



Journal of Management Sciences and
Regional Development
Issue 5, July 2005
Correspondence: ikarkazis@aegean.gr

<http://www.stt.aegean.gr/geopolab/GEOPOL%20PROFILE.htm>
ISSN 1107-9819
Editor-in-Chief: John Karkazis

DESIGN OF A DATABASE APPLICATION FOR OIL SPILL INCIDENTS: A PRO- ACTIVE ANALYSIS FOR THE MEDITERRANEAN SEA

N.P. Ventikos

*National Technical University of Athens
Athens, Greece*

A.B. Alexopoulos

*University of the Aegean
Chios, Greece*

H.N. Psaraftis

*National Technical University of Athens
Athens, Greece*

Abstract. In this paper we present a database containing statistical elements in respect of accidental and operational oil spills which have occurred in the Mediterranean Sea. An electronic tool named SPILLASE was developed that can handle all records of a structured built-in database. This database contains the oil spill incidents throughout the Mediterranean Sea (namely for the period 1978-1995). This effort aims to the formulation of a realistic approach and depiction of all aspects concerning oil pollution issues in the Mediterranean Sea. SPILLASE functions in the following multi-fold manner: It can represent the records of the database in various modes, it can execute all standard operations concerning the administration of a database, it performs multiple simple and complex queries with validated results and it can offer numerous automated statistical analyses generating representative results. SPILLASE aims to produce useful information primarily for maritime administrators and policy-makers when implementing national policies for the preventing and/or combating of oil pollution.

1. INTRODUCTION

Oil pollution resulting from maritime transport is a matter that attracts the public opinion and the industry. It is no coincidence that most international conventions and codes specifically refer to ship movements. Incidents such as the losses of oil tankers that heavily polluted the marine environment cannot be ignored, i.e. the growing pressure from environmental groups in the *Exxon Valdez* incident (1989) or from coastal state authorities in the *Erika* incident (1999), has led to tighter laws and regulations the implementation of which resulted into technical, political and economic consequences.

In the Mediterranean Sea the situation is not different. She mainly suffers from ship-generated oil spills and land-based discharges. Although she is considered as a 'specially protected sea-area' by the existing international legal framework, a high risk of oil pollution exists owing to the dense maritime traffic, the transportation of substantial quantities of oil cargoes, the presence of many ports etc (Alexopoulos & Mavranetzoulis, 2002). It has been estimated that some 30% of the international sea-borne trade volume originates from or is directed towards the Mediterranean ports, yet the Mediterranean Sea represents only about 0,7% of the total surface of the world oceans (IMO News, 2002).

Almost 250 oil tankers are crossing the Mediterranean on a daily basis (REMPEC, 2001). Most oil spills are the result of a combination of actions and circumstances, mostly human error and weather conditions. Almost all these operational spills are small, some 90% involving quantities of less than 7 tons (ITOPF, 2001), whereas accidental spills generally give rise to severe pollution incidents but are substantially less

frequent. The majority of ship accidents in the Mediterranean Sea do not relate to tankers but rather to bulk carriers. Tanker losses and pollution incidents seem to occur within port limits or close to the coastlines, i.e. the *Irenes Serenade* explosion (1980) at Pylos Bay spilling almost 80,000 tons of oil, or the *Haven* explosion (1991) at Genoa roads polluting the nearby beaches with 50,000 tons of oil.

The next section of this paper describes the formalities and problems arising from handling existing marine databases, while the following section introduces the so-called tool SPILLASE in detail. The ensuing section presents indicative results from the statistical module of this electronic tool purporting to prove a modern and efficient way of communication concerning the description and the analysis of marine safety incidents.

2. EXISTING SHIP-CASUALTY DATABASES: DESCRIPTION, FORMALITIES AND WEAKNESSES

A very important feature to assist in minimizing ship casualties is either the upgrading of current computerized databases or the formulation of new ones, so that everyone can have access to and evaluate all the available information. Under these terms it will prove more efficient to study the results and improve the methodology of intended measures. Various published materials/reports (Hooke, 1997) differ when attempting to classify the categories of ship-casualties that have caused or likely to cause oil pollution. The main types of ship-casualties are summarized below (Alexopoulos et al, 2001):

- Foundered/sinking, usually under severe weather conditions (heavy seas) and/or shifting of cargoes.
- Grounding/stranded, mostly in coastal areas of high density shipping either as a result of a mechanical failure or a navigational error.
- Collision/contact, in the former case between two or more ships often in busy sea-lanes and close to coastlines and in the latter case with a permanent structure such as a harbor breakwater or an offshore rig.
- Fire/explosion, when a ship is carrying an explosive cargo (e.g. oil, chemicals) and is offered no assistance from the shore.
- Structure failure, in cases of damage to ship's hull or machinery usually by temporary grounding or prevailing weather conditions.
- War losses, either through requisition of ships for naval use or by entering war zones.
- Other, including (i) missing ships, (ii) scuttling, (iii) unexplained disappearance, (iv) ships found drifting or abandoned.

Depending on the data received from ship-owning or ship-managing companies and the specific needs to be fulfilled, many international bodies (marine-related associations), i.e. ICS, ITOPF, IUMI, Intertanko, LRWS, OCIMF, Intercargo, GESAMP etc., are publishing various casualty-databases using selective information. As a result, there is no identical policy followed, let alone that a maritime casualty database will be of interest to each and everyone involved in the shipping industry for different purposes, i.e. shipowners, charterers, managers, insurers, arbitrators, shippers, salvors, classification societies, surveyors, adjusters and P&I Clubs. Also, this situation creates confusions for the scientist/researcher and makes it harder to categorize each accident or incident in the proper way (Dopler, 1994). We will turn

to a detailed presentation of some existing databases which relate to ship accidents and/or oil spill incidents:

The *Lloyds casualty return database* (L.R.S., 1995) is limited to ships over 1000 G.T. that have been declared as losses. 'Total loss' refers to a merchant ship that has ceased to exist, either due to being a casualty or due to have been broken up. Ships that have undergone repairs are not included. In more detail, the descriptive section includes the ship's name/year of built, GT/flag/type and voyage (from...to) as well as the cargo, circumstances and place of the accident and the category of casualty. The last element is analyzed in more detail:

- (a) ships 'foundered' that means being sank, 'missing' (in peace time they are considered losses),
- (b) 'wrecked/stranded' (instead of grounding), when ship touched sea bottom, sandbanks, seashore etc.,
- (c) 'lost' that includes war loss/damage due to hostilities,
- (d) hull/machinery damage or failure (instead of being a separate category under the 'term' structure failure),
- (e) miscellaneous which cannot be classified.

Additionally, ships being scuttled can be found in part II where details of disposals are reported not consequent upon casualty. Finally, the summary contains statistics for the size/age of vessels, registration, lives lost and the geographical distribution of total losses per annum.

The *IUMI database* (I.L.U., 1997) refers to vessels over 500 G.T. and the classification of available data is as follows:

- (a) size (war and kindred losses are excluded),

- (b) age (ships are treated as '0' years old if the loss is in the calendar year of delivery),
- (c) loss/total loss containing only ships which have been confirmed, normally by insurers, as total losses (excluding ships sent for scrap).

Furthermore, it contains information for actual total losses and constructive total losses (beyond economic repair), the type of vessel and amendments through the use of latest reports to upgrade existing tables. Consequently, it is suitable for specific interests and limited to statistical tables without explaining in more details the facts of each incident.

The *REMPEC database* deals exclusively with incidents that caused or likely to cause marine pollution in the Mediterranean Sea. Collected material and information is received from national focal points, Lloyd's casualty reporting system, Lloyd's list and ITOPF. The basic statistical ship-data consist of:

- (a) geographical position,
- (b) name/flag/dwt and grt/ year of built of the ship,
- (c) cargo carried quantity spilled (in tons),
- (d) surface (in km²),
- (e) comments on whether it was an immediate response,
- (f) remarks concerning the incident can be found in most cases.

The database refers not only to ships but also to pipelines' spills (on account of ruptures), storage tanks and refineries' spills (on account of military attacks) and shore terminals' spills. The categories of each

type of incident/accident leading to an oil spill, both accidental and operational, are the following: (i) accidental: collision/ramming (the latter possibly refers to amidships), fire/explosion, grounding, sinking, structural failure, war operations and unknown causes. In some cases the main cause of the incident was identified as either mechanical damage, or damage to steering, or engine breakdown, or hull damage. All the above should be included in the structural failure 'category'. (ii) operational: it includes spills owing to terminal operations, during discharge, bunkers, valve blockage, fuel leakage, tank overflow, lost towing lines, dragging anchor in strong winds.

The *ITOPF database* describes in detail some case-studies, the most serious tanker pollution incidents in terms of quantity spilled and world media coverage. In the statistics section, data are categorized by size [< 7 tons, 7-700 tons and > 7 tons], containing information on nearly 10,000 incidents, which is received from published sources (mostly shipping press) and from shipowners and insurers. The amounts of oil spilled refer to all oil lost to the environment, including that which is burnt or remains in the sunken vessel. The database contains the mapping/location of selected spills and divides tanker spills to (a) operations: including loading/discharging, bunkering, other operations and (b) accidents: including collisions, groundings, fires/explosions, hull failures other/unknown.

The *Intertanko database* (in printed form) includes selected serious tanker casualties and it refers to certain types of ship carrying petroleum products, i.e. tankers (VLCC, CC, LNG), OBO (oil-bulk-ore). In the appendix section, the accidents are described by the name/flag/year of built/dwt of ships, the casualty with detailed comments and observations/lessons-learned. It explains the contributing

factors of the incidents by using certain methodologies such as the event network (Intertanko, 1998).

The *Canada's environmental technology center database* contains information regarding tanker spills worldwide. Spills recorded over 1,000 barrels [42,000 gallons or 136 metric tons] of petroleum products for the period 1974-1997 (742 incidents included). The source of the spill must be a vessel, generally a tanker or a barge, on which petroleum product was the cargo. Acts of war are not considered accidental spills. Available data is limited to spill date/volume of oil spill, description of oil type and location of the spill (CETC, 2000).

The table below sets a good example of an existing database. It presents the major oil spills from tankers recorded at the global level. The parameters used refer to the name of the ship, the year of built, the flag of the vessel, the date of the incident, the location of the incident, the initial cause of the accident, and finally the oil lost to sea (in tons).

Tanker name	Y/oB	Flag	Date	location	Initial cause	Oil lost (in tons)
Atlantic Empress	1974	GRC	19.09.79	Off Tobago	Collision	287,000
ABT Summer	1974	LIB	28.05.91	w. of Luanda	Explosion	260,000
Cast. de Bellver	1979	ESP	06.08.83	Off C. Town	Explosion	252,000
Amoco Cadiz	1974	LIB	16.03.78	Off Brittany	Grounding	221,000
Odyssey	1974	LIB	10.11.88	Nova Scotia	Explosion	132,000
Sea Star	1968	KOR	19.12.72	G. of Oman	Explosion	121,000
Torrey Canyon	1959	LIB	18.03.67	Scilly isles	Grounding	119,000
Urquiola	1973	ESP	12.05.76	La Coruna	Grounding	100,000
Hawaiian Patriot	1965	LIB	23.02.77	Honolulu	Hull failure	95,000
Independenta	1978	ROM	15.11.79	Bosphorus	Collision	95,000
Jakob Maersk	1966	DAN	29.01.75	Off Leixoes	Grounding	88,000

Table 1. Selective Major Tanker-Oil Spills

Although this sample database would give information about the oil pollution and the types of accidents, it does not clarify certain aspects, i.e. (i) whether these tankers became a total loss or a

constructive/partial loss, (ii) what were the prevailing conditions at the time of the incident, (iii) which actions were adopted to prevent or deal with the incident or the sequence of events that finally led to the recorded casualty, etc.

It is obvious that the above examples of ship-casualty/pollution databases are not ideal to describe in a thorough way each incident that had occurred. It would be more convenient to adopt a globally accepted system of marine databases using identical terms and conditions for particular seas and oceans, i.e. Mediterranean, Baltic, Atlantic, Pacific, Persian Gulf etc., so that more effective and precise information is received and further assist on the prevention of similar accidents to happen. A representative example is provided by DNV (1997), a system called DAMA referring to specific codes of accidents in detail. In this way, we may investigate relationships between the probable causes of an accident and its final outcome. Below we can observe the relation between category 'G' (individual on board, situation judgement, reactions) with categories 'A' (circumstances not related to the ship), 'B' (construction of the ship and location of equipment on board) and 'F' (communication, organization, procedures and routines) – (see figure 1).

So far we may conclude that, the development of databases constitute an important tool in the context of studying and analyzing matters of marine safety. This might seem to be an easy process but in reality it proves to be an extremely difficult and time-consuming one (Domovic, 1996). It is imperative, that all relevant weaknesses should be at least mitigated, in order to formulate complete records. Summing up, the most important problems pinpointed are the following ones (Ventikos *et al*, 2001):

- The inconsistency of entries: all databases present a substantial deviation concerning the recording and coding of data – i.e. the flag of Greece can be found in some databases as GRC in others as GR or GRE etc.
- The reduced density of entries in relation to marine safety: various aspects of oil spills are ill recorded, i.e. the incorporation of operational spills, whether burned oil or cargo remained in the sunken vessel's tanks are classified etc.
- The inefficiency of entries: it is observed that most entries are not complete and therefore they do not impel the exploitation of the existing information: The main reason being the different sources of information, either local points or international authorities.
- The focus on particular goals while collecting data: this practice results into a selective incorporation of information in databases, i.e. several databases refer exclusively to total losses. This may prove useful for the marine underwriter and the adjuster but not for other parties that wish to investigate deeply into a maritime accident.
- The slow rate of incorporation and renewal of entries: the updating of relevant databases is delayed reducing their utility, particularly when small oil spills occur that are either not reported at the right time or totally ignored.
- The non-existence of a commonly accepted and defined procedure for the assurance of the quality of the collected data, i.e. an MARPOL-like approach.
- The non-configuration of a common generic platform for the elaboration of all available data: in this way, the outcomes cannot be set into immediate comparison.

The above mentioned points constitute, in broad terms, the spectrum of possible shortcomings at various stages of developing and administrating a useful and updated (pollution) database. Therefore, all these should be set as targets for similar efforts, in order to assure credibility and exploitability of the results.

Code	Cause
G	Individual on board, situation judgement, reactions
G01	Insufficient formal competence for the task (courses, exams etc.)
G02	Insufficient real competence (practice from occupation, with equipment etc.)
G03	Task not well planned (cargo, night voyage, maneuvering, anchoring etc.)
G07	Not adequate observation of own position/not plotted on charts
G08	Misjudgment of other vessel's movement or intention
G09	Misjudgment of other vessel's movements (current, wind etc.)



Code	Cause
F	Communication, organization, procedures and routines
F01	Routines for average control were lacking/were not sufficient
F02	Routines for average control were not properly known/drilled
F03	Routines for safety control lacked/were not sufficient
F04	Not taken measures concerning testing of rescue instruments etc.
F09	The general level of organization/routines/qualifications poor
F10	Failure of routines for inspection and maintenance on board
F12	Unfortunate management, personal antagonisms or suchlike
F16	Safety routines in connection with bridge watch, but not followed



Code	Cause
A	Circumstances not related to the ship
A01	Very heavy weather, natural disaster etc.

A02	Current wind etc. led to strong drift or other maneuver difficulties
A03	Collided with floating objects, could not be discovered/avoided in time
A04	Fault with navigation systems: lights, external electronic systems etc.
A05	Fault with charts or publications
A06	Technical fault with other ship (also includes towboats and the like)
A07	Operational fault with other ship (wrong maneuver/poor seamanship etc.)
A08	Technical fault with load/unload/bunker construction/quay/sluice, outside ship
A10	Blowout or other extern conditions in connection with oil drilling



Code	Cause
B	Construction of the ship and location of equipment on board
B01	The ship's structural strength not sufficient
B02	The structural strength weakened by later welding jobs, corrosion etc.
B03	Stability failure caused by the construction of the ship
B04	The ship had too poor maneuver qualities
B05	Arrangement of engine room/location of equipment with danger of leakage
B06	Unfortunate arrangement or location of load or storage room
B07	Unfortunate location/arrangement or other rooms on board (not bridge)
B08	Difficult access for cleaning , maintenance and inspection

Figure 1. Codifying Marine Accidents under the DAMA System

3. PRESENTATION OF THE “SPILLASE”

At this point, the total form of this tool will be described concisely, as well as the main possibilities that it offers to potential users. The program was initially designed to cover the needs of managing the particular database – via the constant feedback (enrichment) with new corresponding data i.e. add, edit records, etc. Nevertheless, in short time it was developed in such way to become a very useful electronic tool that embraces the database in many more beneficial ways. All main operations that the electronic tool SPILLASE may perform, are described below in brief:

- Presentation of the entire database of oil pollution in the Mediterranean Sea.
- Administrative functions of the database.
- Simple queries concerning the database registrations.
- Complex queries concerning the database records.
- Multiple automated statistical analyses of the stored data.

The specific electronic tool can represent the existing records in a dual form: tabular and separate. It can also execute swiftly all the classic processes of a database, i.e. adding new records, altering or erasing existing records etc. The simple queries that can be performed are predetermined and they come up with verified and reliable results. Specifically, these queries are indicatively described below (Ventikos, 2002):

- (i) pollution incident data (i.e. date, region, type of spilled oil and incident cause),
- (ii) involved vessel(s) identity (i.e. type-name, flag and age).

Additionally, the program offers the choice for the automatic creation of pre-formatted reports that contain all the results deriving from each of these simple queries. The provided complex queries can function under two basic ways: (i) with predetermined choices and (ii) with free choices. By choosing the former approach the user is provided with ten information sockets, i.e. the type of the involved vessel, the quantity of spilled oil etc. The latter approach gives to the user six information sockets, i.e. the size of the vessel, the date of the accident, the flag of the vessel etc. With this second option the program can accept a significant quantity of unformatted data as input variables.

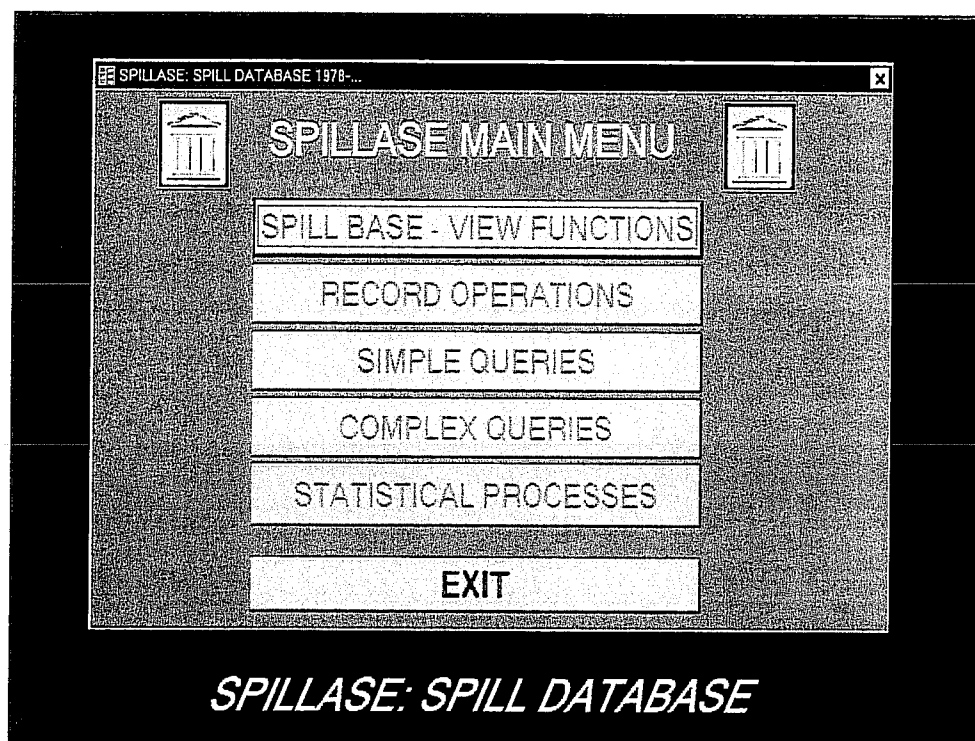


Figure 2. Basic Functions of SPILLASE

Also, SPILLASE can automatically proceed to various statistical analyses that may provide useful and reliable results (mainly diagrams). Moreover, these analyses are divided into two major categories: basic and advanced. A generic and indicative sample of the aforementioned statistical possibilities appear in short below:

- Analysis based on the differentiation of various features of the involved vessels such as flag, age and type (see Figure 1).
- Analysis based on the differentiation of various features of the polluting incident such as region, date, spilled quantity (in tons), cause and type of spilled oil (see Figure 3).

fighting of oil pollution.

- Frequency estimation and advanced quantitative methods for various components of oil pollution (Ventikos & Psaraftis, 2001).
- Estimation of corresponding moving averages (i.e. for the frequency of spill incidents per ship type and chosen flag) implementing the following generic equation:

$$ma'_{(t+1)} = \frac{1}{N} \times \sum_{i=1}^N ma_{(t-i+1)}, \text{ where } ma_0 \text{ is the corresponding moving}$$

average in various time stages and N is the number of time periods used for the calculation of the moving average.

- Manifold regression approach, i.e. by analyzing (regressing) the quantity of spilled oil related to predetermined sizes of certain parts of the Mediterranean coastline. This is done by using numerous types of regression analysis such as the linear regression analysis ($y = m \times x + b$) or the exponential (logarithmic) regression approach ($y = b \times m^x$) etc. From SPILLASE analysis it turns out to be no relation between the quantity of spilled oil and the corresponding size of active coastline.

The screenshot shows a software interface titled "SPILLASE: SPILL DATABASE 1978-...". It features several dropdown menus for selecting search criteria:

- SPILLAGE:** 1900-1949, 1950-1959, 1960-1969, 1970-1979, 1980-1989, 1990-1999, UNKNOWN
- DATE:** 1975-1979, 1980-1984, 1985-1989, 1990-1994, 1995-1999
- FLAG:** CYP, EGY, ESP, FRA, GBR, GRC (selected), HND, ISR
- AREA:** ALBANIA, ALGERIA, CYPRUS, EGYPT, FRANCE, GABALTA, GREECE (selected), ISRAEL, ITALY
- SPILL:** 1-999, 1000-4999, 5000-9999, 10000-99999, 100000 AND MORE, UNKNOWN
- TYPE:** CONTAINER, COMBINATION, GAS CARRIER, MISCELLANEOUS, OFFSHORE, PASSENGER, REEFER, ROAD, TANKER (selected), TWEEN DECKER
- ACCIDENT:** ANCHOR PROBLEM, BUNKERING, COLLISION/RAMMING, DISCHARGE, ENGINE TROUBLE, FIRE/EXPLOSION, FUEL LEAK, GROUNDING (selected), HULL DAMAGE
- RESPONSE:** BURNED, DISPERSION, LIGHTERING, PROTECTION, SURVEILLANCE, WIND/FRONTATION, UNKNOWN
- SOURCE:** CRUDE OIL (selected), DIESEL/OIL, FUEL OIL, GAS OIL, GASOLINE (KEROSENE), NONE, OIL PRODUCTS/RESID, UNKNOWN
- QUANTITY:** NONE, <, 1-99, 100-999, 1000 AND MORE, UNKNOWN

At the bottom, there are four buttons: "CLICK YOUR CHOICES", "ENTER QUERY", "RESET", and "BACK". Below the interface, the text "SPILLASE: SPILL DATABASE" is displayed in a stylized font.

Figure 3. Complex Queries

It is noteworthy that the last three generic options of the above possibilities need extra introductory data in order to produce logical results. However, these extra data are considered to be fairly generic and easy to access rendering SPILLASE as a flexible and dynamic tool for administrating and elaborating the records of pollution databases.

Every time that the elements of SPILLASE database are being in any form of changes (i.e. addition, deletion etc.) the tool can proceed in new calculations and planning of the provided statistical methodologies-diagrams. It should be emphasized that the tool has ready-on code reception possibilities for further improvements if such are proven to be either necessary or useful in the future. As examples for these

- presumptive SPILLASE enhancements are the introduction of more information slots in the basic database structure, the formulation of more pre-formatted simple or even complex queries etc. In any case, SPILLASE model as it is in the present time can be characterized as a user-friendly, straightforward package that can operate completely autonomous.

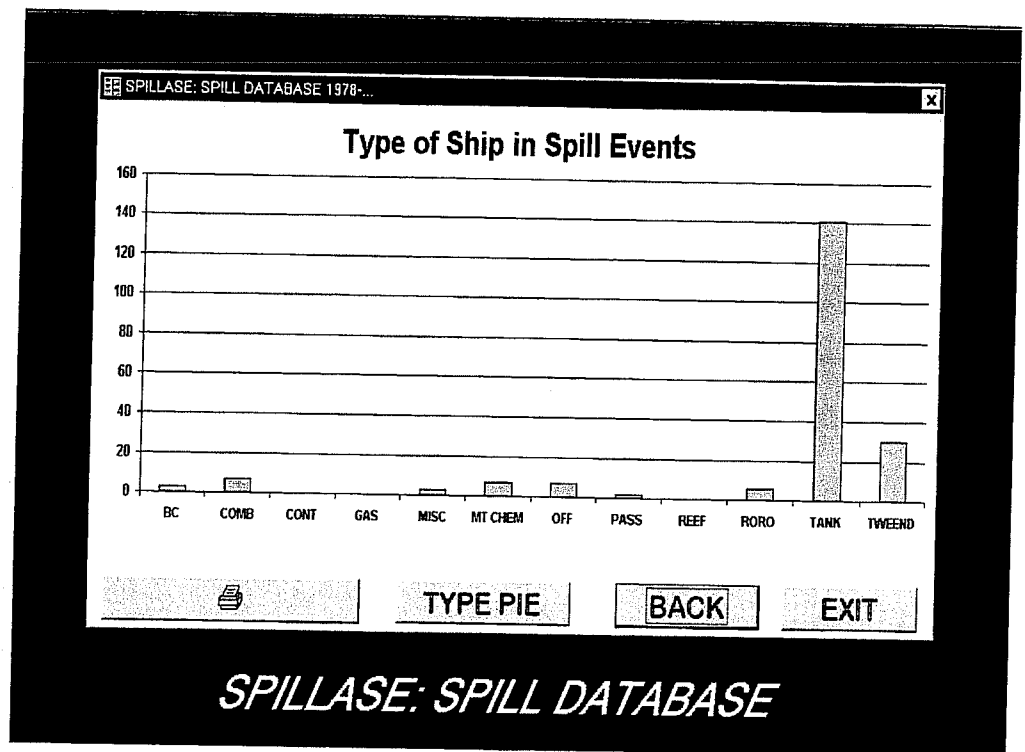


Figure 4. Example of SPILLASE Basic Statistical Analysis

- Finally, certain technical characteristics of the SPILLASE tool must be presented. The computer code is written in Access Basic. The lowest specifications that are required for the computer that will host SPILLASE are a Pentium 266 MHz processor with a 32Mb RAM that has the technical standards to support the examined program.

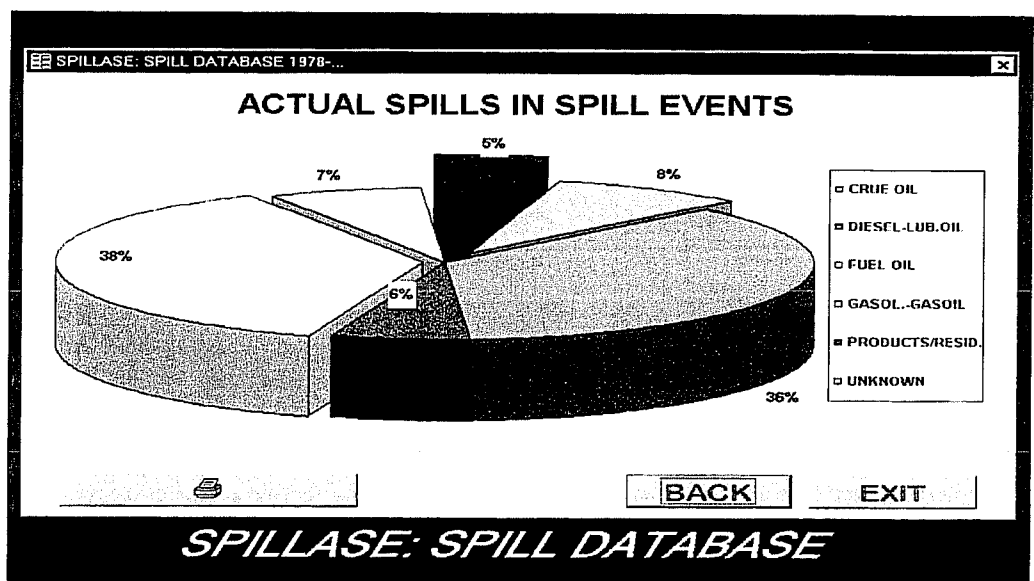


Figure 5. SPILLASE Automatic Spill Type Distribution (1978-1995).

4. VALIDATION AND VERIFICATION OF SPILLASE ANALYSIS RESULTS

It is of high interest to compare and validate the arising results from the incorporated SPILLASE statistical analysis (module) with the corresponding data coming from the international literature and more specifically from REMPEC and IMO. This is done in order to depict the relative capabilities of SPILLASE and its multi-fold spectrum of operations and utilities.

Under this perspective it is rather significant to prove that all implemented (quantitative) techniques in the program are capable of coming up with some interesting and more important reasonable results that strengthen its adopted structure. Of course, the *garbage in – garbage out* theory is perfectly applied in this case rendering the whole

model very sensitive to the so-called *data noise* (data of poor quality). Therefore, it must be accepted that the examined set of data is free of several of the aforementioned weaknesses.

In this section, two indicative-comparative examples are synoptically presented in order to verify in general terms, the statistical operability of the SPILLASE tool. The first of these examples concerns the analysis of the vessel type involved into oil spill incidents. Figure 4 shows exactly this distribution indicating tanker vessels as the key players. On the other hand, table 2 depicts the respective results drawn from REMPEC database in respect of the period 1981-1995 for the Mediterranean Sea.

Type of Vessel	1981 / 1995	
	Number	%
Tankers	126	74
Combination Carriers	7	4
Cargo Vessels	35	21
Barges	2	1
Other	0	0

Table 2. Involved Vessel Distribution According to REMPEC (1981-1995)

By comparing the results from SPILLASE (as shown in Figure 4) and from REMPEC (as shown in Table 2) we may perceive that there is a similar representation of this pollution variable between the two approaches. The second selected example deals with the distribution of the types of oil spilled in the basin of the Mediterranean Sea. The results

deriving automatically from the SPILLASE tool can be seen in Figure 5 while the corresponding data from REMPEC are contained in Table 3.

Type of Oil		1981 / 1995	
		Quantity (t)	%
<i>Persistent</i>	Ship fuel (bankers)	1244	2,5
	Crude Oil	19893	37
	Heavy Fuel	13422	25
	Other	27	negligible
	Ship's Fuel	311	0,5
<i>Non-Persistent</i>	Cargo	18866	35
	Other	48	negligible
TOTAL		53811	100

Table 3. Spill Type Distribution According to REMPEC (1981-1995)

Comparing the above results from SPILLASE (as shown in Figure 5) and REMPEC (as shown in Table 3) one can get in general, a dually akin picture for this pollution parameter with crude oil, fuel oil and oil products sharing the largest portion of responsibility for oil pollution. Of course a deviation is recorded, especially for the product category but this, as already mentioned, should be attributed in a data inconsistency between the two sources rather than in a SPILLASE module failure.

It is rather evident that the selected comparative examples are in a position to validate the adopted SPILLASE functions and to verify in

results spotted in the international literature.

5. CONCLUSIONS

The discussed SPILLASE package is an original tool for advanced database management and record elaboration. This paper presents in some detail all of the provided operations of SPILLASE focusing mainly on data query and statistical processing functions. It becomes quite evident that the development of the structure of SPILLASE is based exactly on the philosophy of a stand-alone tool. It can also mitigate some of the basic database weaknesses already mentioned and analyzed earlier in this paper. So this tool is able not only to administrate dynamically the records of a pollution database but to further study and elaborate the existing data in order to produce automatically viable statistical results.

Moreover, the comparison between the SPILLASE results and the respective conclusions from the international bibliography justifies all the above comments showing the correctness of the implemented modules. The selected indicative examples depict these advantages and constitute SPILLASE as an original and automatic tool of data management and knowledge.

Finally, the necessary information for the records of a pollution database – such as the SPILLASE database – is to be transferred in a structured and determined protocol. This will result in an immediate,

modern and efficient way of communication concerning the description and the analysis of marine safety incidents.

REFERENCES

1. **Alexopoulos, A.B. and Mavranetzoulis, A. (2002),** *Oil Spills in the Eastern Mediterranean Region: The Case of Single-Hull Tankers*, Cyprus Journal of Science and Technology, Vol 3, Issue No2, pp.17-28.
2. **Alexopoulos, A.B. Dounias, G. Kalyvas, E. and Lekakou, M. (2001),** *A Detailed Analysis of Passenger and Ro-Ro Ships' Accidents in Greek Seas Using a Data-Mining Tool*, 2nd International Conference on Safety of Maritime Transport, Proceedings (CD), University of the Aegean.
3. **Canada's Environmental Technology Centre, (2000),** Spills Technology Databases 1974-1997, www.etc-cte.ec.gc.ca/databases/TankerSpills/default.aspx
4. **Domovic D., (1996),** *Sources of Marine Oil Pollution*, International Conference MEDIPOL 96, Athens, Greece.
5. **Dopler J.P., (1994),** *The Requirement for the Publication of Detailed Global Marine Casualties Statistics*, Maritime Policy and Management, Vol.21, No1.
6. **Hocking C., (1969),** *Dictionary of Disasters at Sea During the Age of Steam*. Including Sailing Ships and Ships of War Lost in Action 1824-1962, Lloyd's Register of Shipping.
7. **Hooke N., (1997),** *Maritime Casualties 1963-1996*, Lloyd's of London Press, 2nd Edition, London-Hong Kong.

8. **IMO News, (2002),** *REMPEC 25 Years fighting Pollution*, Issue No1.
9. **Institute of London Underwriters, (1997),** *Hull Casualty Statistics*, IUMI Conference, Paris, September 1997 (statistics for Marine Insurance).
10. **Intertanko, (1998),** *Systematic Approaches to Tanker Accident Analysis – Lessons Learnt*, A Discussion Paper, published by Intertanko.
11. **ITOPF, (2001),** *Oil Spill Database*, www.itopf.com.
12. **Lloyd's Register, (1995),** *Casualty Return: Years 1984-1994*, published by Lloyd's Register of Shipping.
13. **REMPEC, (2001),** *List of Alerts and Accidents*, www.rempec.org
14. **Ventikos N.P., Dilzas K.P., Lyridis D.V., Psaraftis H.N., (2001),** *Contribution of Telematics in the Management of Oil Spill Issues*, International Conference on Shipping Technology & Environment, Piraeus, Greece.
15. **Ventikos N.P., (2002),** *Development of an Evaluation Model for the Importance, the Causes and the Consequences of Oil Marine Pollution: the Case of Maritime Transport in the Greek Seas and in the Gulf of Saronikos*, PhD Dissertation, National Technical University of Athens, Greece.
16. **Ventikos, N.P. and Psaraftis, H.N., (2001),** *Implementation of a Multi-Level Statistical Analysis on a New Database Covering Oil Pollution in Greek Seas: Definitions & Results*, International Conference of Environmental Statistics, Cadiz, Spain.
17. **Zera T.F., (1996),** *Ore-Oil-Bulk. A Pictorial History of Bulk Shipping Losses During the 1980's*, Rutledge Books Inc., Bethel.