The Efficiency of the Greek Lighthouse Network

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Among the many primary causes which lead to a shipping casualty, those of wrecking, stranding or coming into contact with fixed coastal structures depend (although not exclusively and only under specific conditions of visibility) upon the efficiency of the lighthouse and navigating lights network of a national coastline. The analysis of the shipping casualties involving Greek ships in the Greek seas revealed that, despite the recent introduction of sophisticated navigating aids for the prevention of stranding and contact, the share of the corresponding casualties remains unchanged. It appears that for coastal shipping operations, and in particular for port approaches, the traditional light navigating aids are and will always provide an irreplaceable safety service for navigators. This is mainly attributed to their technological simplicity which offers a high level of signal reliability and friendliness for the navigator.

1. INTRODUCTION. The maritime policies of all coastal states must strive for the right balance between the management of sea resources, safety of navigation, protection of the coastal environment and the maintenance of an efficient maritime transport system. Much effort has been, and continues to be, expended in these areas but many tragic casualties that continue to occur are sad proof that more needs to be done.

The results of detailed research into shipping casualties[1,2] indicate the significant involvement of the human factor as the root cause, with particular manifestation in the phase of operation, although its involvement is also found in the design and manufacture of ships and supporting systems.

With the exception of sea crossings, the option of sailing along the coastline has always been of preference, since this generally offers increased navigational safety and economy of voyage resources. However, the distance between the coast and the ship is critical since the above-mentioned attributes of near-shore sailing have to be compromised with the lurking danger of becoming a casualty through stranding. On the safe completion of sailing, the ship must inevitably approach the port of its destination, and here again the danger of casualty through stranding or coming in contact (with the quay or the wave-breaker) is always present. In both cases, the stranding or contact are assumed to be the primary causes of the potential casualty although, as was previously mentioned, human error generally predominates as a determinant factor.

Consequently, most of the technological advancement in shipping, both onboard and ashore, has been geared towards the minimisation of human intervention in the control of shipping operations, with navigation being no exception. Among the many areas of technological intervention, the recent addition of a new range of navigational aids (electronic charts, advanced radars,

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GPS, VTS-VTMIS, etc.) to the more traditional paper charts and lights was aimed at improving the record of stranding or contact induced casualties. It is, however, widely acknowledged that apart from the degree of built-in reliability presented by these highly sophisticated tools of navigation, their effectiveness primarily depends upon the successful establishment of an optimised man-machine interface.[3-6]

The changes in the records of shipping casualties are bound to reflect the changes introduced in measures for the prevention of these casualties, and this realisation inevitably sets the platform for the assessment of the efficiency of the lighthouse network.

2. METHODOLOGY. Among the possible approaches for the assessment of the efficiency of a lighthouse and navigating lights network, the retrieval and analysis of records, which bear the navigator's witness to the prevention of specific shipping casualties by virtue of these aids, appears to be most reliable. However, the retrieval of a representative sample of these records is a cumbersome task, since (if kept) they constitute part of the ship's log-book and are not monitored by any central agency or organisation. Alternatively, the records of shipping casualties due to causes and conditions which relate to the navigating lights as a potential factor of casualty occurrence provide an indirect but manageable approach for assessment. More specifically, it may be safely assumed that the network of navigating lights plays a major and direct role in the prevention of casualties which may be primarily caused by the wrecking, stranding or contact of ships (Fig. 1). Naturally, there are other primary causes

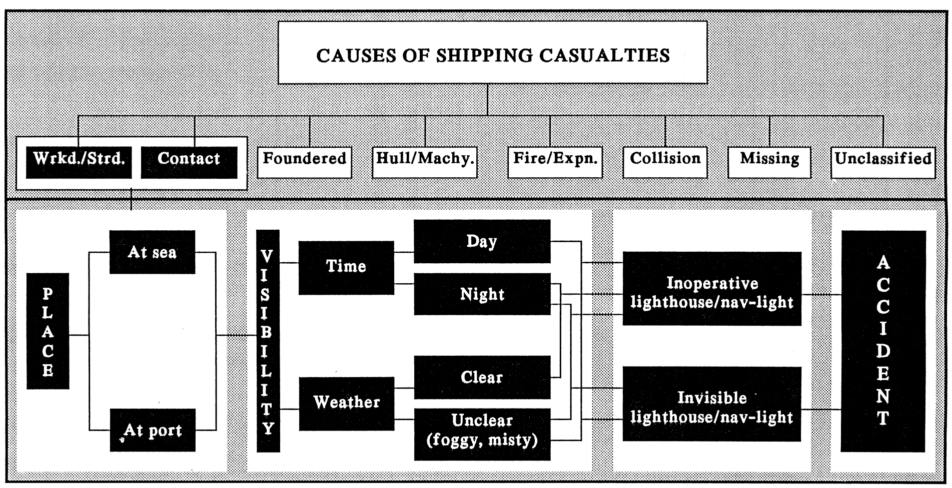

Fig. 1. Causation analysis of casualties dependent on light-aided navigation. The definition of causes is presented in Appendix A.

of shipping casualties (such as foundering) which could have been prevented by the availability of a lighthouse/navigating light, but in this case its intervention with the casualty is indirect. The following remarks may prove to be the most convincing example of the above-mentioned arguments.

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For the ship's navigator, a port call procedure starts with announcing to the port officer his intention to enter, through the establishment of a radio communication link. In conditions of low visibility, such as a night port approach, the indication of the port's entrance by a lighthouse or a light-buoy system provides the navigator of the ship with the most direct (and reliable) means for ascertaining the ship's position relative to the port's entrance and for deciding on the course of entry. Alternatively, for a ship sailing at night near the coast or in shallow waters, a lighthouse is a direct aid of stranding-avoidance complementing that of the radar, charts, etc. No need to mention how important this light navigating aid will be in the event of the ship's black-out, when all the onboard navigating systems are inoperative! On the other hand, a ship sailing in weather conditions which impose upon it a real threat of foundering could ascertain its position relative to a lighthouse and communicate with the nearest Rescue Coordination Centre or another nearby ship for assistance, thus utilising the lighthouse signal as an indirect aid for the prevention of foundering.

Hence, the potential of a direct correlation between the casualties caused through wrecking/stranding or contact and the lighthouse/navigating light network offers the capability of assessing its efficiency. To assess the efficiency of lighthouses and navigational lights in the prevention of shipping casualties, an appropriate place and time of reference has to be selected. The extent and complexity of the Greek coastline offers a good setting, and the period on either side of WW2 is representative of distinct technological levels. In this presentation, therefore, the record of casualties of the Greek merchant fleet within the Greek seas is analysed, and a comparison is made between the all-causes and stranding/contact casualties, with reference to a pre-WW2 record and that of the last 25 years. This assessment is based on the assumption that the services offered by the lighthouse and navigational light technology during the above-mentioned periods went through little alteration, when compared with those which were brought about by the introduction of new technologies. The assessment involves an analysis of the casualty records of Greek ships (and of specific types) with respect to their cause, time and space-distribution of occurrence in the Greek seas. Descriptions of the Greek coastline and the shipping traffic in the Greek seas provide a background to the undertaking.

3. COASTLINE AND SHIPPING TRAFFIC. As the region of reference, the Greek seas have coastline characteristics relevant to the present analysis as shown in Table 1. The coastal length of about 15000 km is split between the islands and the mainland at a ratio of 2·15 : 1 and, with a coastal network of 1111 navigating lights, an overall ratio of one light every 13·5 km is found. However, the unique (in European terms) multi-island structure of Greece does not allow easy comparisons with other continental countries. With a level of coverage of the mainland coast of one installation every 10 km, Greece is closer to the denser distribution of adjacent Mediterranean countries. There are 138 ports of economic significance (wrt shipping operations) and 96 of them serve the Greek islands. All these ports are equipped with a lighthouse and the larger ones with extra navigating lights in the form of an additional lighthouse in some other location or with light buoys.

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Table 1. Greek coastline: geography–ports–lights

Region	Coastal length[a] (km)	No. of ports[b,†]	No. of lights[c]
Mainland*	4756	42	474
Islands	10265	96	637
Total	15021	138	1111

* Including Evia and Peloponnesos.
† Of economic significance.
Sources
[a] Flocas, A. (1986). *Textbook of Meteorology and Climatology*.
[b] Psaraftis, H. N., (1992). *Freight Transport by Ferry to and from the Greek Islands: A Case Study*. Report to the Commission of European Communities, Directorate General for Transport, COST 310 Programme (Freight Transport Logistics).
[c] Hydrographic Service of Greece – Lighthouse Service – *List of Lights of Hellenic Coasts (1996)*

The characteristics of the shipping traffic in the Greek seas are shown in Fig. 2. Although all regions of the Greek seas are busy with international shipping, the Aegean Sea is dominated by the coastal (domestic) shipping traffic of carriers for passenger and/or car transport services. Overall, the number of voyages during which ships of Greek flag are at risk of any form of casualty in the Greek seas is close to 550000 per year. About 30% of these voyages involve night sailing and port calls, which comprise conditions of particular risk towards casualties from wrecking/stranding or contact. Similarly, voyages in conditions of fog, heavy rain or mist and snow storm, although generally considered as high risk for these casualties (due to the reduction of the effective luminous range of the lighthouse), are a rare occurrence in the Greek seas.

4. CASUALTY RECORDS. Over the last 25 years, 567 casualties involving ships of the Greek flag in all seas were recorded, giving an annual average of 27 ships of all types. Prior to WW2, for a period of 5 years, the corresponding record of casualties of Greek ownership stood at 985, giving an annual average of 197 ships of all types (see Table 2). Over these periods, the annual averages of wrecked/stranded or in contact ships were 9 and 70 respectively. The numerical differences between the two periods are influenced by the contrast in terms of the shipping activity and size of the corresponding fleets, i.e. in terms of voyages and the number of ships at risk (due to fleet size, Greek flag vs Greek ownership and fleet size changes with time). However, the assessment of the efficiency of any particular casualty prevention measures, such as those related to wrecking/stranding or contact prevention (namely of the lighthouse/navigating lights network), is feasible provided the comparison is made between the share of the 'nav-light-dependent' casualties presented in each period. This was found to be unchanged and at around one third of the casualties recorded from all causes.

Over the last 25 years, the Greek passenger/car carriers have suffered fewer casualties than their cargo counterparts, although these casualties mostly took

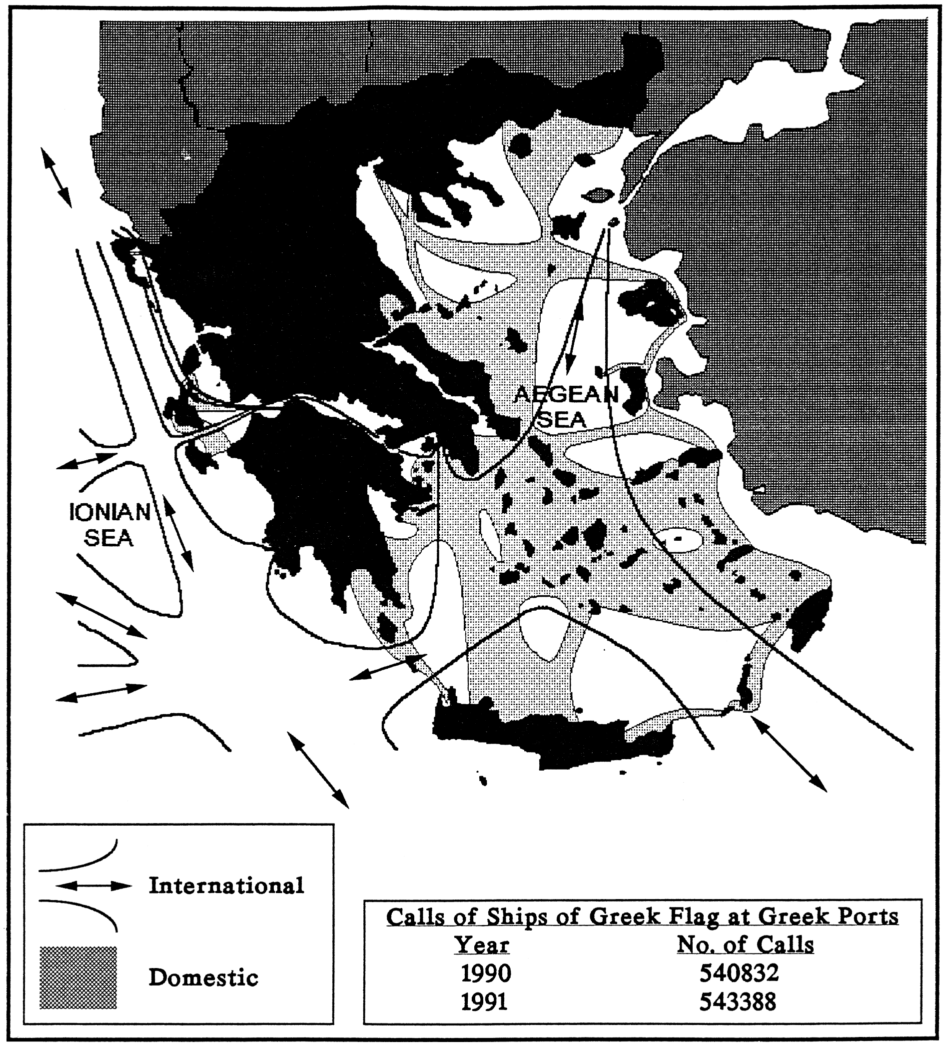

Fig. 2. Regions of international and domestic shipping and traffic statistics. *Source*: The Directorate of Sea Transport (ΔΘΣ), Ministry of Merchant Marine, Greece, and Shipping Statistics, National Statistical Service of Greece, (1996).

place in the Greek seas where these ships predominantly operate. Furthermore, in this sea region, the share of the wrecking/stranding or in contact casualties suffered by the passenger/car carriers was about 50% of their total, nearly double that of the cargo fleet and with an 'in port' location of 50% (see Tables 3 and 4). As expected, all the 'in contact' casualties were recorded in this location and accounted for about 45% of all the casualties which are particularly examined for their relevance to the light navigating aids. These particular casualties show a relatively bad record over the last decade which peaked in 1989 (see Fig. 3).

TABLE 2. ANNUAL AVERAGE OF CASUALTIES INVOLVING GREEK SHIPS

Causes	All ship types – anywhere (1970–1996)	All ship types – anywhere (1926–1930)
No. of casualties from all causes	27	197
No. of wrecked/stranded or in contact	9	70
% of wrecked/stranded or in contact	33·3	35·4

Casualties for the 1970–96 period refer to ships of Greek flag (Appendix B, Table B-I), whereas those of 1926–30 refer to ships of Greek ownership (Appendix B, Table B-II).

Source: The Directorate of Navigational Safety (ΔAN), Ministry of Merchant Marine, Greece.

TABLE 3. SEA REGION OF CASUALTIES INVOLVING SHIPS OF GREEK FLAG

	Passenger/Car Carriers (1970–1996)			Cargo Carriers (1979–1996)		
Causes	Greek seas	Foreign seas	Any where	Greek seas	Foreign seas	Any where
No. of casualties from all causes	226 (93%)	17	243	77 (24%)	247	324
No. of wrecked/stranded or in contact	107 (95%)	6	113	18 (22%)	65	83
% of wrecked/stranded or in contact	47·3	35·3	46·5	23·3	26·4	25·6

Source: The Directorate of Navigational Safety (ΔAN), Ministry of Merchant Marine, Greece.

TABLE 4. LOCATION OF CASUALTIES INVOLVING GREEK FLAG SHIPS IN THE GREEK SEAS

Causes (wrecked/stranded & contract)	Passenger/car carriers (1970–1996)		Cargo carriers (1979–1996)	
	In port	At sea	In port	At sea
Number	54	53	1	17
%	50	50	5·5	94·5

Source: The Directorate of Navigational Safety (ΔAN), Ministry of Merchant Marine, Greece.

5. CONCLUDING REMARKS. The detection of a negligible change in the share of casualties caused primarily by wrecking/stranding or contact during the analysed pre-WW2 period and over the last quarter of the century indicates that, despite the many technological advances which introduced new navigational aids for the prevention of these casualties, the traditional services offered by the lighthouse/navigating lights networks are as vital as ever.

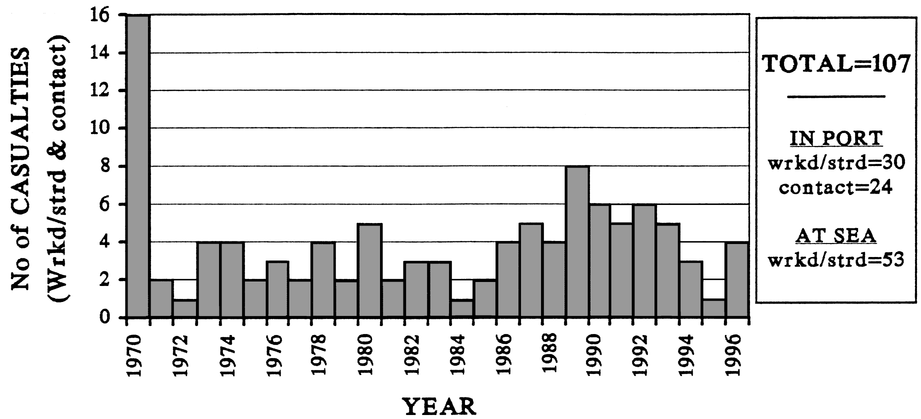

Fig. 3. Record of casualties involving wrecked/stranded or in contact passenger/car carriers of Greek flag in the Greek seas. *Source*: The Directorate of Navigational Safety (ΔAN), Ministry of Merchant Marine, Greece.

Despite the adequate coverage of the lighthouse/navigating lights network of the Greek coast, the extent and complexity of the Greek coastline, coupled with the traffic characteristics of shipping in the Greek seas, presents a high level of casualties caused through wrecking/stranding or contact. In these confined sea regions, the coastal operations of the Greek passenger/car carrier fleet are performed with a level of frequency which puts near-coast sailing and port calls at high risk of loss from this type of casualty. In high season, the congestion of the Greek ports and particularly of many smaller ones in the Aegean Sea by sizeable ferries is a real threat. It is, however, evident from this study that the lighthouses and navigating lights along the Greek coastline alleviate the potential number of casualties for the more than 500 night sailings and port calls every day (450 of Greek flag ships only). Further, their technological simplicity (and their detachment from a possibly distressed ship) provides a high level of operational reliability which offers a service of casualty prevention in the friendliest possible form for the navigator. On the other hand, apart from the limitations which are currently found in many of the alternative sophisticated aids (such as poor close range resolution and noise on radar), these also dictate the requirement of being operated by trained, competent and skilled navigators who do not always function with these attributes even if they generally possess them.

Finally, any Research Coordination Centre (and the Greek RCC in particular) is more than accustomed to receiving a large number of calls from yachts which do not necessarily carry either the sophisticated navigational aids or the trained navigators to enable trouble-free sailing under unfavourable conditions. A lighthouse signal on the dark horizon does not furnish these yachts with a mere hope of survival but with the certainty that, on transmission of the light characteristics, much-needed assistance will be available soon.

REFERENCES

[1] Mutual Steamship Assurance Ass. (Bermuda) Ltd. (1992). *Analysis of Major Claims*, p. 11.

[2] UK P&I Club and James D. (1995). The cost of safety. *Ship Care*, *Unitor Magazine for the Shipping Industry*, p. 4.

[3] Millar, L. C. (1980). The need for a structured policy towards reducing human factor errors in marine accidents. *Maritime Policy and Management*.

[4] Standring B. (1986). The human factor: hard lessons from tanker disasters. *Fairplay*.

[5] Goulielmos, A. and Tzannatos, E. (1997). The man-machine interface and its impact on shipping safety. *International Journal of Disaster Prevention and Management*, Vol. 6, No. 2.

[6] Tzannatos, E. and Oliver, T. (1995). Modern ship handling: towards an optimization of the crew-technology relationship. *Procs of the International Symposium on Human Factors On Board* (ISHFOB '95), 15–17 November 1995, Bremen, Germany.

KEY WORDS

1. Sea. 2. Aids to Navigation. 3. Safety.

APPENDIX A

1. *Foundered*: Ships which sank as a result of heavy weather, leakage, breaking in two, etc., and not as a consequence of categories 2–8.
2. *Wrecked/Stranded*: Ships reported aground for an appreciable period of time and cases reported touching sea bottom, underwater wrecks, etc.
3. *Contact*: Striking an external object other than another ship or the sea bottom. This category includes jetty contacts and striking drilling rigs/platforms, regardless of whether in fixed position or in tow.
4. *Collision*: Striking or being struck by another ship, regardless of whether under way, anchored or moored.
5. *Fire and Explosion*: Where the fire and/or explosion is the first incident. It follows that casualties involving fires and/or explosions after collisions, stranding, etc., would be categorized under 'collision', 'stranding'.
6. *Missing*: After a reasonable period of time, no news having been received of a ship and its fate being therefore undetermined, the ship is posted as 'missing' at the Corporation of Lloyd's and is included in the missing category on the database together with similar cases reported by other reliable sources. Missing ships are considered as losses by marine perils.
7. *Hull/Machinery*: Ships lost or damaged as a result of hull/machinery damage or failure.
8. *Unclassified*: Causes other than 1–7 or insufficiently defined.

Source: Definitions according to the series 'Analysis of serious casualties to...', IMO.

APPENDIX B

Table B-I. Casualties involving wrecked/stranded or in contact ships (ships of Greek flag in the Greek seas)

Year	Number of casualties: Passenger/car carriers	Number of casualties: Cargo carriers
1996	4	0
1995	1	0
1994	3	0
1993	5	0
1992	6	0
1991	5	0
1990	6	0
1989	8	1
1988	4	1
1987	5	0
1986	4	1
1985	2	2
1984	1	1
1983	3	0
1982	3	4
1981	2	6
1980	5	1
1979	2	1
1978	4	n/a
1977	2	n/a
1976	3	n/a
1975	2	n/a
1974	4	n/a
1973	4	n/a
1972	1	n/a
1971	2	n/a
1970	16	n/a
Total	107	18

n/a, data was not available.

Table B-II. Casualties of Greek-owned ships during the pre-WW2 period

Year	No. of casualties from all causes	No. of ships wrecked/stranded or ships in contact	% of ships wrecked/stranded or ships in contact
1930	225	84	37·3
1929	188	73	38·8
1928	173	57	32·9
1927	207	66	31·9
1926	193	69	35·8
Annual average	197	70	35·5