TRANSNAV International Journal on Marine Navigation and Safety of Sea Transportation
Volume 2
Number 4
December 2008

The Implementation of Oil Spill Costs Model in the Southern Baltic Sea Area to Assess the Possible Losses Due to Ships Collisions

L. Gucma & E. Goryczko
Maritime University of Szczecin, Szczecin, Poland

ABSTRACT: The paper presents an attempt to assessment of losses due to oil spills caused by ships collisions in the Southern Baltic Sea area. To assess the losses the data from two models were used. First of them is simulation model of ships collision with consideration of oil spills developed and the second is the model of oil spill cleanup cost is applied without consideration of environmental conditions influence.

1 INTRODUCTION

The safety of large engineering systems can be evaluated by simulation models. In engineering practice the cost of accidents is the most important factor in decision making process and risk analysis. There are two typical engineering systems in consideration of accident consequence assessment: 1. involving human fatalities, and 2. not involving human fatalities. In the second kind of the system pure economical analysis of consequences can be carried out. In case of ships accident in the open sea the fatalities could not be neglected but due to the subject of the paper which is the oils spills probability the possible human fatalities are outside of interest of studies carried out.

Complete model of oil spill cost model was presented in previous works of the Authors [Goryczko & Gucma 2006] where the losses to environment expressed by Life Quality Index was presented.

2 THE COST OF OIL SPILLS

On the basis of statistical analysis of 96 oil spills the correlation with spill size have been found. The cost of small oil spills are at least 20-times higher than big ones [Etkin 2000, 2001].

Independent of size and extend of oil spill every time the proper monitoring full mobilisation of resources and human and equipment which leads to high cost. The Fig. 1 presents correlation between spill size and its cleanup costs in different size group of oil spills. To find the model the exponential model is used (Fig. 2). The cleanup cost are high due to constant fraction not dependant of spill size costs. The model can be written as [Goryczko & Gucma 2006]:

$$C = 255218\, v^{-04184} \tag{1}$$

where: C = cost of oil cleanup in zloty; v = the amount of oil spill [t].

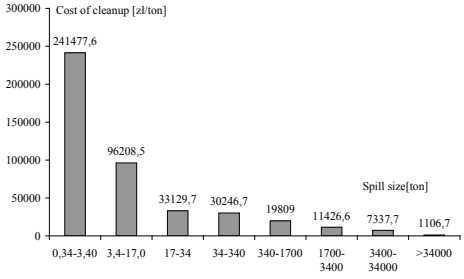

Fig. 1. Correlation of oil spill size with its cleanup cost

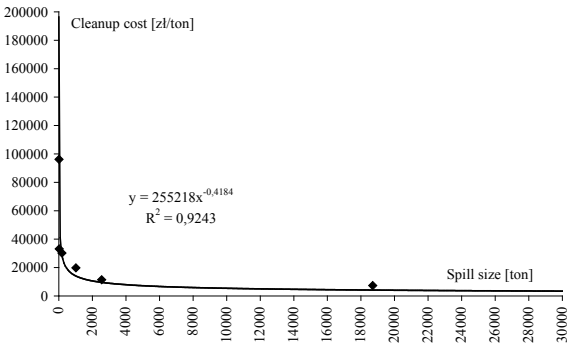

Fig. 2. Theoretical model of oil sill up costs by exponential function

3 STOCHASTIC MODEL OF SHIPS ACCIDENTS

One of the most appropriate approach to assess the safety of complex marine traffic engineering systems is use of stochastic simulation models [Gucma & Przywarty 2007]. The model presented on Figure 3 could be used for almost all navigational accidents assessment like collisions, groundings, collision with fixed object [Gucma & Przywarty 2007], indirect accidents such as anchor accidents or accidents caused by ship generated waves [Gucma & Przywarty 2007]. The model could comprise several modules responsible for different navigational accidents. In presented studies the model was used to assess the probability of oil spills in the Baltic Sea area.

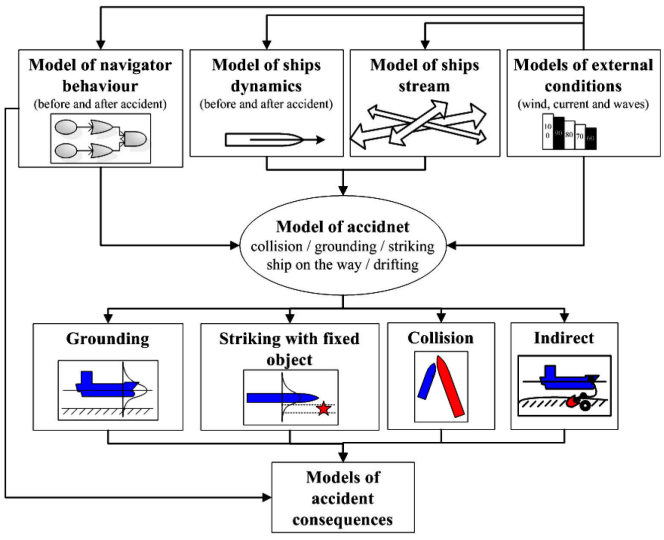

Fig. 3. Diagram of fully developed stochastic model of navigation safety assessment

The simulation results with consideration of collision are presented in Fig, 4. The results are according to expectations – most collision are taken place on the most highest according to ships density places. The assumptions and input data of simulation are presented in Table 1.

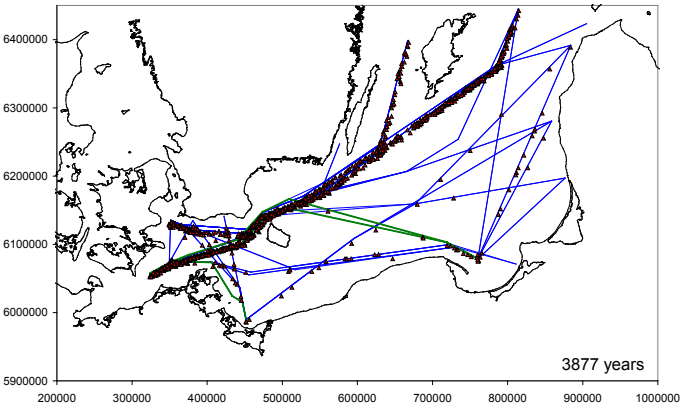

Fig. 4. The results achieved by simulation model (places of ship's collisions) [Gucma & Przywarty 2007]

4 RESULTS – CLEANUP COST

The simulation model results are presented in Table 1. The time between collision are very similar to real data for the Southern Baltic Sea (2-3 collision per year) but the oil spills could not be verified due to small sample of real accidents.

Table 1. Simulation assumptions and its results

Time of simulation [years]	3877
Number of collisions	9036
Number of collisions with oil spills	1406
% of oil spills in collisions	0.15
Number of collisions per year	2.33
Number of oil spill per year	0.36
Time between collisions [years]	0.43
Time between oil spills [years]	2.76
Mean oil spill [t]	2091

To find the yearly cost of oil spills the size of given oil spill expressed in v_i are divided by the simulation time T and multiplied by cost of cleanup c_i of oil spill according to formula 1 and number of oil spills during simulation N_{os}:

$$c_{yi} = v_i c_i N_{os}/T \quad (2)$$

The results are presented on Figure 5. As it was expected the highest cost of oil spill is near the routes of highest traffic of ships. After amendments in routing the main stream of ships moves near the South Sweden coast.

The model of cost is simplified and assumes that:
- oil doesn't move on the water;
- oil doesn't move to the shore;
- all the oil spilled is cleaned on the open sea.

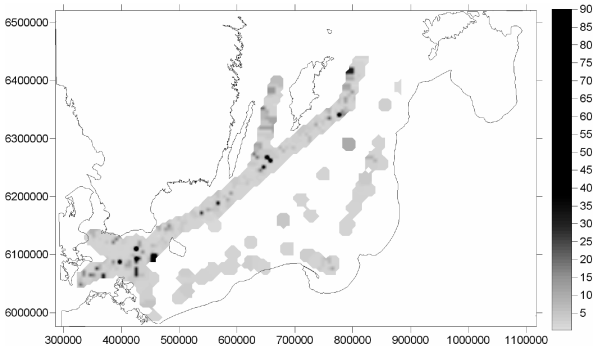

Fig. 5. Mean oil spill cleanup costs in million zloty per year for ships traffic estimated at 2010 year

4.1 *Distribution of simulated spilled oil*

Figure 6 presents simulated distribution of oil spill size. Small oils spills less than 1000 tons are dominating. The smallest spills are most likely are result of bunker spill after collision.

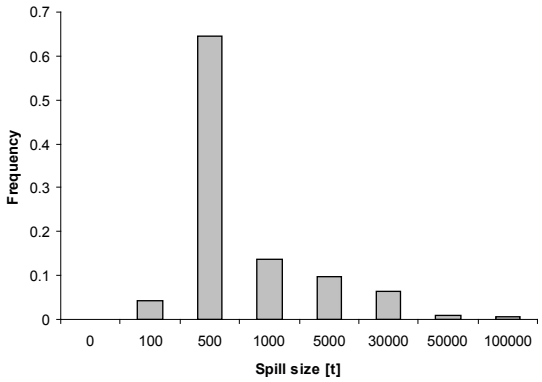

Fig. 6. Simulated distribution of oil spill size

4.2 *Real oil pollution data*

From the other side the historical results from the oil spill accidents according to Maris accident database (Fig. 7) are comparable with simulation results.

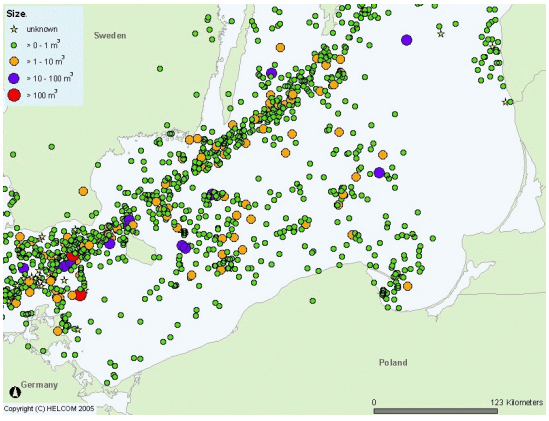

Fig. 7. The real places of illegal oil discharges on the Southern Baltic Sea [Helcom 2006]

5 CONCLUSIONS

The paper presents an example of calculating of oil spill cleanup cost in the Baltic Sea after navigational collision accidents. The model has several simplifications and could be used only for early design purposes. The results of the model are very close to expectations. The cost of accident removal is important factor to design marine traffic engineering systems such as traffic routes or places of refuge. The cost of removal of accident oil spill is highly correlated with ships traffic.

It is planned that the oil spill model will be amended in the future by several factors like:

– complex oil spill behaviour in different conditions,
– extend of coast pollution,
– outflow rate from damaged ship.

REFERENCES

Etkin D.S. 2001. Comparative methodologies for estimating on-water response costs for marine oil spills. *International Oil Spill Conference*.

Etkin D.S. 2000. Worldwide analysis of oil spill cleanup cost factors. Proceedings, Twenty-Third Arctic and Marine Oilspill Program (AMOP) *Technical Seminar.* Environment Canada, Ottawa, Ontario.

Goryczko E. & Gucma, L. 2006. Szacowanie kosztów rozlewów olejowych (Estimation of oil spill cost), Mat. XV Międzynarodowej Konferencji *Rola nawigacji w zabezpieczeniu działalności ludzkiej na morzu*, Gdynia.

Gucma L. & Przywarty, M. 2007. The model of oil spills due to ships collisions in Southern Baltic area. 7th International Navigational Symposium on Marine Navigation and Safety of Sea Transportation TransNav'2007, Gdynia.

Helcom 2006. http://www.helcom.fi