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Disutility analysis of oil spills: Graphs and trends

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ABSTRACT

This paper reports the results of an analysis of oil spill cost data assembled from a worldwide pollution database that mainly includes data from the International Oil Pollution Compensation Fund. The purpose of the study is to analyze the conditions of marine pollution accidents and the factors that impact the costs of oil spills worldwide. The accidents are classified into categories based on their characteristics, and the cases are compared using charts to show how the costs are affected under all conditions. This study can be used as a helpful reference for developing a detailed statistical model that is capable of reliably and realistically estimating the total costs of oil spills. To illustrate the differences identified by this statistical analysis, the results are compared with the results of previous studies, and the findings are discussed.

1. Introduction

Oil pollution is a harmful and dangerous issue. The consequences of such incidents may damage and have catastrophic impacts on the marine and littoral environment. From an economic perspective, these incidents not only influence living standards but can also inflict significant economic harm on human-related activities, such as fisheries or the tourism industry. The aim of this analysis of oil spill cost data is to study compensations worldwide and shed some light on how the total costs of oil spills are assessed under different conditions. This study is similar to those carried out by Yamada (2009), Kontovas et al. (2010) and Psarros et al. (2011) but differs from them in many respects. Yamada (2009), Kontovas et al. (2010) and Psarros et al. (2011) attempted to provide useful insights on environmental risk evaluation criteria for policy evaluation of oil pollution from tanker accidents. This study and the aforementioned ones all used regression analyses, which demonstrates the ability and potential of regressions to efficiently address this type of problem. In this study, the calculated regression lines are compared with each other and with the so-called Cost to Avert one Ton of Spilled oil (CATS), which was proposed by Vanem et al. (2007); these results are discussed in detail later in the paper. The objectives of this study are not simply to provide a total cost estimation formula but also to analyze how the (total) cost of oil spills is assessed while focusing on the different conditions and variables that affect the characteristics of each spill. For example, this approach considers the type of accident, the distance from the coast, and the area of the accident. Therefore, it provides an accurate analysis of the spills and presents useful results for the international community.

The remainder of the paper is organized as follows. Section 2 presents a brief yet substantial review of the literature of oil spill valuation with a focus on the contributing factors and the development of statistical models. Section 3 presents the data used for this analysis, and Section 4 presents the results of the study of the cost of oil spills. Section 5 discusses the results of the analysis and compares them with the results of previous studies. Section 6 concludes the paper with interesting insights gained from the study.

2. Literature review

The total cost of an oil spill is based on several parameters and characteristics depending on the way and the extent that the spill has affected particular groups of people and the environment. For example, if a shore is polluted, environmental damage occurs, but tourism may also be reduced, which can affect the revenues of hoteliers. The factors that affect the total cost of a spill are complex and interdependent. Each incident is a unique event with special conditions and characteristics.

The total cost of eligible compensation claims is based on the effects of the spill on revenues and expenses (EMSA, 2010). This includes the cost of cleaning and restoring the environment, which may burden the local government, property damage, the decrease of tourism revenue, or the suspension of fishing activity (which affects those professionals associated with the fishing industry). The costs of preventive measures also form a significant part of the total cost. Another major issue is the cost of lost recreational

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activities; this cost is associated with environmentally oriented economic damage caused by the oil pollution and the restoration of the environment (Helton and Penn, 1999).

Of particular interest are the findings of Etkin (2001a) about the unit costs of an oil spill, which provides useful results for constructing a statistical model. A useful and commonly accepted finding is that the cost of each ton spilled decreases as the size of the spill increases.

The analysis of factors that affect the total cost is important. The factors are related not only to the conditions of the accident but also to its consequences and subsequently to the adopted mitigation strategies. Previous studies (Etkin, 1998, 1999; White, 2002; White and Molloy, 2003; Yamada, 2009; Ventikos et al., 2009) have identified several factors that determine the total cost, including:

- Spill size.
- Location of the accident.
- Physical, biological and economic characteristics of the area (e.g., tourism, fishing).
- Type of accident (e.g., grounding, collision, sinking, discharge of oil).
- Type of oil spilled.
- Remediation strategies selected and implemented.
- Detection speed.
- Regulatory regime and the degree of enforcement.
- Weather conditions.
- Season of the year.
- Leakage rate of oil into the sea.

Many experts agree that the most important factor that determines the cost of a spill is the location, with includes two aspects: the distance from the coast, because the effects of a spill are often directly related to the area of coastline that is polluted (White, 2002; White and Molloy, 2003), and the country and maritime region in which the accident occurs, which affect the perception and regulatory enforcement as well as the quality and capability of the equipment used to mitigate the spill (Etkin, 1999, 2000). Spills that occur near ports and coasts have significantly larger costs compared to those that occur at sea (Etkin, 1998, 1999, 2001b) due to the economic impacts of spills on coastlines and because of the expense and difficulty of cleaning coastlines. Moreover, the costs of oil spill mitigation are different in Europe or America and Asia because of the different regulations, the effectiveness of the equipment, economic factors, and the perception of the quality of the environment.

The size of the spill is an important factor in the total cost; larger spills require more oil to be removed than small spills, and the remediation process is therefore more expensive (Etkin, 1999, 2000). However, there have been cases where small leaks produced greater costs; this issue makes the study of oil spills a nontrivial task. Smaller spills may be more expensive to remediate on a per unit basis than larger spills; hence, the larger the spill is, the lower its unit cost of cleaning and mitigation may be (Etkin, 1999, 2000). This is because spill mitigation crews and equipment must be mobilized even for small spills, so these costs will apply to both large and small spills.

The fishing industry and local tourism comprise major parts of the economy of a coastal area. Therefore, a spill that affects these industries may create large social problems because of the negative effects on the many businesses that rely on them (VTT, 2009; IOPCF, 2006). When a spill occurs and fishing is affected, ports may be closed to prevent the spread of oil, boats may need to be cleaned, the fish may migrate or become infected and the demand for the fish market may decrease. Activities in these industries may be suspended for months, which may threaten or even devastate the local economy. In addition to commercial fishing, fish farming is often affected because farms are extremely sensitive to contaminants and therefore to the effects of oil spills (VTT, 2009). When tourism activities are affected, the extent of the loss depends on the season and time that the spill occurred, the influence of the media through their broadcasts and criticisms of the mitigation techniques and the pace of the remediation activities. The incomes of shops, bars, restaurants and hotels will decrease, and these types of businesses may make claims for compensation (third party claims). In the case of large-scale environmental damage, local authorities must restore the environment to its original state, (IOPCF, 2006); hence, clean-up operations have become more expensive, and the number of claims is increasing under pressure from environmental groups and public opinion (Hendrickx, 2007).

The type of the accident also affects the overall cost of a spill. There are many types of accidents with different characteristics and effects, such as sinkings, groundings, collisions, fires, overflows, and discharges. Each type of spill has specific costs, but sinking and grounding incidents tend to be the most expensive (Kontovas et al., 2010; EMSA, 2010; Yamada, 2009).

Pollution from ships is a top priority of the International Maritime Organization (IMO). One way of ensuring that action is taken before a disaster occurs is the use of Formal Safety Assessments (FSAs). Improving safety is a matter of technology (Hendrickx, 2007). The political consequences of spills result in new legal requirements, and the economic consequences result in research and implementation of new technologies. Previous studies of spills (including studies of spill costs, such as Siddiqui and Verma, 2010) helped the IMO to introduce evaluation criteria into the FSA guidelines and may also help the IMO to revise and improve maritime safety in the future (IMO, 2007). The study presented in this paper may serve this purpose and efficiently increase the capability to address oil spills at a strategic level. Most of the cost-oriented attempts presented in the international literature are based upon the BOSCEM estimation model, which was presented by Etkin (2004b). Moreover, most of the studies employed various regression techniques, but these methods differ in several respects, including their target, the selection of variables, applications and statistical metrics (Cohen, 1986; Etkin, 2001a, Etkin, 2004a, Etkin, 2004b; Shahriari and Frost, 2008; Yamada, 2009; Kontovas et al., 2010; Debon and Garcia-Diaz, 2011). A different approach was used by Montewka et al. (2013), who developed a probabilistic, though premature, model to estimate the costs of clean-up operations in the Gulf of Finland.

3. Statistical analysis of data

The data used in the analysis presented in this paper were derived mainly from the International Oil Pollution Compensation Fund (IOPCF); however, the data are amended with data from other American, Norwegian and Greek sources. The IOPCF is governed by four international conventions: the 1969 and the 1992 International Conventions on Civil Liability for Oil Pollution Damage and the 1971 and 1992 Conventions on the Establishment of an International Fund for Compensation for Oil Pollution Damage. This set of Conventions forms an international system/framework in which the costs of oil spills are compiled. More information about compensation for oil pollution damage can be found in the IOPCF Annual Reports (such as the IOPCF Annual Report, 2008), which present the claims that the Fund dealt with in the past.

The 2008 report includes 107 accidents; in most cases, the following information is recorded: the time, the place, the type of accident, the gross tonnage, the flag of the involved ship, the volume and the costs eventually covered by the Fund. Spills in the US are not included in this database because the United States has not signed the conventions. Damages are grouped into