Oil Spill Response Planning on Lake Saimaa – Special Features and Comprehensive Preparedness

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Introduction

Lake Saimaa is the fourth largest lake in Europe still in its natural state in spite of significant forestry industrial plants [1]. Several rare species living in the area are protected by fishing and landing restrictions. In addition, the lake area contains several environmental protection areas and two national parks. However, the inland waterway network of Saimaa (overall 814 km) is one of the main transport corridors for merchant shipping. Lake Saimaa is connected to the Gulf of Finland via Saimaa Canal specifying the maximum sizes of cargo vessels up to 82 meters in length. Most common vessel type sailing in the area is a dry cargo vessel with the measurements typical to Saimax-class as represented in Fig. 1.

Figure 1. Saimax-class cargo vessel (L82 m x B12 m x D4.2 m, NT 2500 t)

Due to the vessel traffic, the risk of an oil incident is a real concern. In order to prevent that risk, South-Eastern Finland University of Applied Sciences, regional Fire and Rescue Services, environmental and maritime authorities, and other parties are participating in response capabilities development project called SÖKÖSaimaa. In practice, Lake Saimaa area has a range of many unique characteristics: Numerous narrow straits and the proximity of shores are the reasons why oil spills drift ashore very quickly [2, 3]. Therefore, the response time to oil spills may be surprisingly short compared to spills at the open sea that allow more effective prevention of further damages with right efforts.

SÖKÖSaimaa project contains large-scale oil spill response capabilities development, including updated risk analysis and contingency planning. The objective of this paper is to present oil drift calculation modelling and its usage in practical response operations [4]. The aim is to find out how Gnome trajectory models can assist practical response, which is often done on a rule of thumb basis. The importance of readily applicable rules is underlined at the time of a major oil spill that subject to fast decision-making.

Main Results

Recognition of probable volume of an oil spill in a case of an accident provides a basis for oil spill contingency planning. A risk analysis was done during ÄLYKÖ-project [5] and, based on the results, an accident involving Saimax-class cargo vessel is likely to cause approximately 20-30 m^3 spill of light fuel [2, 5]. In addition, the risk analysis identified the segments of Saimaa fairway network where the probability of an incident was considered higher. The high-risk locations were determined based on statistical data and expert judgement, such as expertise of local pilots.

Due to numerous narrow straits with strong water currents affecting the steering of the ship, almost 33.5 % of whole fairway sections are named as high-risk areas [2]. However, more severe spills can be caused by industry in the area (up to 300 m^3). In addition, oil transportations on roads and railways near shores can also lead to oil spills due to traffic accidents [6].

The aim of the SÖKÖSaimaa project is to create a comprehensive oil spill response plan for Lake Saimaa area including shoreline cleaning and oil waste logistics as illustrated in Fig. 2. The project has been underway since 2016. A similar plan has been implemented in the Gulf of Finland during 2004-2011 [7] and for winter conditions 2013-2014 [8]. Several authorities have been involved in the project, such as, all regional fire departments with operational responsibility for oil spill response. The project is coordinated by South-Eastern Finland University of Applied Sciences.

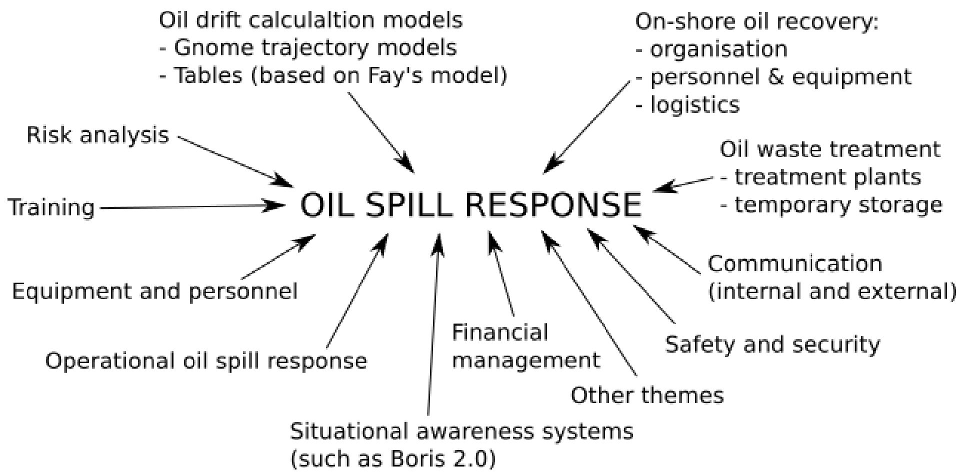

Figure 2. Oil spill response factors (SÖKÖSaimaa-project)

In the following paragraphs, two examples are given that introduce the conditions for oil spill response in Lake Saimaa and describe the application of the contingency plan developed in SÖKÖSaimaa project.

Example case 1: Grounding of a cargo ship in Lappeenranta fairway – spreading model

Example case 1 describes a grounding of a cargo ship near City of Lappeenranta. This area is defined as a high-risk zone, as the fairway is quite narrow with tight turns. In this area, the water currents are low with the exception of potential effects of wind. In high seas, oil slick movement caused by wind is generally evaluated by using 3 %-rule [4]. Following this principle, slick speed is about 3 % of the prevailing wind speed. However, there is no reliable information on how the 3 % -rule really works in fresh watered archipelago.

During the last decades, there have been numerous groundings in this area. For example, in December 8th 2011, a cargo ship grounded losing her water tightness. Until now, accidents have not led to oil spills. In cases of emergency in Lake Saimaa area, assistance is provided according to the following procedure shown in Fig. 3:

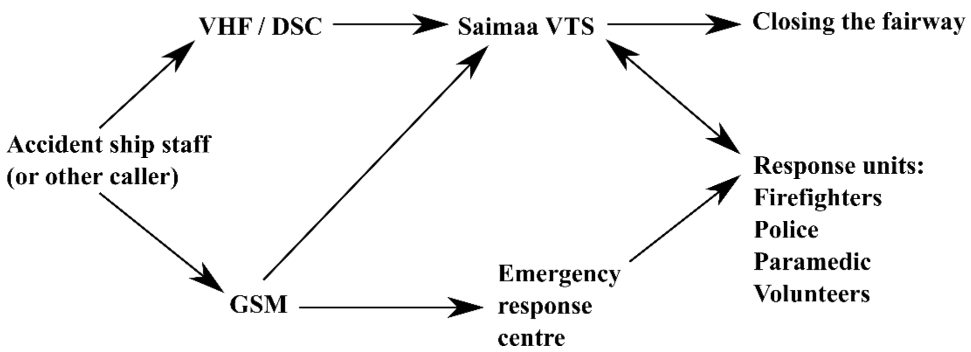

Figure 3. Emergency response chain on Lake Saimaa

In large-scale marine oil spills with thousands of tonnages of oil, the response takes time, especially if the operation involves rescuing people. In Lake Saimaa, accessing the accident location might be difficult due to shallow waters and limited infrastructure. Compared to the facts of the environment, an oil spill response operation can be started relatively fast. Based on assessments of response authorities, an effective response operation will be launched within 1-3 hours after the accident:

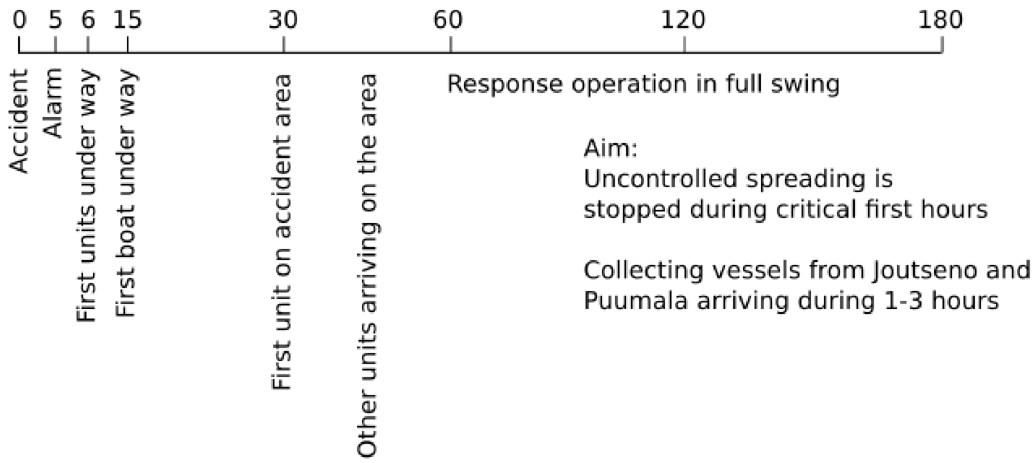

Figure 4. Expected timeline for first three operational hours

Realistic assessment of oil spreading is a key issue for the right planning and the first critical hours of response operation. After an accident, there might be no time for oil drifting simulations. Therefore, oil drift calculation models were produced in advance for most significant high-risk locations. The models were created with Gnome programme, as it is a widely used tool, while realizing its applicability for Lake Saimaa environment still needs further research, due to Lake Saimaa being a small freshwater body with fast currents and short wind fetches, which causes some uncertainties to the calculations. However, by using the oil drift calculation programmes, the spreading of the oil can be modelled in sufficient level of accuracy. The simulation outcome can be compared with the spreading tables available for response units to verify the calculated results. Fig. 5 shows both Gnome trajectory model and oil spreading circles (1-3 h) based on Fay's spreading tables.

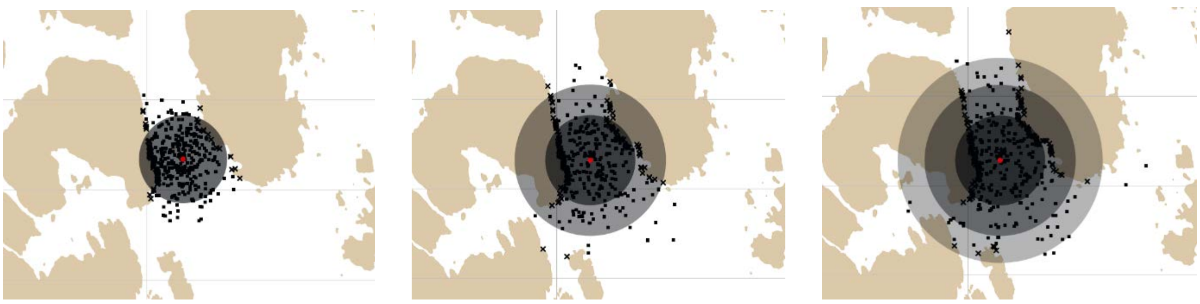

Figure 5. Comparison of oil drift calculation models and Fays' spreading tables (Case 1. Grounding of a cargo ship near Lappeenranta). [Map: © National land survey of Finland 2018]

In Example case 1, at least 6 oil response vessels and few assistive boats are available for operation within 1-2 hours. In addition, oil recovery vessels situated in Port of Joutseno (1 h of distance) and in Port of Puumala (3 h of distance) will be alerted. If needed, two volunteer fire departments and one SAR vessel are also available within one hour. According to the pre-response plan, the logistics of the oil spill response equipment will be coordinated from Port of Lauritsala harbour within 15 minutes of distance. A map of the accident area is shown in Fig. 6, where the accident location is illustrated with a red dot and the widths of the nearing straits are informed in order to demonstrate the minimum boom lengths needed.

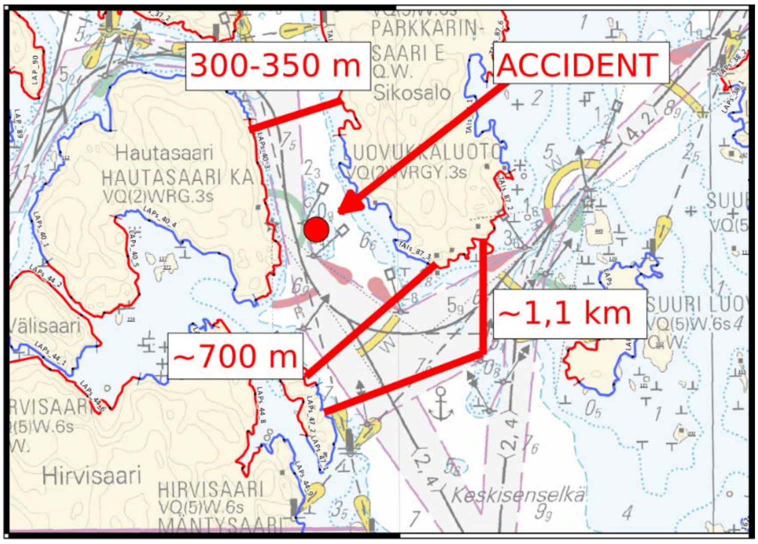

Figure 6. Map of the accident area (Case 1. Grounding of a cargo ship near Lappeenranta). [Map: © National land survey of Finland 2018]

Example case 2: Collision of a cargo ship near Savonlinna – spreading model and oil recovery logistics.

The fairway that passes City of Savonlinna has been exceptionally difficult to navigate. The fairway runs in a narrow strait with strong currents called Kyrönsalmi Strait. It includes road and railway bridges, and one pontoon bridge, allowing no mistake margins for passing cargo vessels. In addition, the flow field of the water current is very turbulent. Based on conducted the risk analysis [9], there have been numerous accidents, for approximately 15 % of vessels accidents in Lake Saimaa area have occurred in that specific position. Fortunately, no serious oil spills have resulted so far.

To facilitate the navigation in the area, a new fairway with more straightforward geometry is under construction. It is supposed to be completed by the year 2019. Nevertheless, also the new fairway passes the narrow strait, in which water flows quite fast. Additionally, there is a dry dock downstream along the fairway, close the narrowest passage. Therefore, although it will be easier to navigate, the new fairway will not be a risk-free area. At the worst, a cargo ship that loses control for some reason can collide into the port structures or vessels at the piers, as demonstrated in the Example case 2. If an oil spill were to happen, oil would drift with the water flow during first three hours after the spillage according to models presented in Fig. 7, that represent Gnome trajectory model and spreading circles (1-3 h) based on tables of Fay.

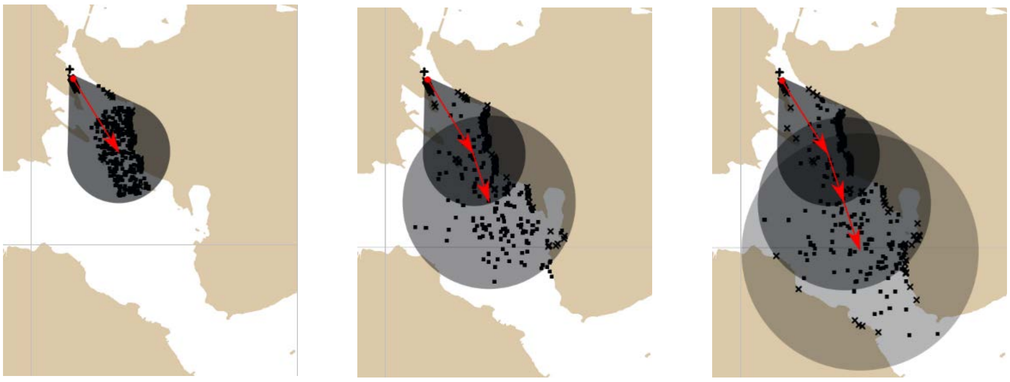

Figure 7. Comparison of oil drift calculation models and Fays' spreading tables (Case 2. Collision of a cargo ship near Savonlinna) [Map: © National land survey of Finland 2018]

Comparison of the Example cases 1 and 2 reveals many differences. The accident location in Example case 2 is close to City of Savonlinna, in an urban region. Several marinas, recreational and residential areas, hospital and protected natural shorelines are under probable hazard area. However, regional fire station, with their vessels, is just minutes away, and oil spill response equipment is stored on both shore sides of the strait. Therefore, oil spill response and recovery capability are operable almost immediately in the area, and effective response operation can be started instantly. In addition, the closest reserves are available in Port of Varkaus (recovery vessel, 3 h of distance) and Port of Puumala (recovery vessel, 3 h of distance). Expected timeline for first three hours is shown in Fig. 8.

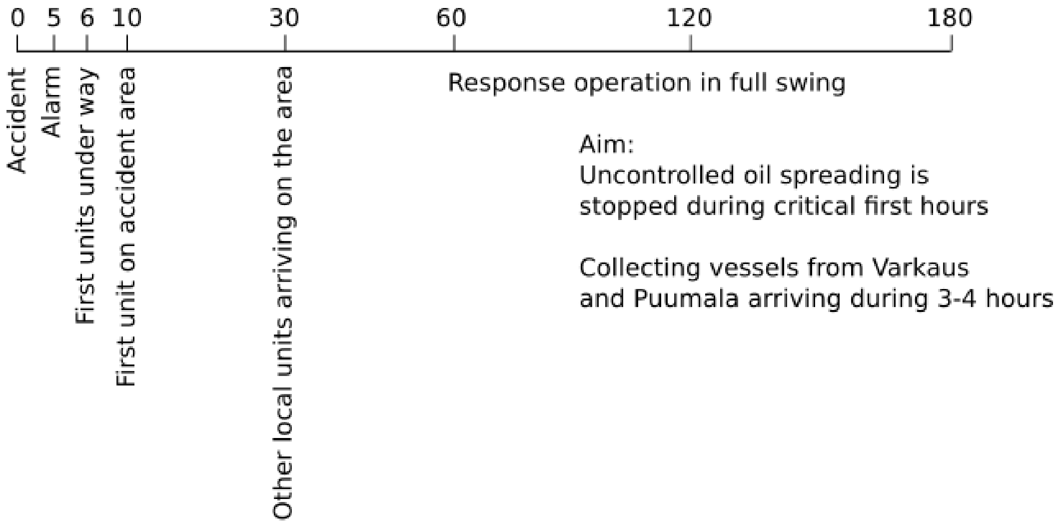

Figure 8. Expected timeline for first three operational hours (Case 2. Collision of a cargo ship near Savonlinna)

As it is throughout the whole Saimaa area, the shoreline is divided into cleaning sectors. In Fig. 9, those sectors are illustrated as lines coloured in red and blue. Shoreline segmentation, which is usually done after an incident, has been done in advance. This enables response and reconnaissance teams to train the use of actual tools prior to a real accident. Segmentation serves also the management of onshore oil recovery operation and waste logistics. Collection points and intermediate storage areas shown in Fig. 9 are chosen as a part of the pre-planning. In addition, WWF Finland has trained almost 3000 volunteers to assist authorities in on-shore oil recovery.

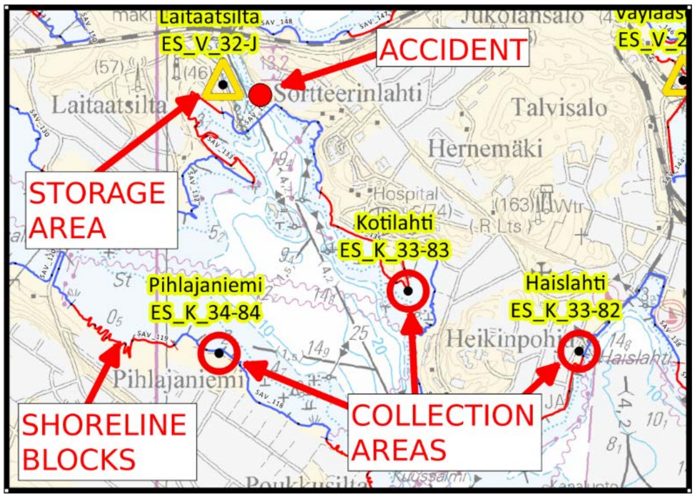

Figure 9. Collection and storage areas of Savonlinna (Case 2. Collision of a cargo ship near Savonlinna) [Map: © National land survey of Finland 2018]

Conclusion

Lake Saimaa is a unique area in the world. The lake contains wide archipelago, its fresh water is still clean and it provides a living environment for numerous endangered species. The area has also a lot of forest industry and through the Saimaa Canal cargo ships can enter the lake. In Lake Saimaa area, regional Rescue Services have the responsibility of oil spill response operations. Particular features of the area are quite fast response times, as in most of the cases effective oil spill response operation can be started within 1-2 hours after an accident, assuming that there are no major delays in calling the emergency centre after the accident.

In this paper, two example cases were given to illustrate oil spill response preparedness in Lake Saimaa area. In Example case 1, an oil spill happened because of a grounding. Example case 2 estimated potential accident including oil spill risk due to the new fairway completed in 2019. Both cases show the importance of pre-planning, as, at the time of an accident, the timeline is limited and the first hours are critical.

In the global history of oil spill response operations, attention is often given to major catastrophes and smaller leakages can be ignored. However, even small spills in sensitive areas or small spills that happen frequently, can cause significant environmental damage.

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