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Marine Crude Oil Spills in Canada

A HAZARD PROFILE REPORT
JEFFREY KENT

YORK UNIVERSITY | Disaster Risk Management Course

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Executive Summary

Marine ship-source crude oil spills in Canadian waters pose a huge risk hazard to the environment, local economies and GDP, and the social welfare of not only coastal residents but to all Canadians. This hazard profile report explains firstly, what type of hazard crude oil spills are classified as and the frequency Canadians would expect them to occur, followed by what magnitude of spill Transport Canada expects with a couple of examples shown.

Spatial regions of focus specifically, south of the 60th parallel, are laid out in the profile report and then some detailed information regarding oil spill duration and what could affect it. The report suggests that there could be a seasonality factor in ship-source spills as well as how the speed of an oil slick can be affected once it hits the water.

Is there a warning system available in Canada? The report explains what Transport Canada uses to help as a warning system, then finally, what are the consequences and impacts when there is a large-scale ship-source oil spill? These are outlined in the last section of the hazard profile.

Type of Hazard

In the way that marine crude oil spills would impact the general community at large, they are classified as a technological hazard, an oil emergency. With that being said, it is possible that the oil emergency could be caused by human error, where an oil tanker gets run aground or crashes into something, other than say an oil pipeline developing a leak and spilling tonnes of crude into a waterway while transporting crude (Pine, 2009, p.31, 74).

Frequency of Occurrence

The probability or likelihood of an oil spill occurring has an inverse correlation to the actual size of the spill whereas; major catastrophic oil emergency events don't happen all that often, while the smaller ones will occur with much more frequency (WSP, 2014, p.21).

The estimates for the overall frequency of oil spills in Canada, as per size of the spill in barrels of crude oil, is as follows; quantified as a percentage: 10 to 100 barrels = 0.022 (2.2%); 100 to 1,000 barrels = 0.014 (1.4%); 1,000 to 10,000 barrels = 0.019 (1.9%); and the likelihood of any spill to be larger than 10,000 barrels would be 0.004 (0.4%). These figures reflect the prior statement regarding relationship (WSP, 2014, p.23).

Transport Canada has estimated that there are approximately 20,000 tanker movements of crude oil off the Canadian coast every year. From these tanker movements, there are approximately

17,000 or 85% of them off of Canada's east coast. Transport Canada suggests that the probability of a large oil spill, those greater than 1,500 tonnes, could happen every 27 to 33 years and most probably off the east coast (Anderson & Spears, 2012, p.20).

Magnitude

The properties of the oil really determine how it will react and behave once it is spilled into the sea. The oil properties, when on the water, can be affected in different ways by a weathering process (WSP, 2014, p.48). See Appendix A for an illustration of the weathering process discussed (ITOPF, 2014).

Crude oil spills can have varying magnitudes with the range going from small accidental oil discharges from pleasure craft in marinas, oily discharge from a ship's bilge in its hull, to very large quantities of oil spilled from an oil tanker wreck (Auditor General, 2010, p.5). When oil gets spilled on water, it thins and gets spread out, which forms a thin *slick*. When this occurs, the area of the spill becomes vastly enlarged; e.g., a spill of 6,300 barrels can reach 10 km² in a couple of days (WSP, 2014, p.49). It's possible that an oil slick from a spill in the range of 36,500 to 365,000 barrels, can spread to cover over an area the size of 50,000 km² (Living Oceans Society, 2011).

Transport Canada completed a risk analysis for the *most* likely size of a spill in Canada. Their findings indicated the most probable crude oil spill off Canada's coast would be in the range of 1,590 tonnes of oil discharged into the water (Anderson & Spears, 2012, p.20). Some examples of catastrophic oil spills are: the Prestige, where 63,000 tonnes of heavy fuel oil were spilled in Spain in 2002; the Exxon Valdez, where 41,000 tonnes of crude oil was spilled off the coast of Alaska in 1989 (Auditor General, 2010, p.5).

Location and Spatial Extent

The Canadian regions south of the 60th parallel that have the highest oil tanker traffic and thus, are the zones most prone to a ship-source oil spill occurring, and also the focus of this report are: 1) The east coast; consisting of the Cabot Strait including southern Newfoundland, the eastern coast of Cape Breton Island, the Gulf of the St. Lawrence, and the St. Lawrence River (WSP, 2014, p.ii), 2) The west coast; consisting of the Dixon Entrance, Hecate Strait, Queen Charlotte Sound, Amphitrite Point to Graham Island, the southern region of Vancouver Island, and the Strait of Juan de Fuca (ITOPF, 2014).

There's a tanker shipping zone off the west coast of British Columbia called "The Great Circle." This region happens to be the shortest distance between Asian Pacific rim ports and the west coast of North America ports. Every oil tanker, and other ships for that matter, must transit through this zone whether they are coming from Alaska or coming from Asia. They all pass by near the west coast of Vancouver Island and Haida Gwaii, whether they're making a call to port with their destination being in British Columbia, Canada or Puget Sound, U.S.A. (Living Oceans Society, 2011, p.14). See Appendix B showing a map of the Canadian regions pertaining to this hazard profile report (WSP, 2014).

Duration

The duration of an oil spill can be assisted by the evaporation process, which reduces the spill volume. Firstly, the lighter more volatile hydrocarbons evaporate, changing the properties of the oil and also speeding up the evaporation. This process is sped up when the air temperature is warmer and if the wind speed is higher. Crude oil however, is still able to evaporate during freezing weather. Taking into account oil thickness, air temperature, and wind speed factors, computer modelling can be used for evaporation prediction rates. Agitated sea conditions can assist with dispersion, helping with degradation by micro-organisms. The microbes can partially or completely degrade oil into water soluble compounds, which eventually turns into carbon dioxide and then water. This process is dependent on the level of nutrients in the water, temperature, and ambient oxygen levels (WSP, 2014, p.51, 52).

The duration of any ship-source oil spill will also vary considerably according to the degree by which the oil slick is retained within the sediments i.e. pebbles, sand, marshland, etc. Oil spills can last for much longer time periods on shoreline composed of coarser materials such as gravel and cobbles, rather than a mostly sandy composition. A 2003 study for the Prince William Sound area indicated residual oil still remained within the shoreline sediments as well as, a number of species still exhibited signs and effects of the oil pollution, some 14 years after the Exxon Valdez oil spill (Living Oceans Society, 2011, p.29).

Seasonal Pattern

For crude oil spills, there really isn't a seasonality attached to them. That being said, within the "Inside Passage," routes between Vancouver Island and the B.C. mainland, and other islands north of Vancouver Island and the mainland, the oil tanker traffic is fifty percent busier

during the summer months (Living Oceans Society, 2011 p.14). This would boost the probability of a ship-source oil spill occurring in these regions during the summer months, accordingly.

Speed of Onset

Spreading over the sea's surface begins immediately as the oil hits the water. It depends on the viscosity (thickness) of the oil as to how quickly this takes place, which in turn depends both on the composition of the oil and the outside ambient temperature. Naturally, if the oil is more fluid (low viscosity) it will spread faster than those of a high viscosity. This process is inverse to the ambient temperature. Oil spreading is rarely a uniform process, with large thickness variations being typical in *floating* oil (ITOPF, 2014).

The slick is carried by the top few cm's of water, with the driving forces being: wind, local water circulation patterns, tidal influences, and freshwater inflows. An approximation for slick movement is made using computer modelling techniques (WSP, 2014, p.50).

Availability of Warnings

For detecting oil spills at sea, Transport Canada operates the *National Aerial Surveillance Program* throughout Canada, utilizing three planes for patrols. Through partnership with Environment Canada's *Canadian Ice Service*, Transport Canada has created a *Marine Aerial Reconnaissance Team* (Auditor General, 2010, p.11).

Potential Impacts

A ship-source crude oil spill would disturb the environment significantly along with causing destruction to various wildlife habitats belonging to numerous fish species, shellfish, seabirds, and mammals. The environmental impact would consequently cause huge economic and social impacts, as all Canadians would suffer the negative environmental effects of a major spill; e.g., the Arrow dumped 10,000 tonnes of bunker fuel in Nova Scotia in 1970, the Kurdistan spilled 8,000 tonnes of bunker fuel into the Cabot Strait in 1979 (Auditor General, 2010, p.5). Some economic activities would be very vulnerable to a large-scale oil spill such as: tourism, commercial fishing, and aquaculture. Recreational activities suffering a setback would be: boating, swimming, and fishing. There would also be human social welfare issues such as anxiety over lost livelihoods (Auditor General, 2010, p.5).

Canada's Pacific Coastal zone sector includes the most important number of finfish, shellfish, and aquaculture sites in Canada. The commercial landing value of fishing alone in 2011 came in at over \$273 million (WSP, 2014, P.71).

There were a total of 4,160 pollution incidents between 2007-2009 reported to the Canadian Coast Guard, of these, 1,580 were ship-source oil spill related (Auditor General, 2010, p.5).

Other commercial businesses would be affected and suffer losses such as: National Parks, transportation companies, and the beaches would be closed during clean-up procedures. The recovery workers cleaning up the oil, along with their equipment, will also be a significant nuisance (ITOPF, 2011, p.2).

There is the possibility of degradation to a region's *brand* image, which would come from negative media publicity that contributes to the public's perception of prolonged and wide-scale pollution effects (ITOPF, 2011, p.2).

Industrial water intake systems could also be affected which would cut off water supply to aquariums, onshore mariculture facilities, seafood processing plants, and numerous other users who need to draw in clean seawater. One major problem could be if a nuclear power plant or other type of power generator, can't draw in fresh water because their intake system was shut down as a precaution, so as not to damage sensitive machinery components. The public consequences for shutting down a major source of power generation on short notice would likely be far-reaching and severe (ITOPF, 2011, p.5). See Appendix C, which outlines the most sensitive zones/areas in focus (WSP, 2014).

Possible Secondary and Cascading Effects

Following a major ship-source oil spill and clean-up effort, there could be some lingering effects such as chronic mortality from ingestion of polluted food i.e. oiled mussels, bioaccumulation through the food supply chain, contamination of drinking water intake systems, and others. Indirect and chronic exposure effects on the natural environment have been shown to persist for decades in some studies. A large-scale oil spill could have other long-term consequences such as to the social structure and public health. This would interfere with local traditions thus, causing cultural disruptions (WSP, 2014, p.58).

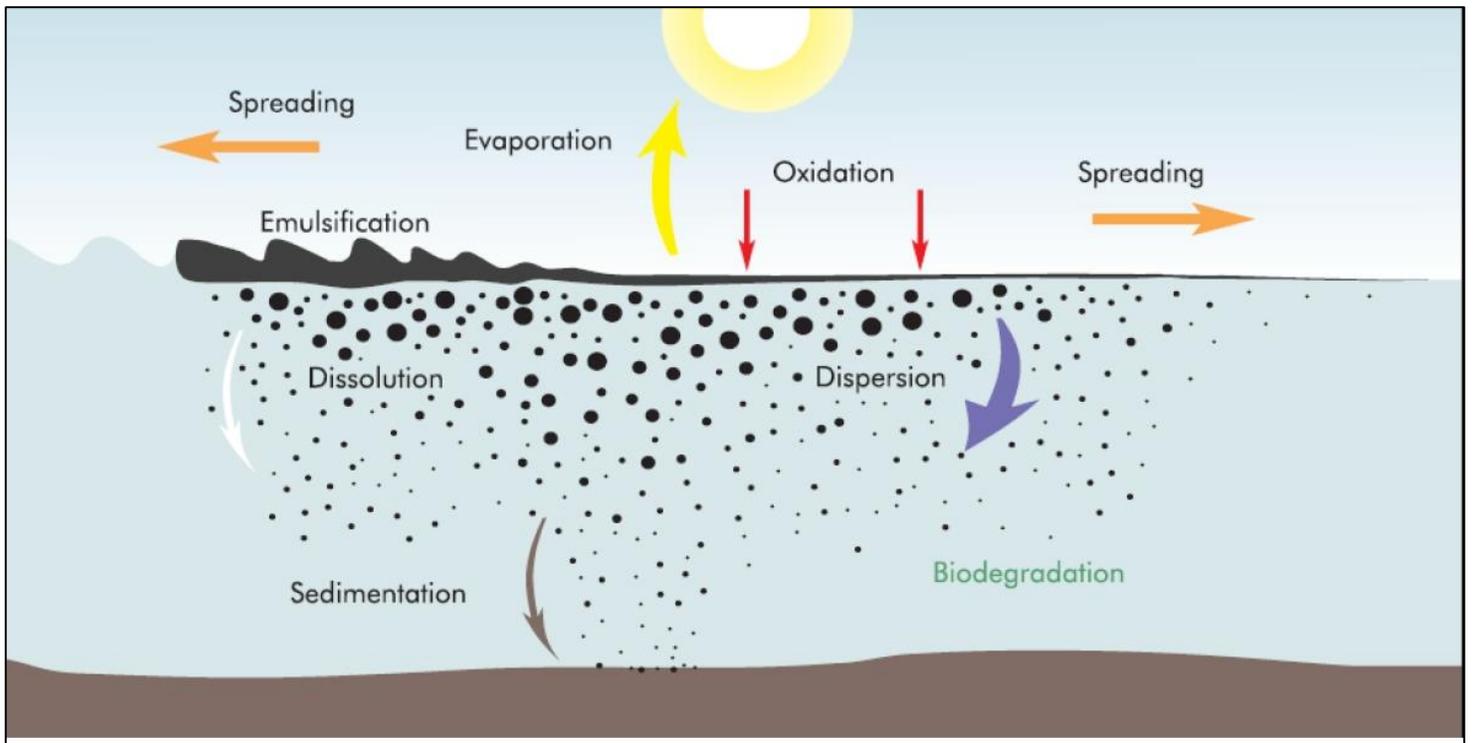
Conclusion

As mentioned throughout this hazard profile report, ship-source oil spills are very dynamic in that they are all somewhat different and can create uncertainties with the general public. It's important for spill responders to know what type of oil they're dealing with and how certain factors can and will affect the slick. Early detection is crucial to lessen the impact on the environment and to the cascading effects on the economy and social welfare of Canadians.

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Appendix A: Diagram of the Weathering Process



(ITOPF, 2014)

Appendix B: Map – Areas of Focus



Appendix C: Map – Vulnerable Sensitive Areas

Appendix-3: Sensitive Areas

