “Godafoss” hit the ground at Kvernskjæret in the Ytre Hvaler national park at the approach to Fredrikstad. “Godafoss” is a 165 m long Island registered container ship of 14664 gross ton, build in 1995. The ship was loaded with 800 tons of heavy fuel. Leakage in two of the midship fuel oil tanks was soon confirmed. The content in these tanks was 250 tons of type IF 380, which is a heavy fuel oil. Oil spill was rapidly observed on the sea surface.

At midnight the 17th of February, the Coastal Administration took the lead of the oil spill response and by that the operation was a governmental action. The Coastal administration made an early warning to IUA Østfold who mobilized their crew and fighters. At a later stage, warnings were also made to IUA Vestfold, Telemark, and Aust-Agder. To inform about areas of priority and assignments to the On Scene Commanders, the Coastal Administration issued operational plans, (see appendix 1). As showed in the operational plan, the communication between the actors followed a structured plan with daily phone calls and meetings. The oil drift orbit forecast was sent as an attachment to the operational plans, and the Coastal Administration and the Coastguard were retrieving the information directly from met.no’s web site. Orders from the On Scene Commanders to the subordinate units were issued by on telephone or VHF radio to vessels provided with maritime VHF radio.

The accident happened in a very valuable natural area with coral reefs, eel-grass beds, lobster reserve, national park, and large seabird populations. SINTEF (independent research organization) assumed that the oil would not sink. Therefore it was just a question of time before the oil would hit the coastline and cause severe damage to the nature.

The Coastguard vessel Nornen, acting as On Scene Commander at sea, was using a major effort was to collect as much information about the location and movements of the oil, and the expected weather conditions to utilize the assigned recovery units as effectively as possible, to recover as much oil from the sea as possible. The different available units were ordered to assist in the oil recovery operation so they were utilized as good as possible according to their own capacity and limitations. At the same time the Coastguard vessel Nornen used its own recovery equipment. IUA in the different counties experienced the same situation on the shore side. Acting as On Scene Commander on land, they had the responsibility to place protection equipment in priority areas in addition to organize the different response teams in their oil recovery work.IUA also spent resources to manually monitor the situation along the shoreline. This was done by foot, by boat and by helicopters.

The prevailing current system in the area of Skagerrak is an inflow of water in the southern Skagerrak and a current flowing north along the Swedish coast. This current is turning south-west off the lighthouse of Færder, and makes an outflow of water along the Norwegian coast. This system is predominant, but is affected by air pressure, wind direction, the moon, and river flow. During the oil recovery operation after the Grounding of "Godafoss" the drift orbit of the oil was monitored carefully. In addition to oil drift orbit forecast calculated by the Meteorological Institute, aircrafts, helicopters, and drift buoys gave useful information about the oil drift. Howerver, during the Godafoss accident the respondents who took part in the "Godafoss" oil recovery operation all agreed that the oil drift orbit forecast was not reliable. Therefore, the oil drift orbit forecast was not payed too much attention when planning the operation. To prevent hit on the shore side along predicted oil drift orbit was nevertheless one of the environmental goals described in the Operation Plan.

Several landfalls of oil were registered the days after the grounding of "Godafoss". The first landfall was located in the immediate surroundings of the ships position at Kvernskjæret. During the early hours after the spill, the main current direction in the area of Kvernskjæret was southwards. This southbound current is caused by the flow in the Glomma River. Friday the 18th the current was running north along the coast line of Østfold, and the next landfall of oil occurred at the islands of Søstrene. As chart nr. 1 shows, oil was seen in the middle of the fjord, as north as the island of Rauøy. The current then turned almost 180 degrees and the 19th of February the southern islands in the archipelago of Tønsberg were contaminated. The distance from Kvernskjæret to Bustein is about 30 km. The next few days, the oil continued its drift south west along the Norwegian coast with an average speed of about 1.5 km/h. The oil hit the coast several locations in Vestfold, Telemark, and Aust-Agder. The farthest contamination was as far west as the lighthouse of Ryvingen, 235 km from Kverrnskjæret. A total of 125 hits were registered along the coast.

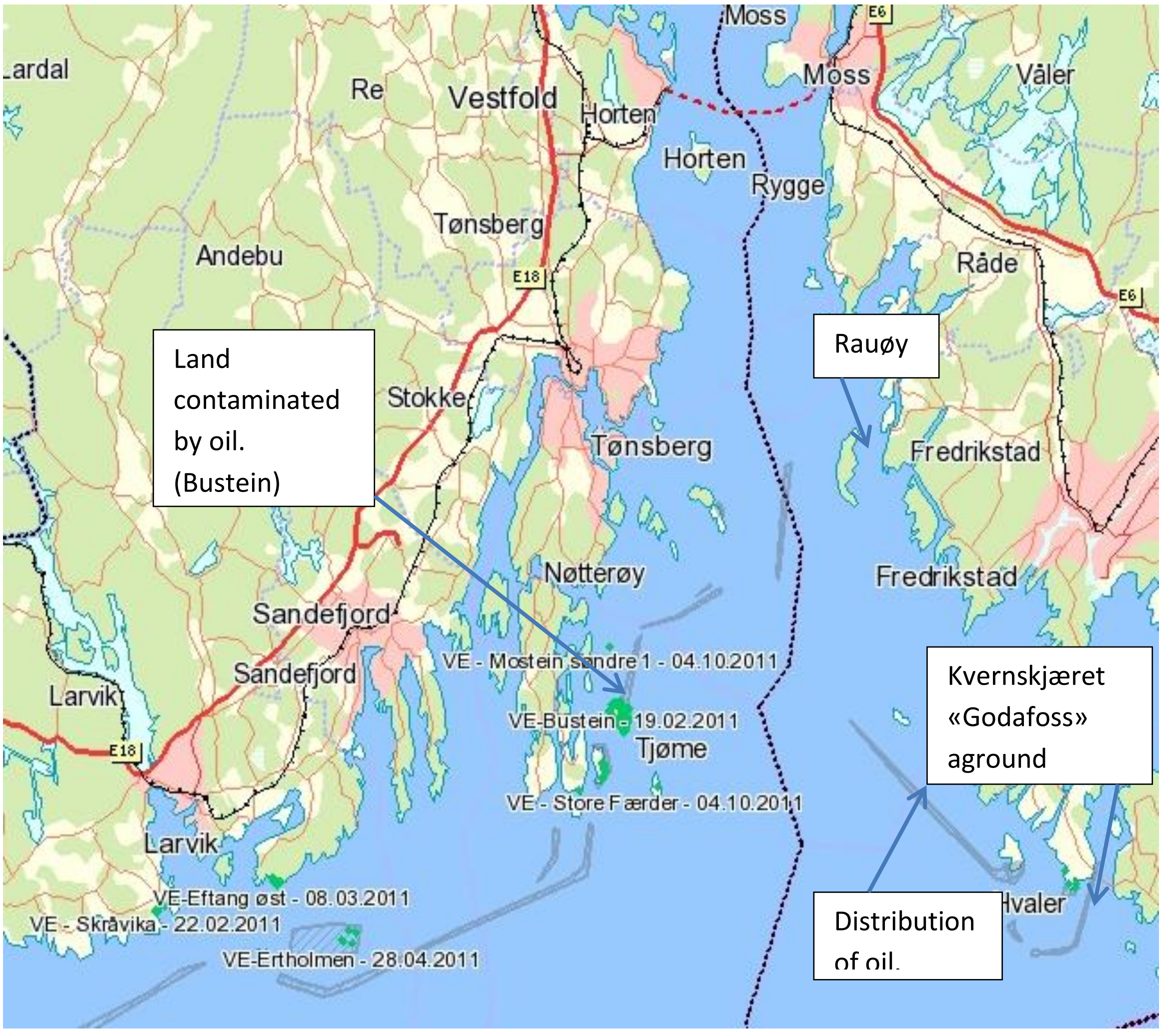


Chart 2: Distribution of oil after the grounding of "Godafoss" in 2011 (Kystverket. W.Y). This chart is an example of the Coastal Administration's own chart soulution "Kystinfo". In this chart soulution several layers of information is available, like place names and distribution of oil as showed on the chart.

Assumptions indicated that limited amount of oil was spilled. Compared to the "Full City" accident where 75 km of coastline was contaminated, the grounding of "Godafoss" caused less than 5 km of oil polluted of coastline. Probably the water pressure contributed to keep the oil in the tanks. Because of the cold temperature, the viscosity of the oil was high and it was impossible to measure the oil level in the tanks, and therefore hard to estimate the amount of spilled oil. The oil contamination on land was fortunately very limited. Of the total of 112 m^3 spilled oil, 22 m^3 could not be accounted for. A milestone in the oil recovery operation happened the 29th of February when "Godafoss" was secured and towed to Odense in Denmark for repair. The source of further contamination was now removed.

The financial requirements after the "Godafoss" operation was about 85 million NOK.

The grounding of Godafoss and the following recovery operation indicates that it is essential for the members of the *recovery organization* that the information shared is as reliable as absolutely possible. Considering the many turns of the water current and the speed of the oil's drift within the archipelago of the Oslo fjord, it seems that unless information is distributed quickly between the *recovery organization* members they will not be able to catch up with the direction of the oil, nor be able to place protection systems in front of the oil's direction.

Therefore the next step in order to identify areas of oil forecasting improvement is to ask how experts in the organizations responsible for oil recovery operations experience the value of the oil drift orbit model today, and whether the accuracy of the calculation has any impact on the decision making.

The Informants' Views on Information Requirements

Environmental researches starts immediately after an accident happens and goes on for quite a long time. The researchers test the consequences for shellfish, seabirds, and fish. Results from a drift orbit can be useful for those researchers when they decide where to take samples/tests, so they can do it form the right spots says one of the respondents from the Coastal Administration.

All respondents from the Coastal Administration points the importance a drift orbit calculation can have for documentation of spreading of the oil after an accident. Sometimes others dump oil in the guise of the accidents oil spill, and an accurate documentation of the accidents spill can play an important role as a proof.

How to optimize the use of the participating units?

Several units can be involved if the accident is large. Examples of possible units in the Oslofjord are vessels from the Norwegian Coastguard, the Swedish Coastguard, the Danish Navy, the Coastal Administration's own units, Exxon Slagentangen's units, private salvage companies, Search and Rescue vessels, the archipelago service, and the port authorities units. It is important to optimize the use of these units to recover as much as the oil as possible.

The representatives from the Coastal Administration point out that it is far less expensive to recover oil from the sea than from the shore. Thus, it is of vital importance both to recover as much oil as possible at sea before it hit the shore and place protection systems outside the shore side exposed for oil hits. If the leaders have knowledge about the drift pattern of the oil, they can assign working areas to the partaking units to utilize their capacities as good as possible. The more detailed information the decision makers have about the oil drift the easier it is to predict hit on land and plan the effort according to that.

Tools available to monitor the movements of the oil

Several tools can be used to utilize the partaking units as efficient as possible. All respondents know about the following tools:

- Drift orbit models
- IR camera
- Oil radar
- Local knowledge about currents
- Visual observations from aircrafts
- Visual observations from the surface
- Satellite pictures
- Drift buoy's with AIS

The drift orbit model

The Meteorological Institute are responsible for the preparedness for calculating oil drift on the behalf of the Coastal Administration. The interviewees from The

Meteorological Institute say the dialog with the Coastal Administration is good. They further inform that they need information about the amount and the characteristics of the spilled oil. The result of the drift orbit calculation is then presented on a chart (see chart 1).

Both the Coastal Administration and the Coastguard have access to a web page ran by the Meteorological Institute and can read the forecast charts there. They can also receive the results as an attachment on e-mail.

Both the interviewees from the Coastal Administration and the Coastguard are satisfied if the result of the calculation is ready about one hour after the request was sent, and agree that this is sufficient to utilize the information in the planning process. Also they say that it is important that the operation management at the Coastal Administration and the effort leaders have the same situational awareness. Therefore they all should relate to the same forecasts.

The representatives from the Coastal Administration and the Coastguard all say that the operation management at the Coastal Administration and the effort leaders need the information from the drift orbit calculation. This is an important tool used in the planning of the operation. Other participating units are following orders from the effort leader and can operate efficiently based on a good order (see attachment 2). Some of the units are small with limited working conditions and have no capacity beyond operating the oil protection and recovery systems.

In general the respondents agree about the lack of user-friendliness of the result of the drift orbit calculation. The drift orbit calculation is presented in a general chart with information about names, navigational hazards or other information like pictures from aircrafts, and plot from visual observations. The information from the drift orbit calculation should have been displayed in a chart system where the users could retrieve information from different data layers. This will ease the building of situational awareness. The respondents from the Coastal Administration want the drift orbit calculations available in their own chart system "Kystinfo" (see chart 1). Then it is possible to measure them with other layers of data, like where the prioritized areas are located. It is also easy to verify the drift orbit model with visual observations plotted in the chart, pictures from aircrafts, and satellite pictures. The Coastal Administration plan to intensify this work in 2013 and the need for integrating information from the Meteorological Institute is reported to the FjordOs.

All the respondents also state the significance of communicating the insecurity of the result of the model. It is important to know to which degree you can trust the oil drift orbit calculation and use them as a planning tool under the prevailing conditions.

None of the respondents complain about their devices available today for receiving the oil drift orbit calculations. They all think it is sufficient enough both to receive and display the information. Internet connection and a computer is what are needed. The Coastal Administration has a project going on to improve the value of using mobile solutions as tools in oil recovery operations informs one of the representatives from the Coastguard.

Accuracy of the oil drift orbit model

Both respondents from the Coastal Administration and the Coastguard experienced drift orbit calculations during the "Godafoss" accident as not reliable. Representatives from the Coastal Administration quote: "the result of the model is not accurate enough, and is not a tool we really can trust."," In the Oslofjord we will not pay too much attention to the result of the model because the insecurity and accuracy is too high.", and "the accuracy is useless in the Oslofjord in my opinion, even in Skagerrak it is not that accurate". One of the representatives from the Coastal Administration has done research with SINTEF and the Meteorological Institute to examine the drift orbit calculation model's accuracy, and the result of the research showed that the model has a large potential of improvement. Both respondents from the Meteorological Institute confirm this lack of accuracy of the result of the oil drift calculations.

Beneficial effects of an improved drift orbit model

All the respondents with responsibility for leading and organizing units agree that an improved drift orbit model can enable them to deploy the units more effective. For the Coastal Administration it is about to avoid oil on land. It is far cheaper to pick up the spill from the sea than the land. It is important to know where the oil is in the near future and if the oil will hit the shore. "If we know the drift direction of the oil we can put units in the front of the oil spill because 80-90% of the oil is in the front of the spill", says one of the representatives from the Coastal Administration. They all state that the most important is to know where the oil will hit the shore.

They all agree that a better model can improve the contingency planning. If the result of the model is reliable, the leaders will have an idea where the oil can drift. If good models are available it is easier to prioritize where to set in resources. It is possible to know with a large degree of certainty where the oil will be. This is important for the from day to day planning. It is also important because it can help deciding where to set out protection systems in certain vulnerable areas. The respondents with leadership responsibility during an oil recovery operation also state that it is important not to move the resources unnecessary, because that takes a lot of time and capacity. Moreover they points that the different units and protection systems has different strengths and weaknesses. If the forecast of the current, wind and weather are trustable, it is possible to assign working areas that suits the unit as good as possible.

Other information needed from the Meteorological Institute

The respondents tell they need information about wind, weather forecast and water level. Current is also interesting for the operation, because of the conditions for the people working on the spot. It is one of more factors to take into account in the practical operation. One of the respondents from the Coastal Administration also points that the tide can be spooky itself. If a ship aground is exposed to tidal change it can move and drift or break. The respondent from the IUA tells about challenges on the beach, if the water level is high at the time of the accident it will take longer time to break it down after the accident than if it happens at a time when low water level, so information about the water level also has impact on the operation.

Information from the Meteorological Institute

The Meteorological Institute is responsible for the preparedness for the oil drift orbit calculation on behalf of the Coastal Administration. Their department in Bergen is responsible for performing the oil drift orbit forecasts, and the department in Oslo is responsible for the research and development. The representatives from the meteorological institute informed about the following possibilities. If you have a computer, internet, and an internet reader you can download forecasts from their ocean-, wave-, and atmosphere model. These forecasts are available from a password protected web portal. The oil drift model is based on the fjord model. In addition to the plans according the new improved ocean model for the Oslofjord the Meteorological Institute is working with a better resolution for the atmosphere model.

It is possible to read the drift orbit calculation in different chart programs. The calculation is on ascii files and can be read by any chart program who can read ascii files. It is the developers working at the Information Technology Department, who are responsible for this. To get the oil drift forecast on the chart "Kystinfo", the Coastal Administration need to have a dialogue with the IT developers at the Meteorological Institute. Technically this is possible. The informants from the Meteorological Institute tell that there is an ongoing work about a new forecast service for professional users. The model will be similar to the Yr.no which is open to the public, but the new model called "halo" can provide more detailed and specific information designed for professional users.

The Meteorological Institute has a goal to make it possible to have a forecast in 30 minutes when the new improved model is ready. When the Norkyst 800 model was developed, fast oil drift calculation were not thought about, therefore it takes too long at the moment.

To predict the percentage probability of the forecast the Meteorological Institute is running something called ensemble forecast (ensemble prediction system). This means running not only one ocean model, but eleven similar models with for example varying atmosphere actuation. If the models have little spread the forecasts accuracy is good and if the spreading is large the accuracy is small. This can also be displayed as "trafficlights" who shows the degree of probability. Another way to predict the probability is to make significant charts over areas with high insecurity of the forecast and significant chart over areas with high security of the forecast. Then it is possible to know if the forecast is trustable or not.

DISCUSSION

The purpose of this thesis is to investigate how decision-making in an oil recovery operation can be improved by a better fjord model and how the information is distributed from the Norwegian Meteorological Institute to the Coastal Administration and other users, and possibilities of improvement. The discussion is therefore based on the factors stated in the research question chapter.

Cooperation within the *recovery organization*

As described in the chapter "The oil recovery Organization", several actors take part in an oil recovery operation. The Coastal Administration's main responsibility is to keep the overall picture if the situation, monitor the development of the situation, and obtain sufficient units for the oil recovery. The Coastal Administration also makes long term strategic operation plans and operation orders. The Norwegian Costguard and the IUA organization take part in the oil recovery operation as On Scene Commanders, respectively at sea and on the shoreline.

To perform assigned tasks it is important to know both their own and others area of responsibility. Both the informants from the IUA and the Coastguard confirm that there are no conflicts in the intersections of their areas of responsibility even though it sometimes could be hard to draw an exact line where the border between the sea and shoreline goes. It is important to know the current and movements of the oil in order to place the different oil protection systems and work together to fight oil hits on the shore.

To avoid any misunderstandings and ineffective allocation of the partaking units, it is important that the participants know about their individual capacities and limitations. This to avoid f. ex. deploying vessels with large depth and a good capacity in heavy weather conditions, to a shallow and protected water area, or assign a small vessel with operational weather limitations an area with strong current and high waves. This is secured through the exercises arranged, where the different actors get to know each other to a satisfying level. In addition the Coastal Administration keeps a record over each unit's capacity which can be distributed to the other units.

There is an agreement among the respondents that it is sufficient if the actors with management responsibilities receive the information from the oil drift orbit calculation.

This includes the Coastal Administration, the Coastguard and the IUA organization. The actors on the level below these three organizations are fully occupied with practical recovery work.

In addition to the organizations and units working directly with the recovery of the oil, environmental researchers will start with environmental tests of the life in sea immediately after an oil spill happen. Results from an accurate oil drift orbit calculation can help these researchers when they plan where to take samples. The researchers will have a tool they can use to select the right spots to take samples form and in that matter save time and be more effective. The better accuracy of the drift orbit calculations they can receive the better data they can give about the consequences for the marine life.

The fjord model's contribution to the efficiency of an oil recovery operation

One of the main reasons to recover the oil from the sea and not from the shoreline is because of the large difference in the cost off the different operations. It is far more expensive to recover oil from land than from the sea. Thus, the main goal in an oil recovery operation is to recover as much as possible of the oil from the sea. This can be done by knowing where the oil is and where it is heading. The reason for this is by having knowledge about the oils movement, it is possible to distribute the partaking units in an as effective way as possible to recover as much of the oil as possible. Also the knowledge about the oils movement will give information about where to deploy shore protection systems to keep the oil at sea where it is cheaper to recover it. An improved fjord model with high accuracy can contribute to predict where the oil is heading, and enable the management in the oil recovery operation to stay ahead with the planning and make effective decisions.

Another factor to utilize the fjord model is the time needed for the Meteorological Institute to do the calculations. If it takes too long, the data from the fjord model will be history and will have little value for the users in the planning of the oil recovery operation when they receive them. The Meteorological Institute is aware of this challenge and has a goal to have a forecast of the oil drift orbit ready in 30 minutes.

No less important is the effect an accurate oil drift orbit calculation can have on the documentation of the spreading of the oil. This can be used as a proof to place responsibility for the oil spill on the right actor. Sometimes others dump oil in the cover of a large accident and a documentation of the oils movement can play an important role here. This also applies when no one assumes the responsibility for the oil spill and no accident is reported.

The accuracy of the oil drift orbit forecast

The drift orbit model is one of several tools that are used to monitor the movements of the oil. The accuracy of the model available today is not good enough to rely on. Therefore, those involved in decision making does not pay too much attention to the result from the drift orbit calculation today. To rely on these models in the future, the accuracy of the model has to be significantly improved. Since the model is a forecast and never can be 100% exact, the users are dependent on a probability forecast of the oil drift calculation so they can decide how much they will base their decisions on the model.

In addition to the new improved fjord model, the Meteorological Institute is working with a forecast system called Ensemble Prediction System (EPS). The EPS will enable a prediction of how accurate each oil drift orbit calculation is. The interview objects all agree that it is important to show the probability in a way that is easy to understand. Another way of predicting the probability of the oil drift orbit is to map the Oslofjord and categorize different areas in high and low probability areas. This can be an important tool for the decision makers in an oil recovery operation, because it will identify some areas where you can pay the oil drift orbit calculation higher attention when planning than others.

Implementation of oil drift orbit forecasts in the chart system "Kystinfo"

In an oil recovery operation several sources of information is available, and the total of information together, are of a vital character for the decision makers to build a common situational awareness as good as possible to make good decisions. Examples of such information in addition to the oil drift orbit are: place names, navigational hazards, pictures from aircrafts, other units' positions, and plot from visual observations. Today the oil drift orbit is presented on a chart with no other sources of information. Today the main chart for planning and leading an oil recovery operation is the chart system Kystinfo. In this chart system it is possible to have several layer of information, but today not the oil drift orbit. This leads to a missing of the oil drift orbit calculation in the total picture of the situation and progress in the operation. A more effective use of the oil drift orbit calculation would be to integrate it in the chart system Kystinfo. The informants from the Meteorological Institute say the calculation of the oil drift model is on ascii files and can be read by any chart program who can read ascii files, therefore it is possible to adapt it to Kystinfo. The Coastal Administration plan to intensify this work in 2013 and the need for integrating information from the Meteorological Institute is reported to the FjordOs project. This integration will probably be one of the success factors to utilize the new fjord model as far as possible, but is not a part of the FjordOs project, but takes place in parallel at the Coastal Administration

The Meteorological Institute also provide other meteorological data useful for the participants in an oil recovery operation, which are not submitted together with the oil drift orbit forecast today This is data about wind speed and direction, temperature, visibility, current, wave heights, and sea level. This information is important for the effectiveness of the execution of the operation, because all the mentioned factors have an impact on both the opportunities and the limitations of the execution of the oil recovery operation. In addition the weather in general is important to take into account to safeguard the personnel hands on the job.

Thus, it becomes important to develop a solution where other meteorological data also is available in the same system.

Requirements to the equipment needed to receive oil drift orbit forecasts.

In order to perform a given task an organizational unit requires a set of information. However when info is given it is important to consider the operator's limitations, abilities and needs.

On the Coastguard vessel Nornen, the information communicated by internet is sent and received through ICE's system based on the old cell phone technology through the 450 Mhz net. This net has a very good coverage, but downloading an uploading is limited relatively to fibre optics.

It is possible to read the oil drift orbit calculations on a web page ran by the Meteorological Institute if the reader has password access. Alternatively it is possible to receive the result on an e-mail. There are no special requirements for the computer needed to read the result from the drift orbit calculation. In addition to the computer, internet and an internet reader is required to download forecasts from the Meteorological Institute, both the oil drift orbit calculation based on the fjord model, and the wave- and atmosphere model which provides other meteorological data like wind speed and direction, temperature, visibility and wave heights.

When developing the new fjord model it is important to ensure that the result of the forecasts from the Meteorological Institute, like the oil drift orbit calculation, still will be readable on both ordinary computers and mobile solutions which can be particularly useful for the decision makers when present on site.

CONCLUSION

Experiences with the fjord model available today, shows that the accuracy of the oil drift orbit forecast is too poor to be used as a tool to increase the efficiency when conducting an oil recovery operation. Interviews indicate that the accuracy of the model has to be significantly improved to utilize the oil drift orbit forecast when deploying units and oil recovery equipment to recover oil and protect vulnerable areas. Additionally, a probability indicator has to follow the forecast, so the operation management and the On Scene Commanders know how much attention they should pay to the oil drift orbit forecast.

This study also shows that the cooperation and communication among the different actors in the *recovery organization* works well. Interviews indicate that the information and the information flow are well suited to meet the different actor's information requirements.

Further, this study shows that the operation management and the effort leaders need to have other weather information from the Meteorological Institute; like wave height, wind speed, temperature and sea current, to utilize the particular unit or protection system optimal according to the unit's or protection systems capacity. This information should be available in the same operation as getting the oil drift orbit forecast.

The oil drift orbit forecast is today presented on a chart with no other relevant information, like manual plots, place names, areas of special interest, and navigational hazards. Interviews indicate that; to increase efficiency, the oil drift orbit forecast should be presented in a chart system with possibility to add additional information like the Coastal Administration's own chart system "Kystinfo". This is to ease the overall picture compilation which is very important when planning an oil recovery operation.

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APPENDIX

Appendix 1: Operational Plan

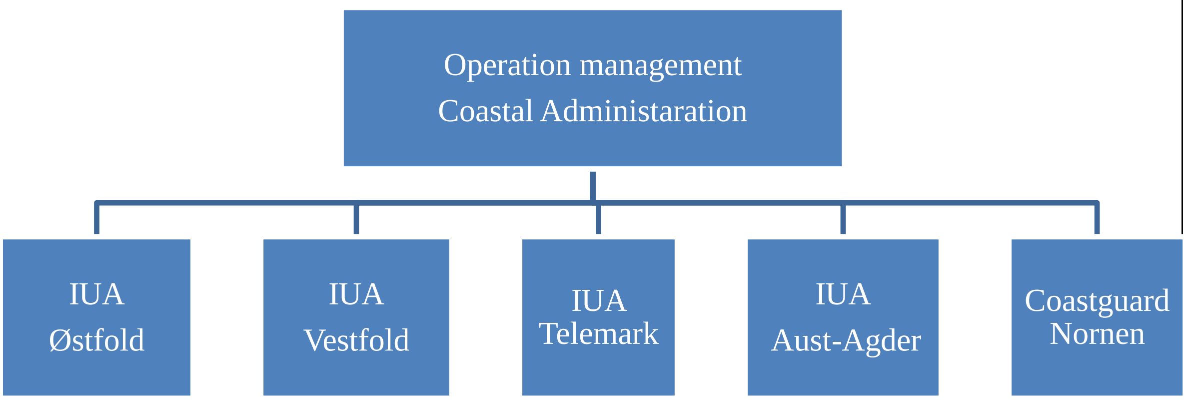
The following operational plan is a translated version of one of the plans used under the Godafoss operation:

OPERATIONAL PLAN, GOVERNMENTAL OPERATION, LEAD BY THE COASTAL ADMINISTRATION

Name of the incident:

”GODAFOSS”

Date of incident:	17.02.2011
Operation phase:	Initial phase
Date of plan:	20.11.2011

Description of the situation
M/V Godafoss, C/S V2PM7, reports to Horten VTS 20:00 that they have grounded at Kvernskjæret at Håbu, Hvaler municipality. The vessel has a leakage in center tank nr. 5 and 7, containing a total of 500 m^3 bunker oil type IF 380. Governmental operation established 17.02.2011 at 24:00. Governmental vessels and the Sweedish Coastguard mobilized. Norwegian Coastguard vessel Nornen is On Scene Commander at sea. Sunday 14:00. Oil is observed from Nøtterøy to the boarder og Telemark/Aust-Agder. The oil at sea is somewhere thick. Ice is observed in parts of the area.
Organisation and management (overall sketch)


Responsibility and authority
The operation is lead by the Coastal Administration. The Coastal Administration hand out operation orders for each phase in the operation with tasks to subordinate units. This is governing documents for the On Scene Commanders, IUA and the Coastguard. The following IUA and On Scene Commander sea is established and reports to the operation management: IUA Østfold IUA Vestfold IUA Telemark IUA Aust-Agder NoCGv Nornen

Environmental goals and strategy to achieve them

Based on the information available 19.02.2011 concerning the extent of the pollution, the following priorities are to be followed, based on environmental values in potential affected areas, when taking action.

- Mechanical recovery of oil close to the source
- Prevent spreading
- Prevent hit on the shore side along predicted oil drift orbit
- Where hit on land occur, cleaning effort shall have high priority to take advantage of snow/ice/frost heave, as a barrier against hit on the shore

Since the oil is of the type IFO 380, one should expect long live time on the sea surface. The consequences for sea- and bottom organisms are assumed to be limited.

The following environmental vulnerable areas should have the highest priority considering protection against the pollution:

- Østfold: Hvaler National park – Akerøya, Tisler and the area of Torbjørneskjær/Heia(shallow area with a lot of rocks and reefs.
- Vestfold: South part of Tjøme, area from Nevlunghavn via Mølen to Helgeroa.
- Telemark: Stråholmstein, Stråholmen, Jomfruland.
- Aust-Agder: Tromøya

In general environmental vulnerable areas should have high attention. First of all seabirds, seals, and the National park and other protected areas along predicted oil drift orbit.

(A listing of the members and contact details of the operation management)

Structure of meetings

Time	Activities
07:30	Phone call with the effort leaders (IUA and Coastguard) for clarification about today’s mission and conditions.
08:30	Phone meeting between operation manager and effort leaders.
09:00	Staff meeting 1. (Functional managers in the Coastal Administration)
12:00	Staff meeting 2. (Functional managers in the Coastal Administration)
15:30	Phone call with effort leaders (IUA and Coastguard) for clarification about today’s mission and conditions.
16:00	Phone meeting between operation manager and effort leaders.
16:30	Staff meeting 3. (Functional managers in the Coastal Administration)
18:00	Start work on the next day’s mission document.
20:00	Receive effort leaders reports containing key numbers and suggestions to mission’s for the next day.

Mission: IUA ØSTFOLD
Attend role as effort leader on the shore side and on land in Østfold. Be prepared to submit personnel at Godafoss. Assist effort leader sea with any measure close to Godafoss. Map oil hit on the shore side. Initiate measures in accordance with the environmental priorities, own plans and after consultation with the Coastal Administration. Be prepared to send personnel on helicopter surveillance. Initiate a running economy record in cooperation with the Coastal Administration. Keep focus on safety related to cold weather and ice. Report key numbers before 20:00 every day. Track sample taking.
Mission: NoCGv Nornen
Attend role as On Scene Commander at sea. Maintain the barrier around Godafoss. Conduct oil recovery with available equipment and have focus on floating oil in the fjord. Take action to prevent oil drifting towards areas of high priority. Prepare a communication plan for the sea side of the operation. Conduct other missions for the operation management. Cooperate with IUA's local representative/effort leader. Keep focus on safety related to cold weather and ice. Report key numbers daily for all units. Take samples of the oil in accordance to current instruction.
Key numbers
Positions where oil recovery is ongoing Persons in staff Persons in effort Vessels in effort Amount of collected oil
SAFETY INSTRUCTIONS

Appendix 2: Example of an Operation Order

Operation Order/ On Scene Commander's plan to assigned units.

1. **Situational Overview**

   Position: West of Fedje 60º50'N- 004º17'E. Collision between two ships. Potential spill: 3000m3 crude oil, 500m3 bunker oil. The oil slick as split in two. Curret runs north, speed 0,6 kn until Saturday 09.02.2013.

   SAR vessel Kr. G. Jebsen meet with Coastguard vessel Bergen, to get sample equipement to take samples of the oil.

2. **Mission**

   Situation assessment. Recover oil, mechanical equipement.

3. **Plan and execution**

   Mobilize appropriate support vessels. Inform Mongstad oil terminal and Fedje pilotstation. Velux (tug) ETA 1600. Adax (tug) ETA 1600. Havila Troll operates own oil boom with own daughter craft. Coastguard vessel Tor to tug Havila Troll's oil boom until other tug arrives.

   Group 1: NoCgv Bergen On Scene Commander + Adax.

   Groupe 2: Havila Troll (Gr.leader) + own daughter craft

   Groupe 3: NoCgv Tor + Velux

   Groupe 4: OV Utvær

   Groupe 1: NoCgv Bergen On Scene Commander + Adax tug, recover oil from the northern oil slick from east towards west.

   Groupe 2: Havila Troll + own daughter craft. Recover oil from the oil slick which drifts south east, as number 1 main system. Recover oil from south east towards north west.

Groupe 3: OV Utvær operates recovery system behind Havila Troll

Groupe 4: NoCgv Tor + Velux runs oil boom behind Groupe 1.

Groupe 5: Smile + Hausk

Groupe 2: 1. Main system southern oil slick.

Groupe 3: 2. Main system southern oil slick.

Groupe 1: 1. Main system northern oil slick.

Groupe 4: 2. Main system northern oil slick.

Groupe 5: Eastern oil slick.

4. Management and supply service

In according to operation managers plan nr. 1. Operation management tries to get tank capacity to the scene.

5. Management and communication

See communication plan attached.

Appendix 3: Interviewguides

Interview guide – Coastal Administration

- How does the organization that is established when an oil spill occur looks like?
  - Which agencies take part?
  - How far down in the organization does the Costal Administration communicate?
  - Which users do you think need information from oil drift orbit forecasts?
- Who decide where the different resources should contribute?
- Which sources do you use to collect information about the oil drift orbit?
- How accurate is the oil drift orbit calculations today?
- Which effect can an improved oil drift orbit forecast provide during an oil recovery operation in the Oslofjord?

- Is the result of the oil drift orbit calculations user friendly?
    - Do you have any suggestions to improve them?
- Did you use/have any experience from oil drift orbit forecast during earlier oil recovery operations in the Oslofjord?

  If you did/have:
    - From the Coastal Administration receive information concerning oil spill, how fast do you need an oil drift orbit forecast?
    - Who needs information from the oil drift orbit forecast and how well do the different actors know each other?
    - Who has access to the forecast?
        - Who do you think access to the forecast?
        - Is it someone you think should have access to the forecast?
        - Have people at different level in the organization different information needs?
    - How is the oil drift orbit forecast distributed to the users to day?
    - How is the oil drift orbit forecast presented to the users to day?
        - Who has this responsibility?
    - What do the users say about the usability of the oil drift orbit forecast?
        - Have you received any feedback?
        - In which way should the users of the forecast whish the information presented?
    - Is the equipment available today sufficient to present such information?
    - Is it any needs for additional equipement?
        - Receive/transmit – presentation?
    - What kind of information is available from the forecasts from the Meteorological Institute today?
    - What kind of information should be available from the Meteorological Institute? (Drift orbit, wave height, wind, temperature, etc.
    - Do you have any experience from ocean models with better solution in other areas?
    - What kind of experiences have you gained?
    - Is there anything we have not discussed which you think is important concerning the use of ocean models in oil recovery operations?

Interview guide - Coastguard

The questions are mostly about the Oslofjord, but if you have other experiences, you are more than welcome to share them.

- How are you alerted if any oil spill occurs?
- As an effort leader, how do you utilize available units to recover as much oil as possible?
    - How do you know where the oil is located?
    - How do you know where the oil will be in the future?
- Do you have any experiences with the use of oil drift orbit forecasts?
    - Is such forecasts user friendly?
        - How is it possible to improve the usability of such forecasts?
    - Is it desirable to have direct access to information from forecast models aboard?
        - What kind of information do you need from such models?
            - Drift orbit, wave heights, temperature, wind, etc.
    - What kind of experiences have you gained?
    - Do you have the opportunity to receive forecasts from the Meteorological Institute today?
- During the "Godafoss" operation, how did you receive information about the oil drift orbit?
    - Did you have direct access to an ocean model?
    - What information did you base your allocation of the assigned units?
- Is there anything we have not discussed which you think is important concerning the use of ocean models in oil recovery operations?

Interview guide - IUA

- How are you alerted if any oil spill occurs?
- Which units and agencies are subordinate to IUA and are alerted by you?
- What is the geographical area IUA are responsible for?
    - Shore side?
    - Archipelago and fjords?
- How do you know where the oil hits your area of responsibility?

- Do you have any experiences with the use of oil drift orbit forecast during oil recovery operations?
    - What kind of experiences have you gained?
    - Is the forecast user friendly?
    - Do you have any suggestions to improve the usability of the forecast?
- If you not have any experience in the use of oil drift orbit forecasts:
    - Do you think IUA could have any advantages of direct access to such a forecast?
    - What kind of information do you need from forecasts from the Meteorological Institute to better fight the oil spill in your area of responsibility?
        - Drift orbit, wave heights, temperature, wind, etc.
- Is there anything we have not discussed which you think is important concerning the use of ocean models in oil recovery operations?

Interview guide – Meteorological Institute

- How do you make the forecast from the oil drift orbit calculation available for the users to day?
- Is there any restrictions or bottlenecks? Capacity, license, encryption, etc.
- Are there any special requirements to the receiver's equipment to receive your forecasts?
- What information does a forecast from a new fjord model contain? Drift orbit, wave height, wind, temperature, etc.
- Can you tell about the web portal Kilden.no?
- Can you add more information to the forecast than the drift orbit calculation?
- What kind of feedback have you got from the users of today's forecasts?
- Do you think the forecasts are user friendly for the users?
    - How well do you know the users of your forecasts?
    - Does it require any special competence to read the forecasts?
    - Is it possible to create a more user friendly presentation of the forecast?
- The users need other detailed information in the chart in addition to the drift orbit, like names and navigational hazards?

    - Is it possible to add the forecast to another chart base?
    - Who makes that possible?
- How long does it take to produce an oil drift orbit forecast, from you get the information about an oil spill?
- Is it possible to say anything about the probability of the forecast?
        - Like a traffic light?
        - The users need to know to which degree they can trust the forecast.
- Is there anything we have not discussed which you think is important concerning the use of ocean models in oil recovery operations?