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LIST OF PREDICTED RISKS BASED ON NON-MILITARY THREATS IN SEA AREAS IN THE CONTEXT OF A PEACETIME CRISIS

Abstract

The paper addresses the possibility of non-military threats occurring in sea areas and assessing their trend. The paper unequivocally indicates that in peaceful conditions of maritime operations, the risk of crisis situation occurrence is highly probable and may even increase in the future. Therefore, a brief review of events and the current safety situation in sea areas was first carried out. Based on already defined phenomena, a trend, and a catalog of predicted risks of a non-military character in the sea regions were developed.
The final effect of the paper will be to indicate the trend of current non-military threats, define a catalog of anticipated risks in the sea areas, and indicate areas of particular sensitivity, i.e., what to put the most significant emphasis on to prepare for the occurrence of a given risk and what are the possibilities of reducing it to an acceptable level or even reversing the trend of increasing threats.

Key words

non-military threats, safety, maritime safety, crisis situation in sea areas, risk management.

Introduction

Shipping is the driving force behind the global economy. The sea carries out nearly 90% of world trade. More than 60,000 sea-going vessels are transporting various goods (1 976 48 thousand DWT in 2019), passengers, and conducting offshore works navigating in the sea area.[1] Hence, ensuring safety in sea regions is a priority aspect of all sea users. Any disturbances in the functioning of the complex transport and organizational system may lead to various adverse effects, including threats on a global or local scale, the event of potentially dangerous situations, and even generate an economic crisis. But most importantly, they can threaten human life and health and contribute to environmental degradation. These threats can pose a significant risk to humans and the environment if the appropriate forces and measures are not taken.[2]

The problem will be considered in terms of non-military threats understood as maritime safety, that is[3]:

- life and health safety of people (working in sea areas, staying on sea-going vessels as passengers or crew members, as well as persons who could be affected by an incident resulting from activities in seaports and aboard sea-going vessels (others marine units);
- protection of the maritime environment (against the environment's degradation during the exploitation of subsea deposits, pollution from ships, and spatial development of maritime areas).

The maritime safety related to asymmetric threats such as illegal transportation of people and cargo, armed robbery and piracy on maritime routes, and maritime terrorism will be not takin into account.

Still, it needs to be stressed that maritime area safety should be considered in the broad aspect of hazards: military (warfare) and non-military (civilian). The author's distinguishes between these two aspects of threats but indicates that the armed forces can provide invaluable support in responding to non-military threats which is important. Generalizing, international maritime security concerns all beneficiaries using the sea and oceans; it is the safety of life and property by protecting the maritime environment against undesirable effects of human activity with nature itself. Its impact is often impossible to predict. The international nature of marine safety means that when building rules addressing the issue of maritime security, we must take into account already existing international concepts and procedures in such a way as to safeguard and comply with national interests. A state's maritime safety is

1 EMSA Annual reports *Facts & Figures* 2020, Review of maritime transport 2019. Report prepared by Electronic quality shipping information system, Equasis statistic, chapter 2 *The merchant fleet population, The world merchant fleet 2019*, p. 8.

2 T. D. Heaver, *The Evolving Roles of Shipping Linesin International Logistics*, International Journal of Maritime Economics 4 (3): 2002. p. 210–230.

3 More: A. Królikowski., A. Mrozowska, R. Wróbel., *Safety culture in the management system of safe exploitation of the ship and pollution prevention*, Polish Naval Academy 2016 Tom 57 nr 2 (205) p. 45-60, Safety management and safety culture, published by IMO, aviable at https://www.imo.org/en/OurWork/HumanElement/Pages/SafetyManagementDefault.aspx.

a component of national security. It is a matter of a country's policy and strategy and safe interaction between land and sea users.[4] Presently, when there is a noticeable increase in rapid and often unpredictable processes occurring in the natural environment[5] and related to unintentional human activity in maritime areas, non-military means and resources cannot eliminate a given threat or reduce the risk of its occurrence.[6]

Methodological and methodological assumptions

The main research problem is to develop a catalog of risks predicted for non-military threats in the marine environment and the indication of the mathematical methodology of solutions to assess the development of occurring phenomena or evaluate the probability of their occurrence in the future. To achieve the main objective, it is worth breaking matters down into the following specific goals, the chronological implementation of which is discussed in the content of individual subsections of the paper. The basic research method used to achieve the aim of this paper is the analysis of source materials, primarily reports developed by leading classification societies, such as, among others: Det Norske Veritas, Lloyd's Register, insurance companies, in particular, Allianz, and scientific papers developed by the leaders of threat analysis and risk assessment in the marine environment.

The applied research technique is participatory observation. Moreover, indicated of risk index based on IMO resolution MSC- MEPC.2/ Circ.12/Rev.2 and basis of information gathered by the author. The research has been divided into phases, such as: global situation in maritime areas types of threats in marine areas, existing threats and risks in marine areas, and finally the catalog of predict risk in maritime areas was prepared.

The collected data and the prepared catalog of predicted risks indicated areas of particular vulnerability to ensure safety in marine areas. And here, there may be a need to apply military force and resources or provide close cooperation of military and non-military forces in the implementation of effective preventive measures and response to the occurrence of an incident.

The catalog cannot be built without identifying hazards and assessing the risk of their occurrence. This chapter, therefore, is devoted to a reminder of the methodology for carrying out a risk assessment. Following the IMO resolution MSC- MEPC.2/ Circ.12/Rev.2., indicators for the impact on the safety of human life and health, environment, and property protection of high value (in this case, a sea vessel) have been implemented from its provisions. The foundation for

4 Anish Joseph, Dimitrios Dalaklis "The international convention for the safety of life at sea: highlighting interrelations of measures towards effective risk mitigtion"https:// doi.org/10.1080/25725084.2021.1880766.

5 More: AGCS. (2019). Worst Accident Locations and Common Causes of Loss, AGCS. Allianz Global Corporate & Specialty. Accessed on 31.11.2020. https://www.agcs.allianz.com/news-and-insights/expert-risk-articles/shipping-safety-worst-accident-locations.html.

6 T.M. Osborne, G.A. Rose, P. Smith, T.R. Wheeler, P. Zelazowski *Climate change and local level disaster risk reduction planning: need, opportunities and challenges*, Climatic Change, 134(3), p. 457-474. https://doi.org/10.1007/s10584-014-1281-2.

further elaboration of the problem is to define the principles of risk index determination. It will be a reference point for additional modeling of the defined risks in the ARLAP range. This area's scope is dictated by the rationale of highlighting preventive actions before they could enter the "Not Acceptable" range. However, predicted risks might be challenging and not applicable in their occurrence due to the complexity and differentiation of the phenomenon from the previously assumed assumptions.[7]

To carry out the most effective risk assessment, it is important first to rank them. In this way, it is possible to understand whether the identified risk is minor or major. By taking this decision, one can achieve a more effective result, ultimately affecting the decision-making process. A crucial step for the success of the analysis process is to identify and prioritize scenarios for the problem under consideration. This will allow prioritizing and rejecting scenarios that are considered to be of minor importance. To this end, matrices are developed consisting of: the consequences of events (Table 1) and the frequency (Table 2) of their occurrence. Based on the data collected, the risk matrix (Table 3) was developed.

The proposed tables are based on the provisions of the Resolution issued by the International Maritime Organization MSC- MEPC.2/ Circ.12/ Rev.2.

In step one, hazards are to be prioritized and scenarios ranked. Scenarios are typically a sequence of events from initiating an event to the consequence through the intermediate stages of the scenario development. The risk index formula is as follows:

Risk = Probability x Consequence,

Log (Risk) = log (Probability) + log (Consequence). To facilitate the ranking and validation of ranking, it is generally recommended to define consequence and probability indices on a logarithmic scale.

Table 1. Severity Index

Severity Index					
Severity (SI)		**Effects on human safety**	**Effect on the environment**	**Effect on vessels**	**Equivalent fatalities**
1	Slight	Minor injuries	Oil spill size < 1 tonne	Minor local damage	0.001
2	Minor	Single injuries	Oil spill size between 1- 10 tonnes	Local damage equipment	0.01
3	Significant	Multiple or severe injuries	Oil spill size between 10 -100 tonnes	Non-severe ship damage	0.1
4	Severe	Single fatality of multiple severity injuries	Oil spill size between 100-1,000 tonnes	Severe ship damage	1

7 A. Wiley, *Risk Assessment. Marvin Rausand Theory, Methods, and Applications. Strategic in practice*, 2011.

Severity Index					
Severity (SI)		**Effects on human safety**	**Effect on the environment**	**Effect on vessels**	**Equivalent fatalities**
5	Cata-strophic	Multiple fatalities	Oil spill size between 1,000 -10,000 tonnes.	Total loss	10
6	Global	Multiple fatalities and multiple severities	Oil spill size >10,000 tonnes.	Multiple total losses	100

Sources: Mrozowska A. *Formal Risk Assessment of the risk of major accidents affecting natural environment and human life, occurring as a result of offshore drilling and production operations based on the provisions of Directive 2013/30/EU,* Volume 134, February 2021, 105007, https://doi.org/10.1016/j.ssci.2020.105007, MSC-MEPC.2/Circ.12/Rev.2, *Revised guidelines for formal safety assessment (fsa) for use in the imo rule-making process*, IMO, 2018. G*uidelines for Formal Safety Assessment (FSA) for use in the IMO rule-making process. – MSC/Circ.1023 & MEPC/Circ.392.* Accessed on 31.11.2020. http://www.imo.org/en/OurWork/HumanElement/VisionPrinciplesGoals/Documents/1023-MEPC392.pdf

Table 2. Frequency Index

Frequency Index			
Frequency (FI)		**Definition/interpretation**	**F (per installation year)**
1	**Extremely remote to extremely improbable**	Likely to occur once in the lifetime	10^{-5}
2	**Remote to extremely remote**	Likely to occur once per 20 years	10^{-4}
3	**Remote**	Likely to occur once per 15 years	10^{-3}
4	**Reasonably Probable to Remote**	Likely to occur once per 10 years	10^{-2}
5	**Reasonably Probable**	Likely to occur once per 5 years	0.1
6	**Reasonably Probable to Frequent**	Likely to occur once per one year	1
7	**Frequent**	Likely to occur several times per one year	10

Sources: Mrozowska A. *Formal Risk Assessment of the risk of major accidents affecting natural environment and human life, occurring as a result of offshore drilling and production operations based on the provisions of Directive 2013/30/EU,* Volume 134, February 2021, 105007, https://doi.org/10.1016/j.ssci.2020.105007, MSC-MEPC.2/Circ.12/Rev.2, *Revised guidelines for formal safety assessment (fsa) for use in the imo rule-making process*, IMO, 2018. G*uidelines for Formal Safety Assessment (FSA) for use in the IMO rule-making process. – MSC/Circ.1023 & MEPC/Circ.392.* Accessed on 31.11.2020. http://www.imo.org/en/OurWork/HumanElement/VisionPrinciplesGoals/Documents/1023-MEPC392.pdf

A risk index may therefore be established by adding the probability/frequency and consequence indices. By deciding to use a logarithmic scale, the

Risk Index for ranking purposes of an event rated "Remote" (FI=3) with severity "Significant" (SI=2) would be RI=5.

Table 3. Risk Index

Risk Index						
	Severity (**SI**)					
Frequency (**FI**)	**1**	**2**	**3**	**4**	**5**	**6**
	Slight	Minor	Significant	Severe	Catastrophic	Global
1 Extremely remote	2	3	4	5	6	7
2 Remote	3	4	5	6	7	8
3 Remote	4	5	6	7	8	9
4 Probable Reasonably	5	6	7	8	9	10
5 Reasonably Probable	6	7	8	9	10	11
6 Frequent	7	8	9	10	11	12
7 Frequent	8	9	10	11	12	13

Sources: Own elaboration supported by: Mrozowska A. *Formal Risk Assessment of the risk of major accidents affecting natural environment and human life, occurring as a result of offshore drilling and production operations based on the provisions of Directive 2013/30/EU*, Volume 134, February 2021, 105007, https://doi.org/10.1016/j.ssci.2020.105007, MSC-MEPC.2/Circ.12/Rev.2, *Revised guidelines for formal safety assessment (fsa) for use in the imo rule-making process*, IMO, 2018. G*uidelines for Formal Safety Assessment (FSA) for use in the IMO rule-making process. – MSC/Circ.1023 & MEPC/Circ.392.* Accessed on 31.11.2020. http://www.imo.org/en/OurWork/HumanElement/VisionPrinciplesGoals/Documents/1023-MEPC392.pdf

The position of an event in the risk matrix should be interpreted as:

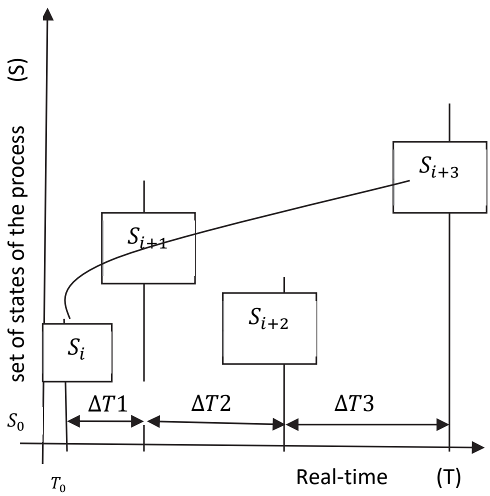
- An event in an acceptable zone (1-5) means that the risk of the occurrence of the event is permitted. There is no necessity to incorporate additional safety measures, but the risk must be monitored.
- An event in the ALRAP zone (AS LOW AS REASONABLY PRACTICABLE) (6-8) means that the risk should be monitored. The ALRAP should evaluate the zone. At the moment, the risk is on an acceptable level and is controlled as low as reasonably practicable. Additional safety measures should be kept according to requirements and risk management.
- An event in a not acceptable zone (9-13) means that the risk is high and must be reduced. The mitigation actions must be undertaken to attend to an activity. If there is no possibility of reducing the risk and incorporating safety measures, the activities will not be started.

In this study, the focus will be on the highest risk level (red) due to identifying this target, i.e., the expected risk. This will also allow us in subsequent studies to mitigate the assumptions made.

Principles of conducting simulation studies and data modeling

The author intends to study the process, which will be recorded correctly in the following chapters and using determinants as the specificity of hazards. Internal and external factors will influence the course of the processes. The method of the process is most convenient to the model using a specific function of the process state, which allows for transition from one state to another.[8]

Figure 1. Simulated process



$S = \{S_i, i = \overline{0,1 \ldots N}\}$ – set of states of the process,
S_0 = - initial state
$T = \{T_j, j = \overline{0,1 \ldots J}\}$ – set of time points of introducing events

Sources: Own elaboration

The central concept of simulation is closely related to the passing of time and changes in the so-called system states. The model of a given facility, phenomenon, or system built for simulation studies must be reflected in dynamic terms as a particular process of change taking place in a specific time horizon. This dynamic and complex system is the process of shaping the safety and managing security as well as emergencies.

An important parameter of computer simulation is time because – due to the subject matter studied – it is vital to show the dynamics of changes occurring in the time perspective. It consists of a sequential reproduction of consecutive fragments of the examined reality in an order consistent with the time horizon. It runs according to a fixed control algorithm, emitting the mechanism of research. The time horizon can be considered a continuous or discrete

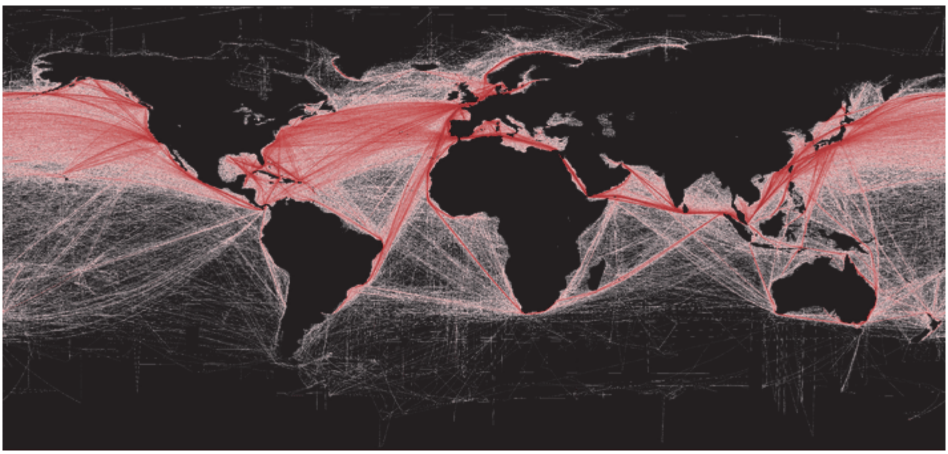
8 K. Ficoń, *Crisis management engineering – system approach*, PWN, Warsaw 2020 pp.502 (in Polish). Jens-Uwe Schröder-Hinrichs,ErikHollnagel, Michael Baldauf, "The use of Functional Resonance Analysis Method (FRAM) in a maritime accident: A case study of Prestige, Ocean Enginering, 2020 DOI: 10.1016/j.oceaneng.2020.108223

quantity, while the process states can be described through any parameters and arguments in many ways. In the research, we will use quantized systems, i.e., discrete in time and discreet in states (sequential), in which changes take place in certain moments, and outside them, the state does not change. Changes in the state of the sequential process are events. In some processes, the past determines their further course. Such process will be used in this research.

The determination of global situations in maritime areas

This chapter presents the aspects of safety in maritime areas regarding threats to the environment and the health and life of people working in maritime regions. Moreover, the determinants of the current situation in terms of safety in maritime areas are indicated. Figure 2 presents the relative global commercial shipping density. The most sensitive maritime areas were thus indicated for threats stemming from shipping.

Figure 2. Relative global commercial shipping density



Sources:. B. Halpern, S. Walbridge, K. A. Selkoe, R. Halpern, B., *Shipping density (commercial). A Global Map of Human Impacts to Marine Ecosystems*, Science 319 (5865) March 2008, p 948-952, 10.1126/science.1149345

Total losses of the vessel

Studies on the risks posed by heavy shipping are backed up by analyses and reports from recognized maritime organizations such as the IMO. Lloyd's Register[9] and insurance companies. They produce reports on a variety of environmental marine casualties and health and safety risks.[10] These may

9 Lloyd's List Intelligence Casualty Statistics, Report 05/02/2018, January 2019, July 2020.

10 Allianz risk barometer – identifying the major business risks for 2020, Allianz 2019. AGCS. (2019). Worst Accident Locations and Common Causes of Loss, AGCS. Allianz Global Corporate & Specialty. Accessed on 31.11.2020. https://www.agcs.allianz.com/news-and-insights/expert-risk-articles/shipping-safety-worst-accident-locations.html

vary by data source, scope, and time. According to the data provided by Lloyd's Register Statistic, at the same time, EMSA has prepared a report (include events in Europe) in which it gives the number of incidents distributed per the data presented in Table 4. Ships involved are as follows in Table 5.

Considering all the above data from Tables 4 and 5, cargo vessels accounted for more than 37% of all total losses during 2019. The number increased year on year. Moreover, fishing, bulk, and passenger are the vessel types that have seen the most total losses over the past decade. They accounted for nearly 70% of all reported losses. But, in the previous decade, there has been a noticeable steady decline from 130 sinkings in 2010, to 41 in 2019. The leading causes of incidents in marine areas are: Foundered (sunk) Grounded Fire/Explosion.

Table 4. Number of accidents & incidents and total losses of vessel in Europa (2020-2015)

Name	2020	2019	2018	2017	2016	2015
Ship lost	7	20	19	19	12	21
Accidents & incidents	2632	3225	3265	3261	3243	3340

Source: Report *Safety and shipping review 2019*, published by AGCS 2020, UK, Report *Safety, and shipping review 2018*, published by AGCS 2019, Report *Safety and shipping review 2017*, published by AGCS 2018.

Table 5. Ship types involved in accidents & incidents and total losses of vessel in Europa

Type of vessles	2020	2019	2018	2017	2016	2015
Cargo ship	1272	1499	1563	1547	1576	1793
Passenger ship	533	957	863	880	917	854
Fishing vessel	628	640	603	625	580	461
Service vessel	287	346	407	394	397	433
Other ship	79	110	171	101	124	113

Source: Report *Safety and shipping review 2019*, published by AGCS 2020, UK, Report *Safety, and shipping review 2018*, published by AGCS 2019, Report *Safety and shipping review 2017*, published by AGCS 2018.

Scientific publications confirm the data collected by international entities involved in maritime affairs. Although the author points out the decreasing trend of incidents, they emphasize their more significant impact and unpredictability.[11]

The most common cause of total loss is due to sinking. In turn, the main reasons for vessel sinkings were: navigation in unfavorable weather conditions, navigational errors, technical factors, violations of procedures, and others.

11 *Report on the Safety of Offshore Oil and Gas Operations in the European Union for the Year 2017*, Brussels, 30.7.2019 COM(2019) 358 final, A. Wiley, *Risk Assessment. Marvin Rausand Theory, Methods, and Applications. Strategic in practice*, 2011.

Casualties in maritime areas

While the number of total losses has declined significantly over the past year, the number of reported shipping casualties or incidents increased from 2,688 in 2018 to 2,815 in 2019. It is up about 5%. According to data from Allianz Insurance, DNV, the primary cause of shipping incidents is machinery damage. Only in 2019, there were 1,044 reported incidents on vessels over 100 GT.

The number of casualties is presented in Table 6. The data include events onboard the vessels on worldwide transportation routes and in the ports. But table 7 include number of personal injured and fatalities in Europe or Flag Europe.

The most causes of casualties were: human error and equipment failure. For the human factor influence: delay of reaction time, inadequate supervision, fatigue, lack of competency, not meeting the local requirements, poor knowledge of the use of equipment, lack of training onboard and misunderstanding, making a mistake and chain of adverse events including external factors (including weather conditions, lack of communication between (in the relation shore-to-vessel and shore-to-shore and others), and internal factors (insufficient procedures onboard, routine, and other connected circumstances).

Table 6. Casualties in maritime areas, in particular on board of the vessels

Region	2019	2018	2010-2019
British Isles, North Sea, the English Channel, and the Bay of Biscay	605	492	4,687
East Mediterranean and the Black Sea	472	535	4,266
South China, Indochina, Indonesia, and Philippines	255	234	2,423
The Great Lakes	195	196	1,393
West Mediterranean	151	103	1,001
Baltic Sea	143	162	1,617
North America, West Coast	120	102	936
Iceland, Korea, and North China	109	104	1,078
Japan, Korea, and North China	103	125	1,474
Other	548	635	6,397
Total	**2,815**	**2,688**	**26,071**

Source: Report *Safety and shipping review 2019*, published by AGCS 2020, UK, Report *Safety, and shipping review 2018*, published by AGCS 2019, Report *Safety and shipping review 2017*, published by AGCS 2018.

Table 7. Total number of casualties and death on board of the vessel in Europe or Europe Flag

Name	2020	2019	2018	2017	2016	2015
Fatalities	36	69	58	48	95	119
Personal injured	618	969	957	1041	1003	995
Pllution events	31	42	63	61	59	59

Sources: Own elaboration supported by Rutkowski, Grzegorz "Safety problems in the offshore industry Part 1. Oil spills and other types of threats registered in the offshore sector,"Maritime Academy Science Papers, Gdynia no. 26, 2011 (in Polish).EMSA. (2019). Accident Investigation – Annual Overview – EMSA – European Maritime Safety Agency. "Annual Overview of Marine Casualties and Incidents 2019". Accessed on 31.11.2020. http://www.emsa.europa.eu/accident-investigation-publications/annual-overview.html [Google Scholar].European Union Maritime Security Strategy Responding together to global challenges A guide for stakeholders.

For the equipment failure (technical factors) influence: technical progress, lack of training (how to use the equipment), not meeting the operational requirements, external factors such as inclement weather, low or high temperature, and others.

Obviously, in the event of an incident occurring in the maritime domain, the appropriate maritime search and rescue services are mobilized.[12] However, when these forces are insufficient, then military resources are activated. They can also provide continuous support in responding to the threat. For example, in Poland, aerial search and rescue (SAR) support is provided by the Naval Aviation Brigade. During the evacuation of passengers from the Costa Concordia, the incident that occurred during the evacuation of passengers involved military forces, as non-military resources were insufficient for many such participants in a maritime disaster. Examples of the use of military forces or their support can be cited.

Threats to the natural (marine) environment

In today's world, the safety of shipping and the state of the environment is not only the safety of shipping of concern. Maritime transportation still generates negative impacts on the marine environment. These include air pollution, greenhouse gas emissions, releases of ballast water containing aquatic invasive species, the historical use of anti-foulants, oil and chemical spills, dry bulk cargo releases, garbage, underwater noise pollution, ship strikes on marine megafauna, risk of ship grounding or sinkings, and widespread sediment contamination of ports during trans-shipment or ship breaking activities. Notwithstanding the above, the amount of oil spilled from tanker incidents has been reduced by 95% since the 1970's. (From 319,000 tonnes per year in 1970 to 16,000 tonnes per year in 2019). Technologies are being introduced to reduce pollution by

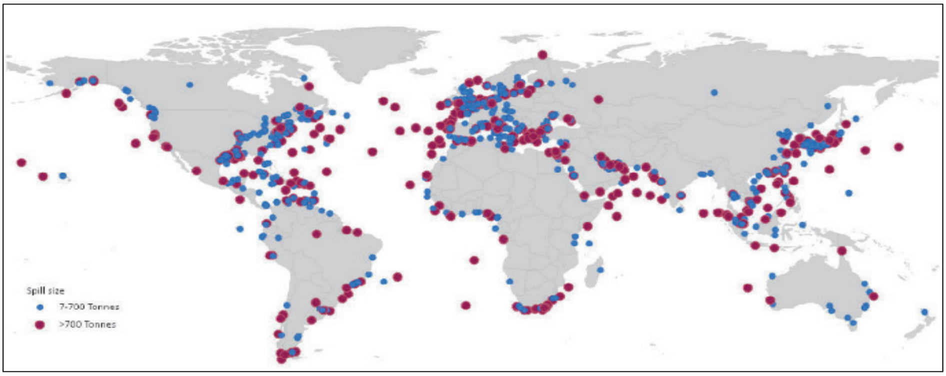
12 TM Osborne, GA Rose, P Smith, TR Wheeler, P. Zelazowski, *Climate change and local level disaster risk reduction planning: need, opportunities and challenges*, Climatic Change, 134(3), 457-474. https://doi.org/10.1007/s10584-014-1281-2. Interim report 12 november 2019 on the investigation into the loss of propulsion and near grounding of viking sky, 23 march 2019, published by Accident Investigation Board Norway Postboks 213 2001 Lillestrøm Norway.

powering marine vessels with hydrogen, gas, or solar energy.

There are now close to 500 dead zones covering more than 245,000 km² globally, equivalent to the surface of the United Kingdom.[13]

Figure 3 presents a map of oil spills. The most frequent causes of oil tanker spills are collisions (31%) and groundings (26%). Moreover, table 8 presents the total number of pollution events in Europe or Europe Flag.

Figure 3. Map of spills (>7 tonnes) from 1970 to 2019



Source: Marine casualties and incidents. Prelinary annual overwiew of marine casualties and incidents 2014-2020, April 2021, EMSA.

Table 8. Total number of pollution events in Europe or Europe Flag

Name	2020	2019	2018	2017	2016	2015
Europe or Europe Flag	31	42	63	61	59	59

Sources: Own elaboration.

In addition, a threat to the marine environment is degradation through the exploitation of offshore energy deposits, which are responsible for several threats summarized in. Threats generated by offshore oil gas exploration and construction of offshore wind farms such as:
- Pollution of the sea, deterioration of water quality, and degradation of the marine ecosystem,
- Electromagnetic radiation (low and high frequency),
- Being hit by falling elements, being pulled in through moving parts, electric shock, burns,
- Connected to the transport of people both by air and using a transport basket,
- Deterioration of air quality.
- Interference in the structure of the bottom

13 Johannes G. Leskens, Christian Kehl, Tim Tutenel, Timothy Kol, Gerwin de Haan, Guus Stelling, Elmar Eisemann, *An interactive simulation and visualization tool for flood analysis usable for practitioners*, "Mitigation and Adaptation Strategies for Global Change" volume 22, pages307–324(2017).

- Noise
- Impact of movable elements in the structure as well as the entire production/drilling infrastructure Related to the transport of cargo.

Research results

The author of the study paid attention to human life and health and the environment, namely the threats generated by human activity in marine areas.

The research verified the question regarding the development of the number of shipwrecks from a time perspective. Before a complete answer was obtained, it was indicated that according to available data, total losses of one in five losses in 2019 were due to bad weather. This constitutes 60% of the causes of total losses of vessels in 2019. One can state that global climate change is the main determinant of these situations.

Table 9 presents a risk matrix that shows the scale of the impact on the safety of vessels. To emphasize the influence of weather determinants on the total loss of a ship, they are compared with data on the loss of machinery and accidents.

Table 9. Risk matrix (Existing risk)– natural hazards, effect on vessels

Risk Index						
Frequency (FI)	Severity (**SI**)					
	1	**2**	**3**	**4**	**5**	**6**
	Slight	Minor	Significant	Severe	Catastrophic	Global
1 Extremely remote	2	3	4	5	6	7
2 Remote	3	4	5	6	7	8
3 Remote	4	5	6	7	8	9
4 Probable Reasonably	5	6	7	8	9	10
5 Reasonably Probable	6	7	8	9	10	11
6 Frequent	7	8 FI=6 SI=2 Machinery damage	9	10	11	12
7 Frequent	8	9	**10 FI=7 SI=3 Failure**	11	**12 FI =7 SI =5 Total losses**	13

Source: Own elaboration supported by Table 2, 3, 4, 5, 6 and Akyuz, E. A marine accident analyzing model to evaluate potential operational causes in cargo ships, Saf Sci, 92 (2017), pp. 17-25, ArticleRecord in ScopusGoogle Scholar, Ahmet MertcanYasa, HakanAkyildiz "A formal safety assessment of offshore support vessels," by The FSA for Offshore Support Vessel has been presented, which in a practical manner presents the methodology of conducting the FSA.

However, further attention of the author will be focused on the red zone, namely shipwrecks caused by adverse hydro-meteorological conditions, whose impact and frequency are at a high-risk level.

Moreover, as outlined above, natural hazards pose a significant risk to shipping and, therefore, to people and the environment. As deduced from the previous section, the reason for this is global warming, which makes atmospheric phenomena violent and unpredictable. The impact of natural conditions may affect the safety of sea-going vessels' operation in sea areas, their movement in these areas, unloading and loading (reloading) in ports, economic factors, delays, i.e., theimpact of these natural factors poses a risk to human health and life.

Table 10. The number of causes of total losses of the vessel

Vessels	2020	2019	2018	2017	2016	2015	Total
Fondered (sunk)	25	32	33	57	48	66	261
Wrecked/stranded (grounded)	12	9	18	15	22	19	95
Fire/explosion	14	21	12	8	13	9	77
Machinery damage/ failure	4	3	3	9	10	2	31
Collision	3	3	3	1	2	7	19
Hull damage	1	1	2	5	4	2	15
Contact	0	1	2	0	0	0	3
Missing	0	1	0	0	2	0	3
Miscellaneous	6	1	0	0	1	0	2
Total	66	72	135	95	102	105	**575**

Source: Own elaboration base on Report *Safety and shipping review 2019*, published by AGCS 2020, UK.

Based on the data from Table 10, it can be pointed out that the most significant risk in connection with the impact of hydro-meteorological conditions is: the sinking of ships. Using the simulation model, the "behavior" of the sunken vessels will be examined from a time perspective, i.e., whether the number will decrease or increase and what types of ships will be sinking. The simulation model can be extended by providing some limitations related to the area of ships' sailing and their sinking. Moreover, it is possible to separate the ship types or to combine these two aspects or, of course, extend it with another database. This model is designed to show forecasts and simulations on the selected example with the highest risk of its occurrence. The above-collected data will indicate the catalog of risks associated with ships' operation, as noted in Table 11.

Table 11. Data include the number of total ship losses in the years (2010-2019)

T	Year	S	Number of total ship losses	~~% natural hazards	Number o total ship losses caused by natural hazards
T_0	2010	S_0	130	42%	32
T_1	2011	S_1	98	29%	30
T_2	2012	S_2	129	30%	23
T_3	2013	S_3	111	32%	29
T_4	2014	S_4	90	26%	29
T_5	2015	S_5	105	37%	35
T_6	2016	S_6	99	40%	40
T_7	2017	S_7	95	38%	40
T_8	2018	S_8	53	38%	20
T_9	2019	S_9	41	60%	25

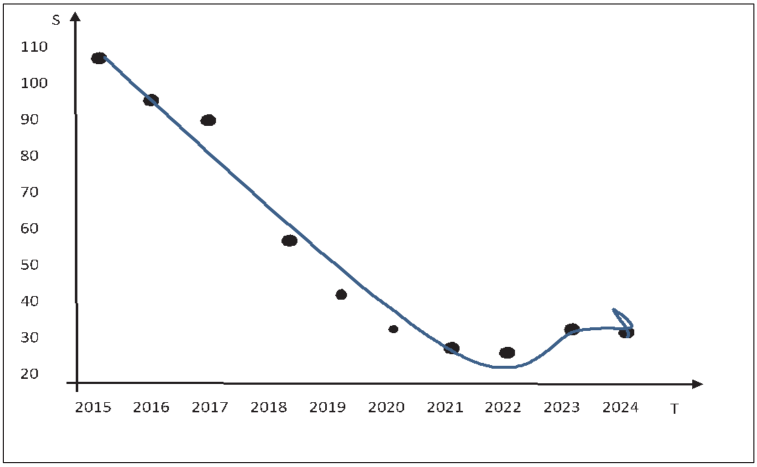
Source: Own elaboration base on data from Tables 5, 6.

The data collected from 2010-2019 indicated a trend. However, the simulation presented in Fig. 4 can be misleading in terms of the case studied and hydro-meteorological conditions on shipwrecks because it shows that the number of wrecks is decreasing. Therefore, the analysis should be extended by a statement on the influence of bad weather on the number of shipwrecks. And here the situation looks completely different and even shows an upward trend.

Considering the risk, it can be both negative and positive. The model shows that in the time perspective, the number of sunken ships will decrease. The question arises – why so? Is it influenced by technical progress related to constructing "safer" vessels, or maybe the number of ships moving in sea areas is smaller, or perhaps it is necessary to pay attention to the maritime capacity, which tends to increase cargo capacity at present.

Trying to answer these questions will allow us to obtain a more reliable approach to the predicted risk (for more details, see chapter referring to technological progress). Namely: the introduction of vessels with modern design solutions, in terms of stability, buoyancy, etc., will reduce their accident rate, but the rapidity of weather changes will contribute to several risks or maybe the beginning of an element of a chain of events. Data shows the list of predicted risks that were prepared based on existing non-military risks and threats generated by inclement weather.

Figure 4. Simulated process of total losses of vessels due to bad weather



Source: Own elaboration supported by simulation predicted risk program.

Considering the subject of the study, it is necessary to indicate a list of risks relating to the safety of life and health of persons on board maritime vessels, protection of the environment, or generating losses of considerable value. The proposed future risks are an extension of the existing ones due to the suddenness of the phenomena, i.e., ships will continue to sink, human lives will continue to be lost, and oil spills will continue to occur due to marine accidents.

The solutions to be implemented, as already mentioned, have to develop a system of early warning of the occurrence of these phenomena and the need for adequate forces and resources for the elimination of the phenomena, their effects, and, above all, for rescue operations. Events require innovative rescue units that can survive in extreme conditions and, above all, be well prepared to function in such situations. The question arises here, whether to risk the lives and health of rescuers. Is it possible to use the units without assumptions and be fully automated? The answer is given by many publications on the construction of crewless marine vessels.[14]

Already existing risks may be continuously present and even increase in their occurrence. The most important will be the lack of predictability of occurring phenomena despite using the best measuring equipment.

In summary of the above studies, hazards generated by the power of the sea element will not only increase the number of shipwrecks, but will cause more significant loss of life and/or accidents to people on ships. They will cause several other risks which may indirectly

14 B. Halpern, S. Walbridge, K. A. Selkoe, R. Halpern, B., *Shipping density (commercial). A Global Map of Human Impacts to Marine Ecosystems*, "Science" 319 (5865) March 2008, p 948-952, 10.1126/science.1149345. Heaver, T. D. 2002. "The Evolving Roles of Shipping Linesin International Logistics." International Journal of Maritime Economics 4 (3): 210–230. doi:10.1057/palgrave.ijme.9100042.

affect all people. And here, it is necessary to point out, the already mentioned area of particular vulnerability. This weak point has been pointed out to us as a series of unfavorable events.

The author points out that starting from the analysis of the global situation on the sea basins, the discussion of accidents, their causes, the intensity of shipping on the sea lanes – that threats appeared, which cannot only directly threaten the life and health of people but also indirectly, for example, may occur due to the lack of supply of goods. And in such a situation it is advisable, as it has already been emphasized, to consider technological development in a completely different dimension, i.e., building ships with greater capacity, maybe not building them so huge, to carry a significant amount of goods at once, but to divide the cargo into smaller, more "efficient" units. As a result, the generated losses during an accident or shipwreck will not be so significant. Someone may question this approach to safety, pointing out that it is not economically justified and we are going back in time. However, as many author emphasizes and conducting safety campaign on vessel, sometimes you have to take a step back to move forward, and our safety is in our hands. Therefore, another argument in favor of this theory based on research is that smaller vessels are crewed with smaller numbers of people, which will generate less loss of life, and with the better equipping with rescue and life-saving equipment due to their greater availability. Or even autonomous emergency response systems alone can deal with and extinguish fire hazards without the need to endanger the health and lives of people going to the rescue of their colleagues.

The conducted research showed that the total losses can occurs by bad weather in 60%, the remaining factor influence, i.e. the machine is 30%, and the remaining factors are other factors (we assume that human error – such was manifested in the database).

The risk of occurrence is uncertain and attempts have been made to reduce it. By introducing an early warning system against the threat as an area of special sensitivity.

The role military forces, highlighted above, indicates that they should be included in the maritime security system as vital support when civilian forces cannot respond effectively and efficiently to a threat (see more in conclusion).

Risks to the natural environment

To present the scale of pollution, the author will use a case study in oil spills from 2010-2019 to show the trend. For a complete picture, the causes of these events and the location of their occurrences are indicated. The collected data allows one to assess the risk of oil spill occurrences. Table 12 shows the environmental risk index and answers such a question.

Table 12. Data including numbers of reported oil spills caused by vessels (including total losses, collision, breakdowns, machinery failure/damage, in the years (2010-2019)

T	Year	S	Number of reported oil spills > 7 tonnes
T_0	2010	S_0	9
T_1	2011	S_1	5
T_2	2012	S_2	7
T_3	2013	S_3	8
T_4	2014	S_4	5
T_5	2015	S_5	8
T_6	2016	S_6	5
T_7	2017	S_7	6
T_8	2018	S_8	6
T_9	2019	S_9	3

Source: Own elaboration supported by Table 2, 3, 4, 5, 6 and Akyuz, E. A marine accident analyzing model to evaluate potential operational causes in cargo ships, Saf Sci, 92 (2017), pp. 17-25, ArticleRecord in ScopusGoogle Scholar, Ahmet MertcanYasa, HakanAkyildiz "A formal safety assessment of offshore support vessels," by The FSA for Offshore Support Vessel has been presented, which in a practical manner presents the methodology of conducting the FSA.

What are the main risks of oil pollution for vessels above 7,000 tonnes. Table 13 presents pertinent data to assess the risk. Table 14 shows risk index for the natural enviromen due to operation of vessels in marine areas. Figure 8 shows the simulated process of oil pollution for ships above 7 tonnes.

Table 13. Indicates the location and causes of oil spills in %

Caused by:	%	Location	%
Collision	44	Loading/Discharging	9
Grounding	14	Bunkering	4
Hull Failure	2	At anchor	17
Equipment Failure	14	Underway	50
Fire/Ex	7		
Unknown	19	Unknown	18

Source: Own elaboration supported by Table 2, 3, 4, 5, 6 and Akyuz, E. A marine accident analyzing model to evaluate potential operational causes in cargo ships, Saf Sci, 92 (2017), pp. 17-25, ArticleRecord in ScopusGoogle Scholar, Ahmet MertcanYasa, HakanAkyildiz "A formal safety assessment of offshore support vessels," by The FSA for Offshore Support Vessel has been presented, which in a practical manner presents the methodology of conducting the FSA.

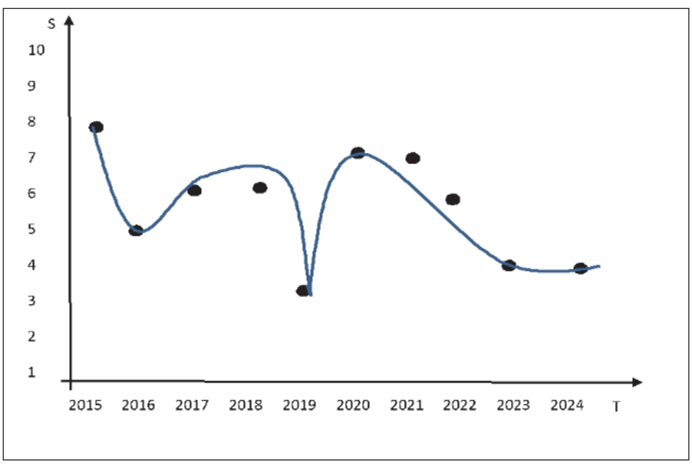
The assessment suggests that ship collisions are the most significant contributor to the risk of oil spills. Therefore, this risk will be investigated further. As indicated by the simulation model, this trend will continue in the long term, at a constant level, and will, unfortunately, result in environmental degradation.

Table 14. Risk matrix for the natural environment– operation of vessels

Risk Index						
Frequency (FI)	Severity (SI)					
	1	**2**	**3**	**4**	**5**	**6**
1	2	3	4	5	6	7
2	3	4	5	6	7	8
3	4	5	6	7	8	9
4	5	6	7 SI=7 FI=4 Fire/Ex	8	9	10
5	6	7	8 SI =3 FI=5 Grounding and Equipment Failure	9	10	11
6	7	8	9 SI=3 FI=6 Collision	10	11	12
7	8	9	10	11	12	13

Source: Own elaboration supported by Table 2, 3, 4, 5, 6 and Akyuz, E. A marine accident analyzing model to evaluate potential operational causes in cargo ships, Saf Sci, 92 (2017), pp. 17-25, ArticleRecord in ScopusGoogle Scholar, Ahmet MertcanYasa, HakanAkyildiz "A formal safety assessment of offshore support vessels," by The FSA for Offshore Support Vessel has been presented, which in a practical manner presents the methodology of conducting the FSA.

Figure 5. Simulated process of oil pollution caused by ship's operations (>7,000 tones)



Sources: Own elaboration supported by simulation predicted risk program and Table 12.

Due to such an important topic, the author will analyze such a disturbing phenomenon as the number of accidents and hazards generated in the waters of the northern route, which in the long run may prove disastrous in terms of consequences for the environment of the entire planet.

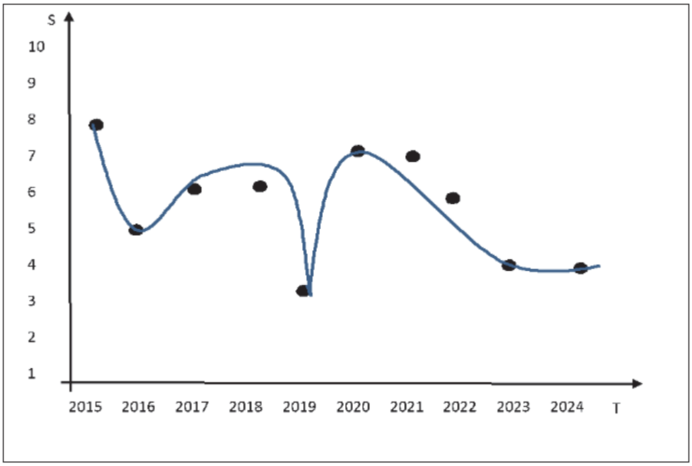
Another significant aspect of protection against pollution is to predict how incidents in these waters can influence this pristine area. Table 15 includes the number of incidents in Arctic area waters. Moreover, Table 16 shows the causes of such incidents. The simulation model of predicted risk in the Arctic Circle waters is shown in Figure 5. Table 20 shows the numbers and causes of incidents in Arctic circle waters.

Table 15. The numbers of reported incidents in Arctic circle waters, in the years (2010-2020)

T	Year	S	Number of incidents
T_0	2010	S_0	51
T_1	2011	S_1	39
T_2	2012	S_2	37
T_3	2013	S_3	50
T_4	2014	S_4	55
T_5	2015	S_5	70
T_6	2016	S_6	55
T_7	2017	S_7	71
T_8	2018	S_8	43
T_9	2019	S_9	41
T_{10}	2020	S_{10}	59

Source: Own elaboration supported by Table 2, 3, 4, 5, 6 and Akyuz, E. A marine accident analyzing model to evaluate potential operational causes in cargo ships, Saf Sci, 92 (2017), pp. 17-25, ArticleRecord in ScopusGoogle Scholar, Ahmet MertcanYasa, HakanAkyildiz "A formal safety assessment of offshore support vessels," by The FSA for Offshore Support Vessel has been presented, which in a practical manner presents the methodology of conducting the FSA.

Figure 5. Simulation process of environmental impact in the Arctic waters



Source: Own elaboration supported by Table 17 and Jens-Uwe Schröder-Hinrichs,ErikHollnagel, Michael Baldauf, "The use of Functional Resonance Analysis Method (FRAM) in a maritime accident: A case study of Prestige, Ocean Enginering, 2020 DOI: 10.1016/j.oceaneng.2020.108223

There have been 512 shipping incidents reported in Arctic Circle waters over the past decade. The harsh operating environment means machinery damage and equipment failure are the most frequent causes (48%). Table 19 shows the number of incidents due to machinery damage in Arctic Circle waters.

Moreover, Table 16 shows the percentage of impact in Arctic Circle waters due to mechanical damage. We take into account that this type of accident could cause environmental incidents. Table 17 indicates the risk matrix for ecological impact.

Table 16. The number of causes of incidents in Arctic Circle waters

Vessels	2020	2019	2018	2017	2016	2015	2014	2013	2012	2011	Total
Foundered (sunk)	2	1	1	0	1	0	2	1	1	3	12
Grounded	8	6	7	9	11	6	14	10	8	9	88
Fire/Explosion	8	8	6	3	1	4	2	4	1	6	88
Machinerydamage/failure	18	14	23	46	32	45	27	20	13	12	250
Collision	6	3	2	4	2	3	0	2	4	4	30
Hull damage	0	0	0	2	2	1	1	2	1	2	11

Vessels	2020	2019	2018	2017	2016	2015	2014	2013	2012	2011	Total
Miscellaneous	0	8	4	6	4	6	5	5	6	2	46
Contactat port	1	1	0	1	1	5	4	6	3	1	10
Total	39	41	43	71	55	70	55	50	37	39	500

Source: Own elaboration supported by Table 2, 3, 4, 5, 6 and Akyuz, E. A marine accident analyzing model to evaluate potential operational causes in cargo ships, Saf Sci, 92 (2017), pp. 17-25, ArticleRecord in ScopusGoogle Scholar, Ahmet MertcanYasa, HakanAkyildiz "A formal safety assessment of offshore support vessels," by The FSA for Offshore Support Vessel has been presented, which in a practical manner presents the methodology of conducting the FSA.

Table 17. The percentage of incidents caused by machinery damage/failure and grounded

Year	Machinery damage in %	Grounded %
2010	31	17
2011	30	23
2012	35	21
2013	40	20
2014	49	25
2015	64	21
2016	58	20
2017	64	12
2018	53	16
2019	34	14
2020	40	18

Source: Own elaboration supported by data from table 16.

The data shows that the most significant risk is the local death of flora and fauna at the site of an accident related to a petroleum substances spill. However, technical progress and proposed solutions supported by the IMO's legal regulations may mean that the risk of environmental pollution will decrease. Moreover, the development of maritime spatial use, and thus, the introduction of vessels and devices in one place, will accumulate the risk of degradation or contamination of the ecosystem in a given location. This is what the data presented above proves. These data are introduced to the simulation model with a time perspective. The simulation will also be used for oil and gas activities in maritime areas, which may also translate into an environmental risk. Tables 18 and 19 describe the risk matrix for offshore oil and maritime spatial planning activities.

Table 18. Risk matrix of environmental incidents – in Arctic Circle waters

Risk Index						
Frequency (FI)	Severity (SI)					
	1	2	3	4	5	6
1	2	3	4	5	6	7
2	3	4	5	6	7	8
3	4	5	6	7	8	9
4	5	6	7	8 FI=4 SI=4 Grounded	9	10
5	6	7	8	9	10	11
6	7	8	9	10	11FI=6 SI=5 Machinery damage	12
7	8	9	10	11	12	13

Source: Own elaboration supported by Table 2, 3, 4, 5, 6 and Akyuz, E. A marine accident analyzing model to evaluate potential operational causes in cargo ships, Saf Sci, 92 (2017), pp. 17-25, ArticleRecord in ScopusGoogle Scholar, Ahmet MertcanYasa, HakanAkyildiz "A formal safety assessment of offshore support vessels," by The FSA for Offshore Support Vessel has been presented, which in a practical manner presents the methodology of conducting the FSA.

In the last 40 years, there have been five major environmental incidents in the offshore industry. [15] They caused degradation of the ecosystem both locally and many kilometers from the place of the incident, also reaching the coastline.

Table 19. Pollution (Oil spills and damage to the environment)

Accident Sub-category	SI + FI – RI
Loss of well control (Eruption)/Blowout (E/B)	SI 6 FI 3 = RI 9
Adverse weather effects (AWE)	SI 6 FI 1 = RI 7
Fire/Explosion (F/E)	SI 6 FI 2 = RI 8

Source: Own elaboration supported by investigation reports and expert judgment.

The calculations show that the risk of incidents for the environment is at the ALRAP level. Figure 10 shows the list of predicted risks elaborated by the author's own experience and data from reports (Allianz Insurance, Lloyd's List Intelligence, Det Norske Veritas- Germanische Lloyds). These environmental threats illustrate the broad spectrum of anticipated risks, including local and long-range marine ecosystem damage and economic considerations. And also, in the case of threats to human life and health, when civilian forces are insufficient, military forces and means are deployed, in the form of spelunking equipment for oil spill control on the sea surface or patrolling areas. Conducted research indicate area of sensivity which is spill response means.

Table 20. Risk matrix of environmental incidents

Risk Index						
Frequency (**FI**)	Severity (**SI**)					
	1	**2**	**3**	**4**	**5**	**6**
1	2	3	4	5	6	7 (AWE)
2	3	4	5	6	7	8 (F/E)
3	4	5	6	7	8	9 (E/B)
4	5	6	7	8	9	10
5	6	7	8	9	10	11
6	7	8	9	10	11	12
7	8	9	10	11	12	13

Source: Own elaboration supported by Table 21.

The conducted research and analyzes show that the marine environment is exposed to a number of factors that degrade it. List of predicted risk based on non-military existing threats and risks – environmental predicted risks are as follows:

- ECOSYSTEM Local or global degradation of fauna and flora Shortage of seafood, fish, mammals
- ECONOMY The collapse of the processing and tourism industries on the coastline
- COSTS High panatelas Increase of high insurances

The aim is to identify a sensitive area that can indicate a reduction in environmental degradation. Increasing the means of collision detection / avoidance and, if an incident occurs, quick response. The author proposes to include early warning systems in the National network. The author realizes that it will involve legislative activities. They may be extended in time and multi-faceted, but as a result, they are supposed to reduce the number of threats to human life and health and the natural (marine) environment, such as the possibility of an easy and quick use of available forces and means, including resources owned by the armed forces. In terms of threats, this is the trend of preparation for reacting and mitigating with the use of all possible means to save health and life. The current situation begins to force such an approach, which is reflected in the research carried out.

Discussion

The presented global situation in maritime areas generated many questions, whichwere answered during the research. The data modeling presented indicates the multi-aspect nature and difficulty in forecasting the occurrence of subsequent phenomena. However, the simulation provides a particular insight. It shows sensitive points for the safety of human beings and the maritime environment (maritime ecosystem).

According to the presented global situation, the old threats are still present: i.e., there are still losses of ships, human lives are exposed to dangers from the maritime environment as well as to incidents that have occurred and even lost (as the data shows).[15]

The major predicted risks to human life and/or health include:

- risk associated with the intensity of unpredictable hydro-meteorological phenomena.
- risks associated with the influence of natural hazards;
- risk related to difficulties in rescue operations through the size of the vessels and number of people on board, and lack of adequate rescue measures;

The major predicted risks to the natural (marine) environment include:

- risk associated with the intensity of degradation virgin areas unpredictable hydro-meteorological phenomena;
- risks associated with the increasing numbers of death zones in marine areas;
- risk related to difficulties in rescue operations through the multipurpose of degradations;
- risk related to human health and property.
- risk related to increase of high insurances.

The current state of affairs suggests the justifiability of preparing hazard scenarios for the possibility of introducing:

- effective anticipation of natural phenomena;
- early warning of natural phenomena;
- strengthening the awareness of the phenomena occurring for the population, reducing the coastline as well as for those working in the maritime areas;
- the best possible structural, operational, and organizational solutions for sea-going vessels.

It is reasonable to consider the broadly understood integration of the possibilities of cooperation of different means and forces in the resulting potential emergency and the possible hazards along with more military involvement. Moreover, the Maritime Forces are not only the Navy but also the Hydrographic Service, marine special operations units, the Maritime Border Guard Unit (cost guard), local maritime administration bodies, the Maritime Search and Rescue Service, the Customs Service, the Water Police, and other entities with competencies to act (function) in the area of maritime safety. When carrying out tasks in non-military threats, the Naval Forces should function as part of joint operations. Joint actions of the Naval Forces can be compared to purposeful, focused on the implementation of a specific task, i.e. organized action and the selection of specific capabilities (means) of their individual components depending on the nature of the threat. Thus, these capabilities should be used in a way that

15 Goulielmos, A. M., Giziakis, Vol. 14, 462-478. K., 2002. Marine accident prevention: an evaluation of the ISM Code by the fundamentals of the Complexity theory, Disaster Prevention and Management, Vol. 11, pp. 18-32.

ensures the full achievement of the assumed objectives. Of course, in combating non-military threats, the most important component is the state and local government administration in the field. They are responsible for effective actions to prevent and combat potential non-military threats. Unfortunately, they do not always have the appropriate potential to fight them. Therefore, they must support themselves with a military subsystem, including naval forces. Only the full cooperation of these two subsystems gives a chance to minimize material and human losses in the event of non-military threats.

The author hopes that the discussion generated by the article and the attempt to provide a global approach to forecasting risks will constitute effective material, making sea users aware of a possible cumulation of risks. Therefore, appropriate preventive and preparatory measures should be taken in advance so that the catalog of risks is not extended and practical preventive tools can be found for the dangers that have already been identified.

Conclusion and summary

Conducted research shows that despite using various forces and means, the risk for human life, health, and the natural environment exists. It is possible to reduce them by all possible means.

The study's main aim was to develop a catalog of risks predicted for non-military threats in the maritime areas. The conducted research showed a broad spectrum of the issue. Decomposing it into specific goals enabled it to be classified in a certain way and indicated the multidimensionality of the catalog's components. In the author's opinion during the study, numerous problems in access to literature and the issue's multidimensionality were encountered, but the goal was achieved. Undoubtedly, the real risk is the uneven development of advanced solutions, technologies, systems integration with the estimation of potential risks of occurrence, and the preparation of means and forces for their emergence. In this respect, the author has indicated that:

1. Identifying hazards and potential risks that may occur in peacetime conditions of a state is a multidimensional sequence of actions. It starts with an analysis of the current situation and trends to develop a given position. The links between the successive modules of a complex chain of studies are the available reports prepared by control, supervision, and expert institutions in a given field.
2. Conducting an analysis of the complete spectrum of hazard identification and developing a catalog of risks to be considered in the international system can be extended to the mathematical modeling of individual process states.
3. The risk catalog is opened by violent, highly intense, and volatile conditions generated by natural forces. Due to their parameters, the risk catalog creates several risks to shipping safety, seaport operations, and supply chain security.
4. Other risks associated with the increase in vessels' sizes should be mentioned at the present technological advancement level. This may cause an increase in the potential risk of

rescue operations, increase the size of the disaster, expose human life to danger or harm, also to the natural environment. The forces and means of rescue are disproportionate to the need of evacuating several thousand people on board a ship or eliminate an oil spill from tankers. Also, the solutions within the ship itself are proving to be insufficient in terms of immediate action. Therefore, design trends should be based on the principles of a safety culture.

It may seem surprising, but the author's research has concluded that the total loss of ships will continue. The number may be decreasing/ or fluctuating slightly, but in the long run, attention should be paid to cargo losses, as they may be higher due to the increase in ships' deadweight. This entails a multi-faceted risk to human life and health that they will not be able to cope with an emergency, nor will the rescue services assist them quickly and efficiently. Also, indirectly, this situation may affect cargo recipients. They may not receive the cargo on time if it is food, but if not produced on land, the effect can be dismal. Also, the loss of ships – which is getting bigger and bigger and all human activity at sea-can be an increasing threat to the environment. Without a properly functioning marine ecosystem, human life is at risk. We can say that the circle is closing, and we are standing at a crossroads as to which way to go. However, the motto of Safety Culture should be taken to heart by all users of the sea.

There is still a lot to be done to reduce unpredictable phenomena. The occurrence of events causes us to prepare for the next event eventuality. We can even say that the end of one event is the beginning of the preparation for the occurrence of the next event circumstance.

The author firmly believes that they have drawn attention to the projected risks with her study. Developing the subject matter further will undoubtedly become the topic of the author's subsequent studies.

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