European Union Action to Fight Environmental Crime

Marine Pollution

WP3 Quantitative Analysis

Deliverable No. 3.2d

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List of Abbreviations

BSAP	Baltic Sea Action Plan
BSIMAP	Black Sea Integrated Monitoring and Assessment Programme
EMSA	European Maritime Safety Agency
GDP	Gross Domestic Product
HELCOM	Baltic Marine Environment Protection Commission – Helsinki Commission
MARPOL	International Convention for the Prevention of Pollution from Ships
OGP	International Association of Oil and Gas Producers
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
POP	Persistent Organic Pollutants
UNEP	United Nations Environment Programme

1 Introduction

1.1 Marine pollution

Marine pollution is a broad category, consisting of oil pollution (including accidents with offshore oil and gas installations) and all other marine pollution as defined e.g. in MARPOL and the London Convention.

MARPOL, the International Convention for the Prevention of Pollution from Ships, is the main international convention covering prevention of *pollution of the marine environment by ships* from operational or accidental causes. Its annexes list various forms of marine pollution, caused by oil, noxious liquid substances, harmful substances in packaged form, sewage and garbage from ships, etc.

The London Convention (Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter of 1972), which entered into force in 1975, aims to control pollution of the sea from *dumping*. It covers the deliberate disposal at sea of wastes or other matter from vessels, aircraft, and platforms.

In addition to the obvious (but difficult to quantify) *environmental* damage caused by marine pollution, there may be *health* damage as well as *social* and *financial* damage. The last two categories are taken together in this chapter and include damage to the operators of installations, lost profits for the tourism sector and fishing industry, etc. The term *economic* damage, like in other chapters of this report, is reserved for the total of all financial and monetised impacts, but only to the extent to which such information is available in existing studies or can be calculated.

It should be noted that marine pollution is not necessarily related to crime. However, the available data generally do not distinguish between intent, (gross) negligence, and other causes of marine pollution. In this chapter we will focus especially on dumping, leaving out accidents with offshore oil and gas installations.[1] Illegal waste shipment is analysed elsewhere in this report and will therefore not be discussed here either.

1.2 Availability of data

The data that are available in existing reports on marine pollution[2] always refer to a specific geographical area or to a specific sea. With respect to marine pollution caused by the discharge of particular substances (e.g. chemicals or oil), there are a number of sources containing either concrete data relating to a specific year, or more general information on trends (e.g. increase or decrease of pollution, increase or decrease in incidents). This chapter is constructed taking into account the information from both these kinds of sources.

The majority of sources concern *environmental* impacts. Some of the data contained in these reports is rather technical, as they refer to pollution levels caused by particular substances. We provide these data as presented in the original reports. Only some sources provide information on health or social impacts, and even fewer make quantitative data available.

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[1] For a literature overview on these types of accidents, see EFFACE Deliverable 3.1.

[2] See Deliverable 3.1 and the additional sources contained in the list of references. The reports mentioned in Deliverable 3.1 covered marine pollution caused by accidents (more specifically, those involving offshore oil and gas installations); here we also present some additional sources on marine pollution caused by dumping.

1.3 Structure of this chapter

The remaining sections of this chapter discuss, respectively, methodology (section 2), quantitative impacts in the various seas (sections 3-7), and conclusions (section 8). This chapter is set up somewhat differently from other chapters in this report, because a wide variety of data relating to different seas was collected, and no economic analysis of these data could be conducted. This will be further explained in section 2.

The sections 3-7 on quantitative impacts provide a summary of data found in existing reports on marine pollution (dumping, littering, spills), by presenting information on environmental, health and social impacts, as well as data on financial damage, where available. The following waters are covered: Baltic Sea (3), Black Sea (4), Mediterranean (5), Arctic Sea (6), North Sea and English Channel (7).

The list of reports quoted is provided in a separate bibliography, included at the end of this chapter.

2 Methodology

This chapter includes a quantitative analysis of data, which we collected by means of an extensive literature survey. Considering the nature of these data, conducting a monetary analysis turned out to be impossible, as that would require monetising the environmental impacts of widely differing substances such as (but not limited to) heavy metals, persistent organic pollutants, and oil. Moreover, environmental pollution does not only have an impact on water quality, but also on coastal areas and animal welfare.

It is even more difficult to monetise any social impact of marine pollution, e.g. on fisheries and tourism, more particularly because it is difficult to obtain reliable quantitative impact data upon which such monetisation can be done.[3] Only some rough estimates exist in that respect. Moreover these data cannot be extrapolated, due to the fact that the sectors concerned differ enormously in importance (e.g. in terms of percentage of GDP) for each country.

With regard to accidents, more information is available, for example on types of accidents and fatalities, primarily through the European Maritime Safety Agency (EMSA) reports. However, these reports do not contain information on economic impacts (defined in the narrow sense of financial and monetised impacts).

The added value of this chapter lies in the collection and presentation of data on impacts and accidents; and in the classification of this information into the different heading for environmental, health, social and financial, and economic impacts.

It is important to note that the impacts of incidents that contribute to chronic problems in the marine environment are difficult to distinguish from long-term degradation. For example, for degradation of the marine environment by pollution, it can be hard (other than for major events) to determine the relative importance of 'legal' pollution (from permitted activities), accidents and illegal incidents in their cumulative effects. As a result, this chapter examines some of the impacts as a whole.

The data were collected mainly through web research and scanning of journal databases. Efforts were made to include as much publicly available sources as possible. The following sources proved to be especially useful:

- Baltic Sea: HELCOM, EMSA, articles and reports
- Black Sea: BSC, EMSA, articles and reports (mainly from Bulgaria)
- Mediterranean: articles and reports (mainly from Greece), EMSA
- Arctic: articles and reports only
- North Sea and English Channel: DG Environment, EMSA, UNEP, articles and reports.

[3] Newman et al (2015) conclude that in industries such as fisheries and tourism, the costs of marine litter are beginning to be quantified and are considerable. In other areas such as impacts on human health, or more intangible costs related to reduced ecosystem services, more research is needed.

3 Quantitative Impacts: Baltic Sea

As explained by the European Maritime Safety Agency (EMSA), the EU coast of the Baltic Sea and its approaches include the coastlines of Sweden, eastern Denmark, north-eastern Germany, Poland, Finland, Estonia, Latvia and Lithuania. The Baltic coast also includes two regions of the Russian Federation: the eastern end of the Gulf of Finland and Kaliningrad. Any data taken from the EMSA reports do not include the latter two regions.[4]

The data available in relation to marine pollution in the Baltic Sea is relatively detailed when compared to the other seas discussed in this report. This applies especially in relation to environmental impacts, as will be indicated in the following subsections.

3.1 Environmental Impacts

Presence of Hazardous Substances

HELCOM, the Baltic Marine Environment Protection Commission of the Helsinki Commission, defines hazardous substances as substances (including synthetic or natural compounds) that "cause adverse effects on the ecosystem and human health by being toxic, persistent and bioaccumulating." Heavy metals such as mercury, cadmium, and lead are toxic to organisms at high concentrations, whereas persistent organic pollutants (POPs), such as PCBs and organotin compounds, may be toxic even at low concentrations.[5]

In the period 1998-2007, all open sea areas of the Baltic Sea, except for the Kattegat, were classified as being 'disturbed by hazardous substances'. 98 of the 104 coastal assessment units were classified as being 'disturbed by hazardous substances', while only 7 out of the 144 assessment units were considered to be 'under-disturbed by hazardous substances'. The main basin of the Baltic Sea, together with certain parts of the Kiel and Mecklenburg Bights, were the areas most disturbed by hazardous substances.[6].

Organic Pollutants

In 2010, HELCOM identified a decreasing trend in the level of persistent organic pollutants in the Baltic Sea, and argued that such decrease may be due to bans or restrictions on the production or use of these substances.[7] Nevertheless, In the Baltic Sea, substances such as PCBs, lead, mercury and several others, still appear as contaminants with the highest concentrations in relation to the threshold levels set by HELCOM.

Marine Litter

HELCOM (2006) identifies that the amount of macroscopic marine litter amounts to less than 20 particles per 100 meters of coastal strip. However, this amount sometimes goes up to 700-1200.[8]

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[4] EMSA 2011, p. 27.

[5] HELCOM 2010(a), p. 18.

[6] HELCOM 2010(a), p. 18.

[7] HELCOM 2010(a), p. 20.

[8] HELCOM 2006, p. 4.

Oil spills

At least until 2008, no significant illegal and accidental hydraulic oil spill from ships has occurred since the 'Fu Shan Hai' incident in 2003. That particular incident resulted in the release of 318 tonnes of fuel oil after 616 tonnes had been recovered from the Baltic Sea.[9]

HELCOM identifies a decreasing number of deliberate illegal oil discharges, from 763 spills in 1989, to 210 spills in 2008.[10]

Incidents

The EMSA reported that 75 ships were involved in incidents at the Baltic Sea in 2009. This number includes sinkings, groundings, collisions, fires/explosions and other types of accidents.[11] 89 vessels were involved in incidents in 2010, which is an increase of 19% compared to 2009, but significantly lower than the 120 incidents that were reported in 2008.[12] The table below (adapted from EMSA 2011) provides an overview of all accidents, which seems to indicate that there is no particular trend that can be discovered in these numbers.

Types of accident	2007	2008	2009	2010
Sinkings	3	5	3	2
Groundings	49	52	33	32
Collisions/Contacts	23	35	24	28
Fires/Explosions	16	17	10	13
Other types	15	11	5	14
Total	106	120	75	89

According to Hänninen and Rytkönen (2006), around 80% of all accidents that took place in the Baltic Sea are due to human factors, such as improper handling of the cargo, inadequate supervision and navigational errors, and machine breakdowns and other technical problems.[13]

General information on environmental impacts

HELCOM identifies eutrophication and overfishing as the two main causes of ecosystem destruction in the Baltic Sea.[14]

Between 2004 and 2006, the Swedish Coast Guard detected on average 308 spills per year.[15]
EMSA points out that the relatively low level of accidents in 2009/2010, compared to the previous years, coincided with the economic crisis.[16]

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[9] HELCOM 2010(a), p. 31.

[10] HELCOM 2008(b), p. 7.

[11] EMSA 2010, pp. 27-28.

[12] EMSA 2011, p. 27.

[13] Hänninen and Rytkönen 2006, p. 6. The authors, studying the transportation by tankers of liquid bulk chemicals, identify the main accidents and divide them in three main categories: (i) accidents caused by *improper handling of the cargo*; (ii) accidents caused by *inadequate supervision and navigational errors* ; and (iii) accidents caused by *machine breakdowns and other technical problems*. Examples of each type of accident are provided in their report.

[14] HELCOM 2010(a), p. 5.

[15] Mullai et al. 2009, p. 323.

[16] EMSA 2011, p. 26.

3.2 Health impacts

No data could be found on health impacts in relation to pollution of the Baltic Sea.

3.3 Social and financial impacts

HELCOM points out that overfishing in the Baltic Sea does not only represent a cost for the environment, but also for the fishing industry itself. Some general data are provided regarding the economic value of the fishing and tourism industries.[17]

- Over 50.000 people are employed in the fishing sector of the Baltic Sea;
- The annual turnover of this industry has been estimated at €4.5 billion;
- Sport fishery has a yearly expenditure in Sweden of €265 million per year. In Finland, Denmark and Sweden together – the expenditure reaches €700 million per year;
- Fishing also has a cultural value, which has been calculated to be €200 million per year in Sweden.
- Tourism in the Baltic Sea is estimated at €90 billion per year.
    - Cruise tourism gives an annual turnover of €433 million per year;
    - The leisure boat industry in Sweden has an annual turnover of €265 per year.

3.4 Economic impacts

There is no information on economic (monetized) impacts caused by pollution of the Baltic Sea. However, there is information on the financial benefits estimated by HELCOM in relation to some pollution reduction targets. HELCOM developed a Baltic Sea Action Plan (BSAP) in order to combat the continuing deterioration of the marine environment resulting from human activities, and ultimately to improve the environmental conditions.[18] The benefits of achieving the BSAP target regarding eutrophication (caused by nutrient pollution) in the entire Baltic Sea region were estimated to be

- €4 830 million per year: benefits for avoiding effect of eutrophication estimated on the basis of the willingness of people to pay;
- €2 564 million per year: total benefits of improved water-quality based on meta-analysis.

[17] HELCOM 2010(a), p. 52.

[18] HELCOM 2010(a), p. 52.

These figures are derived in relation to the targets of the BSAP, which are as follows: [19]

Eutrophication	**Hazardous Substances**
• Concentrations of nutrients close to natural levels • Clear water • Natural level of algal blooms • Natural distribution and occurrence of plants and animals • Natural oxygen levels	• Concentrations of hazardous substances close to natural levels • All fish are safe to eat • Healthy wildlife • Radioactivity at the pre-Chernobyl level
Biodiversity	**Maritime Activities**
• Natural marine and coastal landscapes • Thriving and balanced communities of plants and animals Viable populations of species	• Enforcement of international regulations – no illegal discharges • Safe maritime traffic without accidental pollution • Efficient emergency and response capabilities • Minimum sewage pollution from ships • No introductions of alien species from ships • Minimum air pollution from ships • Zero discharges from offshore platforms Minimum threats from offshore installations

[19] For more information on the specific targets to be achieved, see HELCOM 2007.

4 Quantitative impacts: Black Sea

The Black Sea is one of the main inland sea areas around the EU. The EU parts of the Black Sea include the coastlines of Bulgaria and Romania. Other areas (Turkey, Georgia, Russia and Ukraine) may not always be included in the data below, notably the data on accidents provided by EMSA.[20] Furthermore, some data below only refer to the Bulgarian Black Sea.

4.1 Environmental impacts

Organic pollution discharge

According to Dineva, between 1998 and 2005, organic pollution discharge in the Bulgarian Black Sea varied between 3 tyr^{-1} (the Dyavolska River) and 1040 tyr^{-1} (the Veleka River).[21]

Eutrophication

Between 1998 and 2005, the total orthophosphate phosphorus discharge into the Bulgarian Black Sea by rivers ranges from 65 t P yr^{-1} to 1141 t P yr^{-1}, with the Kamchia River's rate between 36 and 222 t P yr^{-1}.[22]

Nitrogen and phosphorus emissions have been reducing in the last years. However the 2000-2005 values are still 1.5 points higher than their pristine levels between 1955-1965, as indicated by the Commission on the Protection of the Black Sea Against Pollution (BSC).[23]

Heavy metals discharge

Between 2003 and 2005, heavy metal discharge into the Bulgarian Black Sea by rivers is mainly formed by the Kamchia River:[24]

- Total *cadmium* discharge - up to 10 t yr^{-1},
- Total *zinc* discharge - up to 125 t yr^{-1},
- Total *lead* discharge - up to 118 t yr^{-1},
- Total *copper* discharge – up to 44 t yr^{-1}

Petroleum Hydrocarbons Discharge

The total petroleum hydrocarbons discharge into the Bulgarian Black Sea by rivers between 2004 and 2005 is up to 458 t yr^{-1}, with the Veleka River's discharge - up to 116 t yr^{-1}, and the Rezovska River's discharge - up to 50 t yr^{-1}.[25]

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[20] Notably the data on EMSA 2011, p. 29.

[21] Dineva 2011. The document does not contain page numbers, so a precise reference cannot be provided.

[22] Dineva 2011.

[23] BSC 2008, para. 2.6.

[24] Dineva 2011.

[25] Dineva 2011.

Between 1995 and 2005 the mean concentration of petroleum hydrocarbons in the bottom sediments of coastal areas of the Black Sea varied from very low levels to up to 0.8 mg/g.[26]

The most polluted coastal areas, exceeding the average concentration of 13-16 times, are located in Romanian, Turkish and Russian waters. These values are normally registered near large ports, refineries, or oil terminals for transportation.[27]

The maximum values were registered at Romanian and Turkish coasts at very shallow depths, amounting to c. 12 mg/g. These values are most likely due to fresh oil spills in 2005.[28]

Chlorinated pesticides

Most measurements by the Black Sea Integrated Monitoring and Assessment Programme (BSIMAP)[29] were below the detection limit (0.05 ng/l). However, some very condensed patches were detected, in particular near Romanian coastal waters near the town of Mangalia in April 2005.[30]

HCHs and DDTs are the most common pollutants in bottom sediments in the Black Sea. The EHP levels are considered to be 0.25 ng/g for γ-HCH and 12.5 ng/g for DDTs total.[31]

- HCH Pollution: the highest levels of HCH pollution were registered in Ukraine in 1992 (4.5 ng/gin) and in Romania in 1993 (29.0 ng/gin).
- DDT Pollution: the highest levels of DDT pollution were registered in the Odessa area in 2003 (63950 ng/g). According to BSC 2008, those levels can only be explained as an accidental event.

Waste water treatment

Dineva identifies municipal waste water treatment plants as one of the causes of pollution of the Bulgarian Black Sea. The plants discharging above 5000 m^3 d^{-1} are those of Varna, Dobrich, Devnya, Golden Sands, and Albena. The main ones discharging below 5000 m^3 d^{-1} are those of General Toshevo, Kavarna, Dolni Chiflik, Beloslav, and Provadia.[32]

Dineva (2007) considers that large amount of eutrophication matter comes into the Bulgarian Black Sea due to lack of biological treatment in the waste water treatment plants.

Incidents

The EMSA reported that 18 ships were involved in incidents at the Black Sea in 2010. This number includes sinkings, groundings, collisions, fires/explosions and other types of accidents, with an increase of 150% compared to 2009, and of 64% when compared to 2008.[33] With a percentage of 45%, collisions were found to be the predominant type of accident.[34] Mainly as a result of the Karim I sinking, 7 people were reported to have lost their lives in accidents in 2010.[35]

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[26] BSC 2008, para. 3.12.

[27] BSC 2008, para. 3.12.

[28] BSC 2008, para. 3.12.

[29] For more information, see http://www.blacksea-commission.org/main.asp.

[30] BSC 2008, para. 3.2.1.

[31] BSC 2008, para. 2.2.2.

[32] Dineva 2011.

[33] EMSA 2010, p. 30.

[34] EMSA 2010, p. 30.

[35] EMSA 2010, p. 30.

The following table includes data collected by EMSA on accidents relating both to the Black Sea and the Mediterranean Sea.[36]

Types of accident	2007	2008	2009	2010
Sinkings	11	9	3	9
Groundings	20	37	20	23
Collisions/Contacts	63	76	71	70
Fires/Explosions	20	13	11	16
Other types	14	14	9	26
Total (Black Sea & Mediterranean)	128	149	114	144

4.2 Health impacts

According to Rudneva, the most important health-related manifestation of marine degradation is the presence of microorganisms from infected sea water and subsequent consumption of contaminated seafood.[37]

4.3 Social and financial impacts

Fisheries

Up to 150,000 people were estimated to be economically dependent on Black Sea fisheries. Wages loss in processing plants is estimated at $10 mln annually.[38]
Due to pollution and introduction of alien species, only 5 of the 26 commercial fish species abundant in the 1970s in the Black Sea were still commercially viable in the 1990s. Black Sea fisheries, which supported about 2 mln fishers and dependents, suffered almost total collapse. Catch values from the mid 1980s to the early 1990s declined by about US$240 million.[39]

Tourism

According to Rudneva (2003), in the 1980s over 4 mln people visited the Black Sea coastline each summer. This number however declined in the 1990s. Rudneva estimates that this is most likely due to the deterioration of amenity values caused by pollution and eutrophication.

4.4 Economic impacts

There is no information on other economic impacts caused by pollution of the Baltic Sea, except from the information on financial losses for the fishing industry provided in the previous section.

[36] EMSA 2010, p. 29.

[37] Rudneva 2003.

[38] BSC 2008, para. 11.4.1.

[39] BSC 2008, para. 11.4.1.

5 Quantitative impacts: Mediterranean Sea

EMSA (2011) reports that the EU parts of the Mediterranean Sea comprise the coasts of eastern Spain, southern France, Italy, Malta, Slovenia, Greece and Cyprus. The North African, eastern Adriatic, and eastern Mediterranean countries are not included in the EMSA data. Furthermore, some sources are focused only on the Ionian Sea and/or Aegean Sea.

5.1 Environmental impacts

Oil concentration

Ventikos and Psaraftis calculate that the oil concentration in the Mediterranean Sea has increased from 2 to 5 μg/l up to 100m of depth from 1981 to 1993.[40]

Incidents

The Hellenic Coast Guard has analysed the substances spilled into the Greek Sea between 1995 and 1996. Most incidents (more than 400) resulted to involve oil and petrol products. Moreover, over 200 incidents involved industrial run off.[41]

Ventikos and Psaraftis analysed the types of accident between 1978 and 1995 leading to oil pollution.[42]

- Sinking: 0%
- Grounding/Stranding: 1.800%
- Fire/Explosion: 1.542%
- Collision/Ramming: 11.020%
- Engine Trouble: 0%
- Rest: 9.258%

EMSA data concerning incidents at the Mediterranean Sea (combined with data on the Black Sea) was reported in the previous section.

5.2 Health impacts

The only information available in relation to health impacts are data on fatalities (see below) and animal health (presented in section 5.3)

[40] Ventikos and Psaraftis 1998, para. 1.

[41] Hellenic Coast Guard 1996.

[42] Ventikos and Psaraftis 1998, para 1.

Fatalities resulting from ship casualties

OGP identified the number of fatalities arising from ship casualties between 1996 to 2005 for some countries on the Mediterranean Sea.[43]

- Egypt: 4 fatalities out of 2 shipping casualties;
- Greece: 24 fatalities out of 11 shipping casualties;
- Italy: 11 fatalities out of 5 shipping casualties

5.3 Social and financial impacts

Fisheries

Storelli et al. measured the presence of mercury in several species of fish in June-August 1999 from the Ionian Sea.[44]

- Albacore (*thunnus alalunga*): between 0.84 to 1.45 mg kg^{-1} w.w.
- Bluefin tuna (*thunnus thynnus*): between 0.16 and 59 mg kg^{-1}

Storelli et al. also found trace metals in various tissues and organs of loggerhead turtles. Hepatic tissue (Hg: 0.43 µg g^{-1} wet weight; Cd: 3.36 µg g^{-1} wet weight) and kidney (Hg: 0.16 µg g^{-1} wet weight; Cd: 8.35 µg g^{-1} wet weight) exhibited the highest levels of mercury and cadmium.[45]

These data, which strictly speaking refer to environmental impacts, are nevertheless presented here as social impacts due to the importance of the fishing industry in the Mediterranean Sea. The 2014 Annual Economic Reports on the EU Fishing Fleet provides interesting data in that respect.[46] The main fleets to be considered in terms of value of landings are the Italian (€ 925 million) and the Spanish (€ 267 million euro) fleets, which on their own account for around 91% of the value of landings of the Mediterranean and Black Sea fleet.[47] The 2012 revenue generated by the whole Mediterranean and Black Sea fleet (excluding Spain), was estimated to be € 1,045 million. Italy is accountable for 87% of this amount (€ 910 million).[48]

5.4 Economic impacts

No data could be found on economic impacts in relation to pollution of the Mediterranean Sea.

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[43] OGP 2010, p. 14.

[44] Storelli et al. 2002.

[45] Storelli et al. 2005, p. 164.

[46] See European Commission 2014. The authors of this report point out that these statistics are incomplete, because several Member States failed to provide data.

[47] European Commission 2014, p. 115-116.

[48] European Commission 2014, p. 116.

6 Quantitative impacts: Arctic Sea

The Arctic is surrounded by the United States (Alaska), Canada, Greenland, Russia and Norway. Data on impacts of environmental pollution are more difficult to find.

6.1 Environmental impacts

Pollution sources in the Artic Sea

The Arctic does not have significant pollution sources of its own; however it is a recipient of chemical contaminants released elsewhere in the world.[49] Poland et al (2003) note that the Arctic has very seriously polluted sites that are as bad as sites anywhere else in the world.[50]

Levy, in a 1986 study on the Canadian Arctic marine environment, found that baseline data on hydrocarbons in the eastern Arctic show that Arctic marine waters are clean in comparison with marine waters in the mid-latitudes.[51]

- Hydrocarbons in the water column
    - Davis strait: 0.53^2 µg/l^{-1}
    - West Lancaster Sound: 0.40 µg/l^{-1}
    - N. Baffin Bay: 0.52 µg/l^{-1}
    - Hudson Strait entrance: 0.35 µg/l^{-1}
    - Hudson Bay/Foxe Basin: 0.49 µg/l^{-1}
- Hydrocarbons in the surface microlayer
    - N. Baffin Bay: 8.0 µg/l^{-1}
    - N. E. Baffin Is. Shelf: 12.3 µg/l^{-1}
    - Hudson Strait entrance: 4.1 µg/l^{-1}
    - Hudson Strait/Hudson Bay/Foxe Basin: 12.4 µg/l^{-1}

Long range airborne contamination

According to Poland et al., major atmospheric pathways converging on the Arctic transport organic and metal pollutants, acidifying compounds and radioactive contaminants.[52]

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[49] Barrie et al. 1992.

[50] Poland et al. 2003, p. 377.

[51] Levy 1986. Note that these data are almost 30 years old.

[52] Poland et al. 2003, p. 372.

Animal welfare

Moore identified changes in habits of marine mammals as a result of water pollution in the Arctic sea.[53] Some of the affected behaviours are:

- One week-delay in southbound migration;
- Increase in calf production coincident with ice-free Chirikov basin in early spring;
- Reduction in calf numbers and changes in timing of occupation of breeding lagoons by gray whales;
- Lack of gray whales feeding during July in the Chirikov Basin;
- Gray whales feeding year-round offshore Kodiak Island, Alaska;
- Gray whale calls detected in the western Beaufort Sea over the winter of 2003/2004;

Poland et al. also estimate that after the Exxon Valdez oil spill more than 35,000 bird carcasses and 1000 sea-otter carcasses were retrieved in the Arctic and Antarctic [54]

6.2 Health impacts

Barrie et al. find that the Arctic ecosystem is particularly sensitive to contaminants because the highly lipophilic and persistent nature of contaminants causes them to accumulate in the lipid-rich tissues of animals at the top of the food chain (polar bears, whales and seals), which represent the basis of the diet of the inhabitants of the Arctic regions.[55]

6.3 Social and financial impacts

No data could be found on social and/or financial impacts in relation to pollution of the Arctic Sea.

6.4 Economic impacts

No data could be found on economic impacts in relation to pollution of the Artic Sea.

[53] Moore 2008.

[54] Poland et al. 2003, p. 377.

[55] Barrie et al. 1992. See in that respect also Poland et al. 2003, p. 377, who note that levels of contamination in the Arctic are such that some indigenous peoples who rely on a traditional diet are among the most exposed in the world to certain contaminants.

7 Quantitative impacts: North Sea and English Channel

This region includes the coastlines of north-western France, the UK, Ireland, Belgium, the Netherlands, north-western Germany, western Denmark, Norway and Iceland. According to EMSA (2011), the northern part of the coastline of this region is particularly prone to accidents, due to weather effects and the density of shipping operating in that area.[56]

7.1 Environmental impacts

Plastic waste

A report by DG Environment of the European Commission states that the presence of plastic waste is monitored by the OSPAR Pilot Project on Monitoring Marine Beach Litter in the North Sea.[57] This project found the following:

- Greater North Sea Coast: 80% of beach litter; 900 items of litter per 100m of beach
- Southern North Sea Cast: 75% of beach litter; 400 items of litter per 100m of beach
- Celtic Sea Coast: 70% of beach litter; 650 items of litter per 100m of beach
- Iberian Coast and Bay of Biscay: 62% of beach litter; 200 items of litter per 100m of beach.

According to the European Commission's report, there is little information on the amounts, rates, fate or impacts of plastic waste on land, but there has been a major effort done by Barnet et al. (2009) to quantify impacts on shorelines and sea.

Oil concentration

Ventikos and Psaraftis found that oil concentration in the North Sea increased from 0.2 to 2.5 μg/l up to 100m of depth in the period from 1981 to 1993. They attributed this sharp increase to the number of platform activities in the area.[58]

Incidents: data

The EMSA reported that 437 ships were involved in incidents in 2009 in the North Sea and English Channel. [59] In 2010, 411 vessels were involved in incidents. There has been a decreasing trend (at least) since 2007, when the total number of incidents was 528. This is also depicted in the table below, adapted from EMSA (2011).[60]

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[56] Adapted from EMSA 2011, p. 26.

[57] European Commission 2011, p. 8.

[58] Ventikos and Psaraftis 1998, para. 1. For more info on offshore installations, see EFFACE Deliverable 3.1.

[59] EMSA 2010, p. 32.Included in these data is the Atlantic Coast (Portugal, Spain, south-western France).

[60] EMSA 2011, p. 26. Included in these data is the Atlantic Coast (Portugal, Spain, south-western France).

Types of accident	2007	2008	2009	2010
Sinkings	41	47	22	21
Groundings	128	128	124	88
Collisions/Contacts	218	197	197	190
Fires/Explosions	55	59	46	54
Other types	86	54	48	58
Total	528	485	437	411

Tricolor incident

Schallier, Resby and Merlin analyse the Tricolor Incident. A collision took place on 14 December 2002 between the car carrier 'Tricolor' and the containership 'Kariba' in the French EEZ. The Tricolor sank on the spot.[61]

- The vessel carried 1988 tons of at least four different heavy fuel oils (HFO), 167 tons of marine diesel oil (MDO), some 50 tons of lubricating oil, and several tons of gas oil and gasoline;

Despite precautionary measures, other collisions resulting in pollution took place, stemming from the original incident:

- 16 December 2002: the small vessel 'Nicola' collided with the Tricolor wreck;

- 1 January 2003: the tanker 'Vicky', carrying 66.000m^3 of diesel, collided with the wreck. An amount of HFO escaped from the Tricolor, and the Vicky lost 200m^3 of oil;

On 22 January 2003, the hull of the wreck got damaged during the salvage operations and resulted in a major spilling accident. At least 200m3 of HFO were released.

Animal welfare

The DG Environment report underlines that once an animal is entangled in plastic waste, it can drown, incur wounds, or be less able to catch food. Ingestion of plastic waste and of micro plastics can also lead to the death of the animal.[62]

UNEP measured the level of plastic in the stomachs of stranded seabirds in the North Sea. The highest levels have been found in the 1990s, and nowadays levels are similar in quantity to those measured in the 1980s. A change in source has been found: nowadays' plastic mostly is of industrial nature, while in the 1980s consumer and industrial plastic were roughly at the same level.[63]

7.2 Health impacts

The only information available in relation to health impacts concerns some basic data on fatalities (presented here) and animal health (presented in the previous subsection).

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[61] Schallier, Resby and Merlin 2004, para. 1.2.

[62] European Commission 2011, p. 16.

[63] UNEP 2011, p. 24.

Fatalities

The EMSA[64] found that 48 lives were reported lost in the area in 2010, higher than in 2009 when 34 lives were lost.[65]

The great majority of accidents in the region in 2010 took place in the waters around Germany, the Netherlands, Norway and the UK.[66] The highest number of accidents is reported to have taken place in the region's main bottlenecks.

The International Association of Oil and Gas Producers (OGP) identifies the number of fatalities arising from ship casualties between 1996 to 2005 for some countries on the North Sea.[67]

- Denmark: 31 fatalities out of 7 shipping casualties;
- Germany: 3 fatalities out of 3 shipping casualties;
- Netherlands: 3 fatalities out of 1 shipping casualty;
- Norway: 10 fatalities out of 4 shipping casualties;
- UK: 0 fatalities out of 0 shipping casualties.

7.3 Social and financial impacts

Fisheries

The UNEP estimates that marine litter costs to the Scottish fishing industry between $15 and $17 million per year, equating to about 5% of the total revenue of affected fisheries.[68]

Navigational Hazard

The UNEP reports that there have been 286 rescues of vessels with fouled propellers in the UK and in 2008, costing up to $2.8 million.[69]

7.4 Economic impacts

In addition to the financial impacts presented in section 7.3, here we present estimates of cleanup costs.

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[64] EMSA 2011, p. 27.

[65] EMSA 2010, p. 32.

[66] EMSA 2011, p. 27.

[67] OGP 2010, p. 14.

[68] UNEP 2011, p. 28.

[69] UNEP 2011, p. 28.

Cleanup of beaches and waterways

Mouat et al. estimate that cleanup of beaches and waterways in Belgium and the Netherlands amounts to about $13.65 million per year, while cleanup of beaches and waterways for municipalities in the UK costs about $23.62 million per year.[70]

[70] Mouat et al. 2010. The average cost per municipality is higher in the Netherlands and Belgium than in the UK, as these countries are more densely populated.

8 Conclusions

Different from the other chapters contained in this WP3 report, the scope of this chapter on marine pollution has been open-ended, focusing on various types of pollution (ranging from e.g. waste discharges and marine litter to oil and shipping incidents) and on five different seas. This chapter did not include a monetary analysis, but instead presented and categorized various types of data on environmental, health, social, financial and economic impacts in relation to the five seas covered here: Baltic Sea, Black Sea, Mediterranean, Arctic, and North Sea.

It is striking that the availability of data differs for each sea, depending on whether or not there are specific agencies involved. HELCOM in particular provides relatively detailed data on environmental impacts concerning the Baltic Sea. There are also some detailed reports on the North Sea, inter alia published by the European Commission. Some of the data presented throughout this report follow from academic or individual research, e.g on pollution of the Bulgarian Black Sea.

This chapter presented mostly data on environmental impacts. Sometimes the data source focused only on one type of environmental pollution, e.g. caused by plastics or littering. Obviously, these data sources are difficult to add together, even for one Sea. Extrapolation of data is not an (easy) option either. Social and financial impacts, in particular, are likely to differ greatly between jurisdictions. For these reasons (and many others), presenting an estimate of the overall impact of marine pollution, even for one sea, seems impossible. However, as indicated in the overview chapter (D3.2a), this has never been the aim of any of the chapters included in this EFFACE report.

We were able to find rather detailed data on the number of accidents and the number of fatalities in relation to marine pollution, especially those data collected by ESMA. These data can in principle be combined for the various seas, e.g. if one would like to know the number of accidents and fatalities across all European seas. However, no trends over time can be detected, except for (for some seas) a small decreasing trend, explained by EMSA by the economic climate.

Of course, accidents do not necessarily relate to illegal activities; the data do not indicate whether or not these accidents result from a violation of particular legal rules, such as safety requirements, or from grossly negligent behaviour. The same argument applies to e.g. oil pollution incidents. Separating legal from illegal activities in relation to marine pollution, as for many other areas covered in this report, is not possible based on the data we were able to find and present here.

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