

## **RISK ANALYSIS OF MARINE ACTIVITIES IN THE BELGIAN PART OF THE NORTH SEA (RAMA)**

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The Belgian Part of the North Sea (BPNS) is an intensely used marine area. It is a rather small part of the southern North Sea but nevertheless it contains one of the most intensive merchant shipping routes in the world. Besides shipping it is also used for a wide and increasing variety of human activities. All these human activities are posing a certain danger to the environment. However, the frequency of incidents with environmental damage and the severity of these are only poorly known.

The interest and engagement of society to improve the quality of the sea and the coast and to protect the marine environment has led at national and international level to increased attention. This is shown among others by recent changes in the EU legislation and steps taken by the EC to speed up enforcement of the ERIKA regulations. It also shows from points in the Bergen declaration of the 5th North Sea Conference in which the Ministers invited OSPAR to develop an appropriate system of risk assessment and risk profiles connected with relevant human activities (e.g. shipping and aquaculture) in particular regions and localities. Besides this, they also pointed toward the importance of risk reduction relating to hazardous substances and the need for action to reduce the risks and minimise adverse effects on ecosystems, habitats or naturally occurring species. At present, the Bonn Agreement is also considering ways in which relevant environmental considerations could be established in trans-boundary pollution response incidents in the North Sea area. The Bonn Agreement concluded that a key issue to that respect is the establishment in advance of knowledge about environmental sensitivities within the North Sea area and the development of and exchange of information on environmental sensitivity mapping.

To be able to keep the risk (the product of probability and impact) of unwanted incidents as low as reasonably feasible and/or acceptable, appropriate measures, both technical and organizational, need to be defined and taken. However, such preventive and mitigating measures can only be taken on the basis of a sound analysis of the risks involved.

It is in this light that RAMA 'Risk Analysis of Marine Activities in the Belgian Part of the North Sea' was funded by the Belgian Science Policy (BELSPO), in the framework of the Second Scientific Support Plan for a Sustainable Development Policy (SPSD II).

RAMA aims to assess the environmental risks of spills by commercial shipping activities on the Belgian Part of the North Sea (BPNS).

### **Methodology (chapter 1)**

Within the quantitative and qualitative approaches of risk assessment a wide range of methods exists, each with its own characteristics, advantages and disadvantages and fields of application. Despite the diversity of approaches, we can state that in general 7 steps can be identified in an Ecological Risk Assessment (ERA): Problem Formulation, Hazard Identification, Release Assessment, Exposure Assessment, Consequence or Effect Assessment, Risk Characterization and Estimation and Risk Evaluation.

Whatever method chosen, two major topics that need to be taken into account throughout each consecutive step of the risk assessment are (1) uncertainty rating and (2) quality assessment of the input. Identification of potential gaps is also an important topic of risk assessment in order to assure the quality and relevance of the available information.

## **Problem formulation and hazard identification (chapter 2)**

At the Belgian part of the North Sea several human activities take place that are posing a certain danger to the marine environment. Shipping as major contributor to marine incidents resulting in environmental damage has been the focus of the RAMA project.

The RAMA project focuses on the shipping lanes on the BPNS (excluding the traffic in the Scheldt). An inventory of the shipping activities from the total Belgian Continental Shelf (BCS) could not be made due to missing activity data of the northbound fairway of the Noordhinder TSS. This bottleneck will be solved in the future because AWZ will map activities from sea-going vessels on the BPNS with the Automatic Identification System (AIS).

In total 57.791 voyages (or about 320.000 ship movements) took place on the shipping routes of the BPNS for the period April 2003-March 2004. The general conclusions of the shipping analysis are:

- 40% of the transport on the BPNS consists of dangerous goods (oils and Hazardous and Noxious Substances (HNS)) (total 149.653 CTSMRS (CTSMRS =Cargo Type Ship Movements per Route Segment));
- 60% of the dangerous transport is in packaged form (ST4, 6-8), 40% in bulk (ST1-3, 5) (ST= Ship Type);
- the average quantities of dangerous goods per CTSMRS for bulk transport are higher (up to 40.000 ton) than for packaged transport (up to 3.800 ton);
- 74% of transport is done with ship type 1 (oil tankers), ship type 4 (RoRo + car carriers + Ropax) and ship type 7 (container ships);
- cargo type 7 (HNS with low environmental danger) accounts for an average of 45% of the dangerous good transports;
- the products with the highest environmental risk (CT1 & CT2) are mainly transported in oil tankers (ST 1), chemical tankers (ST 2) and container ships (ST 7). The maximum share of both products (4%) is taken by the oil tankers.

## **Release assessment (chapter 3)**

Release assessment is the identification of the potential of the risk source to introduce hazardous agents (oil and HNS) into the marine environment. The quantitative estimation of the probability of release has been approached from both the historical and the modelling approach.

Despite the long-time series of historical accidents (1960-2003), a release assessment based on the historical approach is considered inadequate due to lack of relevant spill quantity data, difference in reporting trends which may lead to an underestimation of number of accidents, etc. Therefore a release assessment based on the MARCS model has been worked out for the Belgian Part of the North Sea (BPNS) based on the ship movement analysis described in chapter 2.

The results of the marine risk analysis of the BPNS show that:

- risk parameters, such as accident frequency (accidents per year) and cargo spill risk (tonnes of cargo spilled per year) tend to follow the number of vessel-miles defined in the shipping

pattern input data. The quality of this input data is therefore of critical importance to the output from this risk analysis;

- the risk reduction measures that are predicted to be effective are those that may reduce the frequency of powered grounding and collision accident types, such as pilotage, vessel traffic services and traffic separation schemes;
- the total frequency of dangerous goods spilling accidents is once every 3 years;
- the highest risk is predicted in subarea SA3 (the entrance of the Scheldt Estuary);
- the highest risk is predicted to arise from spillage of Class 8 from containers;
- cargo spill risks of the two most dangerous product classes vary between 12,3 tonnes per year (Class 1: Marine Pollutants + category A products) and 101 tonnes per year (Class 2: crude oils).

#### **Description of the effects of the incidents (chapter 4)**

The analysis of probability of occurrence of incidents and the release assessment was done for 8 different ship types (ST), 7 types of accidents and 10 cargo types (CT). A discussion of the effects of all these scenarios is unfeasible in the timeframe of the project and a selection of two incident scenarios was made:

- worst case scenario of an oil spill (crude oils (CT2); 17.000 ton/accident);
- worst case scenario of a HNS spill (acetone cyanohydrine (CT1); 8.000 & 1.000 ton/accident).

The impact analysis is firstly aimed at estimating the impact on different communities. Focus has been directed towards birds, fish and benthic organisms. As far as possible the ecosystem approach is guarded during this impact analysis. If an ecosystem approach was not feasible for certain incidents, indicator species are used to estimate the impact.

To be able to assess correctly the impacts, a sensitivity-analysis is carried out that includes besides biological values also socio-economic parameters. The sensitivity analysis is set up to identify the vulnerable areas in the coastal and marine zone of Belgium. As the interests (sensitivity) of the different users of the BPNS vary in time, three different scenarios leading to different sensitivity maps have been identified as the impact and response to a spill will also depend on these seasonal interests:

- general scenario: a scenario in which all parameters are evenly important;
- summer scenario: a scenario in which the tourist and recreational values of the coastal and marine areas have been given special attention;
- winter scenario: a scenario in which the nature values (wintering-, foraging- and spawning areas) of the coastal and marine areas have been given special attention.

In general, the western part of the Belgian marine zone (Flemish Banks area), the area around the harbours of Zeebrugge and Oostende neighbouring the important coastal municipality Blankenberge-De Haan are the most sensitive zones for spills in terms of ecological (focus marine waters/ winter scenario) and socio-economic value (focus coastal municipalities/ summer scenario).

The presented sensitivity maps must be seen as dynamical maps. In the GIS-based methodology the sensitivity scores can be adapted according to the needs or the availability of new data/ parameters. So as more detailed or new information becomes available, especially in GIS format, the sensitivity analysis can be updated and refined.

The effect analysis of the selected scenarios is restricted to an ecological impact assessment. The effect analysis is subdivided into three ERA steps:

- exposure assessment quantifying the Predicted Environmental Concentration (PEC) based on the calculated release rates and spill models;
- the consequence assessment estimating the consequences or effects of release in terms of the Predicted No Effect Concentration (PNEC) or the 50% mortality Concentration (LC50);
- the risk characterization (ecological impact) based on the PEC/PNEC or PEC/LC50 ratio.

Due to lack of quantitative data assumptions have been made in both scenarios (oil & HNS). Furthermore, in contrast to oil spills, a specific operational chemical model estimating the magnitude of the HNS spill does not currently exist in Belgium. The best approach is however being obtained by using the sediment transportation model as a basis for the chemical spilled. So the ecological impact assessments can certainly be improved. However the results can be interpreted as representing worst case effects and show the possible outcomes/magnitude of a selected oil and HNS spill. It is a first attempt of ecological impact assessment of both an oil and HNS spill and should be refined when new methodologies become available.

The effect of oil and chemical spills is different. Oil spills have an effect both at open sea and at the beach (stranding), while the effect of a HNS spill is generally limited to the marine area. In contrast to HNS spills, oil spills have a severe impact on the bird population. In our case study the total number of bird casualties is estimated at about 471 birds (open sea) and 3336 birds (Zwin). Due to the physico-chemical characteristics of the hazardous products the assessment of the ecological impact area is also different. A generalisation of results is thus not possible.

## **Risk estimation (chapter 5)**

The overall estimation of the risk is defined as the multiplication of the consequence for each damage-causing event with the frequency of that event. The frequency of an event is a result of the hazard identification and release step (Chapter 3). The consequence of a damage-causing event is usually defined as casualty probabilities [direct loss (mortality)] (Chapter 4).

The risk of commercial shipping at the BPNS can be summarized as follows:

- the highest risk can be found in the high risk subareas SA3, SA5, SA6, SA7 (range once every 13 (SA3) to 43 (SA6) years) characterized by sandbank formations and/or presence of harbour (intense shipping traffic is not the determining factor [e.g. SA1 (every 119 yr)] ;
- in the first place oil tankers and container ships pose a high risk for almost the total BPNS due to the fact that they transport the most hazardous cargo types (60% of CT1 and 97% of CT2) and that in case of a spill accident high quantities of dangerous goods are spilled at sea (related to high transported quantities) [Max. cargo spill quantity per year in SA3: 124 ton (oil tankers) & 247 ton (containers)];
- secondly also transport with chemical tankers and RoRo traffic are risky, in particular in the high risk subareas, respectively due to the hazardous characteristics of the products transported by chemical tankers (notice the low spill quantity) and a medium frequency (Max. in SA3: every 150 yr) and spill quantity (Max. in SA3: 24 ton/yr) of accidents with RoRo ships;
- the risk from bulk, general cargo and other (passenger ships & other ships) transport is rather low.

## **Examination and recommendations of existing contingency plans (chapter 6)**

The valorisation of the RAMA project results in a thorough analysis of the current status of the shipping at the North Sea in relation to the issue of safety. The scope of the project will however go beyond the mere result of a fundamental risk analysis of the commercial shipping at the North Sea. It is also aiming at the formulation of recommendations to improve the safety level

for the environment and at an optimisation of response in the framework of the Belgian 'North Sea Disaster Plan'. These recommendations are part of the remaining chapter of the RAMA report.

### **Final report**

The final report, figures and additional information can be found on the webpage of the RAMA project: <http://www.vliz.be/projects/RAMA/>