Vulnerable Environments; Sensitivity Mapping and Protection

Ole Øystein Aspholm
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Definition of Environmental Vulnerability

- Vulnerability is a measure of the extent to which a community, structure, service or geographical area is likely to be damaged or disrupted, on account of its nature or location, by the impact of a particular disaster hazard. (Glossary of Environment Statistics, Studies in Methods, Series F, No. 67, United Nations, 1997 – OECD 2001)

- Environmental vulnerability is an estimate of the inability of an ecosystem to tolerate stressors over time. (Williams and Kaputska 2000)

- Environmental vulnerability/sensitivity to oil pollution is a ranking of the environments ability to tolerate and recover from an oil pollution incident.
Environmental vulnerability to oil pollution

Individual sensitivity to oil pollution

- Likeliness to be exposed
  - Behavioural pattern
  - Presence

- Impact mechanisms
  - Loss of insulation due to clogging of fur and feathers
  - Toxic due to ingestion or inhalation
  - Reduction of mobility due to effects on limbs or feeding mechanisms

Populations sensitivity to individual mortality

- The recovery ability of populations
- The general development trend of populations
  - Red list species
- The reproduction strategy and ability of species
- External factors affecting the population development
  - Food limitation
  - Predation
  - Space limitation

Substrate sensitivity

Environmental Vulnerability/Sensitivity

Socioeconomic sensitivity
Environmental vulnerability to oil pollution

**Coastal Substrate**

- **Natural degradation and recovery**
  - Permeability – oil holding capacity
  - Wave exposure – washing effect
  - Biologic complexity and biomass

- **Man made oil spill recovery and clean-up**
  - Ability of mechanical and chemical clean up

- **Potential impact**
  - Biologic complexity and biomass

**Ecological sensitivity** ➔ **Environmental Vulnerability/Sensitivity** ➔ **Socioeconomic sensitivity**
Environmental vulnerability to oil pollution

Socioeconomic

Economic activity related to the sea and coast
- Fishery
- Aquaculture
- Tourism

Importance for economy
- Local
- Regional
- National

Ecological sensitivity ➔ Environmental Vulnerability/Sensitivity ➔ Substrate sensitivity
## Ecological sensitivity

### Highly sensitive - Mediterranean Monk Seal
- High probability of exposure due to behaviour
- Toxic effects through inhalation, ingestion and skin
- Critically Endangered - fewer than 600 species (IUCN Red List)
- Low reproduction strategy
- Extremely low recovery ability
- Endemic

![Mediterranean Monk Seal](Marinbio©)

### Moderate sensitive – Harbour Seal
- High probability of exposure due to behaviour
- Toxic effects through inhalation, ingestion and skin
- Least Concern (IUCN Red List)
- Low reproduction strategy
- Moderate recovery ability due to migration
- Wide spread in Arctic and temperate waters

![Harbour Seal](Marinbio©)
Substrate - ESI from IPIECA*

- **Environmental Sensitivity Index - ESI-1**
  - Exposed rocky shore

- **ESI-2 Exposed wave-cut platforms**

- **ESI-3 Gently sloping fine-grained sand beach**

- **ESI-4 Steeply sloping shores of medium to coarse grained sand**

- **ESI-5 Beaches of mixed sand and coarser sediments**

- **ESI-6 A range of gravel, pebble and boulder beaches with high permeability**

*The global oil and gas industry association for environmental and social issues*
Substrate - ESI from IPIECA*

- **ESI-7** Exposed tidal flats
- **ESI-8** Sheltered rocky shores
- **ESI-9** Sheltered tidal flats
- **ESI-10** mangroves
- **ESI-10** Saltmarshes
- **ESI-10** Coral reefs

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Coastal environmental vulnerability mapping in Europe

- Examples of European environmental vulnerability/sensitivity indexes (the list is not exhaustive):
  - UK – United Kingdom Digital Marine Atlas (UKDMAP)
  - Black Sea – Ukrainian Centre of Ecology of Sea (UkrSCES)
  - Baltic Sea – Environmental Vulnerability Index as part of BRISK: “Sub-regional risk of oil spill and harmful substances in the Baltic Sea” – Finalized January 2012
  - Denmark - «Risk analysis for oil and chemical pollution in Danish waters» (COWI 2007)
  - Ireland and Wales – «Risk assessment and collaborative emergency response in the Irish Sea»
  - Norway – Marine Resource Data Base (MRDB) and sensitivity index for the whole coastline and high sea
  - Spain – Gibraltar strait ESI similar to National Oceanic and Atmospheric Administration (NOAA - US) guideline
Environmental databases

There are a vast number of databases for environmental resources in Europe, national, regional, European and global:

- European seabirds at sea database (ESAS)
- BirdLife International
- World Database on Protected Areas
- Ramsar database - Wetlands of International Importance
- Conservation International - biodiversity hotspots
- Danish Areal Information System (AIS)
- UKDMAP – An atlas of the seas around the British Isles
- The Marine Life Information Network for Britain and Ireland (MarLIN) (on-going)
- Marine AREA database for NOrwegian waters (MAREANO) marine resource and topography mapping in Norway (on-going)
- SeaPop Seabird populations in Norway (on-going)
- Marine Turtle Nesting Database
- Atlas of cetacean distribution in north-west European waters
- United Nations Environment Program (UNEP) - World Conservation Monitoring Centre – Metadatabase
- Natura 2000 Covers:
Need for a common Environmental Sensitivity Index Database

Could it be Natura 2000?
Environmental Sensitivity Index in USA by NOAA

Combined with oil spill response resources to be an Environmental Response Management Application (ERMA) for use in planning, exercising and real responses.
Oil Spill Risk Analysis and Management

System description and Scenario selection

Oil spill drift and fate

Sensitivity mapping

Risk Assessment

Design and dimensioning of oil spill response

Contingency Plan

Legal and organisational aspects

Contingency Organisation

Legal framework

Funding mechanisms
Oil Spill Risk Analysis; Example

- Analysing traffic pattern and frequency
- AIS data and port protocols important tools
Oil Spill Risk Analysis; Example

- Identifying oil spill scenarios
  - Spill Amount
  - Spill Probability

- Oil drift modelling
  - Pollution probability
  - Pollution amount
  - Oil weathering
Oil Spill Risk Analysis; Example

- Map the environmental resources
- Rank the sensitivity
- Assess the potential environmental impact as a combination of oil pollution and sensitivity
- Combine environmental impact with probability for pollution to get the risk level
- Use the risk assessment for planning preventive and mitigating measures
  - Traffic separation
  - Pilot
  - Tug boats
  - Oil spill response plan
  - Localisation of Oil spill response equipment and plans

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Protection of vulnerable environment

- The tool for protection of vulnerable environment against oil pollution is Oil Spill Risk Analysis either as a part of Environmental and Socioeconomic Impact Assessments (ESIA) or as a standalone risk analysis.
  - For national and regional shipping traffic – standalone risk analysis
  - For opening of new petroleum areas – as a part of Strategic Environmental and Socioeconomic Impact Assessment
  - For opening of new oil & gas fields – as part of the ESIA that is input to the Plan for Development and Operation (PDO)
  - For exploration drilling – as a standalone analysis or a part of an ESIA if required

- The Oil Spill Risk Analysis must:
  - use high resolution environmental sensitivity data
  - give input to Oil Spill Response Plans on risk ranking and prioritization of environmental resources at risk, both spatial and temporal
  - give input to Oil Spill Response Plans on likeliness and amount of oil pollution in prioritized environmental sensitive areas
Protection of vulnerable environment

The Oil Spill Risk Analysis has to be followed up with identification of sufficient risk reducing measures:

- **Risk preventive measures as:**
  - regulation of activity in selected areas or in parts of the year
  - implementation of technology that can reduce oil spill risk
  - Implementation of operational procedures that can reduce oil spill risk

- **Risk mitigating measures - Oil Spill Response:**
  - Optimal organisation of response resources
  - Optimal local, national, regional and international organisation of oil spill response
  - Analysis of the need for oil spill response resources based on the Oil Spill Risk Assessment
  - Adequate training and oil spill response exercises based on input from Oil Spill Risk Assessment
Protection of vulnerable environment

- There is a need for a common electronic European Environmental Sensitivity Index Atlas
- Requires a unified methodology for ranking environmental sensitivity to oil pollution
- Has to cover both spatial and temporal variation in sensitivity
- Should also cover seabed, water column and sea surface, coastal and high sea
- The EIS Atlas should be integrated with an oil spill response management tool for better planning as well as faster and more correct decisions during an oil spill response operation
Safeguarding life, property and the environment

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