Area Risk Assessment for Ship-Source Spills

Category: Special Projects
PROJECT SUMMARY

Transport Canada needed a method to assess the risk of ship-source oil spills in Canadian Waters. Dillon led the development of an Area Risk Assessment Methodology that determined the probable locations of ship-source oil spills, where the spills would travel and would likely be impacted by the oil spill. The output of the risk assessment was a series of maps illustrating the likely locations and volumes of ship-source oil spills and the most vulnerable areas.
The Government of Canada recognizes that with the increased transport of dangerous goods, such as crude oil within Canadian Waters, there are inherent risks. To assess these risks, a geographically focused in-depth risk assessment process was developed by Dillon and our partners called the Area Risk Assessment (ARA) Methodology. The methodology was tested by completing ARAs in four regions of Canada with high vessel traffic.

The ARA Methodology is applicable south of the 60th parallel taking into account: biological sensitivities (e.g. marine protected areas); the physical environment (e.g. shoreline classification); socio-economic factors (e.g. impacts to commercial fisheries); and Indigenous communities. The methodology evaluates statistically-defined oil spill volumes from both ship and oil handling facility sources based on the annual frequency of occurrence or return period. Dillon and our partner, RoyalHaskoningDHV, developed a conceptual risk model using the BowTie method in collaboration with Transport Canada (TC), Department of Fisheries and Oceans (DFO), Environment and Climate Change Canada (ECCC) and the Canadian spill response organizations.

Dillon and our partner MARIN, used a model to predict the location, frequency and volume of oils spills from vessels in four pilot areas. Once the probable locations of ship-source oil spills were known oil spill fate and trajectory modelling were performed by our partner RPS ASA. The output of their modelling determined the probability of exposure to oil on the sea surface, shoreline, in the water column and on seabed sediment within each grid cell covering the spill footprint. The modelling was done using a stochastic approach which involves modelling the same oil spill hundreds of times while randomly varying winds and currents. Oil spill trajectory models were first run without any spill response and then rerun using a wide variety of spill response measures, including innovative measures like in-situ burning and applying dispersants. This innovative stochastic approach to model oil spill response, a first of its kind globally, with a goal to see the change in the extent and impact from the spill.

The oil spill trajectory model results were used to determine the impacts of the spill. When oil exceeded a defined threshold the appropriate receptor was considered to be impacted by the spill and a consequence value was determined. Dillon developed a GIS tool that combined the probability of a spill, with the oil spill trajectory analysis and the consequence analysis into a single mapping output that identified the most probable locations and largest impacts from an oil spill.
ARA completes the risk assessment in four phases. The Frequency of Spill (FOS), the first phase, identifies locations within each Study Area that are more likely to experience oil spills. It involves calculating the frequency of marine accidents from vessels. The modelling provides spill frequency, size, location, oil type and vessel type in a two-step process. The first step determines the frequency and location of various accidents. The second step determines the frequency and volume of oil outflowing from the accident. Highest priority scenarios based on total frequency and oil spill volume are used to select scenarios for Phases 3 and 4.

The Probability of Exposure (POE) represents the probability of oil being present above a measurable threshold. Oil spill fate and trajectory modelling, uses historical winds and currents along with oil properties to model the fate and trajectory of hypothetical spills.
Minimum oil thickness and concentration thresholds are used to determine the probability of oil exposure for the three risk receptor categories. Each scenario generated by the model results in a series of maps showing the probability of oil exceeding the thresholds.

The final step calculates the risk score associated with a specific oil spill scenario using the outputs from Phases 1 to 3. Thresholds are compared to other societal-based design standards such as earthquake protection or flood protection. This perspective provided a way to gauge the level of risk that can be tolerated for spill response planning, and what is considered to be an acceptable level of risk.
SOCIAL & ECONOMIC BENEFITS

Transport Canada understands that with growth comes risks, in this case the risk of environmental catastrophe. Dillon held over 20 public engagement sessions across Canada in each of the four pilot areas so that local communities had a voice in the process and understood the inherent risks involved with shipping for hazardous goods.

The goal of the ARA Methodology is to identify the likely locations of an oil spill in the area under study and devise mitigation measures to help minimize the consequences of the spill. Having a good understanding of what would be impacted by a spill will allow the user to implement measures to reduce the chances of spill from occurring. By helping to prevent an oil spill, the devastating social and economic consequences to coastal communities that follow in a wake of a spill will, hopefully never be realized in Canada.

The study was peer reviewed by experts in risk assessment and oil spill management which included Dr. Ertugrul Alp from Alp & Associates, Steve Potter from SL Ross, Robert Unsworth from Industrial Economic Inc. and Dr. Robert Pelot from OREDA Risk and Decision Consulting. Comments received from Mr. Unsworth stated that the methodology developed by Dillon was at the leading edge of innovation in the Risk Assessment world and that he has not seen anything like it before.
ENVIRONMENTAL BENEFITS

The ARA Methodology allows the Government of Canada to identify the most vulnerable environmental areas to an oil spill and develop risk mitigation strategies to help minimize the impact. Furthermore, it allows the running of various mitigation scenarios to help determine the most effective method at preventing a spill as well as minimizing the environmental impact of a spill.

The single largest environmental benefit of the ARA Methodology is the ability to identify the most likely locations of a spill, before they occur, in order to put in place mitigation measures that will prevent the spill from occurring in the first place. However, in the unlikely event of a spill the ARA Methodology has already identified significant environmental and socio-economic receptors within the study area and has developed response plans which should help minimize the environmental impact of the spill.

The environmental benefits are potentially huge in the prevention of a ship-source oil spill to our natural environment, drinking water, flora and fauna.
MEETING CLIENT NEEDS

Developing and implementing a risk assessment methodology can, at times, be both art and science. In order to be successful, key elements must always be kept in mind throughout the process. Dillon, Transport Canada and other team members were focused on solving a problem that may never happen. Although the ARA Methodology is a risk assessment tool, it is also a planning level tool that allows the Government of Canada and stakeholders to make decisions quickly on necessary resources for spill response planning and prevention.

Communicating effectively the risk of oil spills in Canadian Waters is a challenge. While opponents of moving oil by sea generally focus on the consequence side of the equation, arguing that even small spills could have severe negative consequences if the spill occurred in a sensitive location. Depending on which side of the debate a person falls regarding the shipping of oil in Canadian waters, their perspective of risk will vary.

Factoring in individual and societal perspectives it soon becomes challenging to gauge the actual risks that is required to make an informed decision. Therefore, a common, objective-based frame of reference to clearly define the risk associated with shipping oil in Canadian Waters is critical so that informed decisions can be made in order to ensure that the economic benefit associated with oil transport is balanced with society’s legitimate concerns.