Estimating economic impacts to society from oil spills from wrecks

Bergion V. *[a], Lindgren J. F. [b], Rubia J. [b] and Lindhe A. [a]

a) Department of Architecture and Civil Engineering, Chalmers University of Technology, SE-412 96 Gothenburg, Sweden
b) Department of Marine Environment, Swedish Agency for Marine and Water Management, Box 11930, SE-404 39 Gothenburg, Sweden

*Presenting author

Extended abstract

Potentially polluting shipwrecks can be found in most oceans. These sunken vessels and the contained oil pose significant risks since oil releases can cause severe environmental consequences and further harm to society. The direct costs (e.g. emergency response and cleanup) of these spills have been described to some extent (Shahriari & Frost, 2008). However, the indirect costs on society and ecosystems, such as decimated fish populations and impact on tourism, are less investigated (Carson et al., 2003; U.S. Dept. of Commerce, 1983). In this study, we present a framework combining socio-economic analysis with a risk assessment model (VRAKA) (Landquist et al., 2014) to estimate the economic impacts of oil spills on society. Additionally, we evaluate if the costs of salvaging oil to prevent spills from shipwrecks are lower than the combined costs of emergency response and effects on relevant ecosystems and stakeholders in society.

The framework utilises data from literature, past spill events and information from Swedish authorities. The direct effects were included using local examples from a national and Baltic Sea perspective. The indirect effects were categorised using social and environmental costs emphasising the three sustainability aspects (social, economic and environmental). Economic valuation of ecosystem services was used to evaluate the environmental impacts, and the social effects were estimated using benefit transfer of economic impacts mainly on tourism, fisheries and recreation. We highlight how the combination of this information contributes to enhance the overall risk management framework applied by the Swedish Agency for Marine and Water Management (SwAM). Using shipwrecks in Swedish waters, the suggested approach and compiled data are used to demonstrate its applicability and how the results can be used to prioritise measures.

To estimate the direct costs of oil spills, we used data on clean-up costs for previous oil spills that occurred in Sweden over the past 15 years. It is also possible to use international estimates of costs if there are no national/local data available or to use models to estimate the cost (Montewka, Weckström, & Kujala, 2013).

In Figure 1, we present a simplified version of the current framework combining the VRAKA risk assessment model with the socio-economic analysis to assess the indirect costs of oil spills. The cost for oil salvage of shipwrecks was estimated using previous operations conducted by the SwAM in Swedish waters. The direct and indirect costs of instantaneous release of oil were compared to the cost of salvaging the oil to evaluate the societal profitability of oil removal for each specific shipwreck.

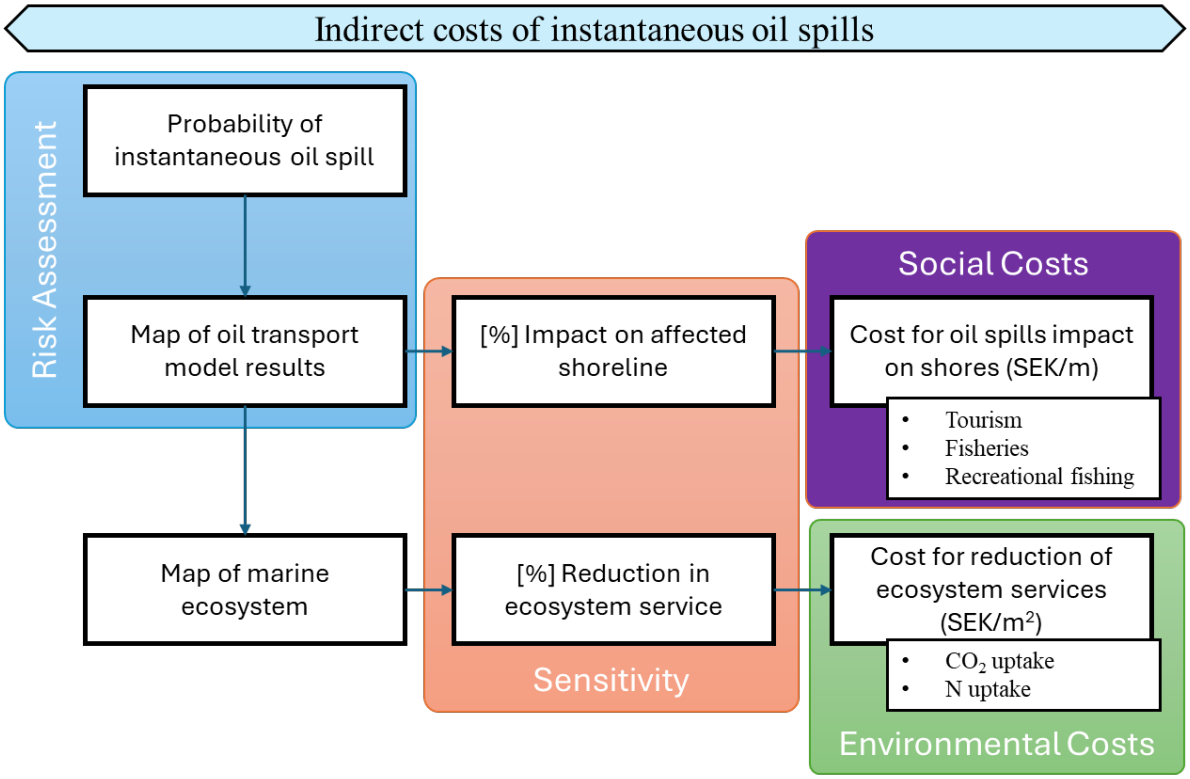

Figure 1 Schematic illustration of the combination of risk assessment and socio-economic analysis.

To apply the framework, information on where and in what amounts the oil ends up and the costs, duration and magnitude of the oil impact at various geographic locations are needed. The information should if possible be local rather than on a national level to obtain more accurate results. Local information can be obtained using contingent valuation studies or utilising expert elicitation. The data needed and the data sources used are presented in Table 1.

Table 1 Information used to illustrate the framework and possible information sources.

Input	**Unit**	**Information source**
Probability of oil spill	%	VRAKA model
Map of oil transport routes	Map	SEATRACK hydrodynamic model
Map of ecosystems	Map	EMODnet - EU
Impact on shoreline • Tourism • Fisheries • Recreational fishing	% red./Year	Estimation
Reduction of ecosystem services[a] • N and CO_2 sequestration	% red./Year	Estimation
Duration of shoreline impact	Year(s)	Estimation through (SEPA, 2024)
Duration of ecosystem services reduction	Year(s)	Estimation through (SEPA, 2024)
Cost for oil spills on shores • Tourism • Fisheries • Recreational fishing	SEK/m/Year	Statistics Sweden collated by SSPA (2005)
Cost for Reduction of ecosystem services • N and CO_2 sequestration	SEK/m^2/Year	Cole and Moksnes (2016)

a) Ecosystem services were illustrated using eelgrass uptake of CO_2 and N.

References

Carson, R. T., Mitchell, R. C., Hanemann, M., Kopp, R. J., Presser, S., & Ruud, P. A. (2003). Contingent Valuation and Lost Passive Use: Damages from the Exxon Valdez Oil Spill. *Environmental and Resource Economics, 25*(3), 257-286. doi:10.1023/A:1024486702104

Cole, S. G., & Moksnes, P.-O. (2016). Valuing Multiple Eelgrass Ecosystem Services in Sweden: Fish Production and Uptake of Carbon and Nitrogen. *Frontiers in Marine Science, 2*. doi:10.3389/fmars.2015.00121

Landquist, H., Rosén, L., Lindhe, A., Norberg, T., Hassellöv, I. M., Lindgren, J. F., & Dahllöf, I. (2014). A fault tree model to assess probability of contaminant discharge from shipwrecks. *Marine Pollution Bulletin, 88*(1), 239-248. doi:https://doi.org/10.1016/j.marpolbul.2014.08.037

Montewka, J., Weckström, M., & Kujala, P. (2013). A probabilistic model estimating oil spill clean-up costs – A case study for the Gulf of Finland. *Marine Pollution Bulletin, 76*(1), 61-71. doi:https://doi.org/10.1016/j.marpolbul.2013.09.031

SEPA. (2024). MARBIPP - Marine biodiversity, patterns and processes. Retrieved from https://www.marbipp.tmbl.gu.se/index.html

Shahriari, M., & Frost, A. (2008). Oil spill cleanup cost estimation—Developing a mathematical model for marine environment. *Process Safety and Environmental Protection, 86*(3), 189-197. doi:https://doi.org/10.1016/j.psep.2007.12.001

SSPA. (2005). *Socio-economic effects from larger oil spill - In-depth study and generalisation*.In Swedish: Socioekonomiska effekter av större oljepåslag - Fördjupningsstudie och generalisering

U.S. Dept. of Commerce, N. O. a. A. A. (1983). *Assessing the social costs of oil spills : the AMOCO CADIZ case study*.