Discrete-Event Simulation of Vessel Response Time for Acute Pollution in Aquaculture

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Background

The Norwegian aquaculture industry plans on increasing production five-fold within 2050, and the production sites are gradually being moved to more exposed locations for better production conditions. However, it is expected that the challenges the industry faces today only will be amplified with the planned expansion.

An expansion in aquaculture also comes with the prospect of interacting with other industries. Ship traffic along the Norwegian coast is increasing, and the biggest threat that an oil spill occur, comes from shipping [1]. The possibility of an oil spill polluting a production site could have devastating effects on the biomass and industry.

Objectives and Scope

The objectives are listed as

- Present the background and relevance for this thesis.
- Perform a state of the art analysis, both regarding emergency response for acute pollution in aquaculture, and the use of simulation within the topic.
- Collect essential input data and calculations for the simulation model.
- Develop a discrete-event simulation in SimEvents which is able to identify emergency response time for several fleet compositions.

Problem Description

The primary sources of large oil spills are groundings (33%), collisions (30%), hull failures (13%), fire and explosion (11%) equipment failures (4%) [2]. Harsh environmental conditions along the Norwegian coast can complicate oil spill preparedness and equipment can become ineffective. As a result, live fish carriers can be the last solution to save the fish before it becomes contaminated.

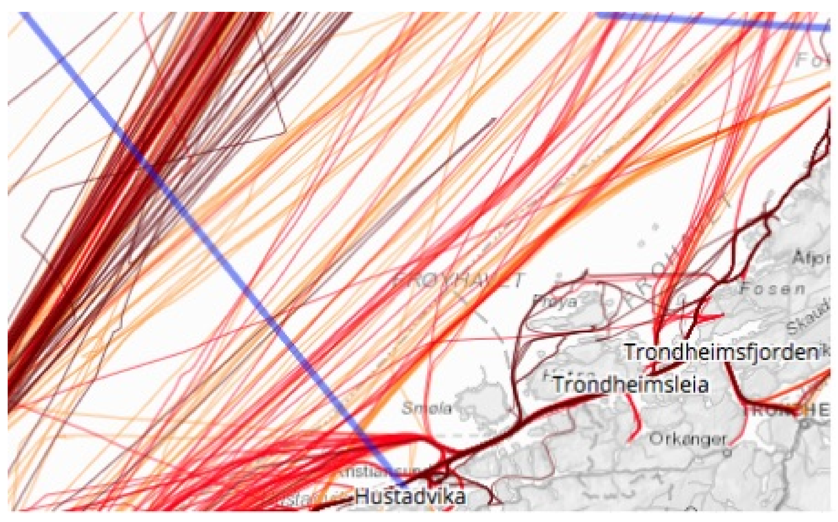

Figure 1: Ship traffic Hitra/Frøya [3]

This thesis aims to identify vessel response time if an oil spill threatens an aquaculture site, and the fish need transportation away from the location. In order to find the response times, a discrete-event simulation model is developed in SimEvents. The model will look to investigate:

- Is it possible achieve a respectable response time with the operational fleet?
- Could it be beneficial to implement a dedicated standby vessel for emergency response?

Simulation Model in SimEvents

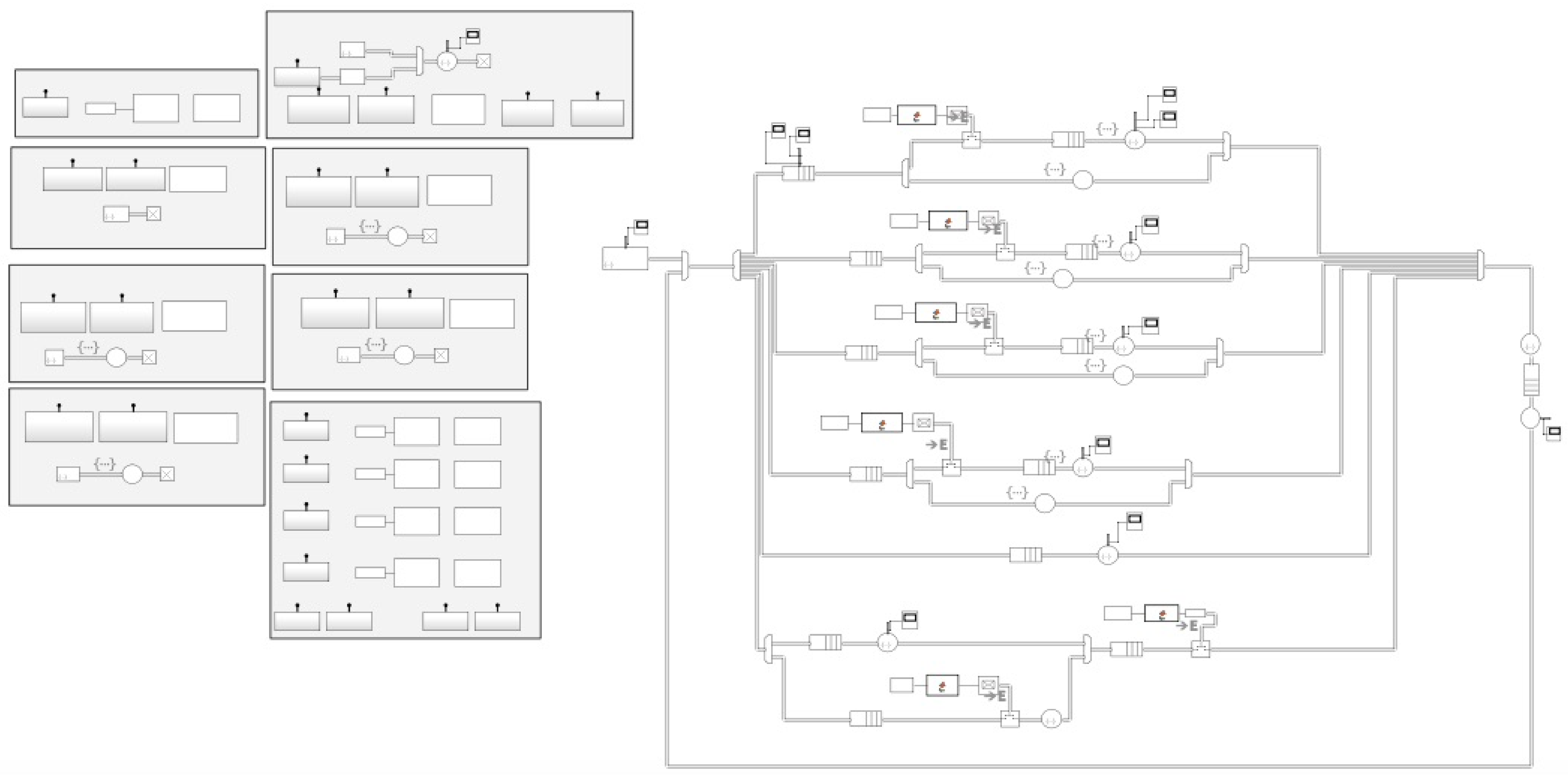

Figure 2: Model construction

SimEvents is designed to simulate discrete-event simulations, and provides a graphical drag-and-drop interface for building the models. This model is constructed to keep the complexity to a minimum, but still able to provide the desired output. The system consist of four fish farms that the vessels conducts normal operations on and responds to under emergency situations.

To emulate the real-life system, met-ocean data is implemented to provide operational restrictions and extended transit time for the vessels. In addition to this, several probability scenarios are included to impact the vessels response time.

Results and Conclusion

The simulation is run for two different fleet compositions. The first run used a fleet of three vessels in normal operation to respond to the emergency. The second run used one of the vessels as a dedicated standby vessel for emergency response. All simulations was run over the same amount of time and with the same time-step.

The response times for sheltered farms do not deviate much, whether a standby vessel is implemented or not. However, the more exposed locations experience greater differences. With the industrys move to more exposed locations, it could be beneficial to implement a dedicated standby vessel for emergency response situations. Due to the cost of such a vessel, a shared emergency preparedness in the industry is recommended. The results presented in Figure 3 and 4 are retrieved from the location *Salatskjera*.

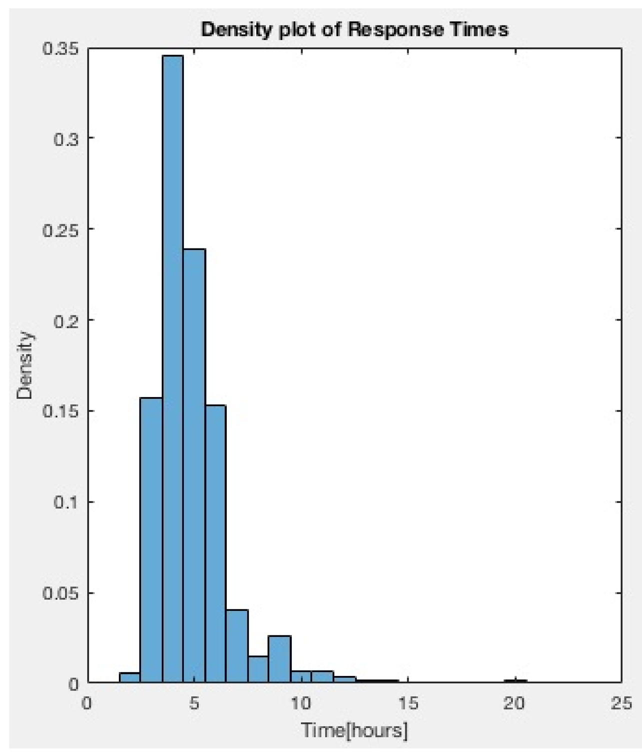

Figure 3: Without standby vessel

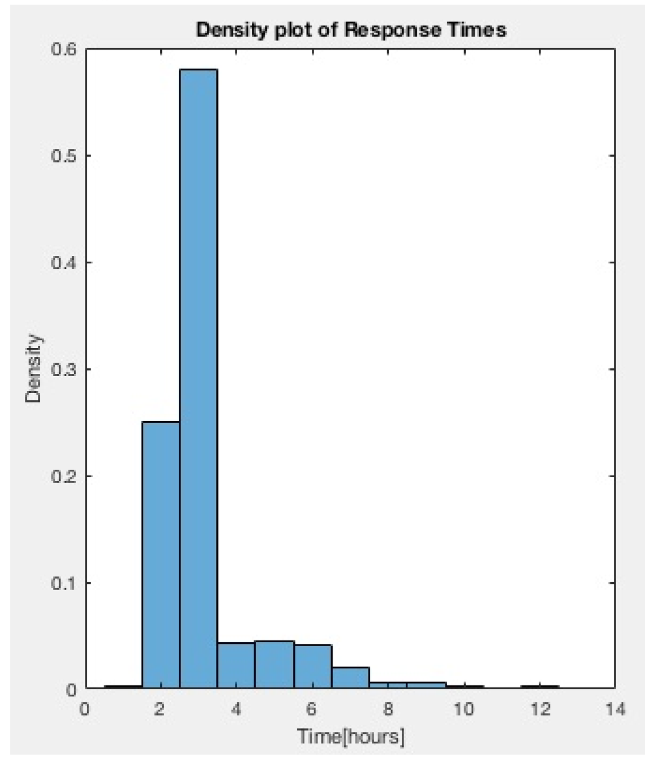

Figure 4: With standby vessel

Future Work

1. Improve input data to acquire better and more realistic response times for the vessels
2. Implement more operational restrictions for the vessels.
3. Improve the models architecture.

Acknowledgments

I would like to thank my supervisor Bjørn Egil Asbjørnslett for valuable input and help during this master thesis.

References

[1] Danielsen, P. (2010).Skimming the oil (of water) - thriving development or status quo? : a study of oil spill preparedness through an organizational approach. Thesis.

[2] Perkovic, M., Ristea, M., and Łazuga, K. (2016). Simulation based emergency response training.19

[3] Havbase (2018). Tema kart.https://havbase.no. [Online; accessed 12-05-2018].