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Agenda item 18

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FORMAL SAFETY ASSESSMENT

Further experience with non-linear oil spill cost functions

Submitted by Greece

SUMMARY

Executive summary:	This document reports on further experience with the non-linear oil spill cost functions. Oil spill data from the United States were combined with the IOPCF oil spill data set used to derive non-linear oil spill cost functions in previous analysis by Greece, so that the derived oil spill cost function is more inclusive and representative of available oil spill data.
Strategic direction:	12.1
High-level action:	12.1.1
Planned output:	12.1.1.1
Action to be taken:	Paragraph 6
Related documents:	MEPC 60/17, MEPC 60/WP.11, MEPC 60/22

Introduction

1 At MEPC 60, the Committee approved the report of the Working Group on Environmental Risk Evaluation Criteria within the context of Formal Safety Assessment (MEPC 60/WP.11). The Group considered three non-linear functions of total oil spill cost versus oil spill weight, and the one proposed by Greece was considered most conservative. This function was derived after regression analysis of data from the International Oil Pollution Compensation Fund (IOPCF) (MEPC 60/17, annex 2).

2 Futhermore, the Committee, among other things, urged Member Governments and organizations to verify and adjust as necessary the proposed regression formula and to submit the data for each cost component and the results of the analysis for consideration by the Committee (MEPC 60/22, paragraph 17.8.2).

3 At the Working Group's discussion at MEPC 60, concerns were expressed by various delegations to the effect that the above oil spill cost function, given it is based on IOPCF data, may underestimate total spill costs. In fact, the IOPCF representative attending the discussion explained that in rare cases (such as the **Prestige** spill) the upper limit set by

the Fund had been reached; and that for some categories of spill costs such as environmental damages, the scope of the Conventions was limited. In addition, the Group was informed that in some cases the shipowner would pay directly some of the costs. In all such cases, the funds disbursed by IOPCF are below actual total spill costs. With regard to the reinstatement/restoration of the impaired environment, the Working Group noted that claims other than loss of profit from the impairment of the environment are accepted only where reasonable measures of reinstatement are undertaken and that IOPCF will only pay for related studies where such studies pertain to establishing the need for reinstatement measures. Compensation is not paid in respect of claims for environmental damage based on abstract quantification calculated with theoretical models. Last but not least, the Working Group also noted that the IOPCF compensation scheme only addresses spills of oil carried as cargo or bunkers from oil tankers or any type of seagoing vessel constructed or adapted for the carriage for carrying persistent oils including crude oil, heavy fuel oil and lubricating oils. Some delegations expressed concern that these data may not be representative for the entire fleet of ships. The Group noted that the value of the limits are expressed in Special Drawing Rights (SDR) so that the value in another currency will vary according to the exchange rate at the particular time.

4 In order to further investigate this issue, and in response to the invitation by the Committee, Greece would like to bring to the attention of the Committee a recent working paper that has tested the formulae derived from IOPCF data against spill data provided by the United States. Such data were circulated by the United States just prior to MEPC 60 to the Correspondence Group on environmental risk evaluation criteria established by the Committee. These data were also discussed at the Working Group established at MEPC 60.

5 The working paper in question is set out at annex to this document and is provided here for preliminary consideration, in view of a more complete analysis on this subject that may be submitted by MEPC 62.

Action requested of the Committee

6 The Committee is invited to consider the information provided in this document and decide as appropriate.

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ANNEX

NON-LINEAR OIL SPILL COST FUNCTIONS: FURTHER ANALYSIS

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Introduction

1 In Annex 2 of MEPC 60/17, we had reported the results of regression analysis that attempted to connect oil spill cleanup cost and oil spill total cost to oil spill size. The analysis were based on data from the International Oil Spill Compensation Fund (IOPCF)[1]. The regression formula linking oil spill total cost with oil spill size was found to be non-linear and of the form

Total spill cost = $51{,}432V^{0.728}$ (1)

where V is spill size in tonnes.

2 This short working paper provides some clarifications on this analysis and extends it by combining the IOPCF data with data on US spills.

Removal of outliers

3 We would like to clarify first that the regression leading to formula (1) above entailed the removal of 8 outliers. Outliers are points that are typically considered anomalous in a regression analysis and are removed to obtain a higher correlation coefficient. In this particular case, the removal resulted in an increase in the value of R^2 from 0.59 to 0.79. However, some analysts are concerned that the removal of outliers may distort reality, and in fact some delegations questioned such a removal in the analysis.

4 To clarify the matter, we note that in this particular case, if outliers had not been removed, the regression formula would be

Total spill cost = $70{,}343V^{0.65}$ (2)

5 It is straightforward to check that formula (2) leads to **lower** total spill costs than formula (1) for V greater than about 50 tonnes. In fact, if V=1,000 tonnes formula (1) overestimates total oil spill costs by 27% versus formula (2). This percentage rises to 53% if V = 10,000 tonnes and to 83% if V=100,000 tonnes. This means that formula (1) is a conservative estimate of total oil spill costs based on IOPCF data and should be adjusted downwards if all spills are included.

[1] For a complete analysis, please see Kontovas,C.A, Psaraftis,H.N and Ventikos,N. P., (2010) "An empirical analysis of IOPCF oil spill cost data", Marine Pollution Bulletin, In Press, Corrected Proof, available online at: http://dx.doi.org/10.1016/j.marpolbul.2010.05.010.

US data analysis

6 Just prior to MEPC 60, the United States circulated to the Correspondence Group on environmental risk evaluation criteria some data on US oil spills. This data included, among other things, the **response** (or cleanup) cost of oil spills that were covered by the so-called *Oil Spill Liability Trust Fund (OSLTF).* Costs were expressed in 2005 USD.

7 The OSLTF dataset consists of 486 cases which are mainly very small spills. The median spill size is 0.16 tonnes and its average is just 168.29 tonnes.

8 We performed our own regression analysis on this data set in the same way that was performed for the IOPCF dataset, as presented in MEPC 60/17, Annex 2. We converted costs to 2009 USD to make our analysis compatible with that of the IOPCF data, which also used 2009 prices.

9 The initial regression showed a very weak relationship (R^2=0.18) between response (or cleanup) cost and oil spill size. Even by removing outliers, no significantly better fit was achieved (R^2=0.24).

10 Note that contrary to the IOPCF, the OSLTF does not deal exclusively with spills from oil tankers. In fact, between 1990 and 2002, in only around 2% of cases in which the source of the spill could be established, were oil tankers the culprits, accounting for less than 4% of total costs. The different sources of spills may be a reason for the weak relationship between cleanup cost and oil spill size.

Comparison with non-linear formula

11 Recall that by using the IOPCF dataset of N=84 spills for the period 1979-2006, our analysis resulted in the following non-linear regression equation of the oil spill **cleanup** cost:

$$\text{Cleanup Cost} = 44{,}435\ V^{0.644} \quad (3)$$

12 Note that the above formula is for cleanup costs only - whilst total costs are given by formula (1) or (2).

13 Figure 1 below depicts a scatter diagram of the ratio R of the oil spill cleanup cost, as recorded in the OSLTF data set, divided by the estimated cleanup cost as given by formula (3) (both costs in 2009 USD). One should note here that the IOPC Fund covers only spills from tankers, and, thus, in theory our model should not be used to estimate costs for spills that may come from other sources. Still, we calculated the cleanup cost (in 2009 USD) for all those spills that were included in the OSLTF dataset.

14 One can clearly see that, with the exception of 8 spills, whose size is between 1 and about 340 tonnes, this ratio R is uniformly lower than 1.0 for spills of 1 tonne and above. There are many spills for which the ratio is higher than 1.0, but these are extremely small spills, quite unlikely to be encountered in a tanker spill accident, or even in a bunker spill. In fact, formula (3) overestimates the cleanup cost for 327 out of the 486 US spills (67.29%). This goes up to 80% of the cases for spills greater than 0.1 tonnes.

15 This would seem to suggest that for all practical purposes, formula (3), obtained from IOPCF oil spill data, generally overestimates US oil spill cleanup costs.

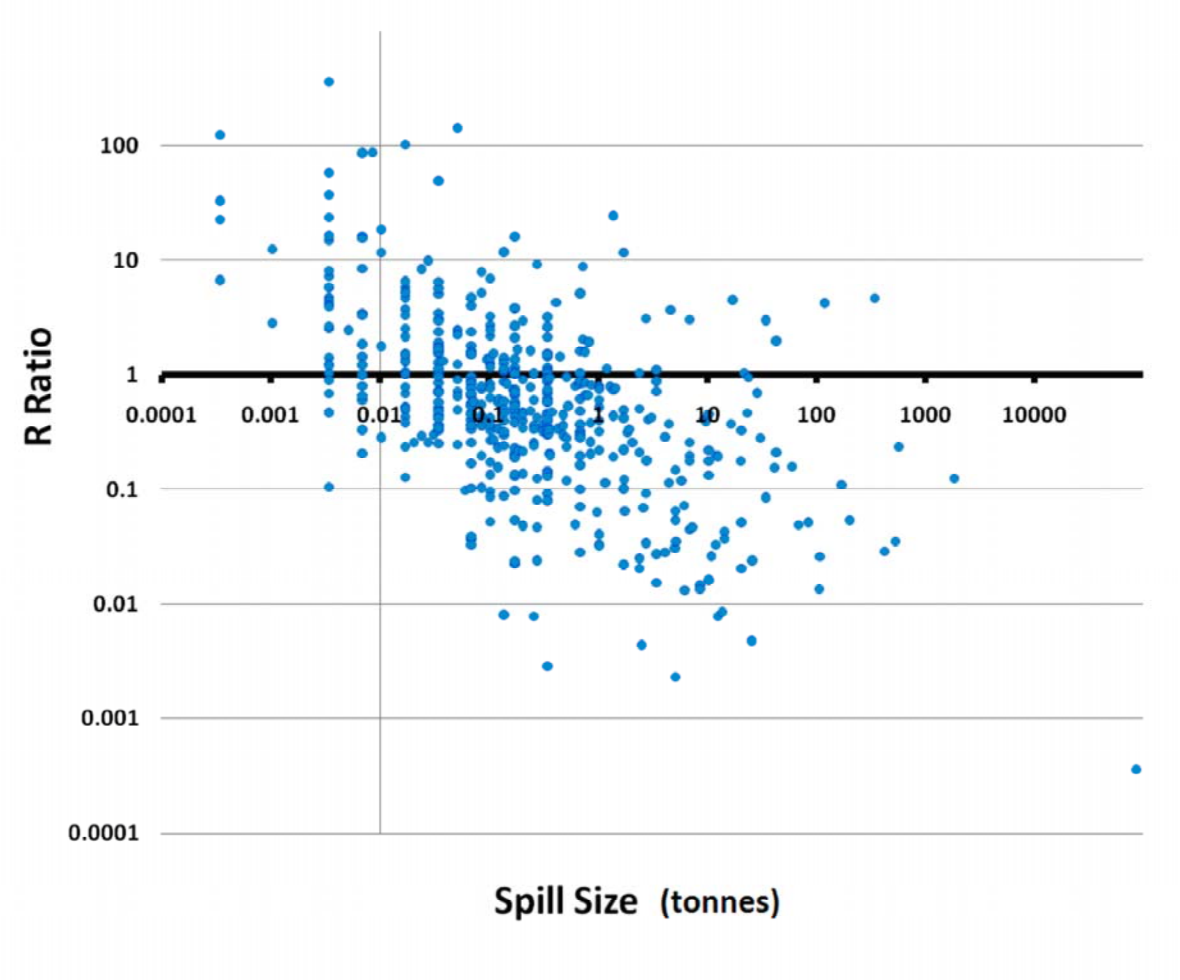

Fig. 1: Scatter diagram of ratio R of oil spill cleanup cost, as per OSLTF data set, divided by estimated oil spill cleanup cost, as given by formula (3) - all costs in 2009 USD. The bold horizontal line is R=1.

Combining the data sets

16 Although these sets of data come from two different spill sources, another interesting question is what happens if we combine them. One reason to do so is that the IOPCF dataset includes mainly large spills and the OSLTF dataset contains mainly small spills. Another reason is that IOPCF does not include US spill data. Again, it should be realized that IOPCF includes only tanker spills while this is not the case with OSLTF data. Therefore, the results of this analysis should be interpreted with caution.

17 By combining the two data sets, we arrive at a combined data set of 570 spills. The median oil spill has a size of 0.25 tonnes whereas the average is 749.38 tonnes.

18 Figure 2 below shows data from the IOPCF database (square dots), combined with data from OSLTF (round dots). The dashed line is the line described by formula (3) – that is, the formula derived by the IOPCF data set alone. By combining all data we arrive at a new regression line that lies well below the original, especially for large spills. Outliers were removed.

19 The regression equation of the combined data set is:

$$\text{Cleanup Cost} = 24{,}936\ V^{0.527} \qquad (4)$$

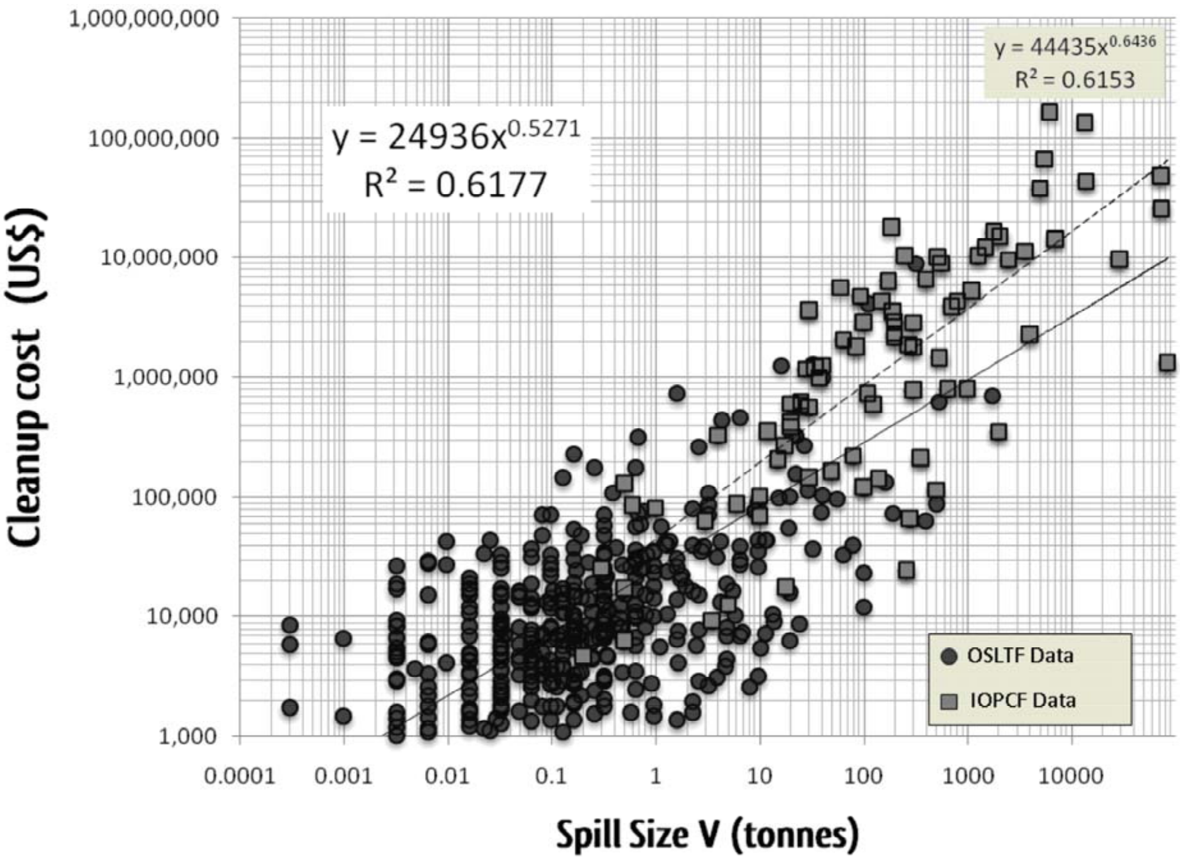

Fig. 2: Linear Regression of Log (Spill Size) and Log (Cleanup Cost) for combined dataset and for the original regression of the IOPCF dataset (outliers excluded).

20 It is straightforward to check that formula (4), which is derived from the combined data set, uniformly leads to lower cleanup costs than formula (3), which is derived from IOPCF data alone. This is true for all spill sizes.

Conclusions

21 It is clear that a non-linear formula derived from an analysis of a dataset which includes as many reliable data points as possible (including U.S. data) should be preferable as being more encompassing of both large and small spill sizes.

22 As the above analysis was limited to cleanup costs, a question is to what extent similar results apply for **total** oil spill costs. We were unable to perform a similar analysis for US total oil spill costs, as these costs were not included in the database. However, given that US spills are among the most expensive spills worldwide, we believe that the results of the above analysis provide enough evidence to support the following conjecture:

23 The non-linear formulae presented in MEPC 60/17 Annex 2 and which have been proposed by MEPC 60 for further testing are likely to over-estimate spill costs if used on a global basis and should probably be adjusted downwards for use in FSA or elsewhere.

24 Note that at this time this is only a conjecture, and analysis of further data, perhaps on a global scale, might lead to more concrete results.

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