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Effects of Oil on Wildlife
10th International Conference
Tallinn, Estonia, 5 - 9 October 2009

EMI

Web-based application for oil spill related ecological risk assessment

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Outline

- Study area: Gulf of Finland (Baltic Sea) and *La Perouse* (Soya) Strait (Sea of Okhotsk)
- Oil spill scenario modeling
- Can the oil spill be combated at sea?
- Impact of alongshore current
- Is the oil threatening a sensitive resource?
- Ecological sensitivity mapping:
  - ArcGIS map sensitivity layers
  - Environmental Sensitivity Index (ESI)
- Web Applications
- Conclusions

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Study area: Gulf of Finland (Baltic Sea) and *La Perouse* (Soya) Strait (Sea of Okhotsk)

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Gulf of Finland

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Gulf of Finland – heavy maritime traffic

- 263 M tons of cargo were transported by ship transport in the GoF in 2007, of which the share of oil products was 56%
- 23% of the cargo were loaded or unloaded in the Finnish ports, 60% in the Russian ports and 17% in the Estonian ports

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Gulf of Finland: GOFREP reporting system

- Ships, especially oil and chemical tankers, carrying hazardous cargo and deep-draught ships proceeding form the Baltic Sea to the GoF and vice versa are strongly recommended to follow the traffic separation schemes in the GoF
- GOFREP - a mandatory ship reporting system for vessels in the GoF came into force on 1 July 2004

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Gulf of Finland: GOFREP reporting system

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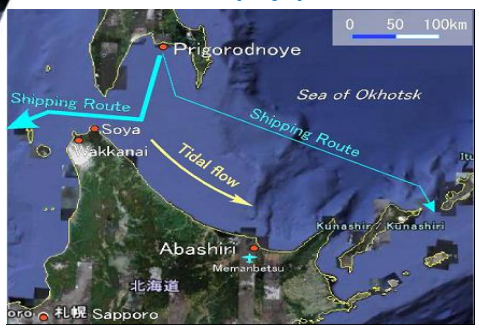
La Perouse (Soya) Strait



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AIS data for the *La Perouse* (Soya) Strait (2009.06.01 – 2009.06.30)

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La Perouse (Soya) Strait

- AIS data analysis for Soya strait conducted in Japan has shown extremely busy ship transport and a number of dangerous crossings while the great deal of that transport is oil and the liquid natural gas (LNG)
- Oil spill related risk assessment and the response advice is an issue of high priority in this ecologically very sensitive marine area

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Oil spill scenario modeling

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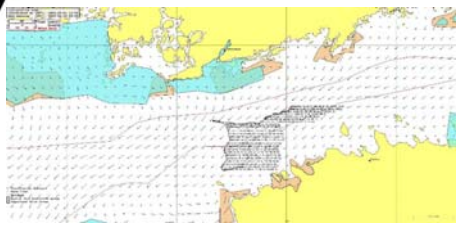
Gulf of Finland: Seatrack Web



Trajectory of the accidentally spilled medium oil in the Western Gulf of Finland calculated using the actual weather conditions for the period starting on 13 April 2009 (12:00 UTC, Coordinated Universal Time) and ending on 20 April 2009 (00:00 UTC). Arrows are showing the direction and speed of the surface current. Locations of Important Bird Areas and the Baltic Sea Protected Areas are shown along the coasts.

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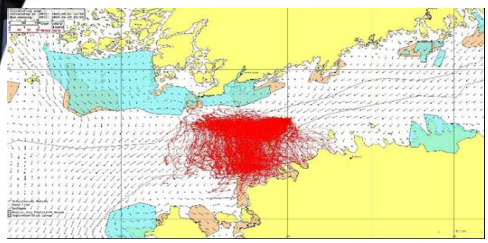
Gulf of Finland: Seatrack Web



Trace (including uncertainty) of the accidentally spilled 100 t of fresh medium oil in the Western Gulf of Finland calculated using the actual weather conditions for the period starting on 13 April 2009 (12:00 UTC) and ending on 20 April 2009 (00:00 UTC). Arrows are showing the direction and speed of the surface current. Locations of Important Bird Areas and the Baltic Sea Protected Areas are shown along the coasts

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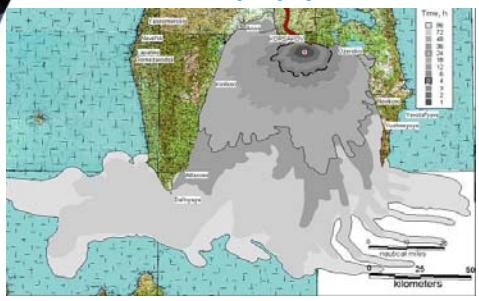
La Perouse (Soya) Strait



Risk Zones for Oil Spill from the Tanker Loading Utility, Aniva Bay

Sakhalin Energy Investment Company (SEIC), 2005

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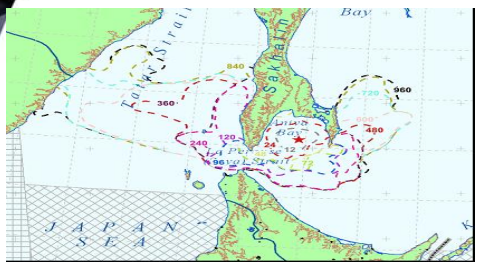
La Perouse (Soya) Strait



Trajectory Envelopes for Modelled Crude Oil Spill (from tanker, 21.000 t) Mid-Aniva Bay in Summer. Numbers indicate hours after incident.

Sakhalin Energy Investment Company (SEIC), 2005

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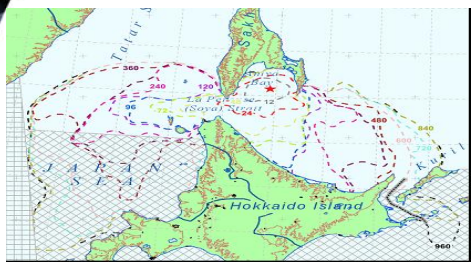
La Perouse (Soya) Strait



Trajectory Envelopes for Modelled Crude Oil Spill (from tanker, 21.000 t) Mid-Aniva Bay in Winter. Numbers indicate hours after incident.

Sakhalin Energy Investment Company (SEIC), 2005

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Can the oil spill be combated at sea?

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HELCOM Recommendation (11/13,1990)

- Contracting Parties should be able to respond to spillages of oil and 1) to reach within six hours from start any place of a spillage that may occur in the response region of the respective country,
- 2) to ensure well organized adequate and substantial response actions on the site of the spill as soon as possible, normally within a time not exceeding 12 hours.
- Decision on deployment of booms and skimmers can be made if mobilization time is less than the calculated time for oil to wash ashore.

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Bayesian belief networks (BBNs) analysis

- The BBN is constructed to assess general situation when answering the question: can the particular oil spill be combated at sea using booms and skimmers?
- When a Bayesian model is actually used the new information is inserted (current speed, wind speed, oil type, time from spill event, and mobilization time) to bring a variable (alternative: use or no use of booms and skimmers) to a state that is consistent with the new information

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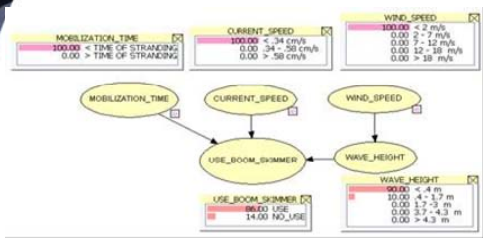
Bayesian belief networks (BBNs) analysis



Low current < 0.34 m/s, and a calm wind < 2 m/s. Mobilization time is less than time for oil to wash ashore. Use of booms and skimmers is efficient with probability of 0.86, and inefficient with probability of 0.14

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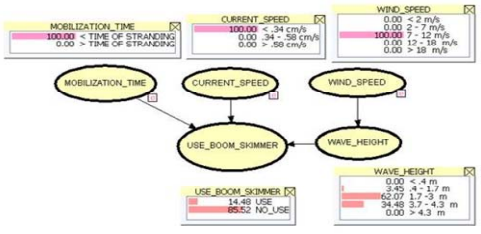
Bayesian belief networks (BBNs) analysis



Low current < 0.34 m/s, and a strong breeze 7 - 12 m/s. Mobilization time is less than time for oil washing ashore. Use of booms and skimmers will be efficient with probability of 0.15, and inefficient with probability of 0.85

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Is the oil threatening a sensitive resource?

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Gulf of Finland

- ArcGIS maps developed for the Gulf of Finland are based on three different ecosystem elements: the EU Habitat Directive Annex 1 habitats and associated habitat forming species, birds and seals. In each raster cell the maximum value of different layers was calculated to give the final assessment of ecosystem sensitivity by coastal water bodies and the seasons

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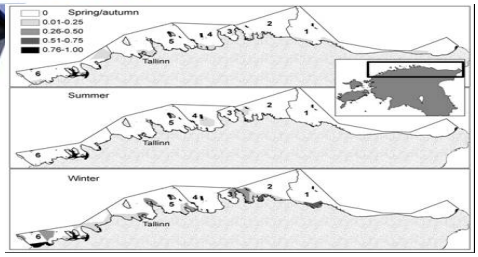

Ecological sensitivities by coastal water bodies of the southern Gulf of Finland (1 – 6) and seasons (spring/autumn, summer and winter). Sensitivity scale according to sensitivity criteria applied: (0) – no sensitivity, (0-0.25) – low sensitivity, (0.26-0.50) – medium sensitivity, (0.51-0.75) – high sensitivity, and (0.76-1.00) – very high sensitivity

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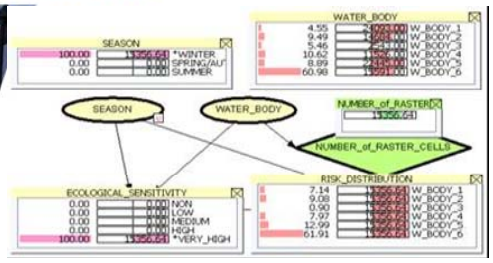

Highest ecological risk is associated with the water bodies 6 and 5 (61,91% and 12,99% respectively) while the ecological risk distribution over the rest of the water bodies is lower and rather uniform

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Environmental Sensitivity Index (ESI)

Approach is used for the oil spill related risk assessment. ESI concept includes in addition to the coastal ecological values also sensitivity ranking of the coastal topography, and the human use values (including the fishery and biological resources)

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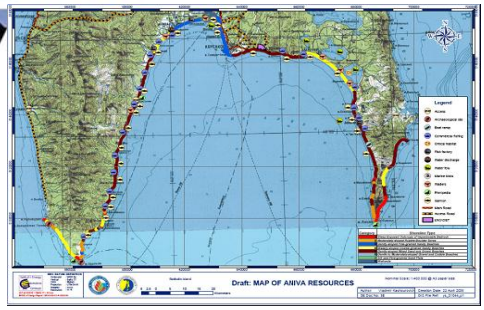

Preliminary Sensitivity Map of Aniva Bay

Sakhalin Energy Investment Company (SEIC), 2005

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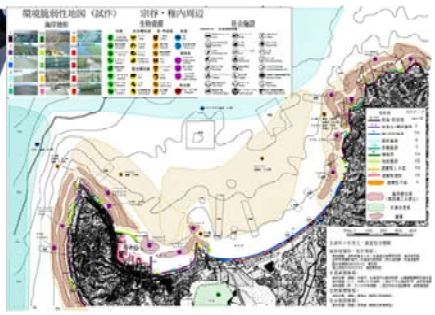

ESI map for the range of the coastline of the Hokkaido Island

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Web Applications

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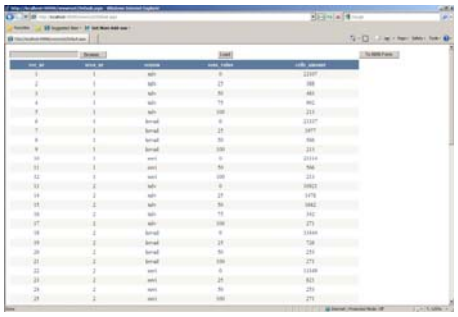
Ecological risk assessment, input table



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Bayesian inference of ecological risk assessment

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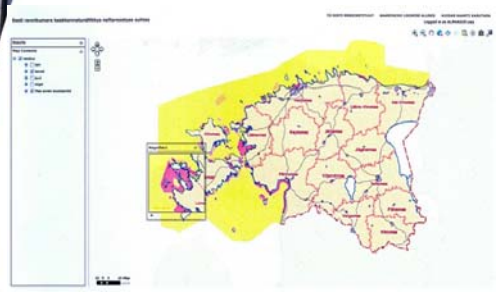
Estonian Baltic coastal sea ecological sensitivity Web based ArcGIS map application (four seasons and five ecological sensitivity levels)



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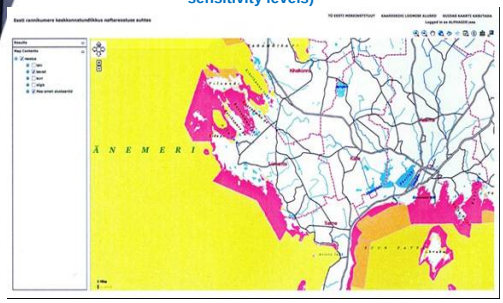

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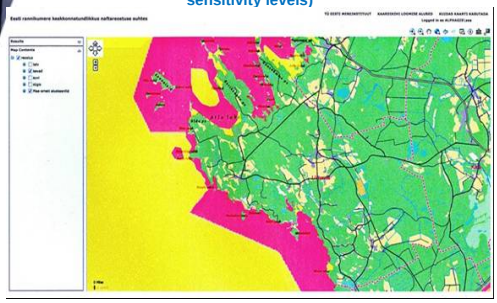

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Conclusions

- BBN integrated with other simulation tools proved to be an efficient modeling approach in performing the potential oil pollution related predictive ecological risk assessment for the southern part of the Gulf of Finland
- It is believed that the combined modeling approach presented in this paper would also be applicable with some modifications to a wide range of oil spill related ecological risk assessment problems including those related to La Perouse (Soya) Strait and the adjacent sea areas

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THANK YOU!