Towards a Framework for Holistic and Integrated Management of Maritime Incidents

Background study

IRA-MAR
IMPROVING THE INTEGRATED RESPONSE TO POLLUTION ACCIDENT AT SEA AND CHEMICAL RISK IN PORT

Co-funded by the European Union

SEA ALARM

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Table of Contents

1 Preface 5
1.1 The IRA-MAR project 5
1.2 Status of this report 6
2 Introduction 6
3 Questionnaire 9
3.1 Aim and methodology 9
3.2 Outcomes 9
3.2.1 Questionnaire completion 9
3.3 Observations and findings 10
4 Interviews 12
4.1 Aim and Methodology 12
4.2 Outstanding insights that were shared in the interviews 12
4.3 Some conclusions from the interviews 12
4.3.1 Concerns about developments 14
4.3.2 Responsibilities around new cargo or controversial situations 14
4.3.3 Sharing experience 14
4.3.4 Rotation of people 15
4.3.5 Staffing the command post 15
4.3.6 Differences between large, medium and small countries 15
4.3.7 Opportunities to exercise 16
4.3.8 EU resources 16
4.4 Other shared insights 17
4.4.1 Maritime vs coast: use of terminology 17
4.4.2 Citizen involvement 17
4.4.3 Holistic/integrated exercising 18
4.4.4 New risk awareness: Container vessels, HNS 18
4.4.5 HNS investments 18
4.4.6 Info on what is on board 18
4.5 Examples of structure that seem to bind authorities together 19
4.5.1 Sweden: annual national events 19
4.5.2 UK: Environment Groups 19
4.5.3 Finland: Role fire/rescue service 19
4.5.4 Finland: MERT system 19
4.5.5 Netherlands: learning from emergencies in a row 20
5 Case histories 21
6 Are risk profiles changing? - A literature review 28
6.1 Changing maritime risk profiles 28
6.2 Traditional oil spills on the decline 29
6.3 Hazardous and Noxious Substances (HNS) 29
6.4 Climate change 33

6.5 Security and emergency aspects of offshore infrastructure ... 34
6.6 Growth of vessel size ... 35
6.7 Development of wind energy ... 36
6.8 Batteries and fires ... 39
6.9 Changing global marine transport patterns due to geopolitical changes ... 39
6.10 Alternative fuels ... 39
6.11 Causes and location of maritime incidents ... 43
7 Conclusions, Recommendations ... 46
7.1 Conclusions ... 46
7.1.1 Questionnaire and interviews ... 46
7.1.2 Literature review ... 46
7.2 Consolidating conclusions ... 48
7.3 Recommendations ... 49
8 Towards a framework for holistic and integrated management of marine pollution incidents ... 50
8.1 Task driven, not responsibility driven preparedness ... 50
8.2 One Incident, One Response ... 51
8.3 Holistic ... 51
8.4 Integrated ... 52
8.5 What is a framework? ... 53
8.6 Developing the framework for holistic and integrated management of marine pollution incidents ... 53
9 Appendix 1 – Questionnaire observations and results ... 54
9.1 Observations ... 54
9.1.1 Changing risk profiles and expanding response capability ... 54
9.1.2 Organisation of the response ... 55
9.1.3 Access to cargo data and HNS response capacity ... 56
9.1.4 Views on holistic and integrated management ... 57
9.2 Further questionnaire results (graphics) ... 58
10 Appendix 2 – References used in the literature overview ... 68
11 Appendix 3 – Questions used in the interviews ... 75

1 Preface

This report provides the results of Task 6.1 of the IRA-MAR project, where the project team has undertaken the following activities:

- A literature study.
- A questionnaire survey amongst 14 countries.
- Series of interviews with country representative and expert organisations.

These activities were undertaken to develop a starting point in Work Package 6 of the project, which was called “Pioneering holistic/integrated management of marine emergencies involving at-sea response and on-shore response”.

The development of such a framework has been identified as an action in the Strategic Action Plan of various Regional Agreements. Work Stream 6 aims to inform these discussions by providing a definition, rationale, the backgrounds, and some relevant options for a proposed way forward to strengthen the joint and individual capabilities of coastal states in Europe and Europe’s neighbouring states for dealing with changing risk profiles of incidents and pollution events. Although the results of this Work Stream aim to benefit the beneficiary Mediterranean countries of the project in the first place (see next section), Work Package 6 will look wider as has collected and analysed information and inputs from countries from four regional seas. It aims therefore to serve the future discussions on Holistic and Integrated Management of Marine Incidents in all regional sea agreements.

1.1 The IRA-MAR project

The project "improving the integrated response to pollution accidents at sea and chemical risks in port" (IRA-MAR) aims to support Spain, France, Italy, Malta, Morocco, Portugal and Tunisia in improving preparedness for marine pollution events through an integrated approach to response, both at sea, on the shoreline and in ports.

Faced with increasingly complex risks due to the growing variety of pollutants and uncertainties regarding their impact on the marine environment and human health, the beneficiaries have identified gaps to be filled in order to improve their operational knowledge and capability. By developing tools, training, and improving knowledge, the project aims to reduce these gaps by placing a coordinated and holistic approach at the focus of the activities developed in the project. It aims in particular to :

- Enable countries to train towards more flexible and versatile capabilities, capable of serving across multiple areas and dealing with the variability of new risks;
- Assess in advance the risks related to HNS in ports by taking into account lessons identified in incidents;
- Study the possibility of using drones to improve monitoring, detection and response capabilities to various pollutants.

The IRA-MAR project deliveries, focusing on enhancing prevention of and protection from the effects of maritime disasters in the beneficiary countries, will be implemented in coordination and synergy with the working programs of e.g. EU institutions and the Regional Seas conventions work programmes and strategies.

1.2 Status of this report

This report has been written to support the development of a proposed framework for holistic and integrated management which can be subsequently discussed at the IRA-MAR workshop.
Based on the discussions during the workshop and the insights it delivers, this report can be further modified before its publication as a project delivery.

2 Introduction

In recent years, European maritime authorities have expressed a growing concern about some changing risk profiles that can be observed in the marine environment:

- Use of new fuels by vessels
- Increasing vessel size
- Increasing number of incidents that involve a wide range of Hazardous and Noxious Substances (HNS)
- New infrastructure at sea, especially wind farms
- New types of incidents seemingly connected to Li-Ion batteries and Electric Vehicles.

These developments could lead to new types of incidents with unusual characteristics for which the established approaches and equipment may not suffice. Whereas the more traditional marine pollution incidents were mainly focusing on fuel oil or cargo oil spills, the incidents of the future may expose coastal communities and the environment with chemicals, gas clouds or new fuel types such as ammonia or methanol. Whereas scenarios of floating persistent pollutants such as oil will still be possible in the future, there is a range of substances that would express some other behaviour (evaporating, dissolving, sinking) if they got spilled. Incidents of the future are bound to involve a mix of substances with behaviours that may only be partly predictable or cannot be combatted with traditional equipment if they can be combated at all.

This also puts a higher risk to the marine environment and coastal communities which may be confronted with the consequences maritime incidents in coastal or offshore waters with characteristics that are different from those that happened in the past.
These were amongst the considerations of three of the main European Regional Agreements (Helcom, Bonn, Barcelona/REMPEC) in their decision to develop a framework of holistic and integrated management for marine incidents that would affect marine waters, coastal waters and the shore (see box 1).

Box 1: References to holistic and integrated management in the strategic action plans of Regional Sea Conventions	
HELCOM	Baltic Sea Action Plan (2021 – 2030) Theme: Response S32 Develop a framework for holistic/integrated management of marine pollution incidents to enable coordinated response operations at sea and on shore by 2025.
REMPEC	Mediterranean Strategy **for the Prevention of and Response to Marine Pollution from Ships** (2022-2031) CSO 1: Prevent, prepare for, and respond to, operational, illegal and accidental oil and HNS pollution from ships 1.3.4 To develop a framework for holistic integrated management of marine pollution incidents that enable a coordinated preparedness and response operation at sea and onshore, incorporating the response to oil-affected wildlife, at a national level and in the region-wide cooperation.
Bonn Agreement Accord de Bonn	Bonn Agreement Strategic Action Plan (2019 – 2025) Actions in relation to Strategic Aim C (response) C.5 Promote links and coordination with shoreline response

This decision to develop such a framework comes from a sense of awareness that coastal authorities

- have a role to play in maritime incidents of which the effects could reach the shore,
- are not necessarily aware of the risks that marine accidents could pose on them and
- may have to develop or improve their maritime response preparedness following their specific responsibilities in the seaward areas of their jurisdiction.

Most maritime authorities have restricted or no responsibilities for organising an extended response to a maritime incident near or on the coast. They are limited in the combat or clean-up of a pollution that has migrated beyond a defined jurisdictional border of their own responsibility. In such scenario's authorities on both sides of the jurisdictional border of what is considered "sea" and "land" have to work closely together.

Can they do this? Is there a unified command under which their duty managers and subject matter specialists can work together? Is there a clear mandate for taking decisions with potentially enormous financial consequences? Are resources in place that can be mobilised and deployed to meet a short window of opportunity? Can such resources be different for the response at sea and the shore, and can they be used in a coordinated way? Are these resources fit for purpose to serve the full range of risks? What are those risks, where do they come from, and which are the scenarios in which they could affect both the sea and coastal domains? Are these scenarios well understood and are they subject of ongoing training and exercises?

These and more questions are explored in this report, and are the result of, a questionnaire, and a series of interviews with representatives of these countries, and a literature review.

Chapter 3 presents the results of the questionnaire that was filled in by 16 countries from across the four regional seas around the European continent. The questionnaire focused on the emergence of potential or real gaps in the response preparedness systems of countries in relation to a range of observed new risks profiles.

Chapter 4 presents the results of ten additional interviews that were held with country representatives to clarify some answers provided in the questionnaire and to look at some more countries to identify examples of what works and does not work well in building an effective joint response preparedness between coastal and maritime authorities.

Chapter 5 presents case histories that were mentioned by respondents as examples of complexity incidents that coastal countries may have to deal with.

Chapter 6 presents the results from a literature review that identifies the trends which lead to the emerging new risk profiles mentioned in the questionnaire and interviews.

Chapter 7 draws conclusions from the previous chapters and lists a series of recommendations as to what kind activities could be undertaken to strengthen levels of preparedness.

Chapter 8 explores the terminology “framework”, “holistic” and “integrated” and introduces the “one incident one response” philosophy as a proposed way forward in “developing a framework for holistic and integrated management marine pollution incidents that enable a coordinated preparedness and response operation at sea and onshore”.

A proposal for such a framework will be developed within the next delivery of the IRA-MAR project.

3 Questionnaire

3.1 Aim and methodology

The objective of the questionnaire was to carry out a comparative study on the structure of existing marine emergency management systems in at least 10 selected countries to detect weaknesses and strengths in the effectiveness of collaboration between at-sea and onshore components of the response, with special attention to the common awareness of new economic trends that may cause unusual future scenario challenges.

The questionnaire was circulated via the European Regional Agreement Secretariats (HELCOM, Bonn and Barcelona for the Baltic, North and Mediterranean Sea regions respectively).

The questionnaire was designed to gather information from authorities on how they view the topic of holistic and integrated management, what they see as key challenges, how they are looking to address these challenges and what mechanisms/tools/for in place or planned which demonstrate a holistic integrated approach. The questions were deliberately kept simple, with the intention to open further dialogue with the countries that responded via telephone interviews to gain more detail on their answers and to delve further into those answers where needed.

3.2 Outcomes

3.2.1 Questionnaire completion

15 countries filled in the questionnaire: Germany, Poland, Finland, Latvia, Denmark, Netherlands, Bulgaria, Slovenija, Cyprus, Tunisia (2 respondents), France, Portugal (2 respondents), Sweden, Malta and Spain.

The types of organisations completing the questionnaire and their roles in an incident are shown in the figures below.

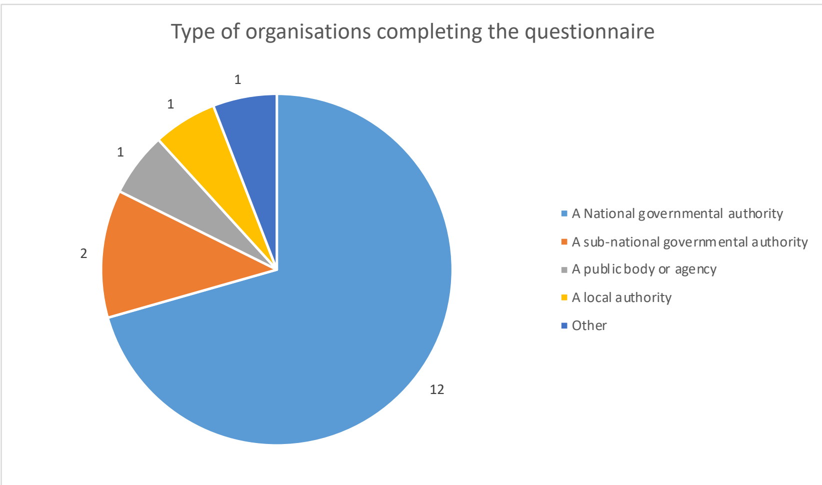


Figure 1 Type of organisations completing the Questionnaire (Note: Other = a range of national & local stakeholders)

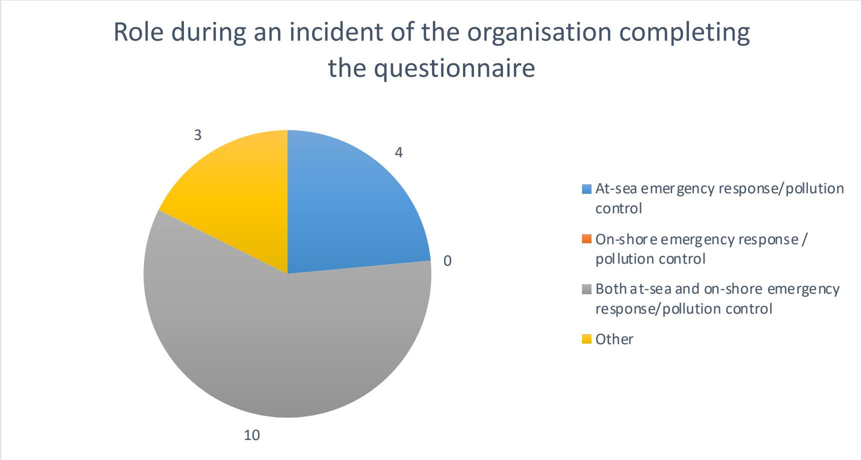


Figure 2 Role of organisations during an incident (Note: Other = National CECIS MP focal point, responding in ports, holistic supporting role (all hazards)

3.3 Observations and findings

The questionnaire provided deeper insights into the realities that authorities face when considering emerging risk profiles, such as HNS spills, the enlargement of container ships, increase in maritime infrastructure such as wind turbines, geopolitical circumstances, among others. From the questionnaire, it was clear that there is plenty of awareness of these risks. In general, preparedness programmes need further development and there is a need for new or improved equipment to deal with future incidents.

The overarching conclusions from the questionnaire are listed below:

- The majority of the persons returning the questionnaire represented both at-sea and onshore emergency response, but none were representing purely the onshore position. It could be beneficial to gather more information from coastal or shoreline authorities in the next phases to provide some more balance to that perspective.
- While new risks are identified and known, the response capability is not yet fully in place to mitigate them and investment into new capacity is still being considered.
- While the respondents acknowledge the need to work together in the event of there being shoreline impacts, two thirds of respondents said they are not discussing changing risk profiles with the authorities who deal with shoreline effects. This highlights a gap for a holistic and integrated response as it appears that when considering preparedness for future risks, many authorities are still thinking within their own siloes. When asked about whether preparedness is responsibility driven (each authority has own individual responsibilities) or task driven (responsibilities adopted by authorities as part of a joint system) – most countries use a mix of both, so it would be beneficial to investigate the modalities of how this works in practice.
- Models are available for coordination between multiple authorities, but more information is needed to elaborate on how these models work in practice and how they can be put in place as part of a preparedness system. Every respondent said that a unified command structure for decision making would be a priority if the offshore response cannot prevent shoreline impacts. However, just over one third of

respondents said that they have two separate command structures that liaise with each other. More information is needed to determine whether the liaisons between the different command structures could be considered as holistic and integrated. Furthermore, having a unified command structure on paper does not by default mean that it is fully holistic and integrated either.

- When asked about having a system in place to accommodate self-mobilising citizens/NGOs as coordinated volunteers, most respondents said they did not have a system in place. From the questionnaire, there seems to be a lack of awareness of the role that such organisations and the general public likely have when incidents occur. It is also worth noting that citizens often self-mobilise regardless of whether there is a system in place which can be a concern for health and safety. Therefore, it is recommended to consider the role of self-mobilising citizens as part of a holistic and integrated response.
- There was a variation between countries when asked about the data and statistics available on quantities and types of oil and HNS cargo that are annually transported through their country's marine waters, ports and harbours. Only a few countries have access to information independent of the vessel master/owner, which could lead to delays in the other countries to acquire the right information during an incident. There are also different perspectives on the application of SafeSeaNet data as not all countries referred to it as a source of information. The questionnaire indicates that there may be difficulties in finding information on cargoes quickly in case of an incident, especially for vessels crossing into waters of different countries as procedures seem to differ nationally.
- Many of the respondents indicated that they would rely on neighbouring countries to expand national capacity for an HNS response. In addition, many countries rely on EMSA to provide HNS capacity, but their services are information-based rather than operational response capacity. More information should be gathered about whether countries are truly aware of the capacity that their neighbours have. If countries are dependent on their neighbours for support, it would also be useful to know whether they have or will run joint exercises to ensure a response would be holistic and integrated. Furthermore, looking at the results from the questionnaire, it does not appear that many countries are well prepared for emerging risks and therefore may not be able to provide adequate capacity to assist neighbouring countries when dealing with an HNS response.

Further Observations and a detailed overview of the main results of the questionnaire can be found in Appendix 1.

4 Interviews

4.1 Aim and Methodology

Following the questionnaire, a series of additional interviews with authority representatives from different countries were held. The aim of the interviews was to:

- Further explore the depth of concerns with apparent new risk scenarios
- Identify ways to develop (and roadblocks towards developing) a holistic and integrated approach, and what this should or could mean.
- Get further insights into the strengths and weaknesses of a country's preparedness and response programmes.
- Learn about solutions or approaches that could potentially be meaningful to explore between countries.

Ten representatives from different European authorities were contacted by email to take part in an individual interview. They were invited to discuss preparedness programmes in their countries, potential gaps, new risk profiles and holistic and integrated management, among other things. Seven of the participating countries completed the questionnaire and an additional three were invited to broaden the geographical scope and to gain further insights. The interviews were scheduled for 45 – 60 minutes on Microsoft Teams with an interviewer and a notetaker.

Ten standard questions (See Appendix 3) were posed to all the interviewees, with some countries being asked more specific questions based on their responses to the questionnaire. After each interview, a summary report was made and conclusions were drawn from the whole set, after completion of all the interviews.

The interviews were representing authorities as follows (following question 1):

- 7 represented marine authorities.
- 1 represented coastal (central) authorities.
- 2 represented an authority related scientific institute.

4.2 Outstanding insights that were shared in the interviews

In the interviews, participants shared personal viewpoints on their own role and that of their organisation in emergency response and preparedness, in the context of past, present and future developments. These viewpoints are anonymously summarised below and grouped under a topic header. In the last sections a few examples are provided of structures or systems that countries have in place, which could be considered as interesting for other countries to consider.

4.3 Some conclusions from the interviews

The interviews confirmed that there is a considerable concern in different countries about the multiple developments that can be observed in the marine environment. The developments can lead to increased complexity of maritime incidents, and some examples of these complexities have recently come to the attention of interviewees, both within Europe and outside of Europe.

From all interviews it has become clear that European countries have systems in place in which maritime incidents can be dealt with by authorities that bear clearly identified responsibilities. These systems often are initiated by the maritime authorities, being the first to deal with vessel incidents and rescue at sea. In all countries the emergency system can be extended to include coastal authorities in the decision making. The coastal authorities could be invited to the table, or would create their own management cell, after which liaisons would connect different management cells that would operate from different locations.

Whereas these systems clearly are in place, in all interviews there was an element of doubt that the systems would be effective on the part of a coastal response. There are a few factors that facilitate (or frustrate) effectiveness of a response. One such important factor is the size and complexity of the country. A small country can be at an advantage because the community of maritime and coastal authorities know each other well, although budgets for maintaining preparedness may be limited. In contract, very large countries with an extended coastline will have to deal with the fact that there are many municipalities, regions and districts in which a large number of authorities have responsibilities and must play a role. Other countries may complexities either in coastline and/or in multiple response cells, which also may have difficulty to make a coordinated response structure work.

Some examples of structures that certain countries have put in place are interesting to consider. They demonstrate a structural investment in regional (e.g. UK) or national (e.g. Sweden) organisation of authority response networks with regular activities to build relationship and train insights. There are also examples of the political will that has innovated the national response structure, which resulted in proven increase of effectiveness (UK) or an experimental new approach to work in multi-stakeholder environments (Finland). A country (Netherlands) can also learn from a series of incidents, building on increased political and social engagement between the incidents, and using insights from abroad.

Other insights from the interviews highlighted some other important points:

- Preparedness budgets have not increased, or have even reduced following a decreasing frequency of major incidents in recent decades. This results in smaller teams who have to work with limited budgets to train and exercise, so less budget is available for investing into equipment and engineered assets.
- The generation that was trained and exercised in decades of frequent incidents is in a process of retiring, leaving the remaining teams with less experience, increasingly dependent on simulation exercises rather than real crisis situations.
- Coastal authorities seem to have a higher rotation rate than their maritime authority counterparts. For officers in maritime authorities this leads to scepticism toward the multiple authorities they may have to deal with, and the continuous drain of experience in the authorities that were exercised, when trained personnel rotates to functions away from maritime incidents.
- There is a well-developed awareness of international services from European institutions and neighbouring countries to assist a local response. However there are complaints that services offered are divided over different platforms, not always easily accessible, and do not always work in practice.

If the risk profiles are really changing towards the possibility of more frequent maritime incidents with higher complexities, the following questions become relevant:

1. Will existing systems be able to cope with the emerging new risk profiles and scenarios that may become apparent in near future incidents?
2. Is there enough political awareness and political will to take decisions towards a further structural investments into restructuring or expanding capacity?
3. Which would be areas in which the gain of capacity and capability per euro investment have the highest return? Is this more vessels, more training of personnel, more exercises, more international services?

4.3.1 Concerns about developments

- Larger vessels, especially container vessels. Diversity of cargo onboard, complex salvage, fires onboard with quick complications and large-scale consequences, containers lost.
- Ships are getting older and lot of Russian vessels (dark fleet) are passing the country's waters, with unclear classification, or unclear insurance. Ship to ship transfers in open water to re-fuel dark fleet vessels.
- Wind farms close to anchoring sites in combination with more extreme weather events. Anchoring vessels wait for entrance to a harbour, but while anchoring may be subject to a storm event, which cause them to drift into a nearby wind farm.
- New wind farms and the new spatial reality they are presenting to a maritime incident. Some countries allow vessels to sail through a wind farm; in others it is prohibited. Wind farms may play a role in causing or complicating the root cause of an incident. They may also play a role in complicating the response to an incident (towing, cleaning up pollutant).
- HNS is too complex to fit traditional response; hard to anticipate; HNS expertise lacking, as well as HNS equipment.

4.3.2 Responsibilities around new cargo or controversial situations

- The responsibility for decision-making for the response to for example batteries or nurdles, is sometimes not formally assigned to any authority, and under normal circumstances will not be adopted and is ignored. This may cause delays in decision-making in an incident.
- Other countries, for example the UK, have put one officer in place who has the mandated authority to take important decisions under time pressure. This ensures that a window of opportunity can be used without delay and without political debate and decision-making delays.

4.3.3 Sharing experience

- Experience from previous incidents is not well shared between response organisations. Oil that was spilled in a recent incident could not be cleaned up using a modern skimmer, but putting some diesel on an old skimmer made the job possible. Such "tricks" are not well communicated and internationally shared.

- Documented information on lessons learned in databases (EU has this) can be overwhelming and will not be consulted beforehand. Only if a problem, and a certain concrete question comes up, the database it may work.

4.3.4 Rotation of people

- In civil protection/local authorities the point of contact for marine authorities tend to change quite quickly. No lifelong careers found there anymore. This means that there will not be a lot of knowledge, experience and routines left. Sharing lessons learnt from marine perspective are not ending up in “institutional memory”.
- In multi-authority decision-making systems, officers with a long track record of training and experience normally provide leadership in meetings where also people with less experience are participating. Regular training, meetings and exercises are therefore good investments in making incident response work.
- In recent years, in a trend of less regular maritime incidents, teams of incident managers have become smaller, due to cost savings. This also has led to a loss of institutional history, routines, and experience.

4.3.5 Staffing the command post

- In complicated incidents the command post must be limited to the key authorities with overall decision-making power. Too many individuals will also bring too many opinions. In large incidents a layered approach is therefore needed to concentrate on main priorities and avoid a complicated decision-making process.
- Fully integrated approach for all authorities, although ideal, is an illusion in consideration of the country and the way responsibilities are organised. Communication with diverse stakeholder groups is important, and structures must be in place to make sure that priorities can be recognised and included in the decision-making system.
- Flexibility in such a layered system is needed to recognise a wide range of stakeholders and ensure that all aspects can be considered for decision-making.
- Often the existing response capacity has developed based on needs from past incidents. Once an incident response is needed – you have to work with what is there, and via a management system to assess and evaluate, improvise and scale up by bringing in resources from external sources. Important to keep monitoring trends in order to develop new capabilities, e.g. on HNS response, which have not developed from past incidents.

4.3.6 Differences between large, medium and small countries

- In some small and medium countries there are reports of a relatively small group of individuals in the core of the maritime and coastal response authorities, which leads to a situation where everybody knows each other. This is considered as an advantage for developing preparedness and delivering an effective response as far as the command structure is concerned. However, a small country may have limited budgets and resources and can maintain only a limited level of operational preparedness.

- Large countries with a long shoreline and a considerable number of independent regions and municipalities can have strong challenges due to multiple jurisdictions (municipalities, regions and districts), wide spectrum of decision-making authorities for different topics, and different levels of preparedness (or expertise/experience) amongst them. Whereas the national crisis management system may be the same everywhere, in each location the players are different, and do not necessarily know each other, and may not know what the other will deliver. This may create challenges in organising plan development (e.g. regions without a known plan), exercises, or bringing together experienced staff to deal with an actual incident. It was mentioned that in the early stages of a developing incident response 2-3 days may be wasted to get to know each other. Another layer of preparedness structure is needed to ensure that these hurdles are overcome.
- Very small countries tend to have only one or two individuals for key roles to be played, sometimes with limited budgets, or limited autonomy for taking important decisions, e.g. for requesting resources from abroad (these decisions to be pushed up to elected officials who are less aware of technical contexts). As complex incidents also can take place in small countries, the individual (trained) officers will be quickly overwhelmed with complexities and scaling up or rotation will become a problem. Although the incident command context will be clear, the response systems will suffer from a lack of local resources.
- Other countries may have a long coastline but a small population and a small emergency response community in which individuals know each other at national levels, who can support local emergency response systems.

4.3.7 Opportunities to exercise

- Incident frequency is low, and new officers do not often get the opportunity to practice their roles.
- Frequency of organised exercises involving both coastal and marine authorities is considered low. If they happen, they can only deal with the scenario chosen, which may not fully extend responsibilities or roles that would be needed in other types of incidents.
- Many responsibilities and jurisdictions. Maritime related responsibilities are not often deployed: incidents and exercises are not reminding these authorities on what can happen, or how a challenging maritime scenario looks like.
- In incidents with large media attention, decisions migrate up the ladder, to managers or elected officers who lack technical oversight or specific training.

4.3.8 EU resources

- Great to have tools at EU level, but also there is fragmentation. EMSA, DG Echo, DG Move have their own services and tools. Useful, but not every national agency is aware of what is there, or has access to it.
- Many different services, but all on different platforms, not easy to use the platforms. There is a need to simplify; request to put all on one platform.
- CECIS marine requests cannot be checked by CECIS Civil Protection (request gone out? Responses received?)
- EMSA's information and equipment cannot be accessed by local municipalities.

- EMSA's equipment resources based on oil spill response
- Tools online have different access modes, e.g. training, command post exercise, operational mode. But these modes have differences, which leads to confusion and complications when having to operate these systems in a real time incident.
- Lessons Learned tool in Civil Protection. Very rich, but complex. Is it being used? Is it being analysed? How to learn from it if it is not easily accessible?
- Having only one person in DG Echo who is au fait with maritime response and preparedness is considered very vulnerable for the durability of what DG Echo aims to provide to the maritime community.

4.4 Other shared insights

- Officers in small countries are often persons with more than one task, overseeing many different fields and building up experiences, networks and skills that are quite unique. Over the years such roles are hard to transition to somebody else. It is also a vulnerability of the system as a whole if the success of a response is heavily depending on a handful of persons.
- Being prepared for marine incidents is depending on a sense of community rather than the division of responsibilities alone.
- Emergency scenarios always different from exercised scenarios. Response plans increasingly describe responsibilities rather than scenarios. Investments need to go towards the quality of the structures and individuals who are supposed to manage the response.
- Think tanks of experts who study risk trends and work out consequences do not exist but it may be interesting concept to be set up, even across country borders.

4.4.1 Maritime vs coast: use of terminology

- Coastal authorities not always sure what boom, skimmer is.
- Maritime authority personnel ready to already "translate" niche language to something the coastal authority will understand.
- Not always know to think in miles, or time it takes for a vessel to sail from A to B in an emergency response.
- Exercises and meetings can create familiarity with language.

4.4.2 Citizen involvement

- Was an issue in the response to the MSC Zoe in the Netherlands, where NGOs organised volunteers to mobilise to the islands that were suffering pollution on the beaches. Large numbers of volunteers were hard to coordinate once they arrived on the islands. Has led to the decision to develop systems for authority-led volunteer recruitment and management, in collaboration with coordinating NGOs.
- Emotions can be involved, which does not always lead to the right kind of decision-making (e.g. wildlife)
- Curiosity with people to see the effects of an incident can lead to lots of visitors on the shoreline. Important to have systems in place to limit access.
- Pro-active communications to inform citizens and lead them into informed decision making. Citizens can be recruited for assistance, but to be organised by local

authorities. Also involvement of citizens as volunteers via accepted NGOs, e.g. for wildlife response.

4.4.3 Holistic/integrated exercising

- External party to design and evaluate: more objective, learning lessons.
- Private sector and service providers to assist, bringing in more aspects, and not the regular scenarios, making participants think. Important to learn lessons and act on them. Political will is required to make changes happen.
- By design try to break existing tunnel vision approaches, by bringing in circumstances or topics that require exploration.

4.4.4 New risk awareness: Container vessels, HNS

- Large vessels of 20,000 TUE of which 200 may have HNS.
- Cargo manifest may be hundreds of pages, info not looked at unless you have an incident.
- Cargo may have specifications for which it is not clear who would be the authority that has responsibilities to take care of the problem.

4.4.5 HNS investments

- Mainly on PPE, specific booms, specific pumps
- Not much R&D on HNS relative to oil
- There is practically no capacity for response; not prepared at all, same for most countries.
- There are private companies with resources, but also limited in what they can do. They provide PPE, instruments for detection and monitoring. Clean up still very much depending on oil spill response resources, which only can be used for HNS that acts like oil.

4.4.6 Info on what is on board

- Data from EU ports can be provided, in reality not that straightforward
- Sources: Master, terminal, shipper
- Material Safety Data Sheet (MSDS)
- In port, accidents info should be provided within minutes, ports are within communities.
- Lack of data is a game changer.
- First point of contact is master. Then agent/terminal.
- Can take something between 2 and 5 hours.
- Undeclared goods can be issues; and goods coming from outside EU where less data available.
- Statistics on cargo: usually held by terminal; can be provided on request.

4.5 Examples of structure that seem to bind authorities together

4.5.1 Sweden: annual national events

Every year, a 2-day national oil spill conference is being organised by the national authority for civil protection (MSB). All authorities with at-sea and coastal responsibilities can voluntarily attend, as well as stakeholders. Via short presentations (10 min) and discussion sessions, all attendees are brought up to speed with latest developments and insights related to risks and emergency response challenges. Group exercises aim to deepen insights in roles and responsibilities. The meetings are always well attended. Any municipality cannot attend every year, but will do so from time to time, and having one large meeting once a year and not many small events during the year, lead to much more focus and coherence. A few municipalities and even regions have not or very infrequently attended. They are subject of a more targeted campaign.

4.5.2 UK: Environment Groups

The coast of the UK is divided into 9 coastal regions each has a so called Standing Environment Group. The SEGs formed in this way are regularly coming together with the Maritime and Coastguard Agency to discuss maritime incidents. In a maritime incident such a group comes together to provide advice on environmental sensitivities, conservation, fisheries, human health and post-incident monitoring. The establishment of SEGs was an important recommendation following the Sea Empress 1997 incident, as a way to create solid relationships between the maritime authorities and those authorities having to deal with multiple possible coastal impacts. Via annual meetings the SEGs are brought together, providing opportunities for key personnel to get to know each other and develop joint insights on risk management, and the ability to cooperate.

4.5.3 Finland: Role fire/rescue service

In Finland the responsibility for coordinating the response on the coast has been laid with the fire/rescue service. The organisation structure of this service, which is represented in all municipalities, allow to provide regional and national oversight as appropriate, to deal with the challenges of a coastal marine response. In this way a seamless scaling up can be ensured and is a coherent strategic and tactical coordination in hand.

4.5.4 Finland: MERT system

Also in Finland, the MERT system has recently been adopted which provides the infrastructure to deal will marine emergencies at all scales and integrating marine and coastal resources. The joint command system can provide a visualised overview of the response taking place via a Common Operating Picture. Another interesting asset is that the involved authorities join up their Planning and Logistics teams, so that these functional groups can provide an overarching support of a centrally coordinated operational management. In an Advisory Board any organisation/entity can be placed who play a role in the delivery of a response, e.g. volunteer organisation, authorities, private sector, salvage companies etc. These organisations are involved in regular preparedness activities such as workshops and exercises.

4.5.5 Netherlands: learning from emergencies in a row

Not so much an innovative structure, but the Netherlands has learnt quickly from a series of maritime emergencies in a row. The management of the *Freemantle Highway* incident (2023) could take advantage of the experience of the 2019 *MSC Zoe* incident and also the experiences from the *Felicity Ace* incident in the Azores in 2022. Because of these previous experiences, a quick communication routine could be established with the shoreline authorities, and expertise from the Azores led to advanced tactics to fight the fire onboard the vessel (cooling the vessel from the outside, not letting water run into the vessel, avoiding destabilisation and capsizing). A newly conceptualised management system for coordinating complex maritime emergencies was used for the first time to optimise decision making in relation to interactions with multiple authorities when selecting a Port of Refuge.

5 Case histories

In this chapter, a series of case histories are reviewed, which were mentioned in the interviews or literature as examples of challenging scenarios of the 'new normal'. Each incident highlights emerging risk profiles that will challenge both onshore and offshore authorities in the event of an emergency and emphasise the need for a holistic and integrated approach when dealing with scenarios of the future. There are also some recent cases with oil which were raised during the interviews and are therefore also highlighted below. Cited references as numbers in square brackets are listed in Appendix 2.

Incident, year	What happened	Relevance
Fremantle Highway, Netherlands (2023)	In July, a fire broke out on a car carrier in the North Sea which burned for almost a week. The ship was carrying 3,783 cars, of which 498 were electric [57]. The exact cause of the fire has not yet been determined, but the batteries of the electric vehicles were highlighted as a key concern if they were to catch fire. The fires on the vessel quickly produced an enormous heat forcing the crew to jump overboard before the rescue helicopter arrived. They jumped from 30m height into the water. All were rescued by life boats although there was one fatality. The incident occurred around 27 km north of Ameland, an island that is part of the Wadden Sea UNESCO heritage site, one of the most extensive intertidal areas in the North East Atlantic region. There were real concerns that if the ship sank it would cause a serious potential pollution of this area which is known as extremely important as a nursery area for fish, feeding and reproduction area for birds, feeding and reproduction area for seals. Salvors were able to attach a towing line to the vessel by which it could be manoeuvred to keep it away from the main shipping lanes and increasing winds. Also under consideration for keeping the vessel in position was infrastructure on the sea bottom such as gas pipelines.	The *Fremantle Highway* incident brought attention to the risks of transporting cargo with batteries, such as electric vehicles. Battery fires pose new challenges as they are more difficult to extinguish. Electrical vehicles were also thought to have caused the fire on the *Felicity Ace*, although that could not be confirmed. The incident demonstrates that safety measures around the transport of electrical vehicles must be further developed. At sea such fires can develop fast, putting crew at risk. The incident highlights the risks that can be posed by cargo consisting of electrical vehicles or batteries. In a quickly transitioning society there is a large demand for such products, and therefore an increasing proportion of such products on board car carriers and container vessels. This incident also highlighted the potential risks of pollution effects to the nearby coast. The Wadden Sea is extremely vulnerable for pollution and also represents a geographically complex setting for pollution response operations. Other issues that can be highlighted are (pers. comm. RWS): • Nearby shipping lanes which could have become blocked by an abandoned vessel on fire had it been impossible to attach a towing line.

Incident, year	What happened	Relevance
	The firefighting strategy aimed to avoid bringing water on deck and into the hull to prevent sinking of the vessel due to the weight of the water. This was a lesson learnt from an earlier similar incident, the *Felicity Ace* in 2022 (Azores). This vessel was lost after the fires went out but sank while under tow because of the water content onboard. On the *Fremantle Highway* the fire eventually went out and the ship was successfully towed to the selected Port of Refuge, Eemshaven in the Netherlands.	• Infrastructure such as pipelines that could become damaged by a sinking ship. The fire on board in combination with a damage gas pipeline could cause considerable additional complications. • Towing the vessel to a Port of Refuge also comes with risk as the vessel will be towed towards the shore. Fires could spontaneously re-ignite bringing the challenges even closer to the shore or inshore. • Towing towards a Port of Refuge also brings in multiple onshore authorities who may have to take over the lead of the response when the vessel crosses borders of jurisdiction. •
Escape, Latvia (2022)	A fire broke out in the engine room of the small container vessel *Escape* off the coast of Latvia, which could not be extinguished with the autonomous fire extinguishing system. The crew had to abandon ship, which left it drifting in the Baltic Sea. Luckily the fire extinguished over time and the ship was successfully towed to the port of Riga. The ship was known to be carrying HNS, but luckily the cargo was not affected by the fire [58].	While this incident did not turn into a complicated HNS incident, the *Escape* accident was a clear reminder of the dangers involving the transport of HNS. The fire onboard, followed by the evacuation of the crew, left the vessel drifting without steer towards the coast. It was fortunate that the fire did not spread to the cargo, and extinguished over time. The incident highlights how an offshore incident can turn into an emergency situation near to the coast. A fire that reaches the diverse containerised cargo can have multiple complications for the unfolding scenario, such as smoke/gas clouds, explosions, sinking vessels, cargo overboard. The distance to the coast is an important factor as to how the effects could impact coastal human communities, vulnerable near and onshore ecosystems, and economic assets in the coastal area.
Julietta D, Netherlands (2022)	The *Julietta D* [59a,b] was anchored off the coast of Ijmuiden, the Netherlands, when the anchor chain broke during a storm. The crew were evacuated when the vessel was taking on water after colliding with an anchored chemical tanker (which did not have considerable damage). The bulker then drifted out of control to the coast of Scheveningen, into a wind farm where it hit a jacket foundation of a transformer platform and collided with the monopile foundation of a turbine. Hindered by the rough stormy sea, salvage operators were eventually able to attach several towing lines, which enabled them to tow the *Julietta D* to the port of Rotterdam. The Captain and First	The *Julietta D* incident highlights a chain of events in a nearshore environment that could have complicated the scenario. It was initially caused by a heavy storm in a larger anchoring area where multiple vessels awaited their access to the Port of Amsterdam at Ijmuiden. Such extreme weather events are expected to happen more frequently in the future. The immediate collision with the chemical tanker could have caused further complications if that tanker had been damaged and spilling cargo less than a few miles from the nearshore environment.

Incident, year	What happened	Relevance
	Mate were subsequently arrested for abandoning the ship prematurely and an investigation is underway.	Further complications arose when the vessel drifted into the near windfarm. This in itself complicates SAR or salvage operations. If the *Julietta D* had been spilling fuel or cargo, the combat of such cargo would have been physically difficult within the windfarm. As infrastructure at sea continues to increase, so too will the risk that incidents will occur involving wind farms or other infrastructure. Such infrastructure could become damaged, and as such create new risks (e.g. electricity cables damaged by an anchor or sinking vessel), or could damage a drifting vessel and cause a further complication onboard, e.g. a fire, a fuel spill, or containers falling overboard, etc.
X-Press Pearl, Sri Lanka (2021)	A large container ship caught fire 17 kilometres northwest of the Port of Colombo, Sri Lanka. An intense fire broke out leading to a loss of an unknown quantity of containers. After a failed effort to tow the ship, it eventually sank after 12 days of burning. The ship was carrying 1,486 containers, including HNS (nitric acid, methanol, sodium hydroxide and other chemicals) and tonnes of plastic nurdles. It was the largest spill of plastic nurdles worldwide to date [60].	The *X-Press Pearl* highlighted the complexities of a large-scale incident of a container ship carrying a wide range of materials, from HNS to plastic nurdles. Onshore authorities were quickly faced with containers and debris washing ashore, and local fisheries were forced into closure. Given the volume of plastic nurdles spilled, the response efforts were still ongoing a year later. The use and management if volunteers became an important asset used to assist the clean-up of plastic nurdles. This incident showed the speed at which a maritime incident can quickly become an onshore incident, the threats of HNS and plastic nurdles and the potential to integrate volunteers into a professional response to deal with relatively safe but extensive clean-up activities on the shore.
Ever Given, Egypt (2021)	A 400 metre-long container ship ran aground and became lodged sideways in the Suez Canal after being thrown off course by strong winds. The ship blocked one of the busiest shipping routes for world trade for 6 days. The insurance company Allianz estimated that the blockage could have cost $ 6 – 10 billion per day to global trade [82].	The *Ever Given* incident highlighted the difficulties that continually growing container ships can get into when navigating relatively tight and trickier areas, such as the Suez Canal. After the incident, the Egyptian Port Authority announced that they would widen the tighter parts of the canal [61]. While engineering advancements are facilitating larger container ships,

Incident, year	What happened	Relevance
		infrastructure such as canals and ports may not be suitable to handle ships of such large size, which can lead to new incidents. The incident also shone a spotlight on the vulnerability of the global shipping trade to maritime incidents. The blockage forced vessels to take alternative routes, increasing traffic intensity in unusual places. For months multiple vessels were anchored on both sides of the canal, waiting for their turn to enter the passage. In relatively calm weather this is relative harmless, but the *Julietta D* demonstrated that an extreme weather event can cause risks when one or more vessels get adrift.
Vera Su, Bulgaria (2021)	A cargo ship became stuck on rocks off Bulgaria's northern coast when a second officer fell asleep and missed a way point for joining the Traffic Separation Scheme [62]. As a result, the ship sailed too close to the shore and ran aground. The cargo ship was carrying 3,300 tonnes of nitrogen fertiliser. While the fuel oil was successfully removed from the ship, the nitrogen fertiliser posed a serious threat to the environment. If spilled, nitrogen fertiliser can cause overgrowth of phytoplankton which in turn creates a toxin that is deadly for marine life [63]. The coastal area and underwater rocks, as well as the weather conditions, created challenges for the salvage operation. Following removal of some of the cargo which made the vessel lighter, it was towed to the port of Varna.	The global fertiliser market is expected to increase, and many fertilisers are transported globally through shipping [64]. Fertilisers have long been transported by shipping, but the risks remain, both as a flammable substance and as an environmentally damaging substance if spilled. Even bulk cargo that is not classified as noxious or hazardous could cause considerable ecological challenges if spilled in relatively shallow areas where its biodegradation by bacteria will quickly use all the oxygen from the coastal ecosystem.
MSC Zoe, Netherlands (2019)	The very large container ship *MSC Zoe* [65] ran into trouble during strong north-westerly winds, north of the Wadden Islands, when it was crossing relatively shallow water outside of the shipping lanes, reacting heavily to the unforeseen wave action. The crew initially reported that around 30 containers had been lost overboard, but this number increased over time, with a total of at least 342 containers being lost, carrying an assessed 3.2 mln kilograms of cargo. While the	The pollution impact of the *MSC Zoe* demonstrated that a marine incident can create an overwhelming situation in terms of large volumes of waste washing ashore and polluting the coastal waters for a long period of time (offshore cleanup operations still being carried out as of October 2023, organised by an NGO initiative [73]).

Incident, year	What happened	Relevance
	coastguard had access to the complete cargo manifest within 24 hours, they could not immediately determine which containers had been lost, or which type of cargo had fallen overboard. Most of the containers eventually appeared to consist of consumables, packaging materials and other plastic objects, including nurdles. Furthermore, the incident was close to the Dutch and German Wadden Islands which are nature reserves and on the UN's World Heritage List. In the days and weeks that followed, large volumes of this material washed ashore, which caused national media commotion, leading to spontaneous initiatives amongst some NGOs who recruited volunteers from the public to help cleaning up. Large numbers of volunteers, which also included families with children, were spontaneously appearing on the beaches of different impacted islands to assist.	The pollution overwhelmed the local authorities in the Wadden Sea area in different ways [75]. It initiated spontaneous actions of locals and tourists, to collect valuable materials that were washing ashore. The accessibility of the islands for self-mobilising citizens put a burden on the communities of the islands, which are small and without the extended infrastructure that could sustain a long lasting response. Dutch army forces were mobilised by the islands' mayors to assist with the clean-up and the onshore coordination of spontaneous volunteers. Whereas the spontaneous volunteers were considered as helpful, especially for the collection of plastic waste, they also caused challenges as they were not well coordinated, leading to some registered risks (related to children, vulnerable nature). The incident led to initiatives of different Dutch authorities [74] to develop structures for coordination, under which citizens can be invited to assist shoreline response following marine emergencies (e.g. cleanup pollution and wildlife response).
Makassar Highway, Sweden (2018)	In July 2018, the 139 metre long car carrier *Makassar Highway* ran aground in the Tjust archipelago, in the Swedish Baltic Sea. The ship was carrying approximately 1,325 vehicles and an assessed 333,000 litres of fuel oil, 38,000L of lubricating oil and 34,000L of diesel. One crew member was arrested over suspicion of intoxication. Following underwater examination by divers, the serious cracks in the hull meant that a fast salvage operation was necessary as there were fears the oil aboard the ship could leak out. Strong winds caused the ship to list and led to a small oil leak during fuel oil removal operations [66] but luckily it was not a major oil spill incident.	While new risk profiles are posing new challenges and threats to coastal and offshore authorities, the *Makassar Highway* is a reminder that oil spills are still a threat and oil spills could happen closely inshore. Another reminder is that, despite the developments in engineering and technology, human error is an important factor in the root cause of maritime incidents.
MOL Comfort, Yemen (2013)	In June 2013, the container ship *MOL Comfort* suffered a crack during a storm in monsoon season 200 nautical miles off the coast of Yemen. The ship later broke in two on the same day and a subsequent fire broke out on the fore part a few weeks later. The fore part sank and	At the time, the *MOL Comfort* raised attention to the ever-growing size of container ships and the risks they may face in storms. It also raised questions about the loading and storage of containers on board these large ships. After the incident, the 6 sister ships of *MOL Comfort* underwent structural

Incident, year	What happened	Relevance
	brought with it 2,400 containers and 1,600 tonnes of fuel to a depth of 3,000 metres [66].	inspections. 3 returned to sea following upgrades to the hull structure [67]. Engineering developments allow for increasing ship size, but there are also risks that mistakes can happen as ships grow ever larger.
Rena, New Zealand (2011)	In October 2011 container ship *Rena*, grounded north of New Zealand, after running aground at full speed on Astrolabe Reef, some 20 km off the coast of Tauranga with 1,368 containers onboard (goods and various HNS) and 1,700 t of heavy fuel oil. An estimated 200 to 300 tonnes of HFO was spilled at sea. About 2,000 seabirds died and an estimate of 20,000 birds are thought to be victims of the oil spill through their ecosystem and food sources being contaminated. 383 oiled little blue penguins were admitted to the oiled wildlife facility, 95% of these were released back to the wild and 89 dead oiled penguins were recovered through the response. *Rena* was carrying 1,368 containers, including 32 containing hazardous substances. In total, an estimated 169 containers fell overboard, of which 23 containers later washed up on the shore. The response operations to remove containers proved to be a very tricky operation. In total, 1,007 containers were recovered [68].	The *Rena* was an example of how one maritime incident can escalate into more than one challenge to be managed: recovery of containers (on board and lost at sea), oil clean-up operations offshore and on the shoreline, wildlife response operations including rehabilitation in a wildlife facility, and wreck management operations carried out by the salvage company to try to minimise further impacts. The *Rena* case highlighted the need for a volunteer management programme. An official call for volunteers was launched online with a massive response from the public (more than 8000 volunteers registered). Causes of the incident also need to be mentioned. According to New Zealand's Transport Accident Investigation Committee, the *Rena* grounding was a multi-factored accident resulting mostly from lack of procedural compliance. Human action and multiple failures in shipboard operations led to a disastrous incident which could have been avoided [69].
MSC Napoli, UK (2007)	While sailing through the English Channel, the container ship *MSC Napoli* ran into trouble during a storm. During the storm, the ship suffered catastrophic damage to its hull and began to list. The strength of the storm immediately posed challenges to the response. French and UK authorities collaborated and it was decided to try towing the vessel to a Port of Refuge in the UK (Southampton). While under tow, the vessel became more unstable and it was decided to ground her on shallow sand banks off the coast of Devon, near a UNESCO World Heritage site.	The *MSC Napoli* incident showed the complications of handling an incident with a combination of different facts – oil mixed with containers with many different types of materials. It demonstrates dilemmas to choose between alternatives for a response intervention e.g. letting the vessel sink in open water, or beaching it inside of a natural reserve, each of which will lead to further complications, and none of the options to choose from is "best". The incident generated a lot of media attention and led to many self-mobilising citizens heading to the beach to look for valuable contents to collect from the lost containers, which included brand new motorbikes in still

Incident, year	What happened	Relevance
	The ship was carrying 2,300 containers and 3,800 tonnes of oil. Its cargo included e.g. explosives, fertiliser, personal goods, glyphosate weedkiller, bisphenol, methyl bromide, pesticides, naphtha, car engines and a variety of food and drink [70]. Lost containers arrived on beaches, others were damaged and released their content, leading to thousands of tonnes of debris in the coastal waters and on the shore. The incident also led to around 302 tonnes of oil being released into the environment. Over the following weeks, around oiled 1,000 seabirds were collected for rehabilitation. The container removal took over 3 months. The overall incident response took 934 operational days. The total cost of the incident was in excess of £120 million.	perfect condition. In an incident, self-mobilising citizens can pose problems for the response operations, unless they can be coordinated and fully integrated into the response. With increasing online activity and messages being quickly spread through technology, self-mobilising citizens are likely to go to an area where there has been an incident. It is important for authorities to anticipate this behaviour.
MV Wakashio, Mauritius (2020)	While sailing the Indian Ocean, the bulk carrier *MV Wakashio* approached the coast of Mauritius, apparently in an attempt to pick up a GSM/4G signal for the crew to connect with their families. On the nautical maps the crew overlooked the presence of a fringing coral reef and the vessel grounded on the reef, and in the weeks that followed started spilling its bunker oil (LSFO). The vessel eventually broke and although the oil on board was pumped out before she broke, an estimated 1000 tonnes of oil was spilled. As the vessel was not loaded, no cargo was spilled [84].	This incident highlighted the properties of the spilled LSFO, especially its fluidity and ability to spread extensively through the island's sheltered lagoons. It was far less viscous than the traditional fuel oils, and could not be stopped nor absorbed by sorbent booms that were improvised on the island. The incident also highlights the fact that the incident took place in a relatively remote area where the local community and government did not have the preparedness and equipment to deal with the emergency and were dependent on the mobilisation and arrival of resources from abroad. Meanwhile the local community improvised booms and sorbent constructions in an attempt to stop the spilled oil from spreading into the sensitive coastal environment [71].

6 Are risk profiles changing?- A literature review

In this section we make an attempt to document how climate change and net-zero policies are causing both significant trends in the way space at sea is used and the way shipping is expected to perform in the years and decades to come. Such trends, also following geopolitical changes, could change marine risk profiles and are important to consider in building more resilience in marine emergency response preparedness in Europe. What follows is a first pilot study of a quickly growing volume of published articles and papers that are reporting trends, in an attempt to highlight issues that are already, or should be, on the radar of marine and coastal emergency responders. Appendix 2 lists all the literature studied, including those cited in this section as numbers in square brackets.

In the following sections, we explore these trends:

- 6.1 Changing maritime risk profiles
- 6.2 Traditional oil spills on the decline
- 6.3 Hazardous and Noxious Substances (HNS)
- 6.4 Climate change
- 6.5 Security and emergency aspects of offshore infrastructure
- 6.6 Growth of vessel size
- 6.7 Development of wind energy
- 6.8 Batteries and fires
- 6.9 Changing global marine transport patterns due to geopolitical changes
- 6.10 Alternative fuels
- 6.11 Causes and location of maritime incidents

6.1 Changing maritime risk profiles

The marine environment is facing a number of challenges to respond to the changing world. Developments related to global, regional, and national political decisions on climate change, such as the decarbonisation of transport, emission cuts and an accelerated energy transition are leading to a range of changes that can be observed or expected in the maritime sector:

- Vast areas at sea are reserved for the development of wind farms, affecting other activities such as fisheries and shipping, sometimes stimulating additional new developments such as sea farming and offshore biodiversity initiatives.
- Decarbonisation and curbs on emissions, which push vessel owners towards the use of alternative fuels (low-sulphur oil, LNG) and more innovative solutions (ammonia, methanol, biofuels).
- Changing cargo patterns reflecting the needs of decarbonisation, energy transition.
- A trend towards larger vessels to reduce the costs of marine transportation.
- Changing global marine transportation patterns due to geopolitical changes including a so called “dark fleet”, operating outside of international legal and insurance frameworks.
- More critical infrastructure emerging seaward, with growing vulnerability against terrorism and security risks.

These developments are changing marine incident risk profiles in various ways. They also can make the traditional response strategies less effective (see Section 6.3) and require consideration by the authorities in coastal states who deal with emergency response in marine and coastal environments.

6.2 Traditional oil spills on the decline

- The statics that ITOPF keeps on tanker spills occurring around the word demonstrates that the number and volume of oil spills from tankers has dropped dramatically (see Figure 3). This is due to investments into vessel safety and construction (e.g. double hulls) and authority regulation and prevention systems.
- Such statistics are not kept for vessels other than tankers, and it is therefore difficult to tell if a similar trend is also visible for non-tankers as such incidents continue to happen. Although the volumes spilled in non-tanker incidents are certainly smaller than those recorded in iconic incidents such as *Amoco Cadiz*, *Sea Empress*, *Exxon Valdez*, P*restige* and *Erika* – the complexity of these incidents and the damage they cause can be considerable.
- EMSA reports that the amount of oil transported at sea has been steadily growing, but the number of oil spills has been on the decline as well as the number of operational discharges of oil [53].

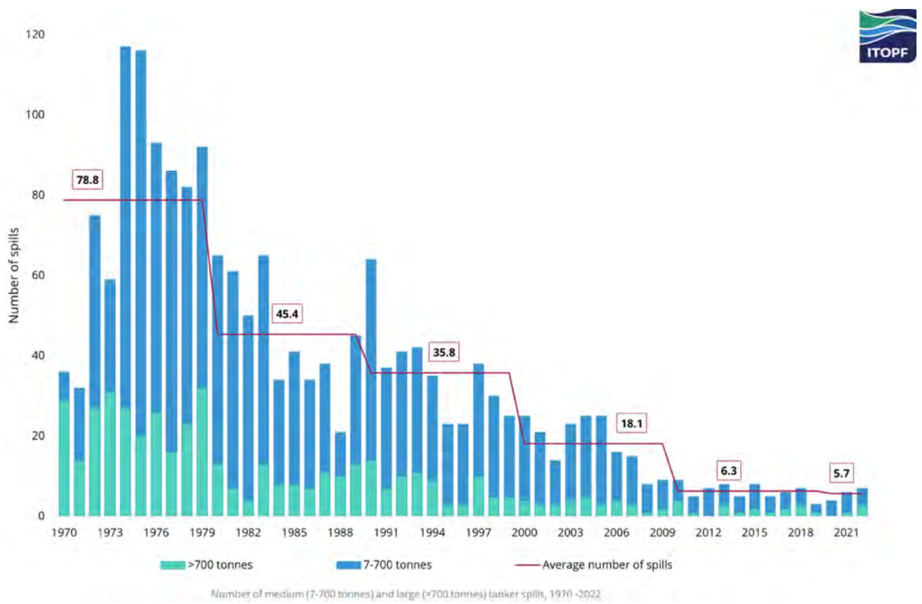


Figure 3: The decline of oil spills from tankers. From [53]

6.3 Hazardous and Noxious Substances (HNS)

- Increasing global demand for chemicals used in a wide variety of industries has resulted in rapid growth of seaborne trade. The sheer variety of chemicals, their varying physical properties and different behaviour once spilt and the potential for effects on human health and the marine environment mean that preparedness and response arrangements for chemical spills are far more complex than for oil spills [9].
- Hazardous and Noxious Substances (HNS) is the cryptic term for an extremely cryptic and complex family of products and chemicals that are transported at sea and can be onboard vessels as cargo. As such they must be considered in the context of maritime incident management and preparedness.

- How countries can prepare and deal with HNS incidents has been extremely well captured in a recently published European regional manual that was developed as part of an EU funded project [46]. Other documents have also been published that aim to provide guidance in dealing with HNS in marine incident response [9, 45].
- Responding to HNS incidents can be complex as there are hundreds if not thousands of chemicals being transported on vessels every day. The most frequently transported chemicals as listed in the online European HNS database [50] include around 125 different chemical compounds, which together are known by around 780 different names under which they can appear on cargo lists.
- Chemicals can be transported in bulk, as liquids or gas on board of bulk carriers or chemical tankers, or in various packaged cargo (dry packaging in plastics, liquid in jerrycans or bottles in containers, liquid in tank containers) on board of container vessels. A chemical tanker could have anything between 1-60 different chemicals on board. Container vessels could have up to hundreds of different containers with chemical contents on board, depending on the size of the vessel.
- The understanding of the possible behaviour of chemicals when released into the marine environment has been captured in 9 different categories, see Figure 4.
- Especially in cases of gases or evaporating substances, there could be a danger for explosions, or the forming of dangerous and toxic gas clouds. These could also form in case of fire on board that reaches the cargo.
- Toxicity of products evaporating, drifting, dissolving or sinking can directly affect human health. For any chemical, these risks can be anticipated via the compulsory labelling that the packaging and transport of these chemicals must have. Chemicals also have international codes, under which their properties are registered by international governmental bodies in collaboration with the industry that produces and trades them.
- As explained in the manuals, monitoring is the most important response option that is available after the release of chemicals. Options for manual recovery or chemical dispersion, as known from marine oil spill response, are quite limited as an option for most of these types of behaviour. The potential success of the traditional oil spill response equipment systems (booms, skimmers, dispersants) is depending on the further properties of the spilled chemicals, especially as to how they match the physical and chemical concepts on which the effectiveness of this equipment is based.
- Most serious are the HNS conditions under which Search and Rescue (SAR) activities must be carried out following an incident notification with a request to rescue and evacuate crew. The kind of critical problems on board caused by HNS and the reason for evacuating crew will also be critically dangerous for the rescue teams.
- The response to a vessel in distress in an HNS spill scenario may require special vessels that are designed to work in environments of chemical risk, and which could approach the vessel in distress closer than traditional multi-purpose vessels designed for oil spill response. The latter type of vessel could monitor the concentration and composition of gas clouds or chemicals in the water, or assist with operations such as the rescue of crew, fire combat or salvage.
- It is important to realise that toxicity to humans also should be interpreted as toxicity to animals. Special attention should be given to seabirds, sea turtles and marine

mammals which are air breathing and whose typical behaviour (feeding, resting, diving) can bring them into contact with chemicals in, on and above the water. These animals can be in high concentrations at or near the location of the incident and be impacted by the chemicals released. After being impacted, they can potentially wash ashore dead or alive, complicating the response and its needs.

- Effects on other marine organisms living in pelagic (deep waters), demersal (on the sea bottom) or in coastal environments (on the shore, in and above shallow waters, intertidal) can could also potentially be observed on the coastline, e.g. the arrival of dead animals on the shore (see Figure 5).
- HNS also includes substances other than dangerous chemicals (so-called non-dangerous goods), which could be harmful to humans or the environment when released in bulk following an incident. This category includes dry products such as grains, soya beans, or liquids such as orange juice, glucose solution. It also includes other products carried by containers (furniture, tooth brushes, food etc.) which could cover the seabed, cause an oxygen deficiency in the water, pollute the shoreline, etc. Also here the variation in possible scenarios is almost beyond imagination (see Figure 6).

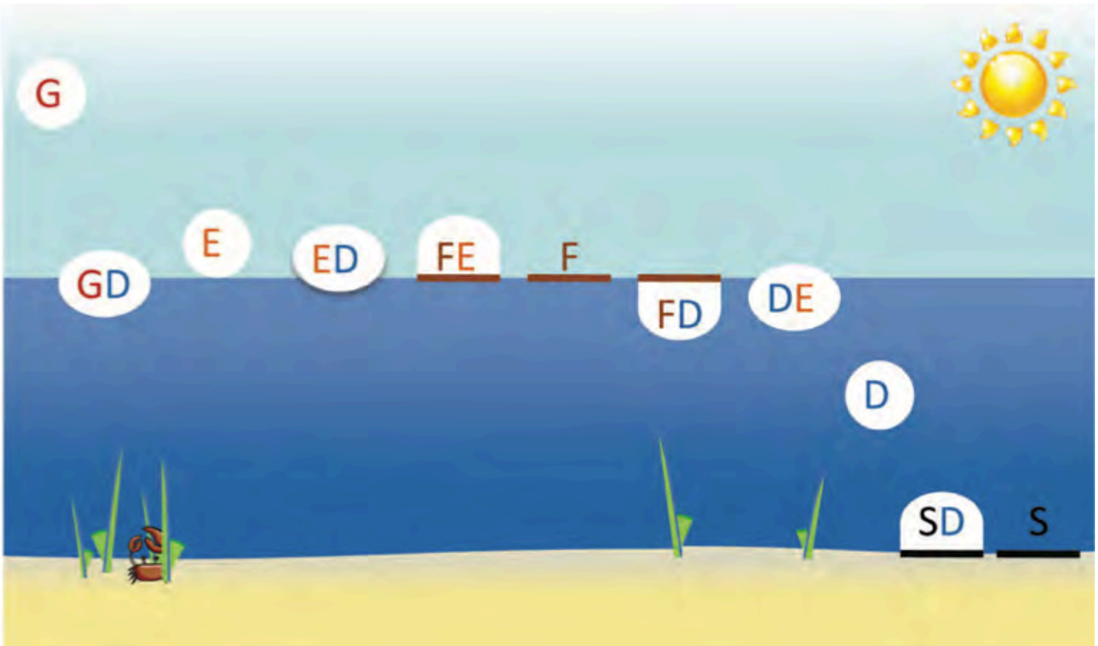


Figure 4 – Nine different categories of possible behaviour of chemicals when released into the sea. The nine categories are sometimes a combination of 5 basic behaviours: G (gas), E (evaporation), F (floating on the surface), D (diluting) and S (sinking). Image from [9].

Figure 5 – Large volumes of impacted marine organisms washing ashore after a mystery event in Kamchatka, Russia, October 2020. In [72].

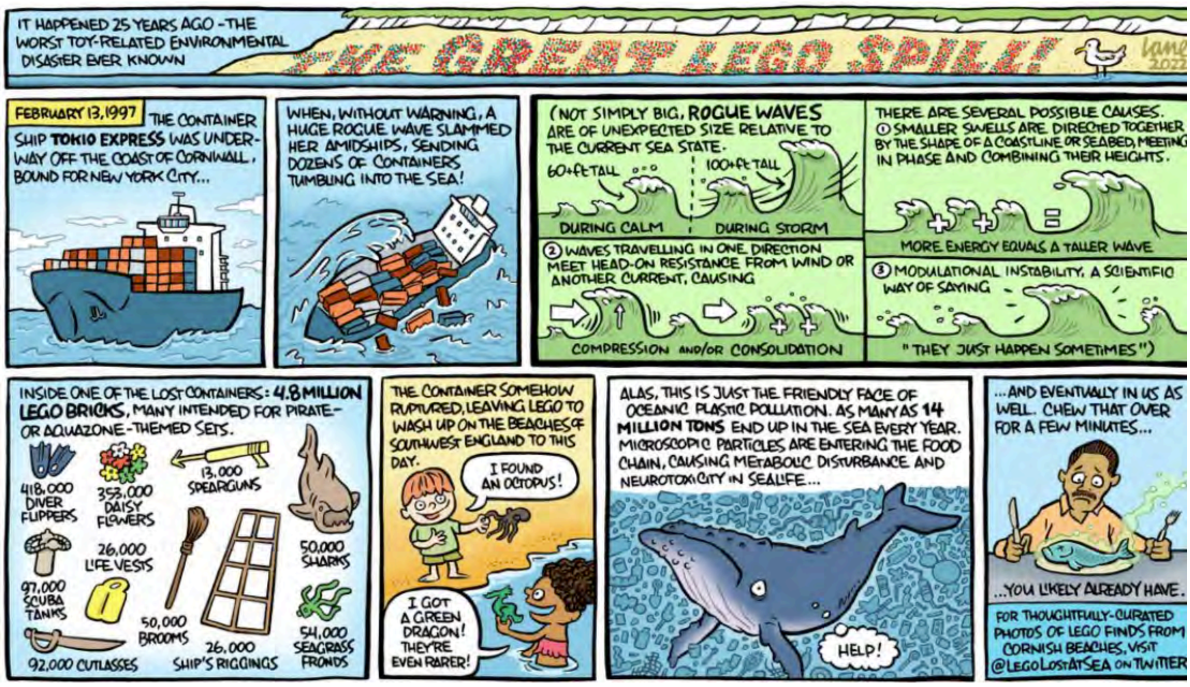


Figure 6 – A cartoon telling the story of Lego particles spilled by the Tokyo Express container vessel incident in 1997. Image credit: A.J.B. Lane. In [51].

6.4 Climate change

- Climate change processes, including warming ocean temperatures and sea level rise, have impacts on marine live, coastal communities, global economy [76], and will also change the use of the sea, and the context in which harbours and shipping operate [28]
- Rising sea level will lead to various gradual changes at sea, nearshore and inshore. It will influence harbour access and harbours will have to adapt.
- The warming ocean will increasingly create a northern Arctic route for shipping between East Asia and Europe (Northern Sea Route - NSR) and Atlantic and the Pacific (Northwest Passage). The use of these passages is not necessarily safe due to various natural conditions, and potential geopolitical effects [52]. But the more these routes become safely available, the more they will change the pattern of vessel movements in European seas. Whereas the opening routes themselves require thinking about marine incidents under arctic conditions, also the changing routes elsewhere may shift marine traffic risks.
- Extreme weather forecasting is difficult, and unexpected or unusual conditions can lead to effects that could challenge operations on board vessels, or the behaviour of cargo on the vessel bringing risks to stability. Extreme weather leads to increased losses of containers at sea, or container stack collapses (in combination with mis-declared cargo weights) [79].
- Extreme weather events e.g. are an increasing challenge for coastal states but also the shipping industry as it can influence port activity and result in lost or damaged cargo. It provides an incentive for the shipping industry to adhere to IMO decarbonisation regulations, minimise fuel consumptions and optimise routing, e.g. to avoid extreme weather [77]
- As the climate changes, the frequency and intensity of extreme weather events are increasing [80]. At sea storms change the water behaviour, creating large waves which challenge marine operations but also the integrity of the vessel construction. Modern shipbuilding and technologies on board provide critical aid for a vessel facing a storm, but it is mainly good seamanship that makes the difference [81]. In a free ocean environment, the Master has space to manoeuvre the vessel proactively to withstand the forces. But in a coastal environment, space may be restricted by natural structures such as sand banks, rocks or islands or manmade, such wind farms and other offshore infrastructure.
- The Mediterranean region is warming 20% faster than the global average. A higher frequency and strength and potential impact of hurricanes seems likely [32], most recently seen in summer 2023, devastating the Libyan coast after causing a dam break.
- Storm waves, sea surges and tornados can cause flooding and damage to coastal infrastructure, including fuel/chemical storage installations. When released into the water they can lead to further short and long term impacts and challenges for emergency response in the coastal environment.
- The loss of containers from vessels during storms is not a new issue, but as the frequencies of storms increase, the risk of containers tumbling overboard is increasing.

- Extreme drought or unexpected weather conditions on land can also affect shipping, especially in harbour entrances or channels that connect marine traffic between different oceans or seas.
- Rain dependent rivers or canals can dry up after extended periods of drought, which can reduce the depth of their shipping lanes. In tidal rivers, where often the margin underneath the vessel is already minimal under normal conditions, such drought related differences can increase the risk of vessels grounding.
- Extreme drought led to traffic congestion in the Panama Canal in the summer of 2023, leading to disruption of global supply chains.
- The *Evergiven* (a 400-metre 20,000 TEU vessel) experienced strong winds while sailing the Suez Canal in March 2021 and grounded, blocking the waterway for many weeks. Human error and technical issues also contributed to the root cause of the incident, which led to large scale disruptions in global supply chains [82].
- Disruptions of such channels increase the number of vessels anchoring at both entrances. Also at the entrance of busy harbours, many anchoring vessels can be found, waiting their turn. An extreme storm in such anchoring sites could be a thinkable scenario, with vessels losing their anchor and drifting, heading for collision or grounding in a worst case scenario. Following such a scenario in Dutch coastal waters in January 2021, the *Julietta D* drifted into a nearby windfarm, and although colliding with infrastructure, did not cause a pollution incident.

6.5 Security and emergency aspects of offshore infrastructure

- With more critical infrastructure moving seawards, there is also emerging vulnerability in terms of security (against acts of terrorism) or added complexity in dealing with marine incidents.
- A well-known example is the Nord Stream pipeline incident in 2022, where an act of terrorism disrupted the newly operational pipeline between Russia and Germany [4]. For days in a row, gas from the pipeline emerged at the water surface, and evaporated near the island of Bornholm. This did not cause any harm to citizens or shipping as the location was far enough at open sea and could be secured until the remaining gas content of the pipeline had disappeared.
- Shore-based facilities (ports, terminals, shipping company IT systems) are also particularly exposed to cyber risks, such as GPS spoofing (vessels giving false locations), to the extent that insurance companies are now providing specialist cover for these kinds of attacks [5].
- One of the considerations when operationally dealing with the *Fremantle Highway* fire incident (July 2023), was that the vessel could eventually sink whilst on fire in a shallow area with gas pipelines. The risk could be averted by towing the vessel to an area away from the submerged infrastructure.
- With the quickly advancing technologies that allow states to extend their capabilities to build innovative critical infrastructure in deeper waters of their EEZs, a seaward trend is likely for industries with a higher risk profile. Plans are already emerging for building artificial islands to accommodate large hydrogen plants or electricity hubs [2]. Such infrastructure creates more spatial complexity and these systems are also subject to remoteness in dealing with emergency situations.

- Creating more of these infrastructures at sea also goes hand in hand with the need for maintenance, and increased shipping traffic between harbours and objects at sea to provide this maintenance (see wind farms in Section 0).
- Networks of cables and pipelines will emerge on the seafloor, connecting infrastructure at sea with the end users on land. This infrastructure needs to be considered as part of emergency response systems as it could interfere with vessel emergency anchoring or lead to vessel sinking situations.

6.6 Growth of vessel size

- To reduce the costs of marine transportation, container vessels are growing significantly. Container carrying capacity on vessels almost doubled from 2010-2020 [6] and the world's largest container ships are now vessels with over 20k TEU, so can carry well over 20,000 standard containers [1]. McKinsey calculate that the limit of growth lies at around 50,000 standard containers [55].

Figure 7 – 20 years of container ship growth. From [1].

- Larger container vessels, where containers can be stacked as many as 26 deep, are vulnerable to extreme rolling and pitching in heavy sea conditions resulting in extreme stress. The potential for human error around storage and lashing of containers also needs to be addressed [1]. The World Shipping Council reports that for the years 2020-2022, 2,301 containers on average were lost per year from its members' vessels [12].
- Vessel size has increased while manning levels have reduced (due to labour saving and assistive technologies). Mariners are under pressure to meet deadlines imposed by shipping companies and to comply with a raft of legislation on safety, security and

marine environmental protection. The associated administrative burden is expected to be handled without any additional manning on board [13].

- Other types of vessels are also growing in size. The world's largest cruise ship when it set off for its maiden voyage in January 2024 can hold a total of almost 10,000 people on board. The demand for giant cruise ships will likely remain due to the lower cost per passenger and more options for cruise companies to generate revenue onboard [14]. Such enormous passenger vessels represent huge challenges for authorities in the case of a marine incident where passengers lives are threatened.
- Ship engines perform best when running at ratings defined by the engine designers (based on the ship's size and targeted design speed). In recent years, ship speeds have been reduced to save fuel and costs. If slow steaming is maintained for months or years, there will be an impact on engine reliability, how much depends on how long the ships are ordered to operate at those speeds [15].
- Ports and harbours will need to consider providing the infrastructure for accommodating these larger vessels, but also for storing and bunkering these fuels. With hazardous cargos being increasingly transported by larger vessels, the consequences of incidents such are amplified and the complexity of responding increases exponentially, resulting in more severe losses and longer delays. Taking fires as an example, a small container fire can easily take hold and overwhelm the ability of its crew to deal with the situation, leading to the abandonment and potential loss of the vessel [1].

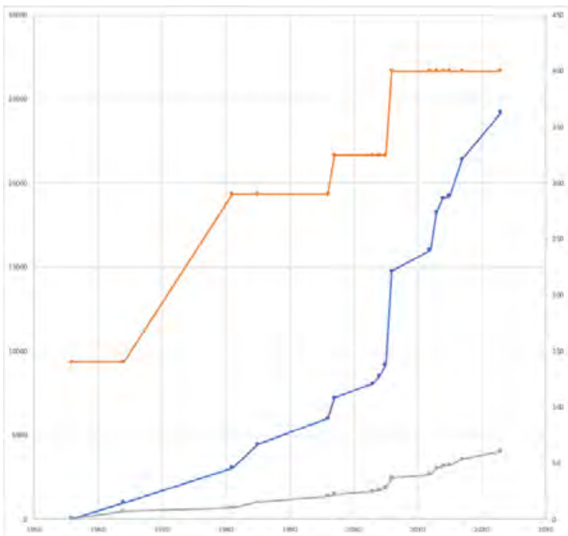


Figure 8 – Growth of container vessel size. Blue: exponential growth pattern in capacity (no. of TEU), orange: stepwise growth pattern in vessel length, grey: exponential growth in capacity (no. of TEU) per metre of vessel length. Based on data from [1] and McKinsey 2017 [55].

6.7 Development of wind energy

- In Europe, there is a campaign to grow and develop wind, to meet the growing demands of households and to provide the clean energy to support and sustain the development of net-zero fuels such as green hydrogen and green methanol.

- Windfarms are increasingly being developed at sea, with growing turbine height, and the infrastructure that goes with them, such as cables and energy hubs. Transporting the large bulky equipment for wind turbines by sea is a specialised sector of the shipping industry and has recently seen an increase in expensive loss incidents [1].
- New projects are already in progress to develop offshore islands where off grid renewables are used for hydrogen production or other alternative fuels such as ammonia. Examples include the energy islands planned for development in the Danish North Sea [2]. It is likely that other offshore infrastructure will emerge as part of these larger projects, such as sea farming of seaweed/shellfish offshore [3].
- Windfarms contribute to the risk of shipping incidents as they reduce the space available for shipping to manoeuvre and create additional spatial challenges for nearby vessels that lose their steering or engine capability. The increased activity for servicing windfarms due to servicing could lead to a higher risk of incidents. Collisions between vessels and wind turbines could lead to damage to hull, cargo loss, fire, or bunker fuel loss. Space and manoeuvrability is also limited for salvage vessels and oil spill response vessels to combat pollution in and around windfarms. Surveillance aircraft may also be restricted in their ability to monitor the extent and fate of pollution in and around large offshore projects.
- Countries with a relatively small EEZ could reach limits of windfarm development quite quickly. Belgium recently concluded [33] that their offshore windfarm area cannot be further extended without conflicting other interests such as sand dredging for coastal defence, tourism and shipping. Further extension of energy production at sea can still be achieved by replacing the early turbines in existing farms with modern, larger and more powerful turbines.

Figure 9 – Maintenance of a wind turbine at sea. De Standaard, 5 Oct 2023 © Kenzo Tribouiillard.

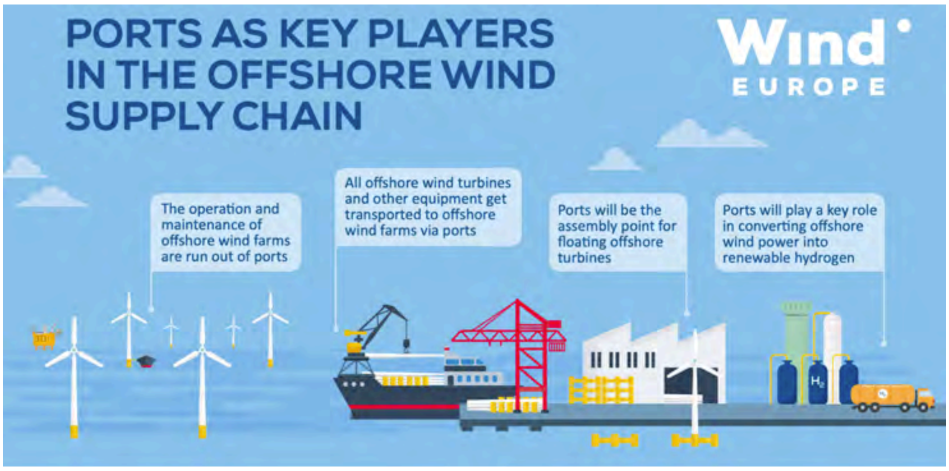


Figure 10 – Ports as key players in the offshore wind supply chain. Detail of infographic by WindEurope [29].

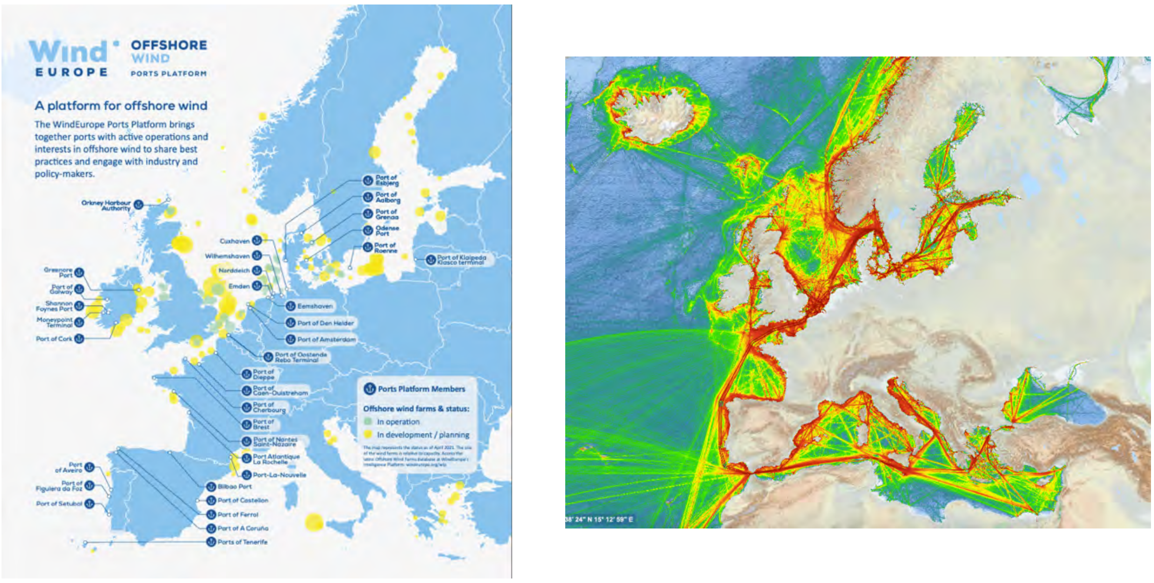


Figure 11 – European offshore wind energy projections in relation to shipping intensities. Left: detail from infographic by WindEurope [29], right: map created with EMODNET Geoviewer [30].

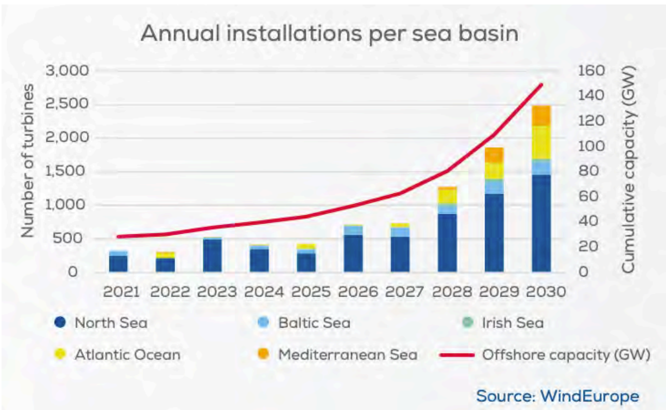


Figure 12 – Projection of the anticipated exponential increase of wind energy per European regional sea in the current decade. Detail from an infographic by WindEurope [29].

6.8 Batteries and fires

- HNS incidents are often associated with ships in port or nearshore, increasing the risk to coastal populations, especially when the products can have a toxic and/or flammable nature [10].
- The consumer market of vehicles (cars, scooters, bicycles) is undergoing a transition to electrical vehicles which are shipped together with the Li-ion batteries on which they depend. So the amount of Li-ion batteries transported on vessels (vehicle carriers and ro-ro passenger vessels) is increasing [11]. Li-Ion batteries have a risk of 'thermal runaway'. Fires in electric vehicles with Li-ion batteries can burn more ferociously, are difficult to extinguish, and are capable of spontaneously reigniting. Most ships lack the suitable fire protection, firefighting capabilities, and detection systems to tackle such fires at sea [1].
- Fires remain a significant and increasing risk onboard vessels. Many cargo fires can be put down to mis-declared dangerous goods (e.g. chemicals, batteries and charcoal), or failure to properly declare, document and pack hazardous cargo, so containers are stowed incorrectly or firefighting efforts are hampered. Some companies try to circumvent labelling a cargo as dangerous (which is more costly) by mis-declaring, e.g. labelling fireworks as toys or Li-ion batteries as computer parts [1]. This also leads to difficulties in properly identifying these products (and their resulting fate and behaviour) in the case of a marine incident.
- The risk of fires starting from electrical vehicles was highlighted by the recent *Fremantle Highway* incident in the Netherlands (see case histories in chapter 9).

6.9 Changing global marine transport patterns due to geopolitical changes

- Geopolitical developments can have strong impacts on maritime shipping and the safety of shipping routes.
- Following the Ukraine war a so called "dark fleet" of vessels is emerging, operating outside of international systems and insurance. Vessels are attempting to circumvent sanctions by various methods including turning off their Automatic Identification Systems (AIS) transponders so they can disappear and carrying out illegal operation such as illegal ship to ship transfer operations. This is often in dangerous waters, open sea or areas with little satellite coverage, so negating many of the safety measures put in place by the IMO and increasing the risk of marine and coastal pollution. It is also reported that the average age of this dark fleet has increased, together with an increase in moves to 'flags of convenience', with less than optimal safety records. Vessels carrying sanctioned oil also cannot be insured under recognised international shipping insurers [16].

6.10 Alternative fuels

- Decarbonisation and curbs on emissions are pushing vessel owners towards alternative fuels, including low-sulphur fuels, LNG and more innovative solutions such as ammonia. One 2050 outlook forecasts a mix of 50% low- and/or zero-carbon fuels, 19% natural gas (mostly LNG) and 18% biomass [6].

- There are different alternative fuels that are being developed, used, or considered by global shipping:
    - Low sulphur fuels which have been added to the traditional marine bunker fuel market in order to comply with the so-called Global Sulphur Cap, an emission control regulations introduced by IMO [71]. The cap limits the global sulphur content to 0.5% and came into force on 1st January 2020, mainly to protect human health. Ships that trade within certain designated coastal regions defined as Emission Control Areas (ECAs) must further restrict the sulphur content of their emission to less than 0.1%.
    - Net-zero fuels, which aim to reduce the greenhouse gas emissions from shipping to 0%, to comply with the Paris Agreement commitments and related regulations aiming to decarbonise shipping. Green hydrogen, green methanol or green ammonia are examples [27], [28].
    - Intermediate fuel solutions that are currently on the market and vessels are using to reduce carbon emissions. These are fossil fuels (e.g. LNG) or net-zero fuels that have been synthesised using fossil energy (grey or blue fuels), e.g. grey or blue hydrogen, grey or blue methanol [27].
- Low Sulphur fuels are often blends of a non-compliant fuel with a low Sulphur oil. But although compliant, these blends typically carry an increased risk of cat fines (residues from catalytic cracking and Sulphur removal which can damage engines [7]. Fuels from different ports and refineries will also have varying properties which could cause damage to engines and essential equipment.
- There is a very broad variety of low sulphur fuel oils (LSFO) and very low sulphur fuel oils (VLSFO) on the market which are broadly used by existing vessels, as engines do not need adjustments. Because there are many ways in which the requirements of 0,5% and 0,1% emission can be achieved by blending different types of oil together, the properties of any one used oil can be totally different to another. Projects such as [83] have tested some products on the market and demonstrated that they have a wide variability in properties and their behaviour when released into the environment. Tests demonstrate that the toxicities are in the same range as traditional fuel oils – but parameters such as pour point and viscosity are highly variable. Their behaviour in terms of floating, weathering and spreading is different, and therefore hard to predict. There are serious concerns about whether they can be effectively removed from the water by standard oil spill equipment. The testing has been carried out on a relatively small subset of products that are on the market and used by vessels.
- When ordering new vessels, the shipping industry is already switching to powering by LNG, which is more affordable, has less compliance issues as it produces considerably lower emissions, and for which a distribution network is already in place. However, there are serious safety considerations with LNG ships and many serious tanker fires with fatalities have occurred in recent years [8].
- Also shipowners are investing into pilot projects to experiment with the use of alternative fuels such as biofuels, methanol, ammonia and hydrogen [1]. Also prototype all-electric vessels are sailing that use solar and battery power. New plants will need to be built in or near ports and harbours to produce these alternative fuels

and attract vessels that supply the component chemicals and distribute the products in large volumes.

- However, all of this takes place at a small scale as the infrastructure for the new energy carriers in harbours across the world and on the normal routes is not available as yet. Also the production of the new energy carriers is not at a volume to sustain a massive transition of vessel propulsion into that direction. Realising the chicken or egg problem, leading harbours and shipping companies have started to set up so called green shipping corridor initiatives. They aim to guarantee the availability of green net-zero fuel so that shipowners can safely invest into vessels that are truly green in their energy consumption. Already a large number of such announced green corridors are appearing on the map, see Figure 13.

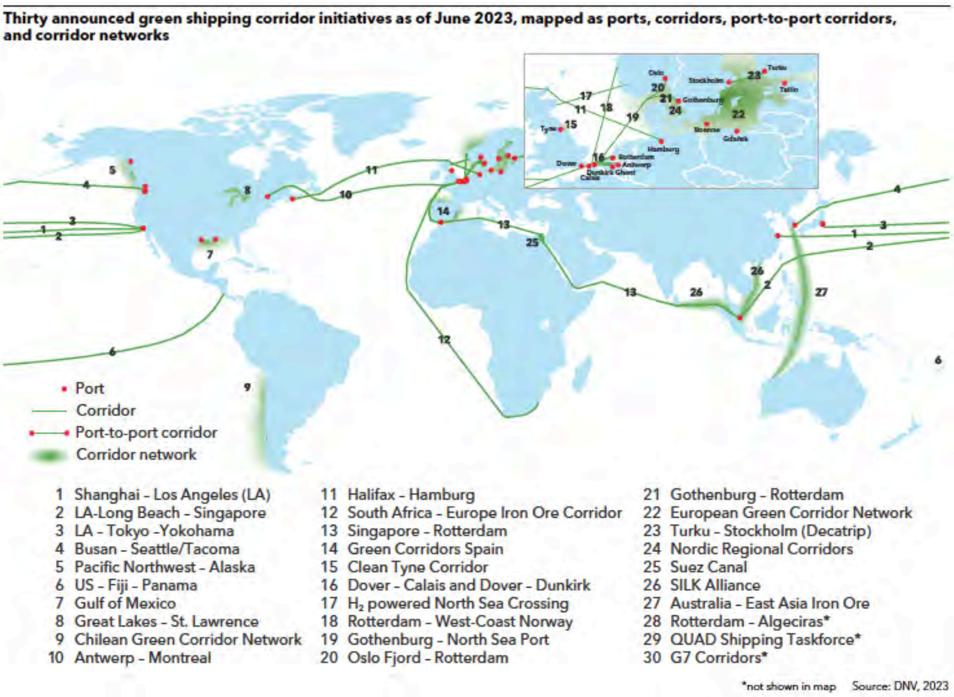


Figure 13 – Announced green shipping corridor initiatives [27].

- An overview of the current global statistics [27] shows that 93.5% of the fleet still operates on conventional fuel (in Europe this would be predominantly LSFO or VLSFO) and 5.96% on LNG. In the order book only 50% will run on conventional fuel, and 40.3% will be on LNG. An important runner up is methanol (8.01%). The alternative fuels such as hydrogen or ammonia are hardly visible yet (see Figure 14).

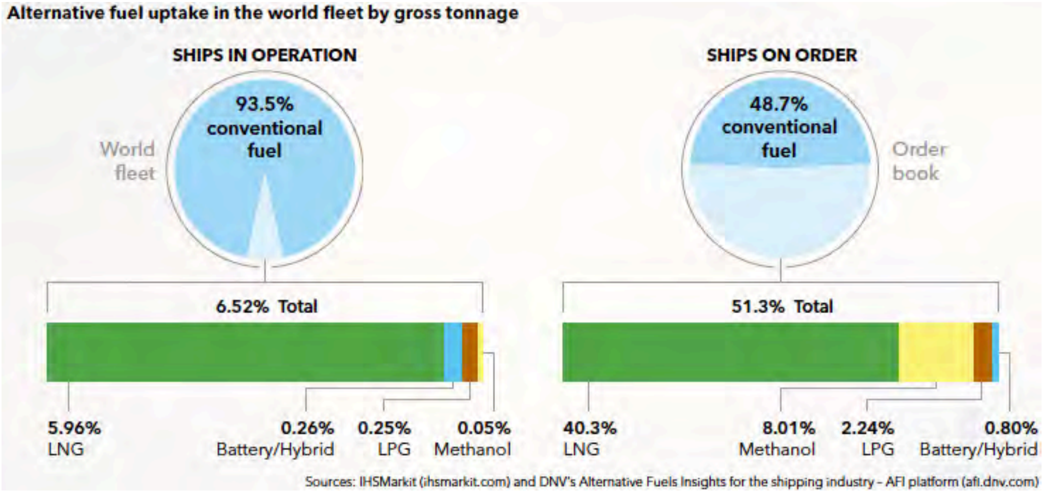


Figure 14 – Alternative fuel update in the world fleet by gross tonnage. From [27]. See text for explanation.

- Whilst vessels propelled by the new net-zero fuels are currently not visibly 'on the water', the pressure on the shipping industry to decarbonise is considerable. This goes hand in hand with large-scale global investments into the production of the net-zero fuels of the future. On the short term this will aim at investments into a variety of carbon-neutral fuels via grey, blue or green production methodologies (see Figure 15). On the longer term this should be overtaken by the production of purely green net-zero alternatives, such as hydrogen and green methanol using durable energy from wind and solar.

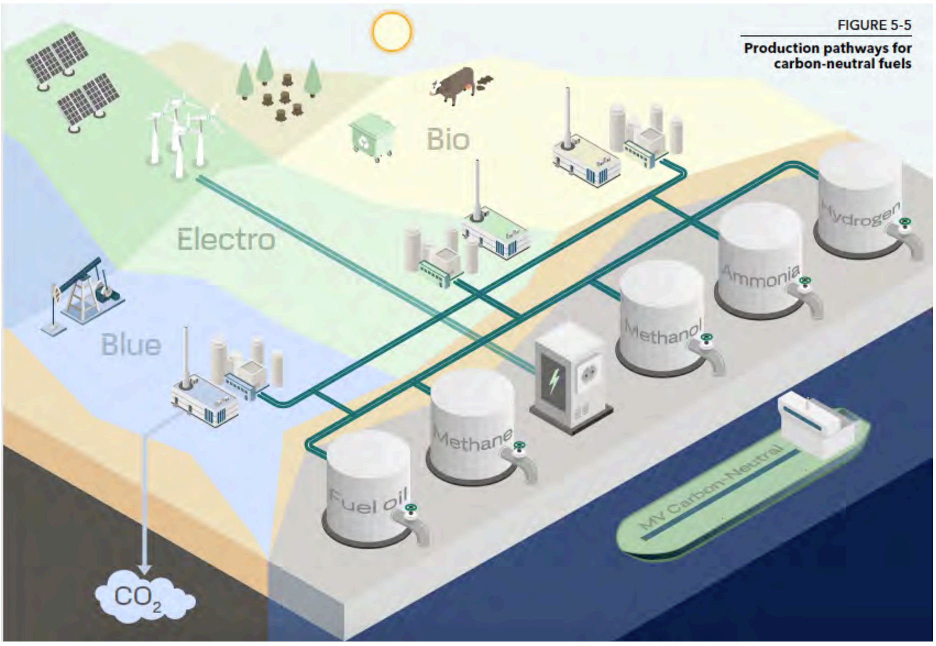


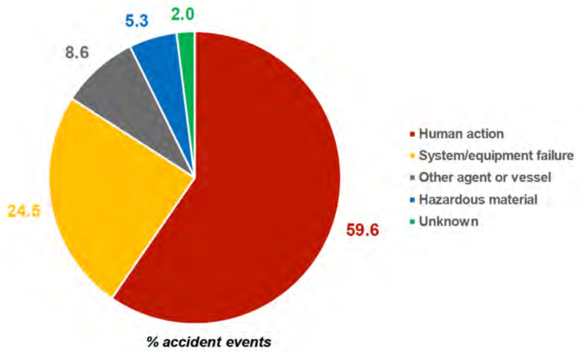
Figure 15 – The production of carbon-neutral fuels. Image from [27].

- Another investment that vessel owners are currently considering is to reduce fuel consumption by installing aids on board vessels that provide wind propulsion or generate electricity from solar power installations.
- From a global perspective, the production of large volumes of new net-zero fuels also requires large volumes of substances needed to synthesise these fuels. This means that substances such as ammonia will have to be transported from where they are produced to where they are transformed into fuels. Subsequently the produced volumes of new fuels must be transported to where they are needed as bunker fuel for ships, but on a larger scale, to where they are needed in the distribution networks for fuelling e.g. hydrogen cars, or electricity plants that produce electricity to load the electrical vehicles. Much of that transport will have to be provided by vessels too.
- From an emergency management perspective the result of all this for the medium and long term is that an increasing variability of vessel types will be appearing in European waters and harbours, which run on a wide range of fuels and propulsion systems. This means that a much wider range of possible incident scenarios should be considered with a large array of possible bunker fuel on board, in combination with a large possible variety of cargo that could be spilled.

6.11 Causes and location of maritime incidents

- The statistics that authorities keep on causes of vessel incidents demonstrate that the most important factor in these events by far has been human action – especially shipboard human action (see Figure 16).

A



B

C

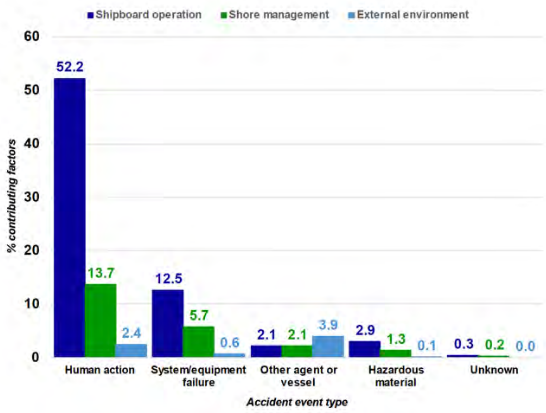


Figure 16: Causes of vessel incidents. A : Overall picture (all vessels), B - Cause of incidents per vessel type. C: Location of cause. From [56].

- Despite the fact that vessels have become very advanced and computerised, they still need to be operated by humans – and humans make mistakes. And although the bias in accident statistics will be slightly towards ageing vessels being more involved in accidents, on more recent vessels humans still take the key decisions while being informed by images and numbers provided by onboard electronic devices and computers.
- EMSA [56] assesses the contribution of the human element in registered accidents in 2022 at 81.1%. Another conclusion from this analysis is that 79.6 – 88.1% of all accidents happen within approximately 12 miles of the shoreline (see Figure 17).

A

B

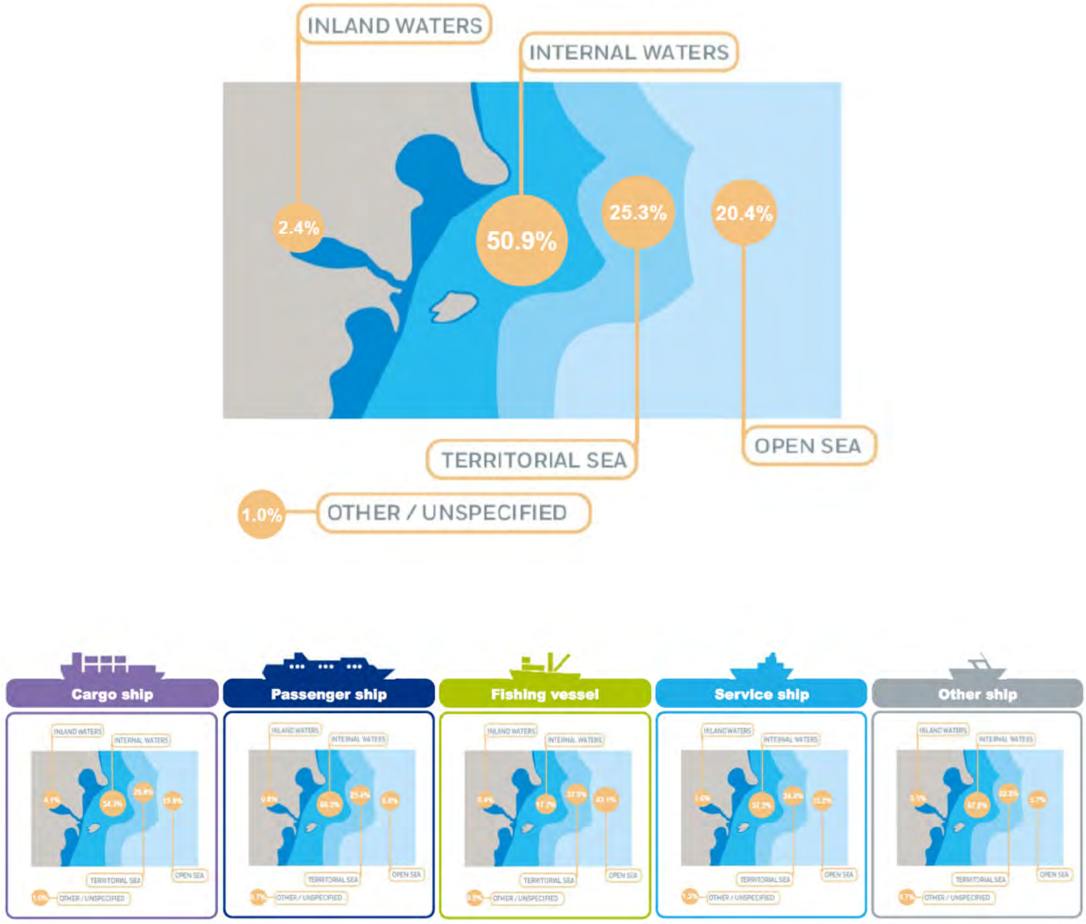


Figure 17 – The geographical location of shipping incidents [56].

A: As much as 79.8% of all registered accidents happen landward of the outer limit of the territorial sea, which is roughly 12 miles from the shore.

B: Only fishing vessels have a relatively large proportion of incidents happening in the open sea (43,1%). If fishing vessels are excluded from the statistics, then 88,1% of all incidents happen landward of the outer limit of the territorial sea.

7 Conclusions, Recommendations

7.1 Conclusions

7.1.1 Questionnaire and interviews

- There is a clear awareness of new risks building up in the marine environment. These risks are reflected in some incidents that have happened in recent years (see chapter 5 on case histories). These incidents did not always have the alarming scale as past incidents such as *Torrey Canyon*, *Amoco Cadiz*, *Sea Empress*, *Exxon Valdez*, *Prestige* and *Erika*. But they are pointing into a direction of "out of the box" scenarios which are more complex than before, which under certain circumstances could lead to challenges that may require another perspective on preparedness. This is concerning the expertise needed to deal with certain substances and products that could be spilled (HNS), the limited effect that traditional oil spill equipment seems to have in dealing with such products and the absence of innovative new equipment on the market.
- The awareness comes against a background of some challenges in current preparedness systems: the frequency of traditional incidents is declining which has led to budget cuts, smaller teams, fading expertise and skills, less real-time experience.
- Although emergency response systems are in place in all countries that allow an integration of maritime and coastal authorities, there is a scepticism about whether they work in practice, and an awareness of relative weakness on the side of coastal authorities in the technical understanding and expertise regarding maritime risk scenarios.
- The frequency of joint meetings between maritime and coastal authorities via e.g. workshops, training and exercises is considered low in most countries. Some countries have put in place interesting solutions that are aiming to bridge gaps in common awareness, capacity building and joint decision-making.
- An important strength factor that respondents unanimously identify for dealing with crisis management is that individuals around the table know each other well, which facilitates collaboration and decision-making.
- Smaller countries have an advantage in having small emergency response communities where parties know each other well. They also will know in advance what would work and what not. Large countries could suffer from not knowing exactly who is who, and what will be delivered by whom, when and to what quality.

7.1.2 Literature review

- The literature review backs up the sense of awareness that different countries have about new risks building up in the marine environment.
- Many changes in the marine sector are taking place following climate change and e.g. the implementation of Sustainable Development Goals. (e.g. sulphur emission cap) and international net-zero policies (new generation of vessels, new generation of fuels, expansion of wind farms at sea, transition of harbour services/facilities etc).

- All developments can be considered as revolutionary as they happen fast, with political will and pressure, with considerable investments and with changes that are visible and reported on every day.
- Example incidents are building up globally that together provide a widening scope for "out of the box" thinking as to what incidents in the future may look like. Example incidents may not always escalate into large complex incidents because of e.g. lucky circumstances or a timely intervention. But it is normally easy to imagine that they could when circumstances had been different.
- Major iconic oil spill incidents such as *Amoco Cadiz*, *Sea Empress*, *Exxon Valdez*, *Prestige* and *Erika* have been on the decline for decades. With hindsight these incidents led to systems of national and international preparedness that target a family of oil types with more or less the same properties. Spill response preparedness systems have become biased towards these traditional fuel types, and the associated expertise as how to deal with them, as well as response vessel design and equipment stockpiles.
- Such incident combat concepts and strategies will become challenged by the properties and behaviour of products spilled in emerging modern incident types. The behaviour of modern fuel oils in the environment is less easy to predict, and in many cases quite difficult to combat with traditional approaches and equipment. This would reduce the effectiveness of the offshore "first line of combat", resulting in more product volumes reaching and impacting the coastal environment.
- Modern incidents also bring in products, so called HNS, which have a wide variety in nature, properties and behaviour when released. The variety of products, potential toxicity, and the way they behave is so large, that it almost impossible to oversee what impacts they may have, let alone being able develop counter-pollution strategies and equipment that will be effective for all of them.
- The modern new generation vessels that will join the global shipping fleet obviously will have more state of the art designs and advanced modern computerised technologies on board. They should be safer in their operations and this will surely help incidents from happening. But this layer of safety can never be considered being absolute, as vessels operate in environments that become busier, are more populated with offshore infrastructure, and will see more weather and sea condition disruptions on route. Finally, despite the aid from electronics and software, and perhaps Artificial Intelligence, the safety of a vessel in emergency operations is still heavily dependent on human decision making. There are many ways in which distortion or system failures can occur, and at sea it will be difficult to make repairs to failing software or failing interface devices. Whereas most vessel journeys will be safely accomplished thanks to these technological systems, a vessel that loses its operational capabilities at sea will still become a casualty in the more traditional way. Crew must be rescued, the vessel must be towed, cargo must be dealt with.
- On the side of the marine emergency response community, there is an emerging variability of scenarios that have to be anticipated – as vessels become bigger, fuels more varied, fuel tanks possibly containing more explosive or toxic substances, and cargo maybe including an additional complexity of chemicals which have properties of their own, but can potentially react with other substances on board.

- The emergency community also needs to invest into systems that can deal with these complexities and adequate vessels, equipment and training. Future maritime emergency rescue services should match the profile of the kind of vessels and the kind of scenarios in which they may have to assist.
- Finally, marine incidents will have their origin at sea, but can be located close to the shore, near to human settlements and impacting marine organisms above, on, in or beneath the water. Although marine authorities can provide knowledge and a first line of response to a developing scenario, coastal authorities should also be prepared to deal with complex marine incidents that happen close to the shore, or incidents which may considerably impact the shore and onshore communities. Whereas coastal preparedness is normally directed to a wide range of identified incidents and crises of a humanitarian, social, traffic, industry, agriculture, or terrorism nature, a marine incident could hit any piece of coastal system. As such a vessel represents a wide complexity of potential hazards, which could have serious impacts which cannot be easily prevented or mitigated. Coastal authorities therefore should be prepared, not only by having a multi-authority emergency decision making system in place, but also by investing into technical knowledge and operational understanding of marine incident response, and by training and exercising local, regional and national crisis teams to effectively manage them.

7.2 Consolidating conclusions

- Whereas most of the current energy transitions are viewed from a “yes we can” perspective, in the field of marine and coastal emergency response preparedness there are emerging new risk profiles which may only slowly make their way into a more collective awareness. These new risk profiles are challenging the traditional emergency systems that have been put in place in the last 50 years following a long chain of iconic oil spill incidents happening in Europe and worldwide.
- Current emergency response plans and preparedness systems base their investments into resources, training and exercises which may still be biased towards traditional oil spill incidents – which are on the decline. The new type of risk profiles would need a reconsideration of the assumptions about the effectiveness of traditional combat strategies, and the related tools and equipment that are available.
- It is also important to include a reconsideration of space, time and socio-economic context in which response actions are supposed to take place. Space may become more limited and restrictive at sea with increasing infrastructure appearing which its own related sensitivities, vulnerabilities and maintenance activities. Time may be more restricted or critical in a response, e.g. given the properties of new net-zero fuels or cargo that near-future vessels may have on board. The socio-economic context is also changing with social media in a global society, but also the more complex use and valuation of natural and economic assets in the coastal zone. Finally, harbours are becoming more important and multifunctional in supporting the energy transition, being the hub for maintenance of infrastructure at sea, for new fuel bunkering and storage or even production, and the and transhipments of large volumes of raw or half-products between sea and hinterland. In the fast transition, some harbours may develop better or faster than others, causing changes in shipping traffic, and related shifting of risk areas in congested areas.

7.3 Recommendations

- Coastal authorities and responders to explore marine incidents with the aid of maritime authorities. Overcome the restriction of responsibilities and identify gaps and potential fields of conflict in decision making or priorities. Set up projects and mechanisms to fill gaps and develop decision-making aids.
- Internationally, authorities to look into the future of fast changes and risk development. Stimulate thinking out of the box. Cross-sectoral thinking, extrapolate scenarios of different complexities, find gaps via creative and playful exercises.
- Identify a set of universal roles and responsibilities in marine and coastal incident response. Target these roles for internationally standardised training and exercise opportunities.
- Create a standing think tank at European level, of experts whose task it is to look at unfolding developments and highlight areas of attention for further exploration of risks, opportunities and expertise development.
- Run annual marine pollution workshops at EU level, to identify cross-sectoral challenges, risks, etc.
- Develop tools that can present the essence of complex scenarios that can help groups of leading emergency decision makers (from various authorities and with various responsibilities) to think beyond their scope of comfort. Exercises should aim to focus on these areas of discomfort, so that gaps become more visible, and can be transitioned into new tasks, skills and knowledge building.
- Organise annual events at local/national/regional levels that structurally build insight, skills, collaborative action and decision making, and share lessons learnt from across the world.

8 Towards a framework for holistic and integrated management of marine pollution incidents

The previous chapters have given an overview of the fast-changing scope for a new generation of marine incidents, following climate change and decarbonisation policies. These incidents will be more complex as vessels are changing, as is the environment in which they operate, their propulsion fuel and their cargo. This is assuming that vessels will continue to transport 90% of world trade consisting of food, drink, household, chemicals, raw material, half material, fuels, cars etc. Any type of cargo on a vessel could potentially end up in the marine environment, and potentially on the shore.

Emergency response systems operated by coastal countries must be aware of these developments, identify and analyse the range of known and less understood future risks and anticipate the physical, chemical, and technical consequences of such risks. They must also elaborate strategical, tactical, and operational solutions for a timely and effective response on the water and on the shore that can seamlessly scale up building on local, national, and international resources.

8.1 Task driven, not responsibility driven preparedness

It is useful to internationally redefine what such an effective response would look like as something that authorities should be aiming to deliver. Citizens and stakeholders are not interested in hearing that an apparent problem is not taken care of because it was not defined as somebody's responsibility. The expectation is that the job is getting done. Response preparedness should therefore be developed in a task driven way, rather than responsibility driven. Those who have to prepare for a response should explore and anticipate tasks within a range of scenarios, and identify, involve and empower parties who can make the difference in such tasks. Scenario-driven exercises are the best way to explore the challenges and discuss what should be done, who is best placed to do it, and where the gaps are. Not one costly single exercise with one scenario per year, but multiple discussion-based tabletop exercises where a wide range of scenarios can be considered, aiming at out of the box thinking, beyond the restrictions of defined responsibilities.

Such an approach focuses on building a resilient form of incident management preparedness which is in place to prevent escalation to types of crisis management in which tasks (that could have been anticipated) have to be improvised by self-mobilised citizens, stakeholders or appointed officers, with a lack of professional experience and resources. It is pro-active, and requires the leading authorities (i.e. the family of authorities with 24/7 emergency response responsibilities) to create a safe and creative space to discuss and explore a coherent response that can deal with the multiple complexities of maritime emergency in a coastal zone environment.

The essence of such a pro-active approach in emergency preparedness building fits under the slogan: *One Incident, One Response.*

8.2 One Incident, One Response

- There is one incident – despite all its complexities, complications, partial problems and challenges, whoever has the responsibility to deal with each of these, it should be dealt with the aim of delivering one, coherent, professional response.
- This requires a re-thinking of what makes an incident an incident, and what makes a response a coherent and successful professional response.
- It also requires a re-thinking on who the beneficiaries of a coherent and successful professional response are. This question can also be answered by considering who will lose when a response is not coherent, unprofessional and unsuccessful. Reducing the number of losers will automatically increase the beneficiaries.

8.3 Holistic

A *One Incident, One Response* approach is per definition a holistic approach. It should connect the variability of scenarios to the variability of values and stakeholders, and make sure that the system that is activated to protect the values and stakeholders can deliver – so that it leaves a minimum of losers and a maximum of beneficiaries.

To deliver this, authorities cannot separate their collective responsibilities simply in an at sea and onshore component, as many challenges following from a marine incident will require a response system that can act coherently in the coastal zone which is complex by definition. Both sides (wet and dry) must be able to deliver fully on the objective, and this is not guaranteed by just setting up a crisis management system. Both sides should be able to set up an incident management system that prevents an escalation to a crisis management system. The latter comes in when the incident response fails to deal with the nature or size of the problem. To be able to set up an incident management system that can prevent a maritime incident escalating into a crisis, means that all possible scenarios, consequences, strategies and response resources and potential gaps must be considered. This approach requires coastal and maritime authorities to explore the complex area in which they have to collaborate, and not just concentrate on their core business, see Figure 18.

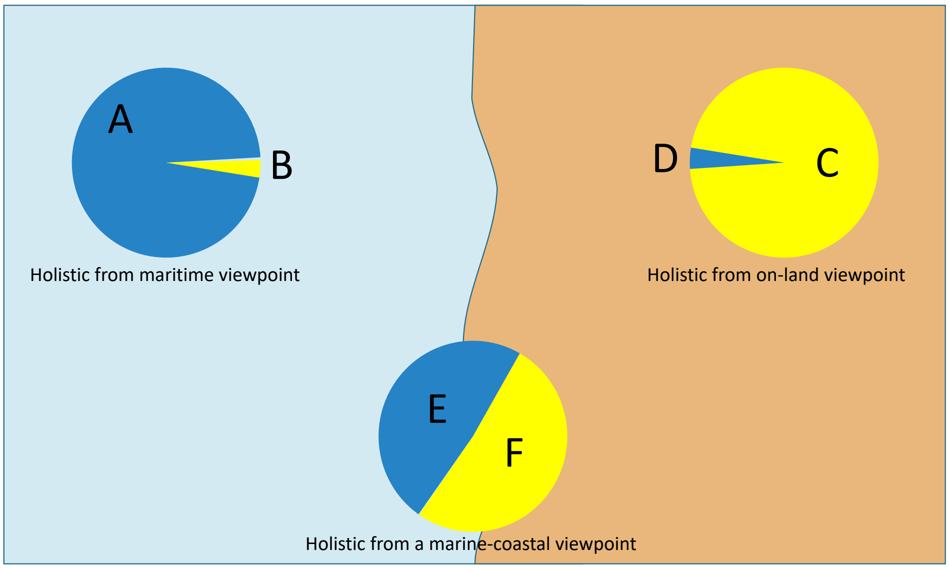
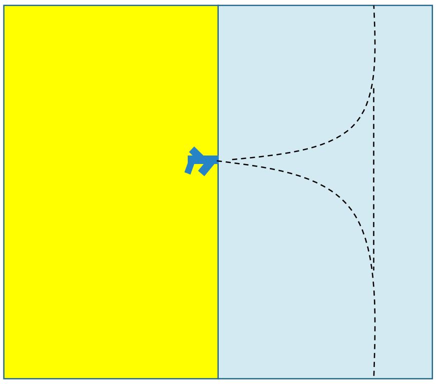


Figure 18 – A holistic approach for dealing with coastal aspects of a marine incident requires marine and coastal authorities to explore their effective collaboration in an area they would normally not consider as their "core business". Maritime authorities tend to consider the coastal aspects (B) in relation to all other aspects of a shipping incident (A) as difficult, but not necessarily part of their core business. Coastal authorities tend to consider maritime incidents (D) as only one exceptional scenario in a multitude of crisis-scenarios (C) they consider as their core business. In a maritime incident with coastal effects, both sides should be able to deliver an incident response capability (E, F) that prevents such a scenario from escalating into a crisis.

8.4 Integrated

A *One Incident, One Response* approach builds not only on authorities who have responsibilities, but also on stakeholders who have values which potentially are impacted by the incident. Too often the word "integration" is used to define that the crisis management system is delivered collectively by all key authorities who have a responsibility to act. This limited definition overlooks the fact that the system eventually is supposed to serve an array of stakeholders outside of that defined group, some of them with subject matter knowledge, equipment, unique and relevant skills, who can provide further links and connections with groups of citizens who individually are stakeholders motivated to help – but as such are not organised to assist. Integrating such stakeholders in the response preparedness system would proactively allow them to develop important skills and routines that would enable them to act more efficiently within an incident response system, and improve the effectiveness of their contribution to prevent and mitigate effects.

A



B

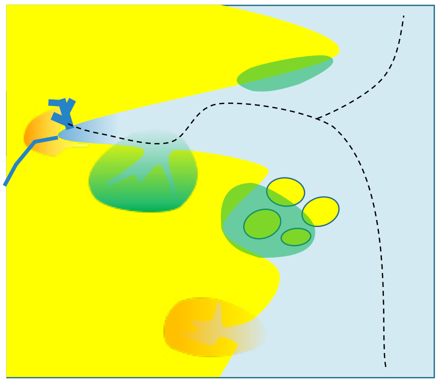


Figure 19 – The coastal context of an emergency response cannot be a simple split between maritime (blue) and coastal (yellow) responsibilities such as in A. There are many geographical, natural, and social complexities in the coastal environment (B). These need to be considered as part of thorough incident response and preparedness planning, applying a ***One Incident, One Response*** *philosophy.*

8.5 What is a framework?

A framework is something abstract. It can consist of iron, wood, bones, words or documents holding things (tiles, pictures, muscles, thoughts, ideas, intentions, agreements) that together have more value when connected to each other in the framework than without. The framework enhances durability of the coherence of all the different values and allows more value to be gained over time (the whole is more valuable than the sum of its parts).

8.6 Developing the framework for holistic and integrated management of marine pollution incidents

Coming back to the title of the chapter, the objective of the Regional Seas Conventions is to develop a framework for holistic/integrated management of marine pollution incidents to enable coordinated response operations at sea and on shore (see chapter 2). This background report has placed that objective in the context of a changing maritime environment where new risk profiles are developing. The next phase of the project is to propose a framework that will help to improve the ability of countries to deal more effectively with the complexities of maritime incidents that have potential effects on the coast, applying a *One Incident, One Response* philosophy.

Whereas the Regional Seas Conventions in themselves are an existing framework for collaboration between countries for dealing with maritime incidents, the new framework will focus more on the geographical scale at which marine incidents happen, and on the structures for preparedness that collaborative authorities can put in place that allow incident responses to be effective, task driven, and with the assistance of resources that are pre-identified and empowered to assist.

A proposal for such a *One Incident, One Response* framework, and a related tabletop environment, will be developed in another phase of the IRA-MAR project, in which also a workshop will provide input to the design of that framework.

9 Appendix 1 – Questionnaire observations and results

9.1 Observations

9.1.1 Changing risk profiles and expanding response capability

Questionnaire results	Findings
• Developments over the last 5-10 years, which change the risk profile for marine incidents. The respondents identified these four developments as those with highest potential to challenge their national response capability: 1. Busier marine traffic and probabilities of risk following human errors 2. Larger container vessels and related scale and complexity of potential response, (HNS, lithium-ion batteries, plastic nurdles or other type of cargo on-board, risks of shoreline pollution, risks of containers drifting) 3. New propulsions energies (fuels, batteries, ammonia, hydrogen…) with new and variable properties, and related complexity of responding with traditional procedures and equipment 4. New infrastructure (e.g. wind farms/energy solutions, artificial islands) and related reduction of space for free shipping • Less than half of the countries have, in the face of these new developments, expanded their emergency response coordination systems or capability and then only in certain areas – not across the board. Several of these expansions relate to prevention, not response measures. • Changing risk profiles are seldom discussed with authorities that deal with shoreline impacts/response. • Just over half the countries hold exercises taking these changing risk profiles into account. • Investments into at-sea response capacity (vessels, aircraft, and at-sea combat equipment), only 5 countries plan to extend national capacity in coming years as a result of new risks	• New risks are identified and known but response capability is not yet fully in place to mitigate them. • Many countries have not yet invested into new at-sea response capacity. • Efforts to expand or change emergency response coordination systems are often quite specific to one risk profile, rather than a broader approach. • Discussions on how to mitigate effects on coastal communities is lacking in many countries and many countries are not including these new risks in their emergency response exercises. • Only a few countries bring offshore and onshore authorities together to discuss these new risk profiles.

9.1.2 Organisation of the response

Questionnaire results	Findings
• Scaling up response management so that decisions can be taken centrally 1. one country states that every municipality must be approached and heard. 2. 5 countries have central decision-making but municipalities still have a say 3. 5 have central decision-making but also regional command systems that make independent decisions so there may be regional differences in strategy & resource use. • In most countries, at-sea authorities would quickly notify onshore authorities in case of an incident, but in some cases only after knowing that the incident will be serious or have serious shoreline impacts. • How will at-sea authorites relate with onshore authorities 1. 6 countries will have two parallel systems that share & communicate with each other. 2. 5 countries have an integrated incident management system overseen by one operational command. 3. 3 countries have a central command but operational elaboration of decisions is left to each of the attending authorities. • Which priorities do you think onshore authorities should be prepared for if the offshore response cannot prevent shoreline impacts 1. Almost all countries identified as top priority: create a unified command structure for decision making if a response would need the collaboration of multiple authorities with local, regional and national responsibilities. 2. Only a few countries identified allowing self-mobilising citizens to assist response operations. • Would you describe your preparedness as responsibility driven (each authority has own individual responsibilities) or task driven (responsibilities adopted by authorities as part of a joint system) – most countries have a mix of both. • Do you have a system to accommodate self-mobilising citizens/NGOs are coordinated vounteers to assist a response – most countries said no but that would consider these citizens to assist a response ad hoc. Only three have a volunteer coordination programme.	• A few countries have a model in place for an emergency response coordination system that still gives coastal authorities a say in overall decision-making. • Coastal authorities are sometimes reliant on at-sea authorities to define what would be a serious incident. • Almost all countries identified having a unified command structure for decision-making as important for shoreline authorities to prepare for. • Many countries do not see the value in having pre-defined mechanisms to deploy self-mobilising citizens and almost all have not set this up to be ready to call on during an incident.

9.1.3 Access to cargo data and HNS response capacity

Questionnaire results	Findings
• Access to information sources (independent of vessel) on HNS/oil cargo passing through your waters, ports and harbours 1. 6 say yes can access any time, 3 only request when an incident happens 2. 3 rely on vessel master/owner, 2 rely purely on SafeSeaNet 3. 5 say no or unsure • Sources mentioned: SafeSeaNet, MAR-CIS and MAR-ICE, customs and port authorities, harbour master's offices, Coastguart, ports and harbours, law enforcement agencies, ships terminals. • Statistics on quantities of oil & HNS cargo transported through your waters, ports & harbours 1. 6 countries gather data (most do not publish it). 2. Remainder only have partial data or data is lacking. • Acess to expert advice for an incident with oil/HNS impacts – most countries have either a national advisory body or an international advisory body such as EMSA MAR-ICE. 5 countries have specific commercial/private experts. These experts are mostly used for incidents which could have both offshore and near/onshore impacts. • Which entities your rely on to extend your national capacity for HNS response – most countries rely on their neighbours, all rely on EMSA. Two thirds also rely on private entities such as oil spill response provides, chemical industry and salvage companies.	• Only several countries can access independent information when needed. • EMSA tools not mentioned by all Member States. • Much reliance on EMSA and neighbouring countries to extend support with HNS capacity.

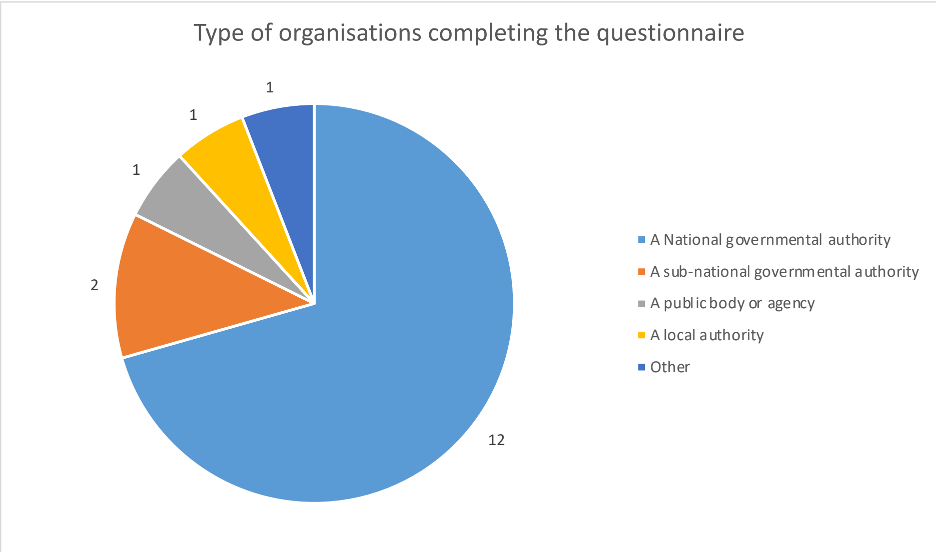
9.1.4 Views on holistic and integrated management

Questionnaire results	Findings
• Do you agree with the working definition of holistic and integrated management – the majority of countries said yes, but two noted that this needs further elaboration at national and international levels. • Aspects of holistic and integrated management in your country that you would be particularly proud of, or advise as good practice – several countries describe aspects of their organisation structure which apply a nolistic and integrated approach, such as a national board/committee or overseeing organisation, mechanisms to interface at-sea and onshore authorities and multi-agency pollution response exercises. One country note that the civil protection community has been working for a long time on an al hazards approach and that the marine pollution community could learn much from this.	• Positive support for the project's working definition of holistic and integrated management. • Some models for holistic integrated approach are already being used by the countries who answered the questionnaire.

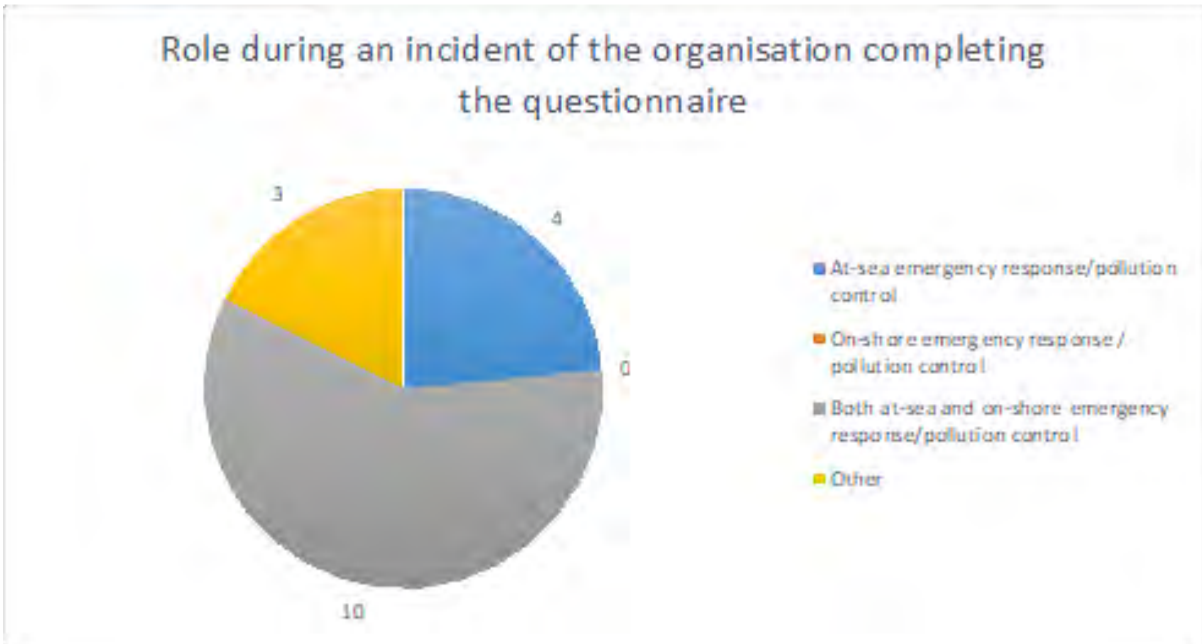
9.2 Further questionnaire results (graphics)

The answers to selected questions of the questionnaire are provided in this section. Only questions that are not personal or with answers to a particular country have been provided. Results to the questions have been represented in diagrams, showing summarized results from all participants and countries. There is no detail on what an individual participant or country has replied and this has been done on purpose so as to keep those answers anonymous. The main objective is analysing the situation in Europe as a whole, not the particularities of individual countries.

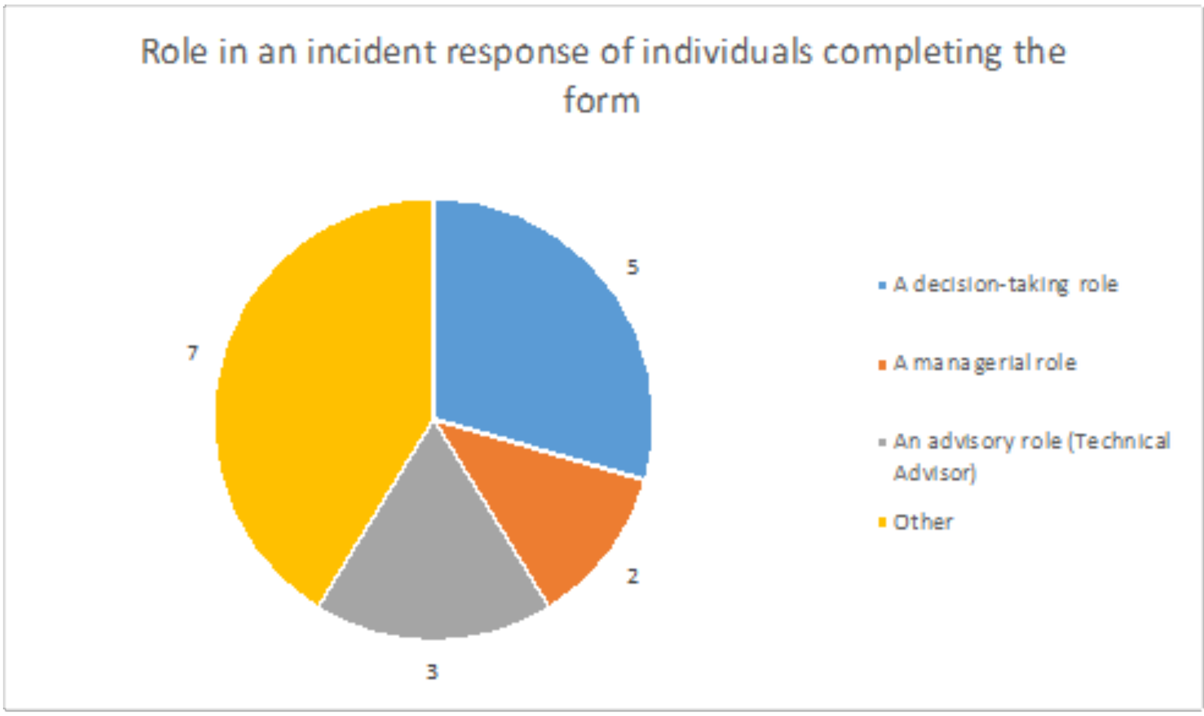
Q1 - Your organisation, or the organisation you represent, is:



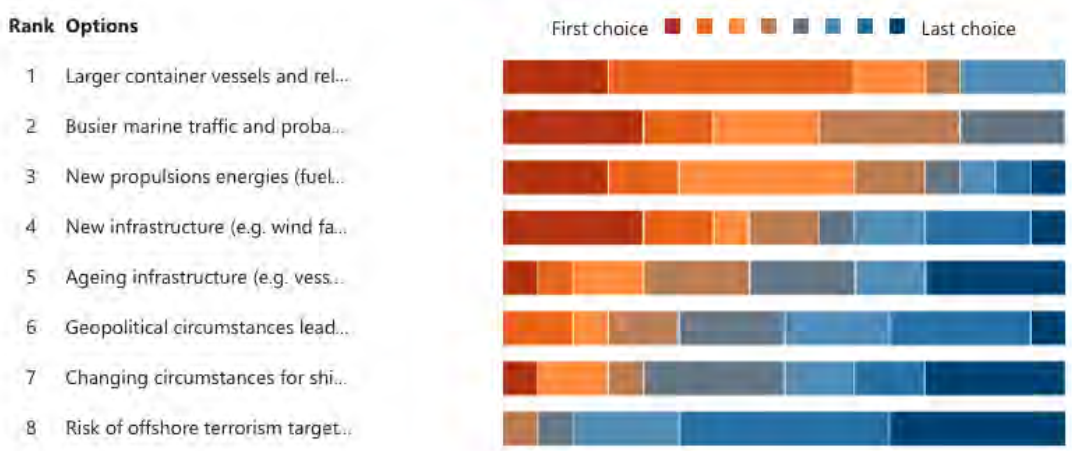
Q9 - The organisation you represent has the following role during an incident:



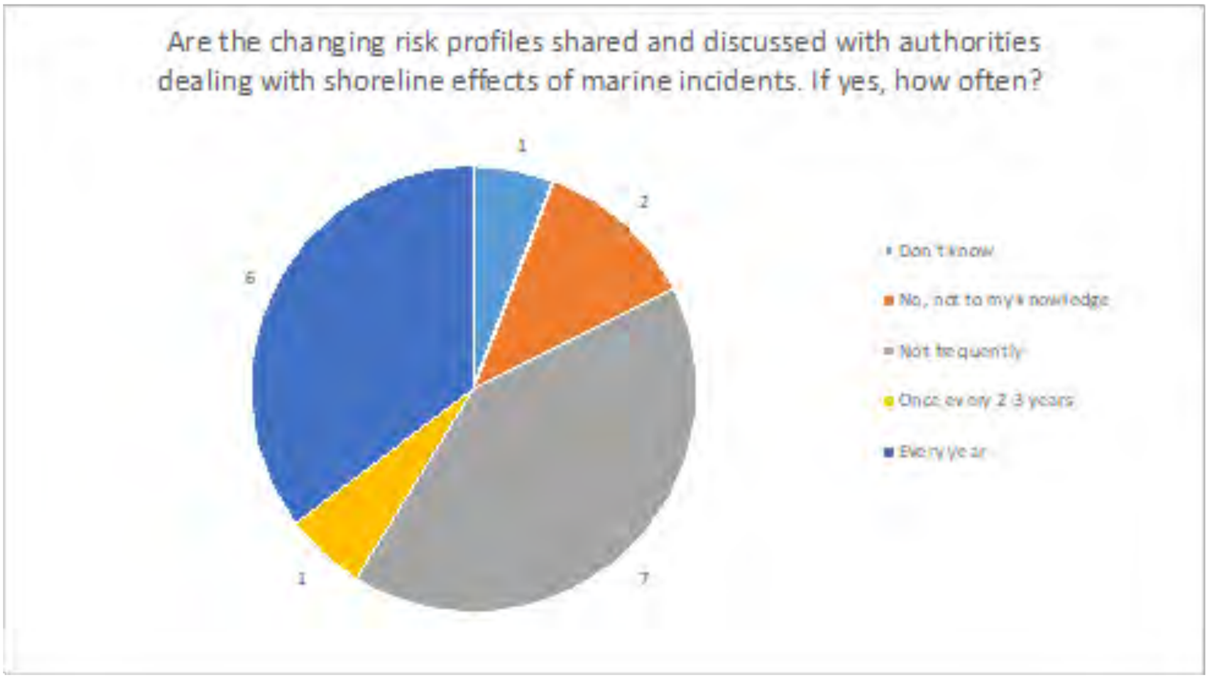
Q10 - In an incident response, you will have:



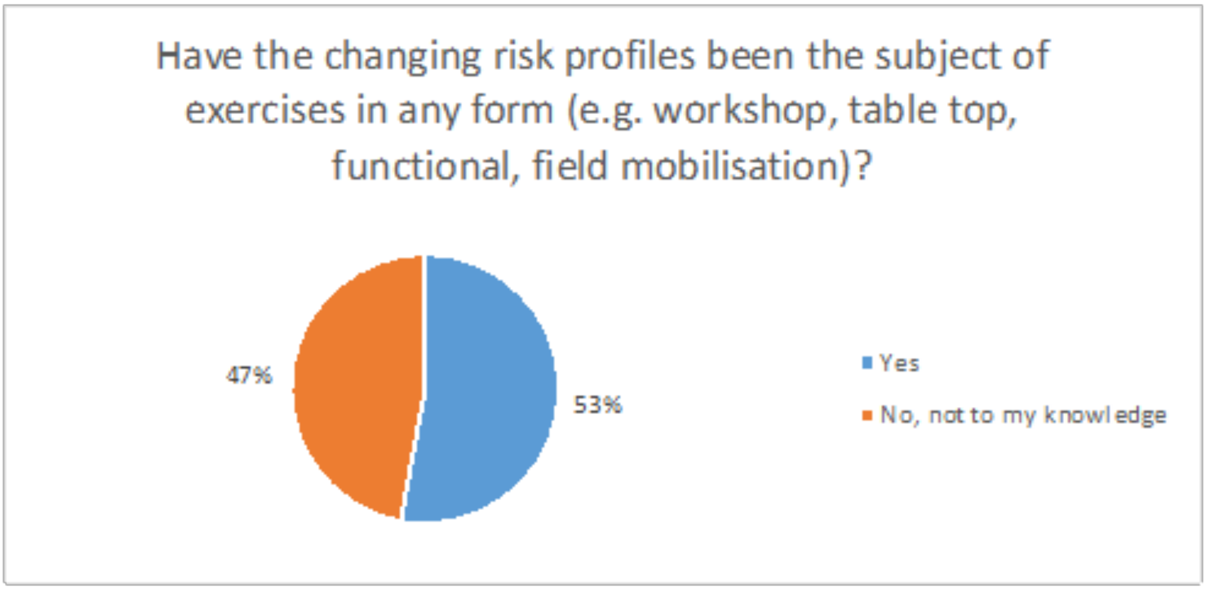
Q11 - Various developments have become apparent over the last 5-10 years, which potentially change the risk profiles for marine incidents. Prioritise the developments listed below according to their potential to challenge the current level of preparedness of your country: (place the options in order by dragging them up/down)



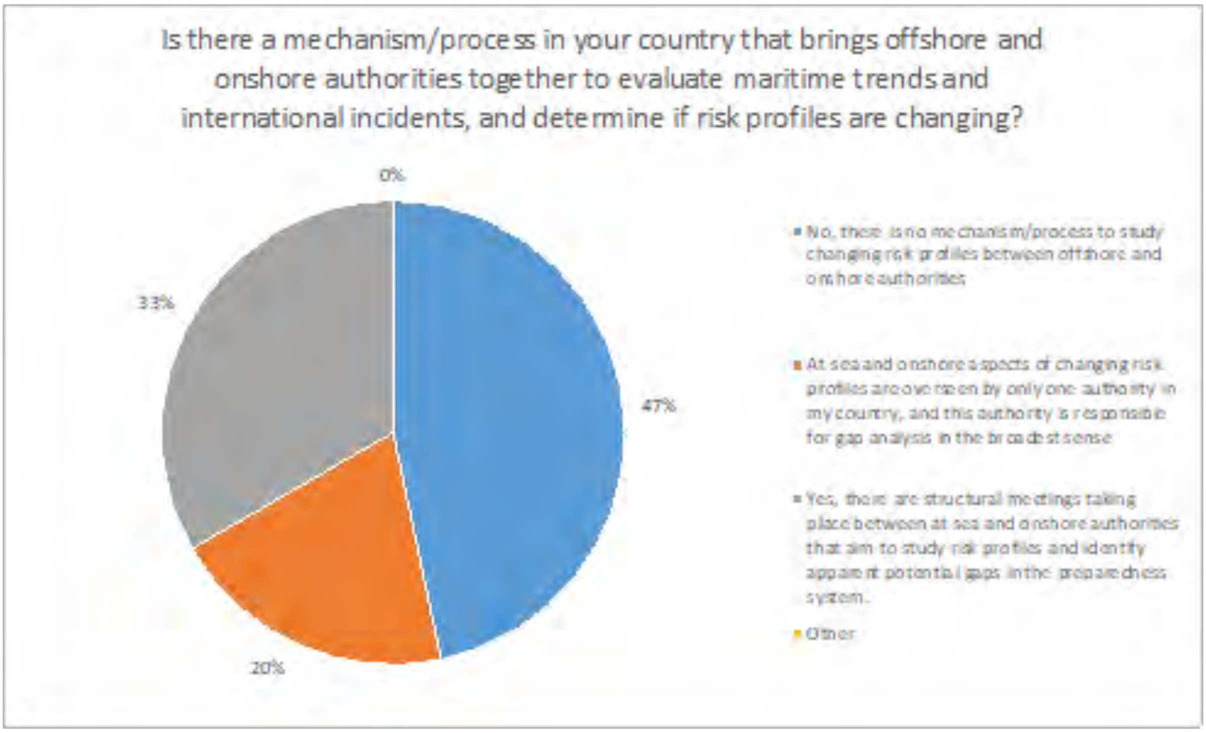
Q15 - Are the changing risk profiles shared and discussed with authorities dealing with shoreline effects of marine incidents. If yes, how often?



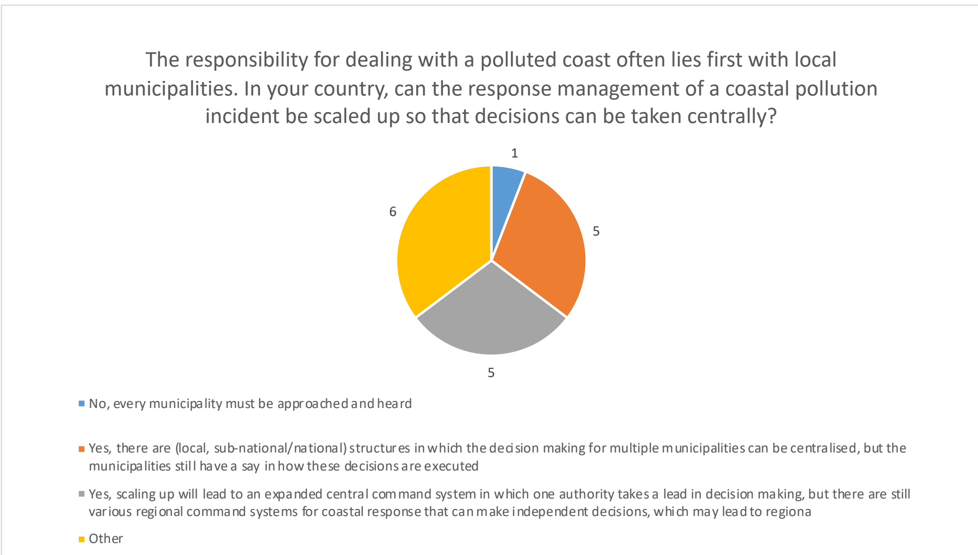
Q16 - Have the changing risk profiles been the subject of exercises in any form (e.g. workshop, table top, functional, field mobilisation)?



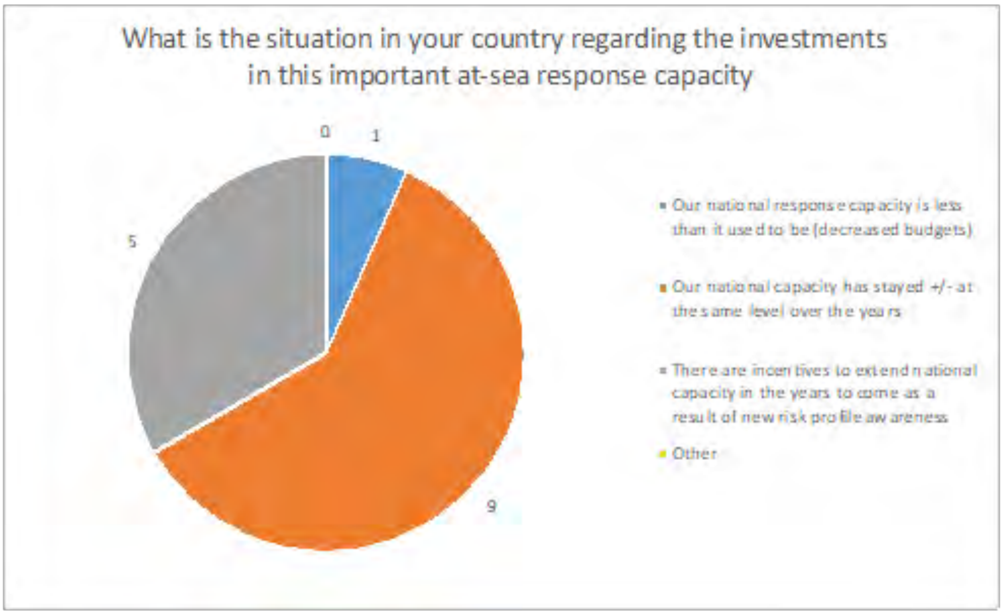
Q18 - New risk profiles often become apparent via incidents that happen internationally. Is there a mechanism/process in your country that brings offshore and onshore authorities together to evaluate maritime trends and international incidents, and determine if risk profiles are changing?



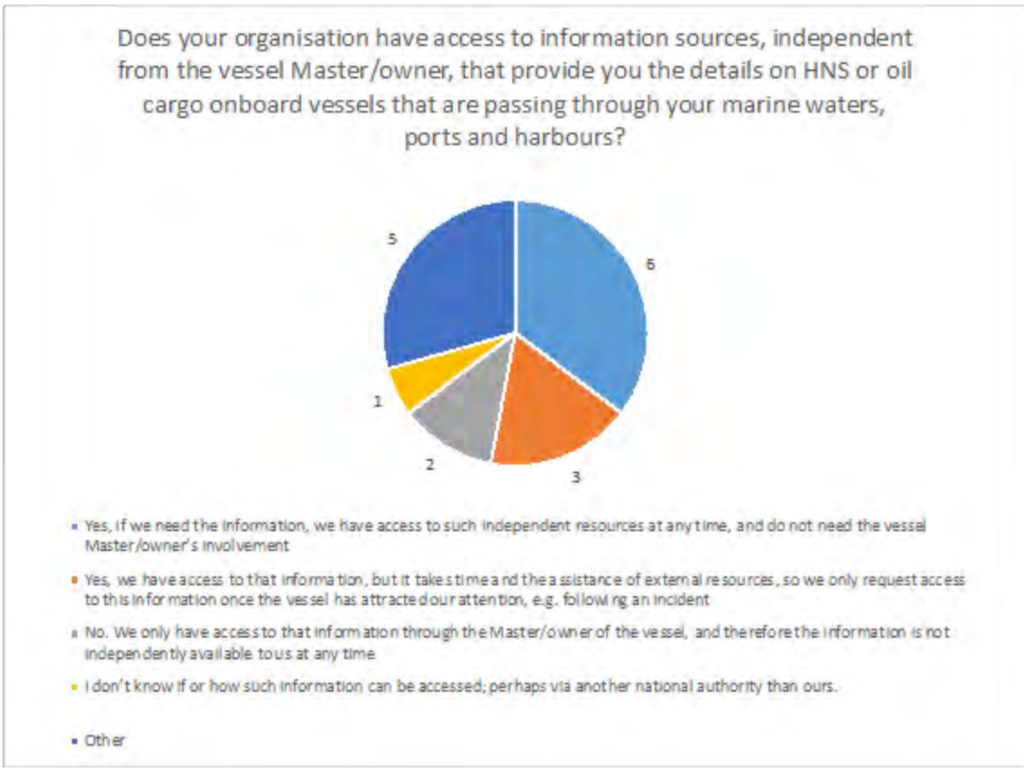
Q20 - The responsibility for dealing with a polluted coast often lies first with local municipalities. In your country, can the response management of a coastal pollution incident be scaled up so that decisions can be taken centrally?



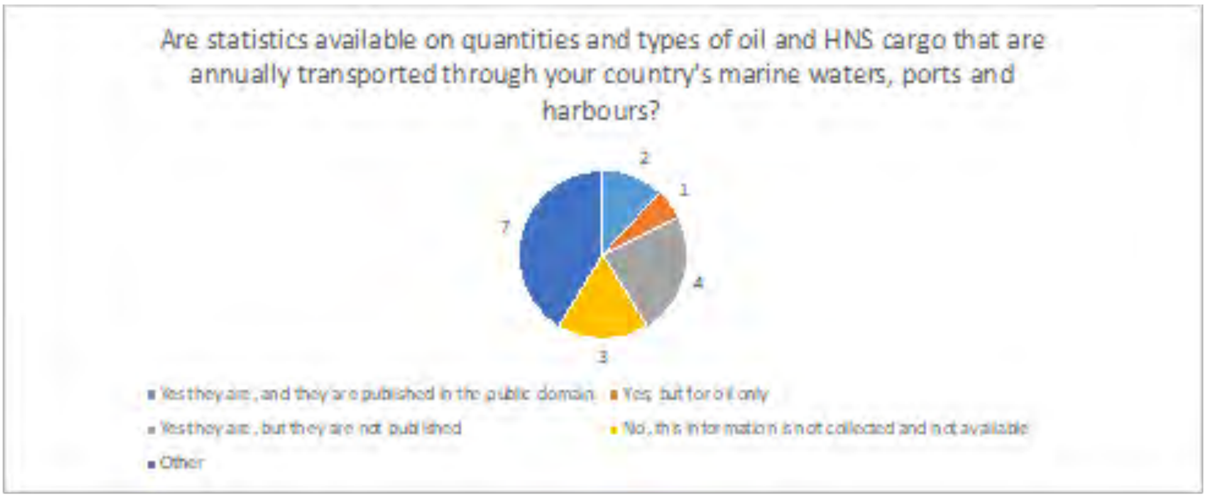
Q21 - Vessels, aircraft, and at-sea combat equipment (booms, skimmers, dispersants) are key in preventing pollution from reaching vulnerable ecosystem and coastal systems. What is the situation in your country regarding the investments in this important at-sea response capacity:



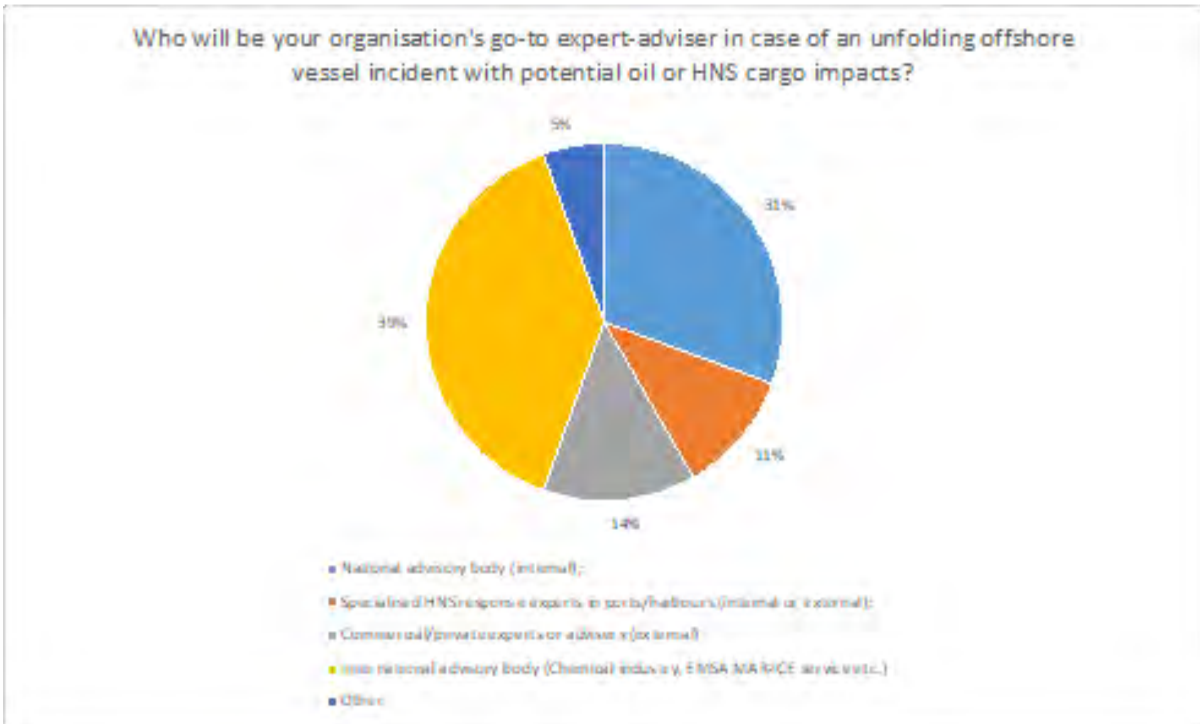
Q22- Does your organisation have access to information sources, independent from the vessel Master/owner, that provide you the details on HNS or oil cargo onboard vessels that are passing through your marine waters, ports and harbours?



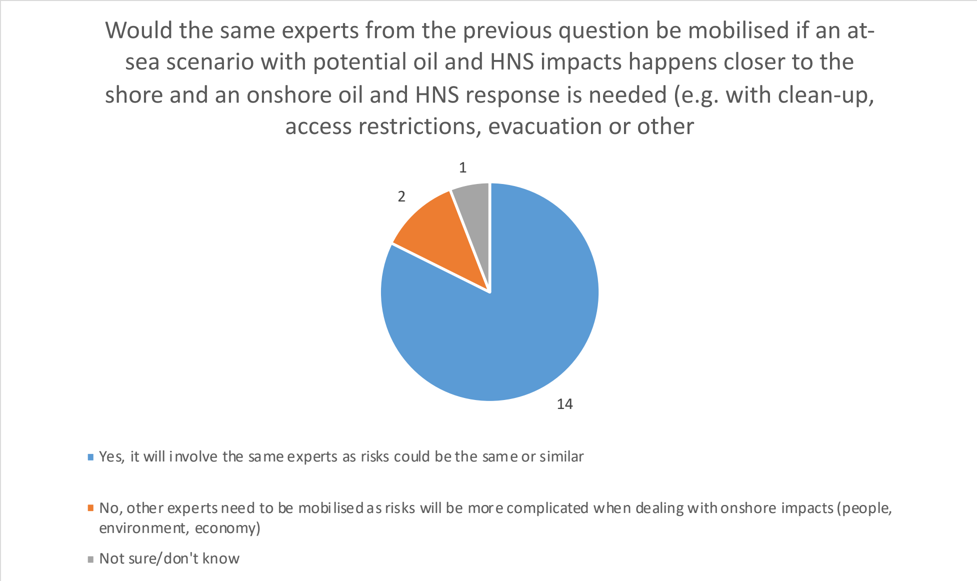
Q24 – Are statistics available on quantities and types of oil and HNS cargo that are annually transported through your country's marine waters, ports and harbours?



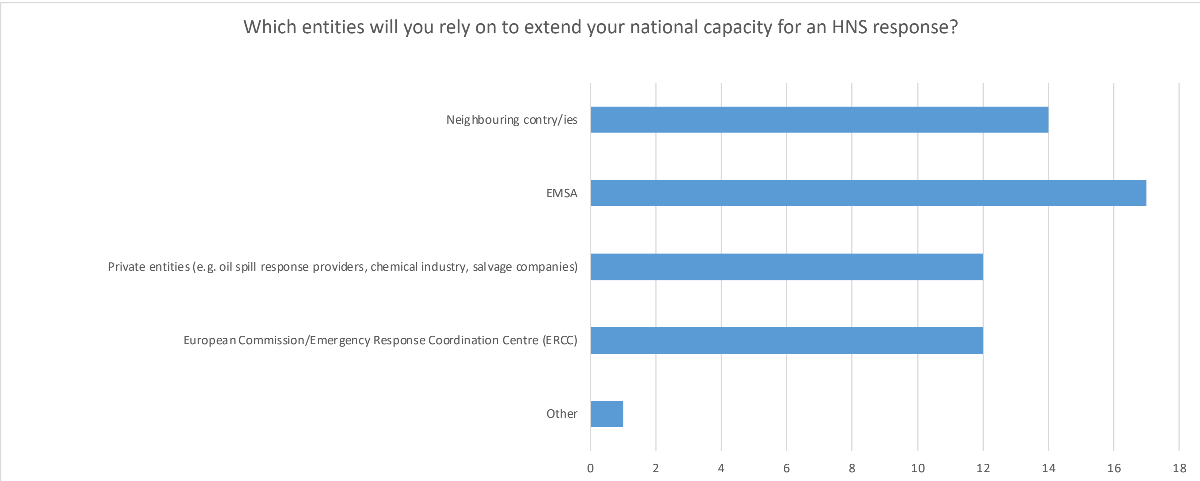
Q26 - Who will be your organisation's go-to expert-adviser in case of an unfolding offshore vessel incident with potential oil or HNS cargo impacts? (multiple answers are possible)



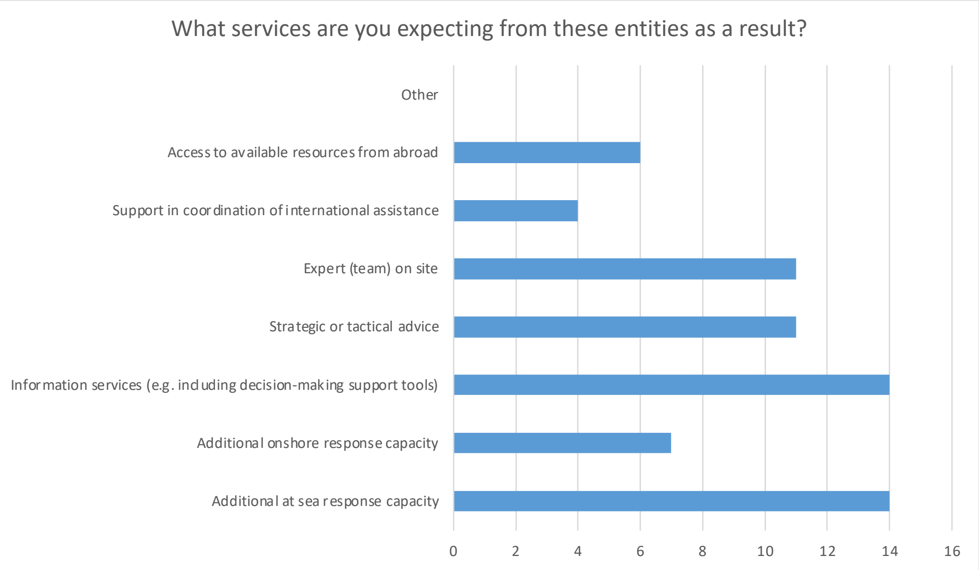
Q27 - Would the same experts from the previous question be mobilised if an at-sea scenario with potential oil and HNS impacts happens closer to the shore and an onshore oil and HNS response is needed (e.g. with clean-up, access restrictions, evacuation or other civil protection/humanitarian response)?



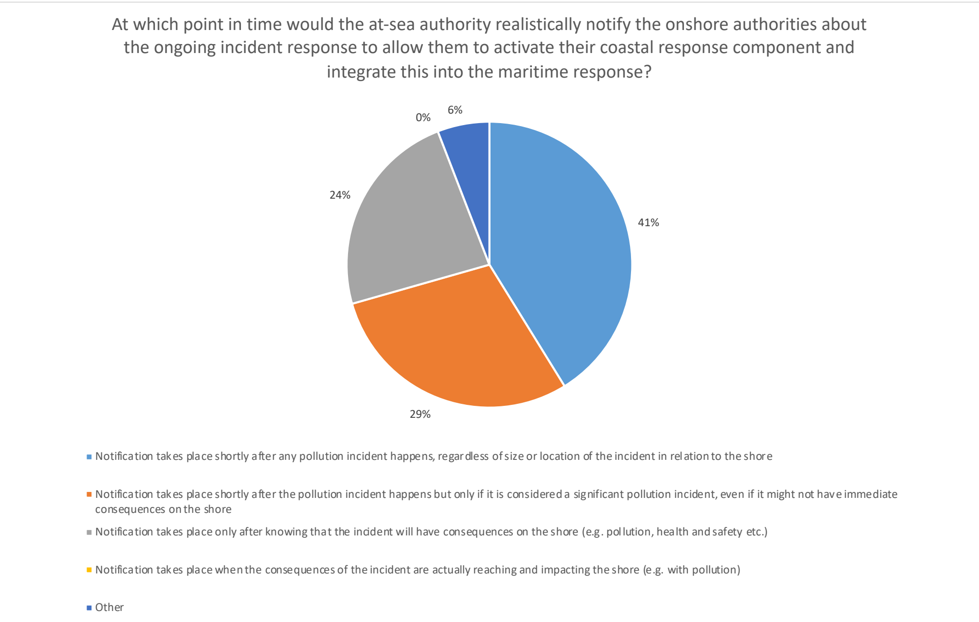
Q28 - Which entities will you rely on to extend your national capacity for an HNS response? (multiple answers are possible)



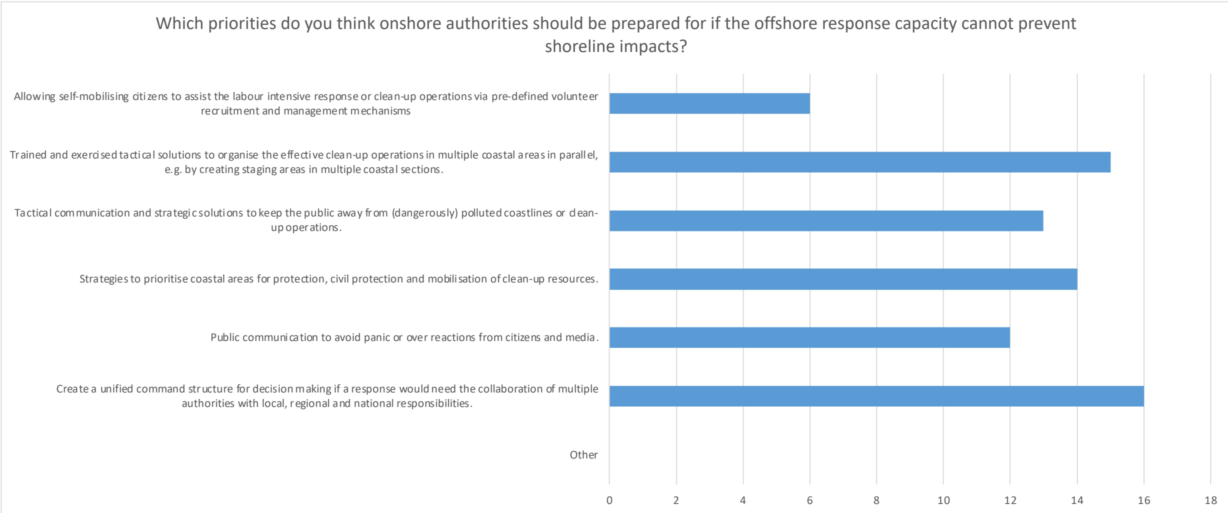
Q29 – What services are you expecting from these entities as a result?



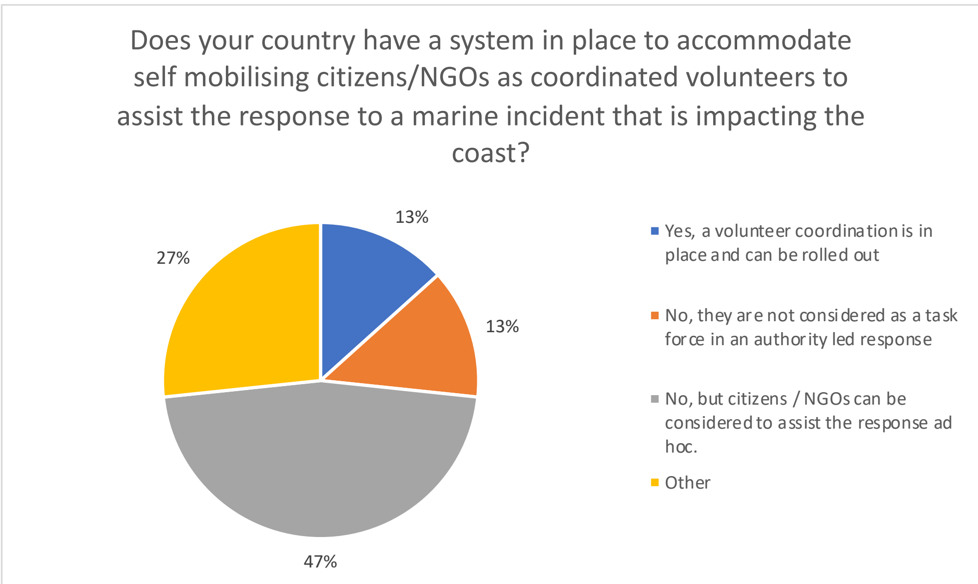
Q30 - At which point in time would the at-sea authority realistically notify the onshore authorities about the ongoing incident response to allow them to activate their coastal response component and integrate this into the maritime response?



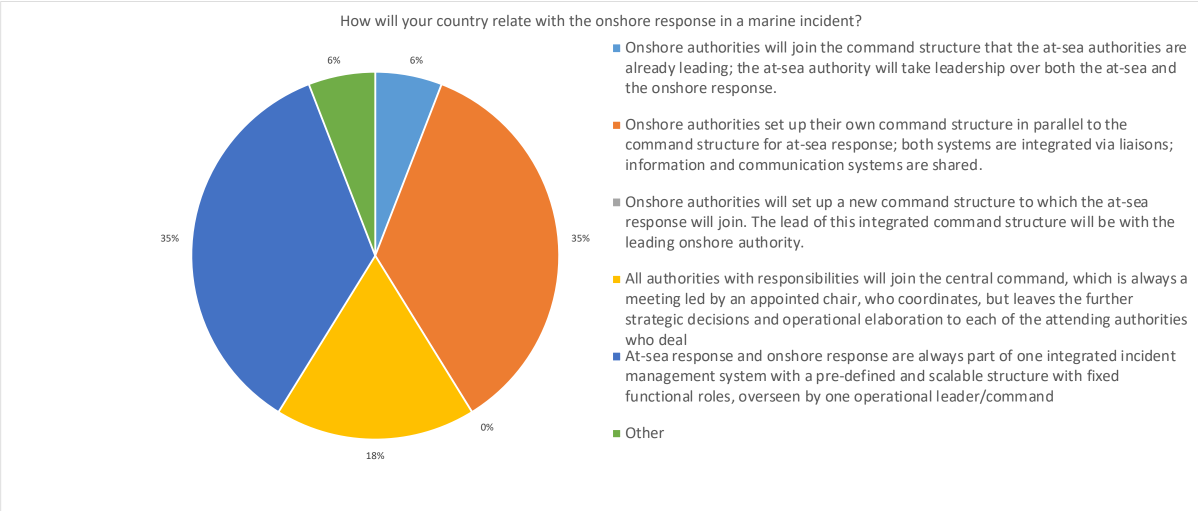
Q31 – Which priorities do you think onshore authorities should be prepared for if the offshore response capacity cannot prevent shoreline impacts? (multiple answers are possible)



Q32 - Does your country have a system in place to accommodate self mobilising citizens/NGOs as coordinated volunteers to assist the response to a marine incident that is impacting the coast?



Q33 - How will your country relate with the onshore response in a marine incident?



Q36 - Response preparedness can fit into two categories:
- Responsibility driven preparedness defines the various responsibilities in an emergency, identifies the authorities that should deliver on these responsibilities, and leaves it to these authorities to organise themselves individually to define and prepare for tasks within their set of responsibilities.
- Task driven preparedness explores multiple scenarios to analyse which challenges may appear and describes the related set of tasks that need to be delivered by the system as a whole. Identified tasks are adopted by authorities within their responsibility and delivered by them as part of a joint response.

How would you describe the response preparedness in your country?

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Outputs and findings from the following projects have also been studied as part of the literature review:

Name	Year	Partners
BE-AWARE: "Bonn Agreement: Area-Wide Assessment of Risk Evaluations"	2012-2014	Bonn Agreement Secretariat, Belgium, Denmark and the Netherlands, with co-financing from Norway and Belgium
HAZARD: Seaport Safety and Security in the Baltic Sea Region	2016-2019	14-partner multinational ensemble, University of Turku (UTU) (Lead)
HNS-MS : Improving Member States preparedness to face an HNS pollution of the Marine System'	2015-2017	Royal Belgian Institute of Natural Sciences, CEDRE, ARMINES-Ecole des Mines d'Alès, Alyotech France, Belgian FPS Health, food chain safety and environment
MANIFESTS: MANaging risks and Impacts From Evaporating and gaseous Substances To population Safety	2021-2022	9 institutes and administrations from 6 countries: CEDRE (Lead), ARMINES, CETMAR, RBINS, INTECMAR, Meteorologisk Institutt Norway, IST, Public Health England, HE, DG ENV
IMAROS: **I**mproving response capacities and understanding the environmental impacts of new generation low sulphur **MAR**ine fuel **O**il **S**pills	2020-2021	Norwegian Coastal Administration, Swedish Coast Guard, Institute Royal des Sciences Naturelles de Belgique, Royal Danish Navy Command, CEDRE, Transport Malta.

11 Appendix 3 – Questions used in the interviews

1. What role does you organisation have during an incident – at sea emergency response/pollution control, onshore emergency response or both?
2. In the event of a major incident which involves onshore and offshore authorities, would you envision a joint incident command centre where all decision makers are in one room? If so, has this ever been discussed in your country? Which model
   a. Onshore authorities set up their own command structure in parallel to the command structure for at-sea response; both systems are integrated via liaisons; information and communication systems are shared
   b. At-sea response and onshore response are always part of one integrated incident management system with a pre-defined and scalable structure with fixed functional roles, overseen by one operational leader/command
   c. All authorities with responsibilities will join the central command, a meeting led by an appointed chair who coordinates but leaves the further strategic decisions and operational elaboration to each of the attending authorities who deal with the matters for which they have adopted the responsibility.
3. Where do you see most scope for improvement for coastal and offshore authorities to have better joint preparedness for a marine incident that would involve both? For example, HNS spill in a coastal zone.
4. The responsibility for dealing with a polluted coast often lies first with local municipalities. In your country, can the response management of a coastal pollution incident be scaled up so that decisions can be taken centrally?
5. How big of a barrier is the specific terminology used by the onshore/offshore authorities for carrying out a coordinated response? Is communication hampered by the use of niche terminology?
6. In which scenarios have you seen/would you expect that citizens would self-mobilise to assist the response to an incident that impacts a coastal area? Would you see it as a problem if they did?
7. Thinking about previous or planned exercises for emergency response, which characteristics would demonstrate a more holistic and integrated response and where do you think it could be improved?
8. How often have exercises focusing on new risk profiles been organised? Which new risk profiles do you consider? For example, HNS spills, new fuel spills such as from hydrogen and ammonia, nurdles spill, incident involving wind farms, lost containers from container ship.
9. If there was a major incident, would you ask a neighbouring country for assistance? Are you aware of the capacity and expertise that your neighbouring countries have? Do you think that capacity would be enough/sufficient to fill the gaps your country might have?
10. Who will be the authorities go-to expert-adviser in case of an offshore incident with oil/HNS impacts? Would they also be mobilised for impacts closer to shore?

11. When thinking about data and/or statistics on HNS cargo passing through your waters, do you see any gaps? If there was an HNS incident, would you have access to reliable data in sufficient time? If so, where would you source it? Would you use SafeSeaNet?
12. What part of your preparedness programme are you most proud of? (provide examples and why/details).