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# Analyzing values chains for identifying opportunities for reducing pressures on marine ecosystems

*Deliverable 2.2 - WP2, ResponSEAble*

*Key words: value chain, marine sectors, eutrophication, sustainable fisheries, coastal tourism , invasive speciaes, microplastics*

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# Note to the reader

The Horizon 2020-funded project *Protecting the ocean: our collective responsibility, our common interest - Supporting the development of cost-effective ocean literacy in Europe,* short named **ResponSEAble**, aims at supporting the emergence of an effective and dynamic ocean knowledge system that contributes to raising awareness on everybody's (individual and collective, direct and indirect) responsibility and interest in a healthy and sustainable ocean.

In its initial phase, ResponSEAble elaborates a knowledge base on the key components of the human-ocean system. In particular, its Work Package (WP) 2 entitled "*Diving into the functioning of the ocean market economy*" has investigated the components and the functioning of the economy that is directly or indirectly connected to the ocean. The investigations have been carried out for the economic activities connected to 6 main challenges relevant to the sustainable development of European seas, addressing both marine ecosystem protection issues and (Blue Growth) sectors seen as strategic to the economic development of Europe. Using a so-called "value chain approach", economic activities connected to the following 6 challenges that have been investigated:

- Sustainable fisheries in the Atlantic;
- Invasive species in the Mediterranean Sea;
- Eutrophication in the Baltic Sea and in the Black Sea;
- Coastal tourism in the Mediterranean Sea;
- Microplastics from cosmetics in the European seas;
- Sustainable Marine Renewable Energies in European seas.



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The present report summarises the first key findings of the investigations carried out under WP2. It offers two levels of reading:

- The main text of the document presents the individual and comparative results obtained for the value chain assessments carried out for the 6 challenges, in particular with regards to: (a) the economic activities of the value chain connected to the challenges (Chapter 4); (b) the constraints and opportunities faced by these activities for implementing 'marine-friendly" practices or seizing the benefits offered by the seas (Chapter 5); and (c) the actors relevant to these activities that could be the focus of specific "ocean literacy activities" (chapter 6);

- Annexes that present the assessments carried out for each individual challenge.

Due to the challenges faced with the coordination of WP2, the WP2 has experienced some delays in carrying out specific activities. Thus, the elements presented here will be further revised and adapted to provide sound knowledge on value chains for each challenge in preparation to the final WP1/WP2/WP3 European workshop foreseen in March 2017.

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# 1.Introduction

Marine protection has historically been implemented by ensuring some areas were dedicated to marine preservation. A more integrated approach of preservation of marine ecosystems has been implemented at the EU level with the implementation of the Marine Strategy Framework Directive (MSFD) in 2008. The MSFD intends to increase coherence among existing environmental policies and to integrate environmental objectives in sector policies.

Assessments of the impacts linked to economic activities are however often focusing on the activities exerting a direct pressure on marine ecosystems. When looking at the issue of overfishing, attention is often concentrated on fishing activities. To deal with the issue of eutrophication, agricultural practices are questioned. However fishing activities and agricultural practices are linked to a wide range of other activities taking place in society such as food processing, transport, consumption in regions far away from production areas,etc. Hence, finding solutions for addressing pressures on marine ecosystems requires changes in practices of activities responsible for these pressures, but potentially from many other connected socio-economic activities, sectors and actors. This requires that some understanding is gained on the overall functioning of the economy in which economic activities exerting pressures operate. Constraints, drivers and opportunities for change of a wider range of actors of the economic value chains would then help identifying solutions and shared responsibilities for moving towards more sustainable behaviours that would contribute to effective ocean preservation.

Based on the knowledge on pressures and state of regional seas mobilized in the frame of the MSFD, combined with priorities of the EU Blue Growth strategy, key issues and challenges linked to the human-marine ecosystem relationships have been selected for focusing activities carried out under ResponSEAble. Overall, 6 priority challenges (also named “Key Stories” in the internal ResponSEAble jargon) have been selected, with detailed assessments being carried out different scales (from a single regional sea to wider Europe) depending on challenges.

The 6 challenges along with their main geographic focus include:



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- **Sustainable fisheries** in the **Atlantic**;
- **Invasive species** coming from ballast water and hull fouling in the **Mediterranean Sea**;
- **Eutrophication** and agriculture in the **Baltic Sea** and in the **Black Sea**;
- **Coastal tourism** in the **Mediterranean Sea** and the **Black Sea**;
- **Microplastics from cosmetics** in **all European seas**;
- Sustainable **Marine Renewable Energies** (MRE) in **all European seas**.

Data and information on the Drivers-Activities-Pressures-State-impacts-Welfare-Responses (or DAPSI(W)R) associated to each "story" or challenge have been gathered under WP1 activities in parallel to the analysis of the value chains carried out under WP2 (see D1.1 for further information on the issues investigated and the approach proposed under this WP). Combined, these data will deliver a sound understanding of the links between economic activities organized within an overall economy and the pressures it imposes on marine ecosystems and eventually on human well-being (via the delivery, or absence of delivery, of ecosystem services).

Overall, WP2 has provided insight into the functioning of the economy connected to each challenge or key story, characterizing how economic activities at the origin of pressures on marine ecosystems, or that might potentially contribute to Blue Growth, are linked to other economic activities and to the delivery of goods and services, including ecosystem goods and services.



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# 2. Objectives of the report

In coherence with the objectives of WP 2 of ResponSEAble, the present report addresses the following questions:

- What are the **main activities** of the economy that are connected, directly or indirectly, to the economic activities at the origin of pressures on marine ecosystems? And what are the links between these activities and the marine ecosystems?

- Who are then the **main actors** that are connected to the main activities of the value chain, and who might represent potential groups for targeted literacy on their role in supporting more sustainable practices – or in seizing development opportunities offered by the ocean?

- What are the **main drivers, constraints and opportunities** faced by these activities/actors and that could represent solutions for a more sustainable economy accounting for the protection of marine ecosystems and for Blue Growth?

The analysis presented in the present report provides answers to these questions for each of the 6 challenge selected for critical in-depth assessments in the context of the ResponSEAble project.



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# 3.Methodology

The identification of the activities and actors of the ocean economy connected to particular challenges has been implemented by using a "value chain approach"[1].The purpose of this assessment is to make explicit the embedment of activities in a vertical/linear socio-economic structure and cross it with pressures so the different socio-ecological components of the system attached to a specific challenge of issue are well accounted for. For the main economic activity associated to each key story, a value chain has been developed. Individual economic activities have been characterized from a socio-economic perspective, looking in particular at indicators such as value added, employment and the structure of connected input and output markets. It allows for a qualitative assessment of the most important components of the value chain in terms of their potential market power. Links between economic activities, and their connections to marine ecosystems, are identified and characterized based on available knowledge.

Actors related to components of the value chains are identified. Special interest is in identifying actors who could drive changes along the value chain so more sustainable practices are put in place.

Finally, drivers and constraints faced by the most important economic activities/actors are characterized in order to better understand margins for changes in behavior or practice that would reduce pressures on marine ecosystems, or seize development opportunities and contribute to Blue Growth.

[1] See Deliverable D.2.1 of ResponSEAble for more information on the framework applied for supporting WP2 activities.



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**Box 1. Actors and activities: what are we actually looking at?**

A classification of economic activities and actors has been developed for the Knowledge Base of ResponSEAble. WP2 uses this classification.

By "**activities"**, we refer to economic activities that are categorized following NACE classification of economic activities. In order to better analyse activities in the context of ResponSEAble, the category "Consumption and Household Activities" has been added to the NACE classification of activities.

By "**actors**" we refer to all people involved in implementing activities or being part of its socio-economic and regulatory context. Actors have been classified in four categories: professionals involved in performing the activities; contributors to the regulation framework, eg. the European Commission as the actor preparing specific Directives; actors that belong to the social framework, e.g. environmental NGO lobbying for specific regumations; and individual actors such as consumers or citizens[2]. Depending on their role in relation to the individual challenge/key story, actors can have different relations: economic or "commercial" relations that can lead to increased wealth; governance relations in the context of the preparation, adoption and implementation of the regulatory framework, or influencing an actor's ability to act, its rights and its obligations; knowledge relations including those that lead to sharing information with a specific actor.

In order to implement these steps, a first draft of the value chain (mapping of economic activities) was developed for each challenge/key story. A mixed approach investigating the flow of products along the process upstream and downstream of the primary activity putting direct pressure on marine ecosystems was followed. For the microplastics story for example, it was possible to look at how fuel is transformed in microplastics, which are

[2] See the work carried out by the ResponSEAble team for the classification of knowledge for more information on the sub-categories of each of these categories.



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then transformed in cosmetics, which are spread in EU seasthrough consumers behavior. This was complemented by an assessment of the links backwards by starting from the release of microplastics in European seas to economic sectors at the origin of these releases, and then activities connected to these sectors.

Based on the first mapping of economic activities, literature review mobilizing economic data (Eurostat etc.), grey literature (reports by big companies or lobbies, international institutions reports) and scientific data (academic papers) and interviews with key stakeholders of the value chains were carried out. This helped to review the first mapping of activities, and to progressively develop a sound assessment of the functioning of the value chain. This qualitative approach aimed at rediscovering issues heavily studied in the past (eutrophication or overfishing, for example) from an ecological perspective by adding a wider socio-economic perspective including in relation to the EU Blue Growth and the contribution of the seas to the overall socio-economic development of Europe.



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# 4. What are the main activities of the value chains?

The value chain approach has been applied to identify the economic activities that were directly and indirectly connected via the sale/purchase of goods and services to the main sector at the origin of the pressures or central to the blue growth story investigated (i.e. fisheries, agriculture, cosmetic production, tourism and Marine Renewable Energy production). Much attention was given to:

- The relative importance of **EU-based activities** in the value chains, for which different drivers and opportunities for future development or change exist.

- The **boundaries of the analysis**, ensuring the main economic activities only (in terms of economic importance, specificity and contribution to pressures) were more specifically described. As most activities and sectors are directly or indirectly connected in today's economy, the challenge was to provide a simplified picture of the economy that makes sense and that can be understood in light of the marine/ocean issues selected and investigated;

Although following the same logics, the application of the value chain approach differed from one issue to the other. In particular, the investigation of the value chain linked to Marine Renewable Energies combined the traditional value chain approach (activities connected via sale/purchase of goods & services) with an assessment of the activities and actors involved in the development and wider application of these (relatively new) technologies.

The following sections present the main activities of the value chain for the different issues investigated.



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# 1. Activities of the value chain linked to sustainable fisheries in the Atlantic

**Fishing activities**

Fisheries face a stagnating level of catches from the nineties (about 93 million tons the last four year including inland fisheries) when aquaculture production increases dramatically (73.8 million tons in 2014 with an estimated value of US$ 160.2 billion) (FAO 2016). Marine capture fisheries counts for 81.5 million tons (2014), 87.3% of the total capture fisheries. Marine aquaculture follows the same growth than inland aquaculture and counts for 26.7 million tons (2014), 36.2% of the total aquaculture production. But in 2014 and for the first time, the supply of fish for human consumption from aquaculture overtook that of wild-caught fish for the first time.

In 2014, the European (beyond of EU) fishing fleet counts for 2.1% of the total number of fishing vessels and 3% of motorized fishing vessels, when Asia counts for 75.1%. This is even worst in terms of fishers and fish farmers where the number of European fishers decreased dramatically the last years counting for less than 1% of world fishers and 0.35% of fish farmers, when Asia counts respectively for 84% fishers and 96% fish farmers. But European aquaculture slightly continues to grow and European catches remain at similar levels over the last years underlining a higher concentration and intensification in European fisheries and aquaculture.

In 2013 a third of commercial fish stocks (assessed and monitored fish stocks) are still overharvested at biologically unsustainable levels. It is a level that had been stable since 2007 (FAO 2016), in spite of decreasing fish landings observed in some regions, especially in Northwest Atlantic. In the Mediterranean and Black Sea, 59% of assessed stocks are fished at biologically unsustainable levels (over the Maximum Sustainable Yield). Fish stocks such as hake, red mullet, sole and sea breams are overfished, catches declining from 2 million tonnes in 1982 to 1.2 million tonnes in 2013.



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The North East Atlantic (NEA) fishery is the most important fishing area in the EU, counting for 71% of catches in 2014 (Eurostat 2016). It's the logical consequence of the most important European coastline length. Fishing pressure is the most widespread in the N-E Atlantic region, with demersal fish stock (plaice, cod, haddock) coming under significant strain. In addition, fishing affects habitats and seabird populations (Turner 2011).

The five most popular species caught by EU Member States in 2014 in this area are Atlantic herring (one fifth of the total catch), Atlantic mackerel (17 %), European sprat (12 %), sandeels (5 %) and blue whiting (5 %). These top five species made up 59 % of the EU North East Atlantic catch in 2014 (Eurostat 2016).

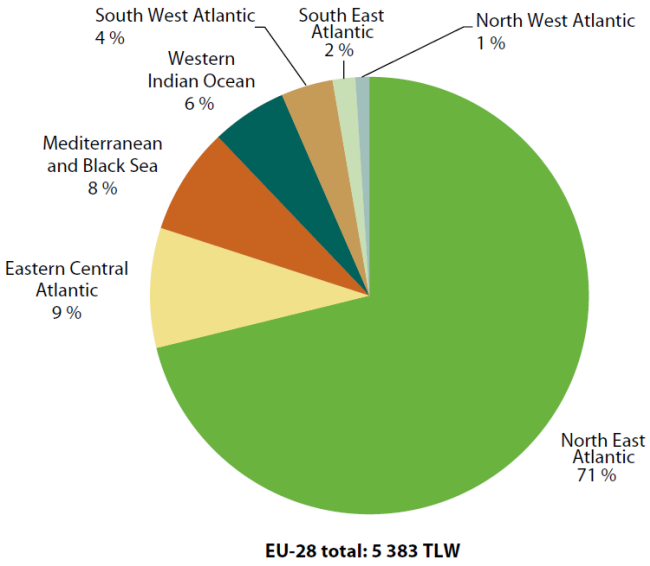


***Figure 1 Catches by fishing area, EU-28, 2014 (Unit: 1,000 tons live weight %). Eurostat (2016)***



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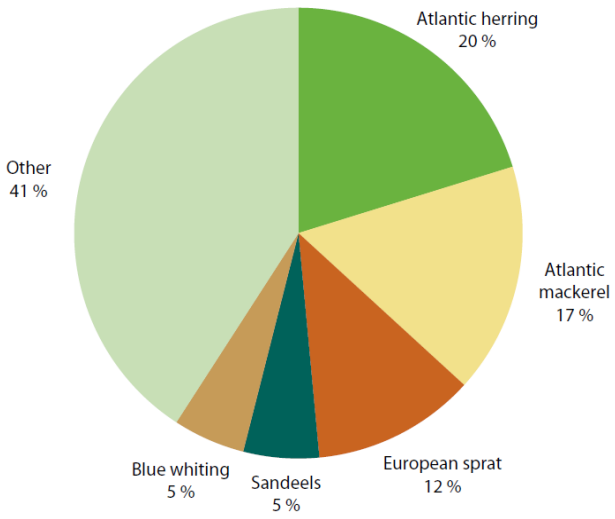


***Figure 2 Top 5 species caught by EU Member States in the North East Atlantic, 2014 (%). Eurostat (2016)***

In the fishery industry, added value is usually brought through handling, preservation and processing. **Handling** is a preprocessing aiming at delivering catches or harvests to the next segment of the value chain under good conditions from a sanitary and quality point of view (fresh and undamaged products). Handling (including sorting and grading) can take place on fishing vessels or in farms as well as primary and secondary processing for large scale fishery and farming. But handling and processing can also take place elsewhere (on a mother boat collecting catches avoiding fishing vessels to transit for landing in harbor, or in inland infrastructures).

EU catches and harvests can be **processed** within the EU or outside the EU. Most of seafood processed within the EU remains in the EU. In 2013, 80% of the EU processed fish products are directed to internal consumption (EUMOFA 2015). There're two dimensions in the European seafood trade: the Extra-EU trade and the Intra-EU trade. From 2014, EU has become the first seafood product importer, making up 24% of the total value of world trade (Figure 14).



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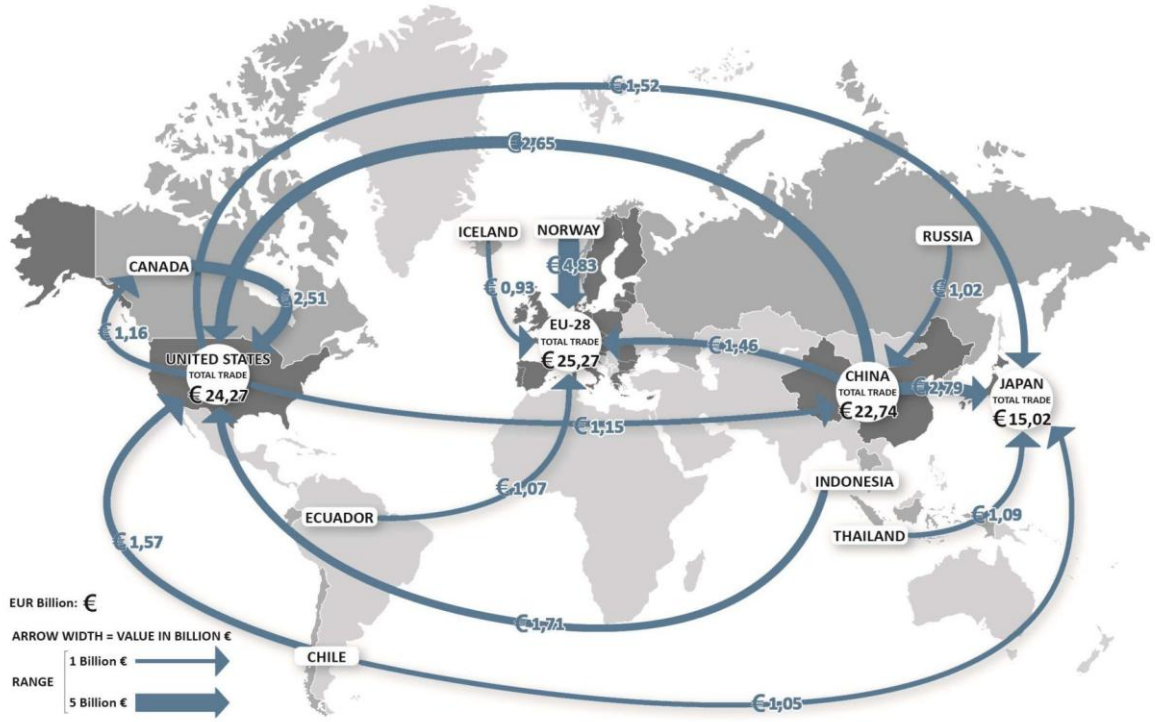


***Figure 3 Main trade flows of fishery and aquaculture products in the world (2014)***

Source: EUMOFA – GTIS

But European raw materials (catches and harvest) can also be exported for processing. Once semi-processed or processed they can be imported to Europe where there had been initially exported. This is for instance the case for part of the Norwegian salmon (aquaculture) and cod (fisheries) production fileted in China and imported to Europe for secondary processing.

Finally intra-European imports and exports also take place between EU member States. Trade between EU Member States is the most important in the whole EU fishery trade. In 2014, it accounted for 86% of the total trade within and outside the EU (EUMOFA 2015). Salmon represents 11 of the 15 top flows within the EU in value. Denmark and Sweden act as trade hubs for Norwegian salmon exports to the EU.

**Consumption**



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Fish counts for almost 20% of the animal food consumption in the World and demand for seafood products is still growing due to the combination of several factors: demographic growth, urbanization, increase of richness, international trade providing wider choices... World per capita apparent fish consumption increased from 9.9 kg in the 60's to 14.4 kg in the 90's and 19.7 kg in 2013 (FAO). According to a horizon 2022 scenario, FAO assessed a per capita fish apparent consumption ranging from 23.5 kg to 25 kg from the baseline scenario to the optimistic one (FAO 2014), with important disparities between developed and developing countries. It is then asked to aquaculture to fill in this gap by doubling its production to 2030.

The diagram below presents the simplified value chain of sustainable fisheries in the North East Atlantic.



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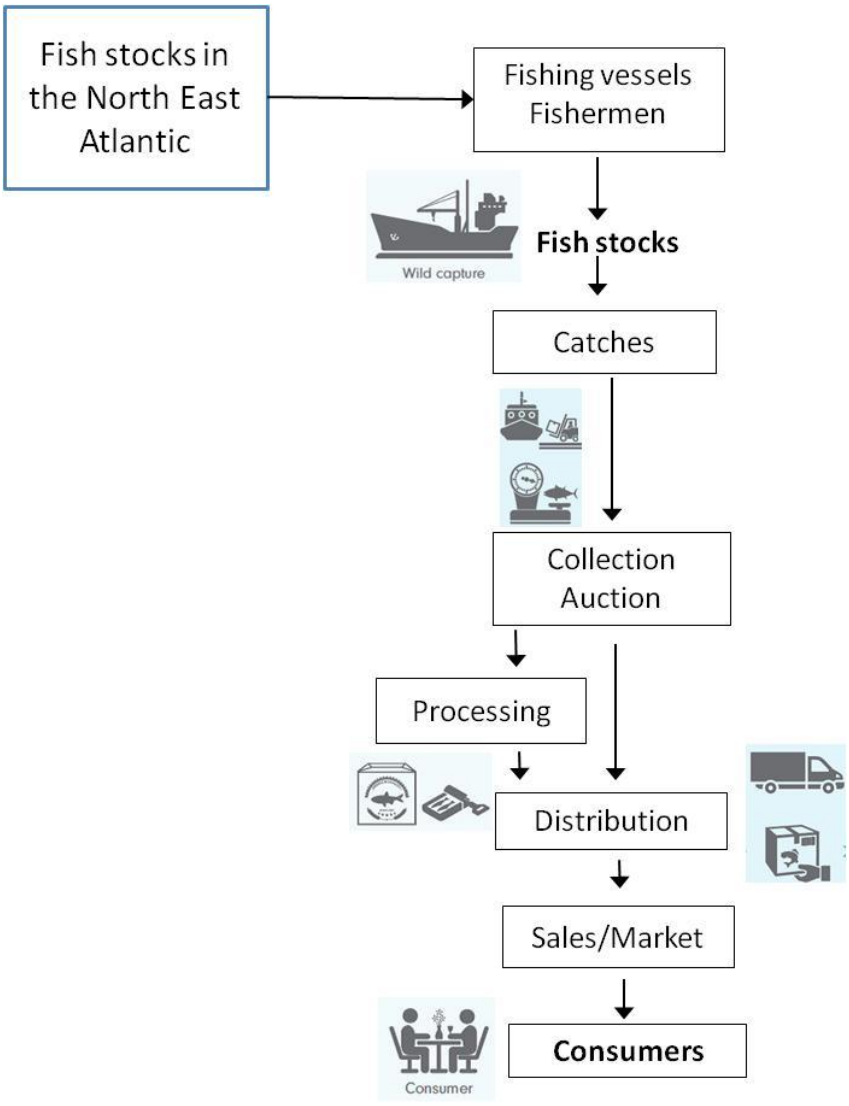


***Figure 4 Mapping of economic activities related to sustainable fisheries in the North East Atlantic***



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## 2. Activities of the value chain linked to invasive species in the Mediterranean

Non-Indigenous Species (NIS) are species, subspecies or lower taxa introduced outside of their natural range (past or present) and outside of their natural dispersal potential (Olenin, 2010). Non-indigenous species have been introduced into new geographic locations worldwide, posing a threat to local habitats, biodiversity and ecosystems' functioning, especially when they become invasive and out-compete the local flora or fauna. There are various ways NIS may be introduced to a marine environment, including both anthropogenic and natural pathways. The anthropogenic pathways include water transport, aquaculture, marine leisure activities, as well as releases from aquaria or accidental releases.

The main economic activity responsible for the introduction of the invasive alien species (IAS) is trans-oceanic water transport, which includes both sea freight transport and passenger transport. Ships transport organisms over long distances, either through their ballast water taken up in one location and released in another or through hull fouling. It is widely recognized that the most significant vectors for aquatic IAS invasions are ballast water taken up at sea and released in port by transoceanic vessels and IAS transport through hull fouling (Molnar et al, 2008; Xu, et al., 2014; Shine C., 2010). Local marine

**Box 2 – Key terms related to the invasive species challenge**

**Ballast Water** (**BW**) is water taken on by ships in the coastal waters in one region (after they discharge wastewater or unload cargo) in order to provide stability and manoeuvrability for the vessel during voyage. At the destination port, ballast water is typically discharged into the environment as cargo is taken on. It is estimated that approximately 10 billion $m^3$ of ballast water is transferred globally each year (UNCTAD, 2015). Ballast water discharge typically contains a variety of biological materials, including plants, bacteria, microbes, small invertebrates, eggs, cysts and larvae of various species. According to estimates, ballast water transports over 7000 different marine species worldwide every day (Tamelander J., 2010). These ballast water often include Non-Indigenous Species (NIS)

**Invasive alien species (IAS)** are a subset of established Non-Indigenous Species (NIS) which have spread, are spreading or have demonstrated their potential to spread elsewhere, and have an adverse effect on biological diversity, ecosystem functioning, socio-economic values and/or human health in invaded regions (Olenin, 2010).

**Hull Fouling** (**HF**, **Biofouling**) is the undesirable accumulation of microorganisms, plants, algae and animals on submerged structures and especially on ships' hulls. Some of these organisms are then detached from the hull by hydrodynamic forces when the vessel is travelling at a sufficiently high speed. In coastal regions

activities associated with local transport, such as short sea shipping and cruising, yachting, sailing and motor boating, may worsen the problem by spreading the IAS to nearby waters (Johnson L., 2007).

This section analyses the segments of the economy which are mainly responsible for the phenomenon of IAS in the seas, according to the value chain approach. The service which is at the center of the analysis is the transportation of persons and goods through vessels. This activity has been recognized as the main cause for introducing and spreading IAS. Following the value chain, the analysis identifies upstream and downstream additional economic sectors and activities supporting the water transportation industry in various ways. An overview of all these economic activities is provided in Table 1, while the most important ones are analyzed in detail.

***Table 1: Economic activities related to introduction and spreading of IAS through water transport*** *(upstream activities are marked in red cells, main activities in blue, and downstream in green cells)*

| Sector | Activity | NACE Class (Rev. 2) | Relevance |
|---|---|---|---|
| A – Agriculture, Forestry & Fishing | Growing of cereals and crops | 01.11 Growing of cereals (except rice), leguminous crops and oil seed | Seaborne trade good |
| | Fishing | 03.11 Marine fishing | Fishing may spread IAS already established in one region to nearby waters. |
| UPSTREAM (B – Mining & Quarrying) | Mining of coal | 05.10 Mining of hard coal | Seaborne trade good |
| | Extraction of crude petroleum | 06.10 Extraction of crude petroleum | Seaborne trade good |
| | Extraction of natural gas | 06.20 Extraction of natural gas | Seaborne trade good |
| | Mining of iron ores | 07.1 Mining of iron ores | Seaborne trade good |
| | Other mining and quarrying | 08.1 Quarrying of stone, sand and clay | Seaborne trade good |
| | Shipbuilding | 30.11 Building of ships and floating structures | Various aspects of shipbuilding influence the risk introducing IAS, such as: the design of ballast tanks, the installation of BWMS, the application of anti-fouling coatings |
| | Shipbuilding | 30.12 Building of pleasure and sporting boats | By applying anti-fouling coatings on the hull of small boats reduces the risk of biofouling being attached. |
| H – Transportation & Storage | Transport of freight overseas<br>Ship rental with crew for sea and coastal freight water transport | 50.20 Sea and coastal freight water transport | This is the main economic activity responsible for the introduction of IAS through hull fouling and the transportation of ballast water. |



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| | | | |
|---|---|---|---|
| | Cruising<br>Yachting<br>Boat excursion<br>Traveling with ferry boats<br>Traveling with pleasure ships<br>Traveling with water taxis<br>Coastal water transport | 50.10 Sea and coastal passenger water transport | Traveling with smaller ships in the same sea region will not introduce IAS. But such activities may spread IAS already established in one region to nearby waters. |
| D – Manufacture | Refineries | 19.20 Manufacture of refined petroleum products | Dependent on goods from overseas |
| | Manufacturing industries of chemicals and chemical products | 20.- Various | Dependent on goods from overseas |
| | Hull coating and painting | 20.30 Manufacture of paints, varnishes and similar coatings, printing ink and mastics | Anti-fouling paints and special hull coatings may reduce the risk of IAS which are attached to the ship's hull as biofouling |
| | Manufacture of basic metals | 24.- Various | Dependent on goods from overseas |
| | Retrofitting of BWMS (Manufacture of machinery and equipment) | 28.12 Manufacture of fluid power equipment<br>28.13 Manufacture of other pumps and compressors | Retrofitting of existing vessels with Ballast Water Management Systems is the most promising technology for the prevention of transporting IAS through ballast water. As most of the older ships currently in operation do not have such facilities on-board, this sector is expected to become important once the BWMC will enter into force. |
| E – Water Supply, Sewerage, Waste Management & Remediation Activities | Hull scrubbing and wiping | 38.12 Collection of hazardous waste | Brushing/wiping the fouling from the vessel's hull is a key activity in the IAS story. This way Non-Indigenous Species are detached from the vessel hull and released into the water where they may build viable populations and become invasive. |
| | Port based de-ballasting | 38.22 Treatment and disposal of hazardous waste | In case of de-ballasting, the ballast water is transferred from the ballast tanks to onshore treatment facilities where NIS are neutralized |
| | Dismantling of ships | 38.31 Dismantling of wrecks | Improper dismantling can lead to the detachment of the NIS from the vessel hull and their release into the water |
| DOWNSTREAM G – Wholesale & Retail Trade | Ship trade | 46.14 Agents involved in the sale of machinery, industrial equipment, ships and aircraft | Retrofitted ships have an increased resale value. Older ships with no ballast water management systems on-board have a smaller value and are more likely to be disposed earlier. |
| K – Financial & Insurance Activities | Loans, Financing | 64.19 Other monetary intermediation | The risk calculated by institutions financing the new or older ships may take into account whether the vessel complies to regulations governing ballast water management and especially the U.S. Coast Guard regulations and the BWMC. |
| | Marine insurance<br>Transport insurance | 65.12 Non-life insurance | The risk calculated by insurance companies may take into account whether the vessel complies to regulations governing ballast water management and especially the U.S. Coast Guard regulations and the BWMC.<br>Retrofitted ships have an increased resale value. |



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| | | | |
|---|---|---|---|
| M – Professional, Scientific & Technical Activities | Research and development | 72.19 Other research and experimental development on natural sciences and engineering | Protection from IAS can be increased with research and development efforts in various fields, such as filtering and neutralizing IAS in ballast water, improved anti-fouling paints etc. |
| | Marine consultants Maritime consultants | 74.90 Other professional, scientific and technical activities n.e.c. | Marine/Maritime consultants provide a variety of services in the fields of marine commercialization and marine ecosystems. Based on their expertise they are able to advise the marine business sector about what it should and shouldn't do, including all aspects that are related to IAS. |
| | Ship rental & chartering without crew | 77.34 Renting and leasing of water transport equipment | Same as ship rental with crew (see 50.20). |
| O – Public Administration & Defence | Administration, supervision and operation of the navy | 84.22 Defence activities | Activities related to naval operations, contributing as well to the transport of IAS through ballast water and hull fouling. |
| U – Activities of extra territorial organisations & bodies | Guidelines, Treaties, Conventions, Directives etc. | 99.00 Activities of extraterritorial organisations and bodies | Intergovernmental and International organizations may have a significant influence in the prevention, monitoring and defence against IAS. |

- **Sea and Coastal Water transport (freight, passengers)**

| Activity (ResponSEAble classification) | NACE Class |
|---|---|
| VII.2.2. Sea and coastal freight water transport | 50.20 |
| VII.2.1. Sea and coastal passenger water transport | 50.10 |

Transoceanic shipping is widely recognized as the main cause of the IAS problem. Especially large commercial vessels, moving over 80% of the word's commodities, are responsible for the transfer of approximately 10 billion tons of ballast water annually (UNCTAD, 2015). It is proven that a large number of IAS transported either in the ballast water or accumulated as hull fouling manage to survive and to produce viable populations in foreign seas, causing significant damage to the local ecosystems. Figure 5 illustrates the shares of goods transport from/to European ports. The total intra-EU transport represents 47.1% of the whole trade in the EU-28 ports, while 51.6% represents the international extra-EU transport (to/from other non-EU countries).



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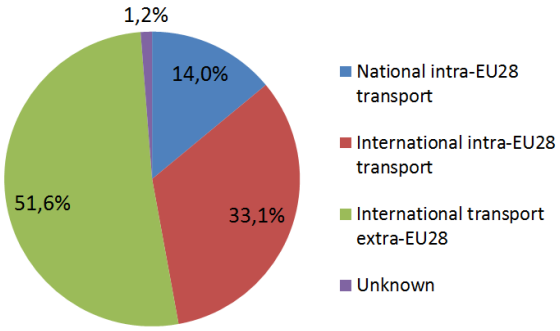


***Figure 5: Gross weight shares of seaborne goods transported to/from main European ports. Based on annual data 2014/Q4-2015/Q3 (Source: Eurostat - Maritime transport - Goods mar_go)***

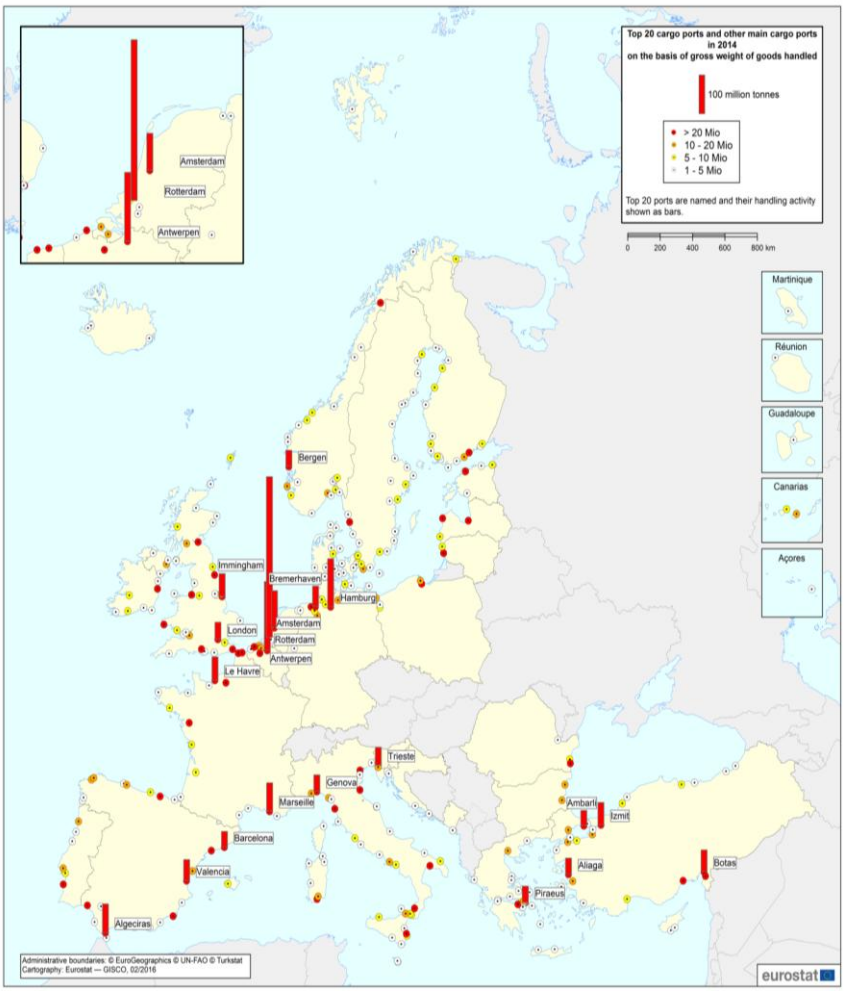


***Figure 6: Main cargo ports in the reporting countries (in 2014) by gross weight of goods handled Source: Eurostat***



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**Passenger transport services** over the sea are mainly for recreational purposes. On a larger scale these transports are made by oceanic liners and large cruise ships and ferries, capable to travel across seas. They contribute to the problem of IAS through ballasting and de-ballasting of their tanks. Additionally, activities with smaller boats such as traveling with smaller ferry boats, cruising, yachting, leisure boats, water taxis and other kinds of coastal transport contribute to the spreading IAS from one region to another. Sea passenger transport seems to have decreased slightly in the last decade in Europe (source: Eurostat).

- **Mining & Quarrying**

| Activity (ResponSEAble classification) | NACE class | Import | Export |
|---|---|---|---|
| II.1.1. Mining of coal and lignite | 05 | X | |
| II.1.2.Extraction of crude petroleum and natural gas | 06 | X | |
| II.1.3. Mining of metal ores | 07 | X | X |
| II.1.4. Other mining and quarrying | 08 | X | X |

There is hardly an economic activity nowadays which is not dependent to a certain degree from international seaborne trade either as exporter or as importer of goods from overseas. However, looking closer at the top of the value chain resulting to pressures such as discharging ballast water to the sea, we find mainly industries from the mining and quarrying sector which are heavily dependent on the worldwide transportation of their products as these can practically only be transported by ships. They account for the biggest part of the global seaborne trade. Looking at the breakdown of the seaborne trade in the EU-28, the main products imported or exported by sea in 2015 are crude oil and petroleum products, gas, coal and their by-products, representing 52.8% of the total seaborne trade. Ores represent the second largest category with 7.2%, while iron ores account for 5.5%, and other products containing iron and steel for 4.2%. Cement, gravel, broken or crushed stones and other plastering materials represent 4.5%, while cereals 3.6% of the total quantity transported by sea. From these data it is obvious that the the



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mining and quarrying sector is mainly responsible for the largest part of imports or exports to/from European ports.

- **Fishing**

| Activity (ResponSEAble classification) | NACE class |
|---|---|
| I.3.1. Fishing | 03 |

The fishing industry is involved in the story of IAS as various sorts of fishing boats, from small recreational boats to large commercial vessels, are related to the spreading of IAS. According to Eurostat, in the last decade the total number of European fishing vessels has been slowly and constantly decreasing by an annual average of 1.3%. When it comes to the Gross Tonnage (GT) the trend is more obvious, showing that the European fleet has been shrinking with a rate of 2.5% on average. About half of the European fishing fleet is located in the Mediterranean Sea but the average size of the boats is smaller than those operating in the Atlantic. In the Black Sea the fishing fleet is small in terms of numbers and GT.

- **Shipbuilding**

| Activity (ResponSEAble classification) | NACE class |
|---|---|
| III.21.1. Building of ships and boats | 30 |

The shipbuilding industry is another upstream sector in the value chain. The rise in the global trade pushes the shipbuilding industry to build larger vessels capable to transport enormous amount of goods. Figure 7 shows that in the last 15 years the world's merchant fleet has more than doubled showing an average annual growth rate of over 5%. The enormous growth of the international merchant fleet is mainly due to the growth of the bulk carrier sector, which makes now the largest of all ship types. Another ship type showing a steady growth is container ships. The prevailing trend towards bigger ships has



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advantages for the enterprises due to economics of scale (i.e. the cost per unit of output decreases with increasing scale as fixed costs are spread out over more units of output). However, the bigger the ships, the larger the volume of ballast water they need to maintain stability.

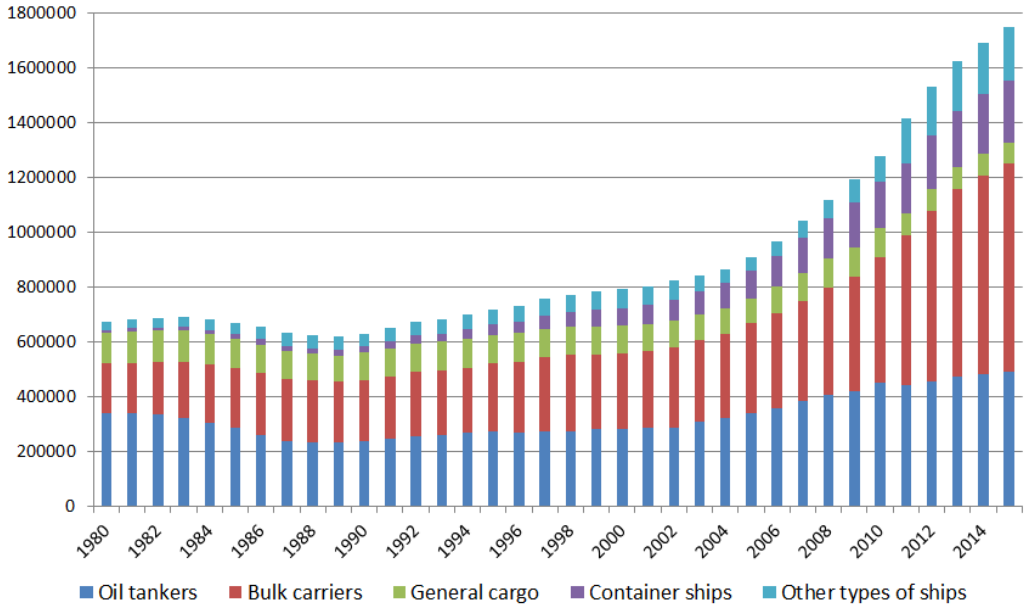


***Figure 7: Global merchant fleet by vessel type in thousands of dead weight tons (unctadstat, 2016)***

- **Port-based services (related to waste collection, treatment and disposal)**

| Activity (ResponSEAble classification) | NACE class |
|---|---|
| VI.3.2. Waste treatment and disposal | 38 |
| VI.3.1. Waste collection | 38 |

Next to the water transport industry, additional port-based services have emerged, supporting the ships' voyage, the loading and unloading of goods, the maintenance of the ship, etc. With respect to IAS two port-based services are playing an important role:

Port-based ballast water treatment: In case of de-ballasting, the ballast water is transferred from the ballast tanks to onshore treatment facilities where NIS are neutralized. Clean seawater can be used to fill the ballast tanks. The construction and



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design for this kind of facilities must be unique for each port as long as marine species are different between different marine environments (Tsolaki E., 2007). The installation of such a facility occupies a large area in ports.

Hull surface treatment: Over time, biofouling is inevitably attached to the ship's hull and propeller causing, next to the transportation of NIS, a number of undesirable effects, such as decreasing the ship's maximum speed, hampering the ship's ability to sail upwind and causing damage to the hull. It is estimated that vessel bottoms not protected by anti-fouling systems may gather 150 kg of fouling per $m^2$ in less than six months of being at sea (IMO, 2002). Anti-fouling systems can only reduce or delay the development. Hull surface treatment removes fouling from the hull and is applied either in drydocks or in water. This treatment, also known as hull scrubbing and wiping, is highly specialized as it has to be effective enough to wipe out fouling substances from the hull and at the same time retain the remaining anti-fouling paint.

- **Marine equipment manufacturing**

| Activity (ResponSEAble classification) | NACE class |
|---|---|
| III.19. Manufacture of machinery and equipment n.e.c | 28 |

It is expected that due to their cost-effectiveness onboard Ballast Water management System (BWMS) will prevail in the long term over port based facilities. However, most ships currently at sea are not equipped with any BWMS, although the lifetime of a modern merchant ship is about 25-30 years. **Marine equipment manufacturers** have developed a variety of BWMS that can be retrofitted to any existing vessel. Onboard BWMS make use of combined technologies neutralizing or eliminating harmful aquatic organisms and pathogens. They usually consist of a filtration system followed by a mechanical or chemical treatment during ballasting and/or deballasting. The most common mechanical methods include ultraviolet radiation (UV), thermal, ultrasound (US), magnetic and electrical treatment. Chemical methods include the use of biocides, chlorine, ozone,



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hydrogen peroxide, chlorine dioxide and others (Tsolaki, 2010). Their effectiveness varies according to seawater salinity, temperature and sediment load.

- **Manufacture of chemical products**

| Activity (ResponSEAble classification) | NACE class |
|---|---|
| III.11.3. Manufacture of paints, varnishes and similar coatings, printing ink and mastics | 20 |

Another sector closely related with the retrofitting and/or building of ships is the manufacture of paints and coatings able to prevent marine growth (biofouling) on the hull of the ships. Marine growth affects the performance of ships as it decreases the maximum speed of the vessel, it is responsible for increased energy consumption[3] to maintain the required speed and may cause severe damage to the hull over time. In addition to this, special paints act as a barrier against corrosion of metal hulls. A common technology is to use a specialized coating such as anti-fouling paint applied to the hull of a ship which has the ability to slow-down the growth of subaquatic organisms attached to the hull. As a common practice, antifouling paints are formulated with biocides, toxic chemical substances usually based on copper. Biocides are held in the pores created by the paint and released slowly. Paints often include teflon and silicone coatings which are too slippery for biofouling to stick. "Sloughing bottom paints", are designed to create a hull coating which ablates slowly, exposing a fresh layer of biocides. Scrubbing a hull with sloughing bottom paint while it is in the water will release its biocides and the attached biofouling into the environment. One way to minimize the environmental impact from such a treatment is to haul out and clean the vessels at boatyards with a "closed loop" system.

[3] It is estimated that a small amount of fouling can lead to an increase of fuel consumption of up to 40% (IMO, 2002).



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Environmental friendly technologies emerge including brushes which are able to clean the hull in the water and simultaneously suck the detached layer and contaminated water.

- **Other economic activities related to the introduction and spreading of IAS**

Other sectors contribute as well to a smaller but not insignificant degree, directly or indirectly, to the release of NIS through BW and biofouling. Some of them are the following:

- Other manufacturing industries, especially the **food industry** related with the production of grain

- The **marine insurance** sector is involved in two main activities: a) building of ships by giving loans to shipowners, and b) providing insurance which may cover the loss or damage of vessels and cargoes.

- **Marine consultants and service providers** offer their experience in the areas related with shipping to shipowners.

- **Scientific research and development** in various fields supported by private and public funding. Such activities may take place in the R&D departments of companies or academic institutions. The most promising brunches with innovative products have been introduced in previous sections (manufacturers of marine equipment and chemical products).

- A number of countries have significant **naval fleets** capable to operate in distant seas. The U.S.A. as the country with the biggest military power maintains a number of navy bases all over the globe including the Mediterranean Sea (Naples, IT; Souda, GR). Other types of vessels such as submarines use ballast water to control the buoyancy of the vessel. The world's total number of submarines used for military purposes is no more than 500.



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Schematic diagrams of the above-described activities of the value chain, presenting the main activities along with their links to pressure of NIS (release through ballast water and sediment discharge and through biofouling) are presented in Figure 8 and Figure 9, respectively.

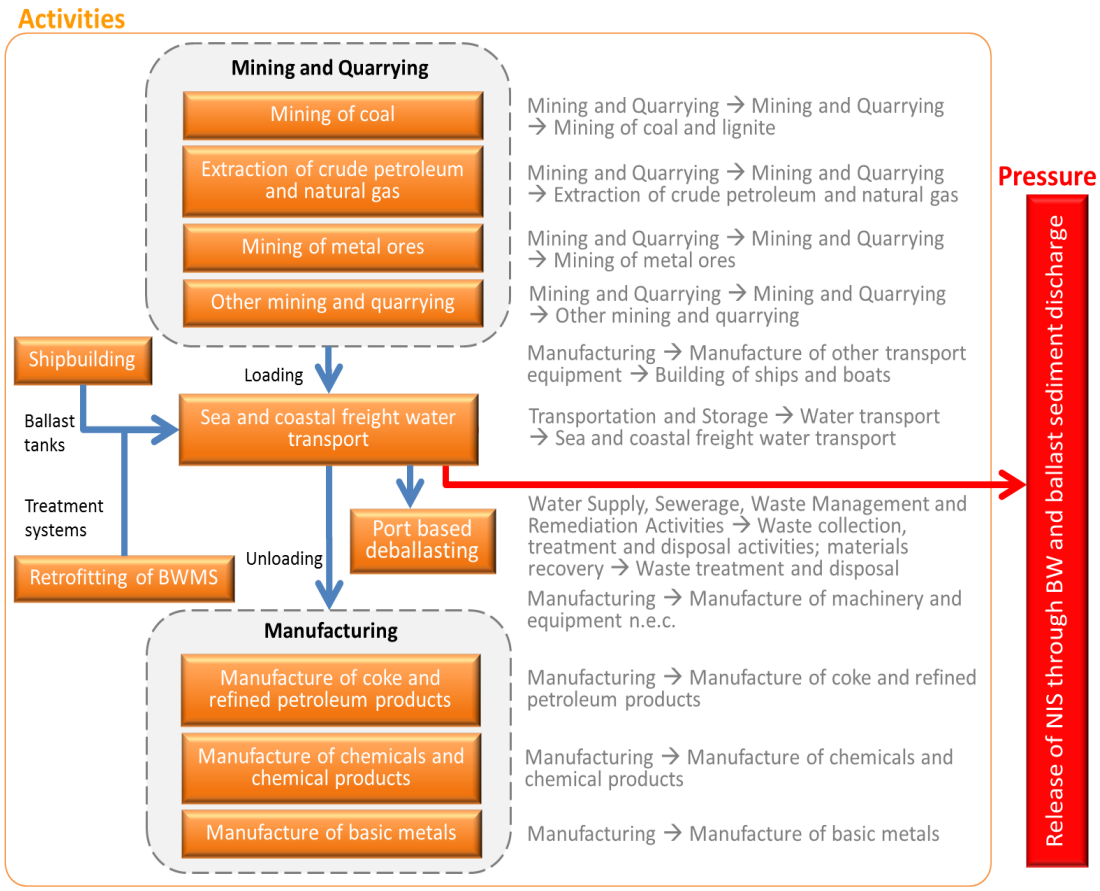


***Figure 8: Value chain map of main economic activities and flow of resources resulting to the release of NIS through ballast water and ballast sediment discharge.***



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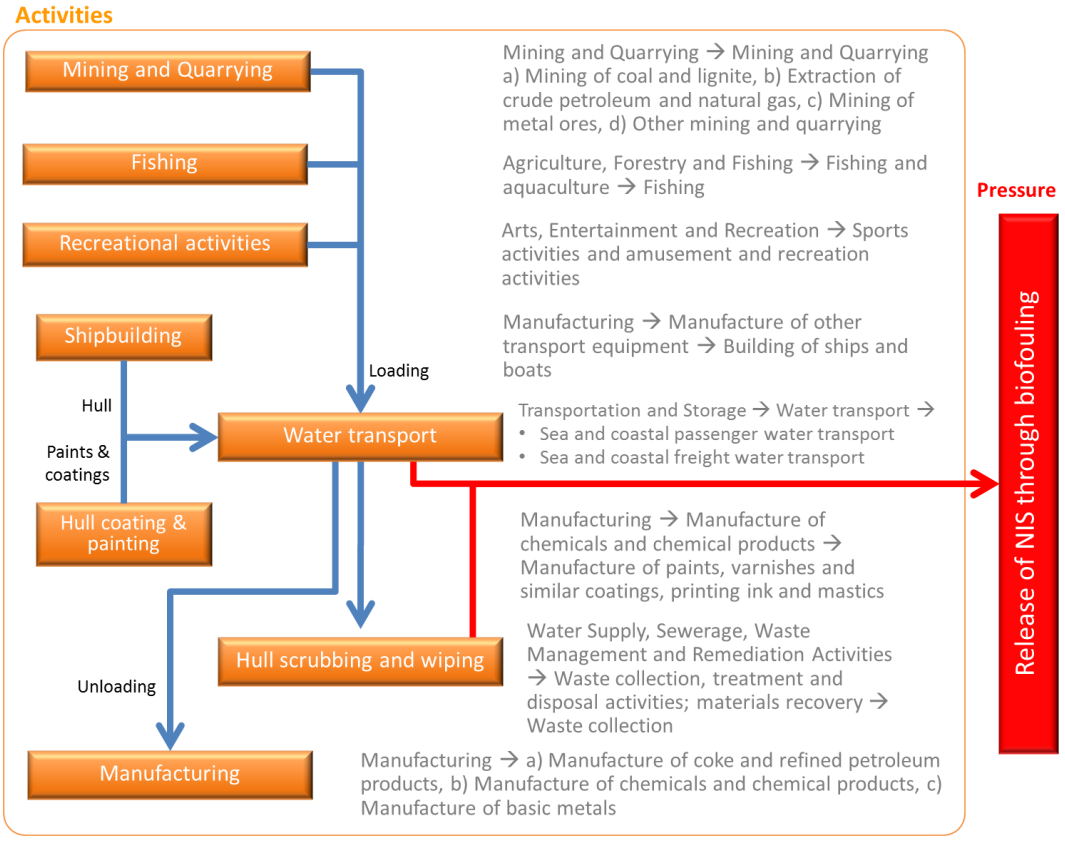


***Figure 9: Value chain map of main economic activities and flow of resources resulting to the release of NIS through biofouling*.**

# 3. Activities of the value chain linked to eutrophication in the Baltic sea

## Agricultural production

The main components of the EU 28's agricultural industry in 2014 were crop output (50.6% of the total) and animal output (40.9%); agricultural services and inseparable secondary activities, generally the processing of agricultural products, provided the residual shares (4.8% and 3.7%). The agricultural products accounting for the highest share of output value in the EU 28's agricultural industry in 2014 were milk (14.8%) and cereals (12.6%), while pig and cattle output also accounted for relatively large shares (8.4% and 7.6%). While the Baltic Sea Region production of crops form approximately



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32%, and production of livestock event 38% from the EU28, the total agricultural output is less than 20% of the EU28 (Eurostat, 2015).

**Crop production**:

The European Union is one of the world's biggest cereals producers and an important cereals trader. About 15% of the EU's wheat crop is exported annually, while large quantities of oilseeds, animal feedstuffs and rice are imported. Nearly two-thirds of the EU's cereals are used for animal feed, with around one-third for human consumption. The biggest cereal producers in EU are France (21.8% of the EU-28's cereal production in 2014), Germany (15.6 %), Poland (9.6 %) and UK (7.3%). Nearly 34% of EU 28 cereal production is produced in the BSR countries.

Sugar beet production: The EU-28 produced 128.4 million tons of sugar beet in 2014 — 19.4 million tons more than in 2013. More than half of the EU-28 sugar beet production in 2014 came from France (29.5%) and Germany (23.2%) followed by Poland (9.0%) and the UK (7.3%). The EU is the world's leading producer of sugar beet, with around 50% of the global production (However, beet sugar only represents 20% of the world's sugar production).

Oilseeds production: Rape and turnip rape, and sunflower seeds are the main types of oilseeds produced in the EU-28. An estimated 24.3 million tons of rape and turnip rape were produced in 2014, more than a quarter (25.7%) of it produced by Germany. Sunflower seeds are mainly produced in Bulgaria and Romania, so not relevant for the Baltic Sea region.

Vegetable production: The EU produces a broad range of fruits and vegetables thanks to its varied climatic and topographic conditions. The EU-28 produced an estimated 5.5 million tons of carrots and 6.4 million tons of onions in 2014. Carrot production was relatively high in Poland (14.2%) and the UK (14.9%). Onions come mainly from Netherlands and Spain but from Baltic Sea countries Poland and Germany have the highest onion production.



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Potatoes for human consumption belong to the most competitive segments of EU agriculture. In 2007, with the share of 19,3%, the EU-27 was the second largest producer of potatoes in the World (after China) (European Commission, 2016).

Fruit production: Around 14 million tons of apples were produced in the EU-28 in 2014. Apples are produced in almost all EU Member States, although Poland, Italy and France are by far the largest producers. (Eurostat, 2015)

In total Baltic Sea Region's agricultural production of crops form approximately 32% of the EU total (permanent crops excluded) (Eurostat, 2013).

**Livestock production**:

Animal production accounts for 43.1% (EUR 167 billion) of the total EU-28 agricultural output. Animal production covers:

1) output for animals (57.5% of animal output) which is the value of animals produced either directly for slaughter, or used alive for herd renewal or for further growing and fattening;

2) animal products account for the remaining 42.5% and cover eggs, milk, wool, etc. (Eurostat, 2016)

In 2014, looking at EU Member States, Germany, Spain, France and the United Kingdom held the largest number of livestock. The largest number of pigs was recorded in Germany and Spain (28.3 and 26.6 million heads respectively), bovines in France (19.3 million heads) and sheep (23.0 million heads) in the United Kingdom.

The largest pig meat producers in EU are Germany (24.9% (5.5 million tonnes) of the EU-28's pig meat in 2014) and Spain (16.4%).

France (19.1%), Germany (17.0%) and the United Kingdom (13.7%) made up almost half (49.8%) of total EU-28 beef production in 2014.



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Germany, France, Poland, and the UK, each accounted for 12-14% of the total production of poultry meat in the EU-28 in 2014.(Eurostat, 2015).

In total Baltic Sea Region's agricultural production related to animals forms almost 38% of the EU 28 (Eurostat, 2013).

**Fertilizers' production**

In the EU there are approximately 1000 enterprises (1058 in 2013) producing inorganic fertilizers and at least 700 compost producers. In total the EU produces 9% of global nitrogen and 3% of global phosphate while consuming 10% of global nitrogen, 7% of global phosphate and 10% of global potash (Fertilizers Europe, 2016). The volumes of inorganic fertilizers consumed in the EU are estimated at 16 million tons of nutrients, at least 1600 million tons of manure, and 13 million tons of compost. In 2007 the turnover of the inorganic fertilizer producers amounted to 19.5 mEUR. Studies show that inorganic fertilizers can account for around 90% of farmers' expenditure on fertilizing materials (Netherlands example). (ECORYS, 2013)

Although the EU also produces mineral fertilizers it does not fulfill it needs. Therefor the EU is a net importer of nitrogen and phosphate fertilizers. In 2009 the Baltic Sea Region N consumption formed 30.6% of EU 27 total and Phosphorus consumption formed 29.5% of EU 27 total. Germany and Poland are the biggest consumers of mineral fertilizers in the Baltic Sea region. (Eurostat, 2009)

**Distribution of farming products through retail and wholesale**

Large modern retail chains (especially discounters) have been opening stores both in their domestic markets and in other Member States. Retail chains have significantly increased their market share over the decade. Modern retail is predominant in the majority of the Member States which has decreased the number of (fruit and vegetable market, non-branded neighborhood stores, butchers and bakers). The modern retail concentration is especially high in Nordic and Baltic countries.

The increase of modern retail has impact on choice, and innovation in the food sector. The top 10 European food retailers accounted for 26% of edible grocery sales in the EU in



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2000, compared to 31% in 2011. Another important factor that has shaped the sector is retailers' own brands or private label products that have become more and more successful in Europe over the last decade. Private label market share has increased across most product categories in most of the Member States. (European Commission, 2014)

Modern retail has also influenced increasing concentration at the procurement level. This allows retailers to improve their purchasing conditions and enhance market competitiveness. Established cross-boarder groups have strengthen the retailers'' bargaining power through higher volumes with the aim of reducing purchasing costs. This is especially important for large international brands and for private labels. (European Commission, 2014, pp 50-51)

**Consumption of agriculture products**

In 2012 The EU households spent on average 14,6% of expenditure to food and drink. This is second in the consumption expenditure of households after housing, water and energy, and significantly higher than the third expenditure group - transport (FoodDrinkEurope, 2014). Consumers have become more demanding in terms of food (e.g. product variety and price). The economic and financial crisis of 2008 had a significant impact on EU consumers' purchasing power which also affected their behavior. Lower prices became a priority for many EU consumers. In addition, changes in household composition, an ageing population, increased interest in healthy food and increased environmental awareness have all had an impact on the food retail market in Europe. (European Commission: Competition, 2016) The EU agri-foods trade balance is in surplus meaning that the EU food products export exceeds the import numbers. In 2012 the recorded trade surplus was 23 billion EUR (Food Drink Europe, 2014).

The following diagram presents the main activities of the value chain as currently developed.



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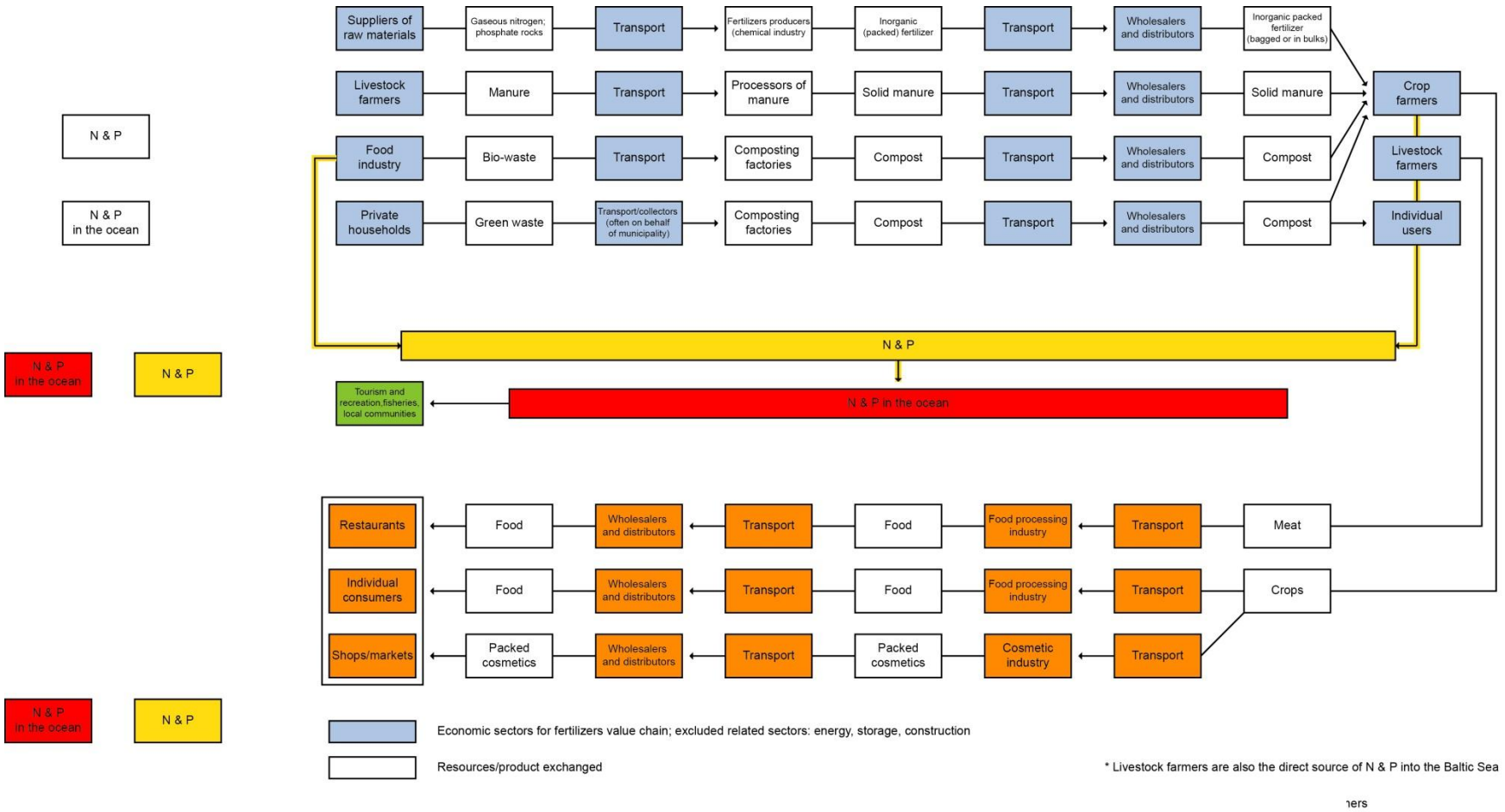


***Figure 10: Value chain map of main economic activities linked to eutrophication***



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# 4. Activities of the value chain linked to coastal tourism in Mediterranean countries

Although touristic models can differ, it was possible to develop a basic value chain for coastal mass tourism in the Mediterranean and the Black Sea, which is illustrated in the figure below.

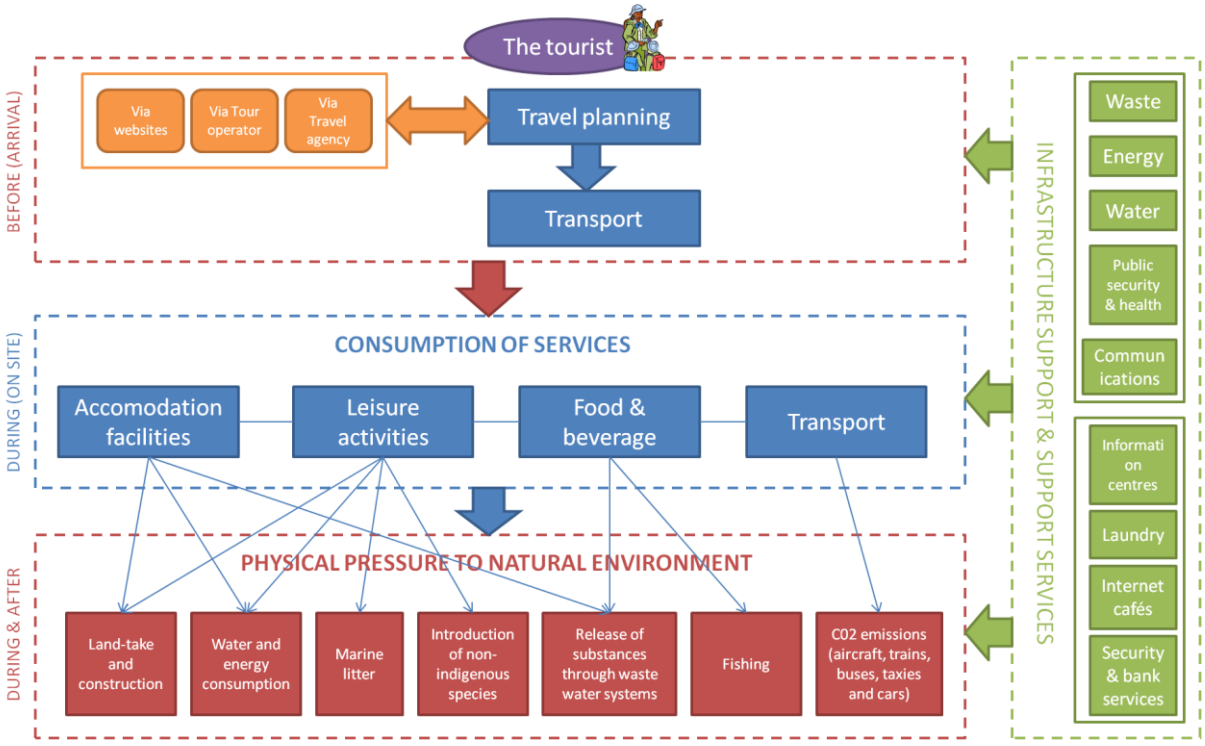


***Figure 51. Coastal mass tourism: overall value chain***

In particular, two main phases and six main blocks can be identified:

- Before the holiday: (i) travel planning; and (ii) transport from the place of residence to the touristic site;



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- During the holiday: (i) accommodation; (ii) leisure activities; (iii) food and beverage; and (iv) transport in and around the touristic site.

Several pressures are linked to this six building blocks of the value chain, and namely: land-take and construction, water and energy consumption, marine litter, introduction of non-indigenous specied, release of substances through wastewater systems, fishing and CO2 emissions.

The value chain is supported by a basis of infrastructures and services, such as for example waste collection and disposal, wastewater collection and treatment, water and energy provision, information centers, etc.

Coastal tourism is a complex sector, characterized by a large number of activities and of economic actors –for example, in a single touristic site accommodation, food and beverage are often offered by several small operators. Large companies can exist (e.g. beach resort corporations, cruise corporations) but, as previously mentioned, they represent just a small part of the global touristic offer in the Mediterranean and the Black Sea. In order to sharpen the focus of the analysis, so that a meaningful analysis can be conducted, it was decided to focus on four areas or regions: Italy, Southern France, Greece and Romania. In these regions, an overview of coastal tourism is being developed, aimed at identifying the dominant touristic models; and some representative sites or tourist areas where the dominant models are mostly developed.

**Coastal touristic centers with high density of hotels and commercial accommodations**

In sites in France and Italy, the main accommodation types are hotels, often offering all-inclusive packages (accommodation and three meals per day). Tourist spend their days mostly in private beaches, renting beach chairs and umbrellas; private beaches also offer bar and restaurant service, as well as recreational activities. In Italy, this model is very well represented by Rimini and the surrounding Riviera Romagnola. Emilia Romagna is the Italian region with the largest share of beach tourism. In addition, Rimini and Riviera Romagnola also bear the highest (by far) coastal pressure in Italy, measured by number of tourists on the coastal areas. In France, there are different types of accommodation types: the eastern part of Var and Alpes-Maritimes include large touristic centers and



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important coastal resorts. Camping sites are more present on the western part of the Mediterranean seaside (Languedoc-Roussillon region). In particular, the area of Cannes and Nice is among the large, strongly touristic centers. As seen in the tables below, hotels have the largest share of accommodation offer in these two sites.

**Coastal tourism characterized by a high density of summer houses**

In France and Italy, besides some areas with a high density of hotels, the most common accommodation type are summer houses, be it own private house, parents' or friends' houses or rented houses. Official data do not necessarily fully reflect this phenomenon, as in many cases there is no financial transaction, or the transaction goes through unofficial channels. Tourists spend most of their days in private but also public beaches; private beaches normally offer food and bar service, as well as leisure activities. Tourists have their meals at home or in restaurants and bars.In Italy, a region where this type of tourism is intensely practiced is **Liguria**, and in particular in **Riviera di Ponente**. In this region, presences in private houses are around four times official presences in commercial structures (e.g. hotels). This means that these houses are empty for most of the year. This is also the dominant model in Southern France, and the Var department will be taken as an example site of this touristic model.

## *5. Activities of the value chain linked to microplastics in the European seas coming from cosmetics*

Looking at the issue of microplastics coming from cosmetics, in European seas, eight activities have been identified: Fuel production, transport (especially transport from microbeads though seas), cosmetic ingredients production, cosmetics production, retail and wholesale industry, consumption, wastewater treatment and Agriculture using sewage sludge. The figure below illustrates this value chain.



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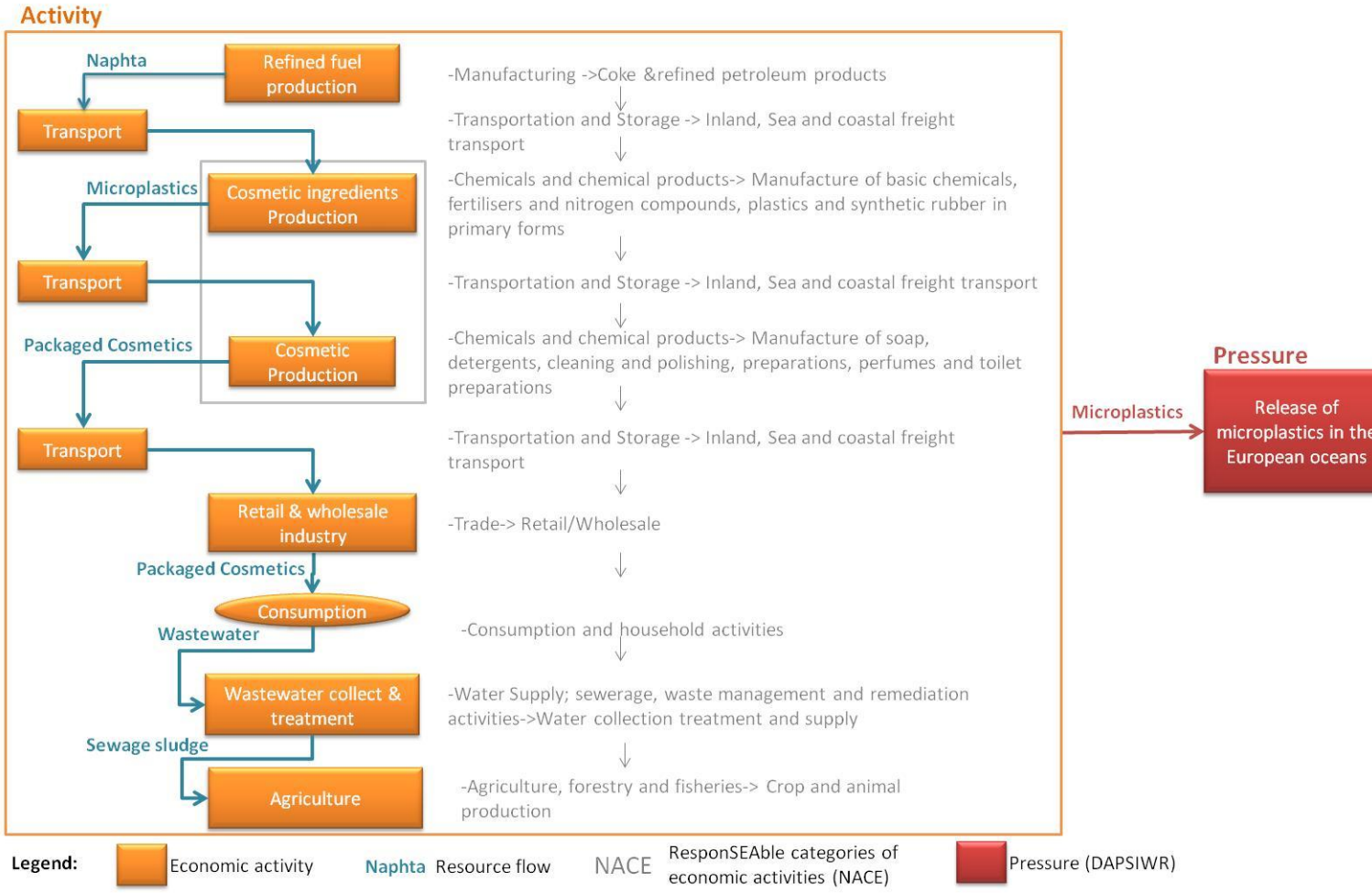


***Figure 12. Mapping of economic activities linked to the microplastics-cosmetic case***

**Refined fuel industry** at the basis of plastic polymers production mainly takes place outside of Europe. Europe is depending on oil imports. In 2013, this dependence represented about 88% of its consumption. Russia is the main supplier of oil and natural gaz in Europe. In 2013, 33.5 % of crude oil importation to Europe came from Russia.



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Norway is the second main supplier of Europe (Eurostat, 2016). At the global scale, plastic production only represents 4% of oil consumption[4].

**Transportation of resin pellets** between plastic producers and cosmetic producers can lead to release of microplastics in the seas through accidental loss of resin pellets/nurdles during transport, transshipment (UNEP, 2016)[5].

The **cosmetics Ingredients** Suppliers provide aromatic raw materials and non aromatic materials (Interview, J. Romestant, Cosmetic Valley, July 2016). Microplastics are used as additives in cosmetics for their abilities to conserve, stabilize, perfume, color etc. Western Europe (France, Germany, Italy, UK) is the first producer market for cosmetics ingredients. North America is the second one[6]. Together Western Europe and North America represent 50% of the market. It is expected to grow thanks to an increasing demand. Microplastics production is a small part of this activity and European production is taking place in Sweden, Norway, Germany and France[7]. Raw Plastic production can lead to unintentional direct release in rivers and oceans through urban runoff[8]. There is a lack of data on diffuse inputs (UNEP, 2015) via losses from plastic pellets from processing plants (UNEP, 2015).

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[4] http://www.bpf.co.uk/Press/Oil_Consumption.aspx

[5] Terrestrial transportation leads to release of microplastics from tyres dusts (UNEP, 2016), and three quarters of inland freight transport in Europe used roads as the main transport mode (Eurostat, 20135 - http://ec.europa.eu/eurostat/statistics-explained/index.php/Freight_transport_statistics ). However this story focuses on primary sources of microplastics

[6] http://www.slideshare.net/SayaliTribhuvan/global-cosmetic-ingredients-market-to-grow-by-44-to-reach-us153139-mn-in-2016

[7] This is based on the location of companies identified so far as microbeads producers.

[8] http://web.tuat.ac.jp/~gaia/ipw/en/what.html



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European **cosmetics production** is the biggest of the world with €72 Bn far behind United-States (€ 37,8 Bn) and Japan (€29,3Bn). Germany, France and United Kingdom are the three main European producers (cosmetic-valley.com). Besides, exportations out of Europe represents one third of the global market. France is the first exporter and with Germany's exportation, theses two countries ensure 53% of total global exports from Europe. The European cosmetics provide both luxury and mass consumption. Information on the level of microplastics released directly from cosmetic production companies into water ways and finally oceans, are almost not documented.

**Wholesale and retailing industry** is also part of the microplastic-cosmetic value chain. In 2012, there were approximately 20,100 enterprises involved in the wholesale of cosmetics in Europe, the majority of which were located in Italy (18%), Spain (14%) and France (11%)[9]. The main channels of cosmetics distribution are specialized market as perfumeries, pharmaceutical market, mass distribution, direct sell. Sales on the internet are increasing.

European **consumers spend, on average, €129** per year in cosmetic products (Cosmetics Europe, 2016). Highest European spendings on cosmetic products by consumers are located in Germany, France and UK (Cosmetics Europe, 2016).

Despite **wastewater treatment** plants, substantial amounts of microplastics fom PCCPs will enter waterways and hence oceans. However some modern plants in Sweden and St Petersberg, for example, are reported to retain over 96% of microplastics by filtration (UNEP, 2016). Sewage sludge being used by **agriculture** as a fertiliser some agricultural production can contribute to microplastics releasesin river basins and eventually in European seas.

[9] (Eurostat, 2012 from Cosmetics Europe, 2016)



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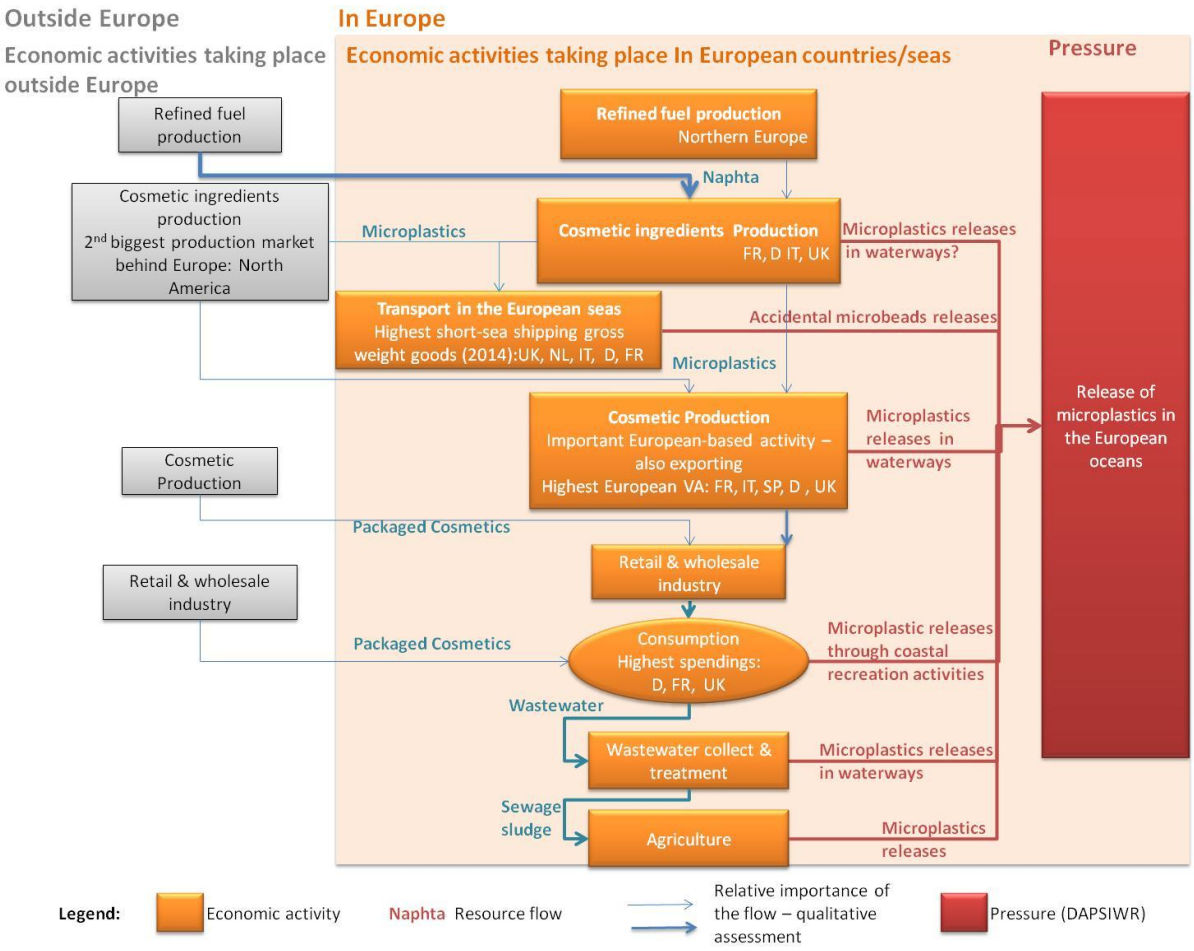


**Figure 13. European and non European activities leading to microplastic releases in European seas**

D = Germany, FR = France, UK = United Kingdom, IT = Italy, SP= Spain, NL= the Netherlands, VA = Value added

Fuel production takes mainly place outside Europe, and as such is not considered as an activity whose actions can be “changed”. Cosmetic ingredients production, Cosmetic production and maritime transport of microplastics are activities well developed in Europe with activities especially important in countries like France, Germany, the UK, Italy and the Netherlands.



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According to this analysis, 6 activities may directly release microplastics in European seas, in relation to cosmetics:

- Cosmetic ingredients production through wastewater releases;
- Maritime transport through accidental release while transporting microbeads;
- Cosmetic production through wastewater releases;
- Consumption through recreational activities like bathing;
- Wastewater treatment through releases of sewage sludge and treated water;
- Agriculture through the use of sewage sludge as fertilizer.

Unfortunately, information on the relative importance of pollution for these different activities does not exist.

**Main discoveries from this approach**:

- There are several points in the cosmetics-microplastics value chain where an economic activity can lead to releases of MP in European seas, and little knowledge about these releases.
- Plastic industry as such is not so much involved in the microplastics-cosmetics story in European seas. It is more the chemical industry that is producing microplastics used directly in cosmetics.
- Agricultural practices might contribute to the diffusion of microplastics used in cosmetics towards river basins and finally in European seas.

# 6. Activities of the value chain linked to the development of Marine Renewable Energies in all European seas

If deployed worldwide, ocean technologies could meet the world's current electricity demand of close to 20,000 TWh (IAE/OES 2015). 20,000 TWh is equivalent to the present world power production, all sources of energy included, for an installed power around 5,000 GW.

***Table 2 World Potential for MRE***

| Power sources | Potential | Dimension | Nuclear reactor eq. |
|---|---|---|---|
| Floating Wind | 3,000 to 4,000 GW | World level | 2,000 |
| Fixed Wind | 1,000 to 1,500 GW | World level | 800 |
| Wave | 1,000 to 1,500 GW | World level | 800 |
| Marine current | 75 to 100 GW | World level | 60 |
| Ocean thermal | 100 to 150 GW | Tropical areas<br>(present available technologies) | 80 |
| **MRE** | **about 20,000 TWh/year** | | **3,740** |

In Europe the solely potential for wave resource is estimated to be at least 2,800 TWh/year, corresponding to 80% of the EU electricity production in 2010 (EC 2014). But from the current deployment of MRE to this theoretical potential, there are still a number of constraints and issues to cope with. The technical potential of ocean energy is constraint by high technology costs and as a consequence these estimates also vary widely according to fluctuation of carbon energy costs.

**Wind power** presents the most important potential (> 4,500 GW) due to a more mature technology fed by inshore wind power experience. Fixed offshore wind power is the relay of the onshore wind power growth. According to the European Wind Energy Association



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(EWEA) offshore wind accounted for 24% of total EU wind power installations in 2015, double the share of annual additions in 2014. This confirms the growing relevance of the offshore wind industry in the development of wind energy in the EU (EWEA 2016). Offshore wind power installations represented 24% of the annual EU wind energy market, up from 13% in 2014. Germany, the UK and the Netherlands were the most active countries in the deployment of new offshore wind farms these last years. The North Sea is the main deployment area counting for respectively 86% and 69.4% of new and existing installations in European waters (EWEA 2016). The Baltic Sea and Irish Sea count respectively for 17.6% and 12.9% while the Atlantic Ocean counts only for 0.1% of the installed capacity. For the coming years, the North Sea will remain the most important area with 78% of the consented offshore wind farms in terms of capacity. The Mediterranean Sea will slightly develop with 1% of consented capacity while Baltic Sea and Irish Sea will be the place of significant developments (respectively 12.4% and 8.6%).

Fixed structure is the rule in terms of infrastructures and monopile substructures dominates largely (80%) compared to other substructures (jacket and tripods mainly). Floating substructures are marginal (2 operational turbines) and count for 0.1% of the total offshore wind substructures. Inter-array cables represent another important segment of the offshore wind industry and more largely of the MRE industry. Having a leadership over the activity, European manufacturers also export cables. First decommissioning operations were initiated over old small scale offshore wind farms, completing the entire steps of the value chain. With a capacity of 11,027.3 MW, the 84 European offshore wind farms are able to produce about 40.6 TWh/year, that is to say 1.5% of the EU's total electricity consumption (2,707 TWh/year). The UK counts for 45.9% of the total offshore wind installation, followed by Germany (29.9%) and Denmark (11.5%) (Table 2).

***Table 3. Installed capacity for European offshore wind power (2015 – source EWEA 2016)***

| Country | UK | Germany | Denmark | Belgium | The Netherlands | Sweden | Finland | Ireland | Spain | Norway | Portugal | **Total** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nb. of farms | 27 | 18 | 13 | 5 | 6 | 5 | 2 | 1 | 1 | 1 | 1 | **80** |
| Nb. of turbines | 1,454 | 792 | 513 | 182 | 184 | 86 | 9 | 7 | 1 | 1 | 1 | **3,230** |
| Capacity (MW) | 5,061 | 3,295 | 1,271 | 712 | 427 | 202 | 26 | 25 | 5 | 2 | 2 | **11,027** |

The UK and Germany are also the countries having the highest share of consented offshore wind farms in terms of capacity for the coming years.

**Tidal and waves.** Aside the offshore wind power, the most promising and advanced ocean energy technologies are **tidal** and **wave energy**. But their deployment doesn't meet the expectations stated by European member States in the 2009 National Renewable Energy Action Plans (NREAPs). Objective for tidal and wave energy was set to 2,250 MW, 0.5% of the electricity capacity of the EU by 2020 and to 100 GW by 2050. But present forecasts assess a capacity about 170 MW by 2020, 7% of the NREAPs target (Magagna et al. 2015). Beyond of trials and tests a first tidal project is expected in 2016 in the UK as well as a wave project in Sweden. A 10 MW OTEC plant is expected later in Martinique as well as a 50 kW salinity gradient plant in the Netherlands.

The European MRE system can first mapped and described through a comprehensive and global view, underlining the succession of operations to be completed in order to settle and develop a MRE project, from site selection to operation (Figure 3). It includes the different actors, potential impacts foreseen over and between subsystems (especially regarding the ecological and human system) as well as market and distribution.



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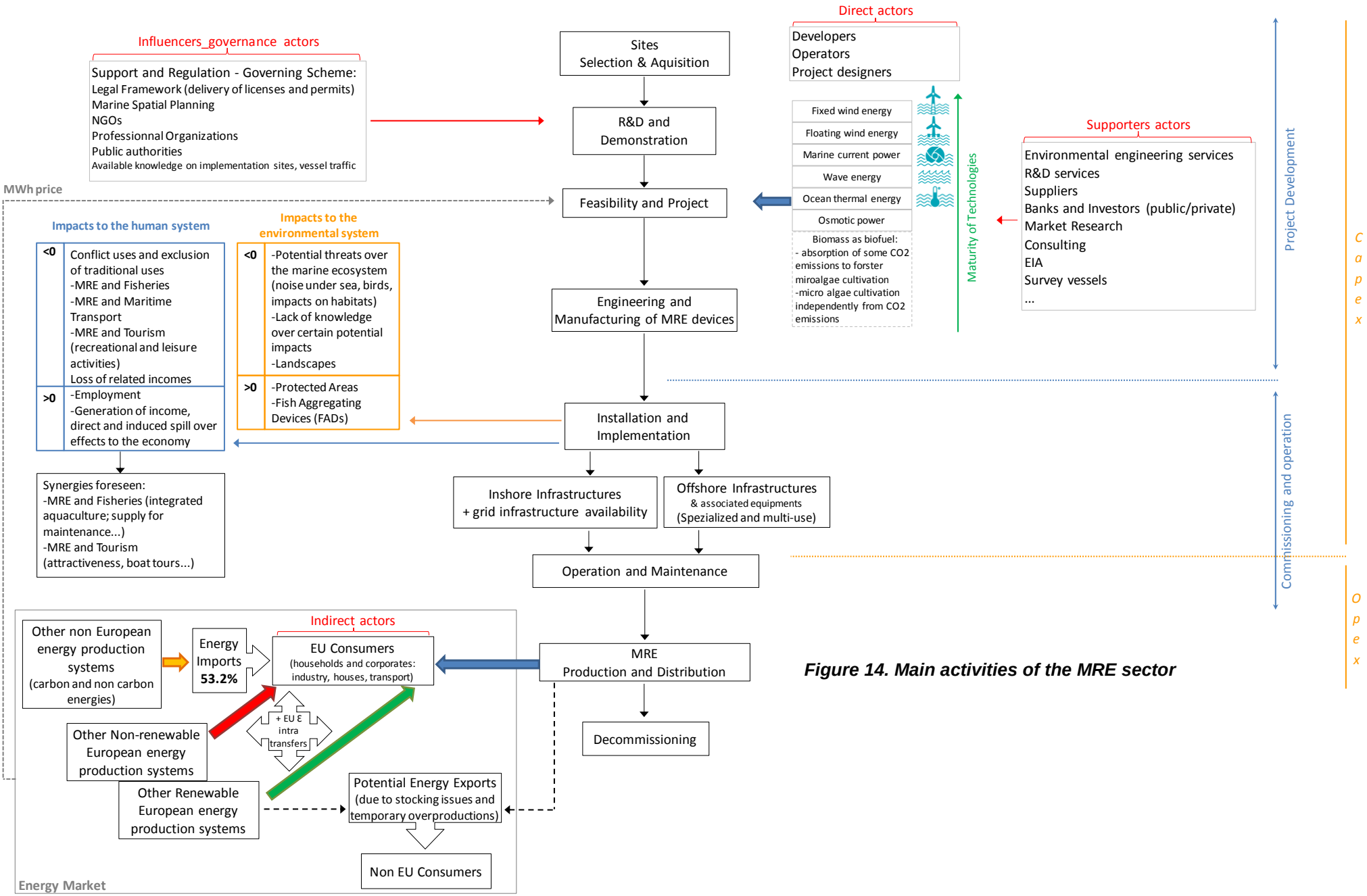


***Figure 14. Main activities of the MRE sector***

# 5. What are the main actors that could be targeted by literacy activities?

The description of the value chains connected to the marine challenges investigated stressed the diversity of the activities that directly or indirectly are connected to these challenges. There is often a wide knowledge on the changes in practices and behavior that are necessary for the sector putting the direct pressure on marine ecosystems to reduce its pressure. However, ensuring the change effectively takes place might result from actions and changes taken elsewhere in the value chain, or for stakeholders connected to components of this value chain. For example: ensuring eutrophication in the Baltic Sea is reduced might come from the decision of the EU regulator, or of the State administration of one Baltic country, to establish food labeling that make explicit the nitrate footprint of food – that in turn will influence consumers and eventually agro-food industry and farmers themselves. In some cases, some of these stakeholders might them become priority target group for communication, information and literacy activities – if their current knowledge on the human-marine system needs to be strengthened to make opportunities for change more explicit.

A wide range of stakeholders are connected to the value chains investigated. Some of these are similar (e.g. EU consumers, or some of the EU regulators) while others are very specific to one value chain or marine challenge (e.g. ship owners in relation to the issue of invasive species).

The following sections present the main actors of the different value chains, illustrating for each the complexity of the stakeholder system considered and some of the main formal and informal interactions that might exist between these actors – including those responsible for the activities of the value chains.



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# 1. Main actors of the value chain linked to sustainable fisheries

Actors linked to the sustainable fisheries system are mapped in the diagram below.

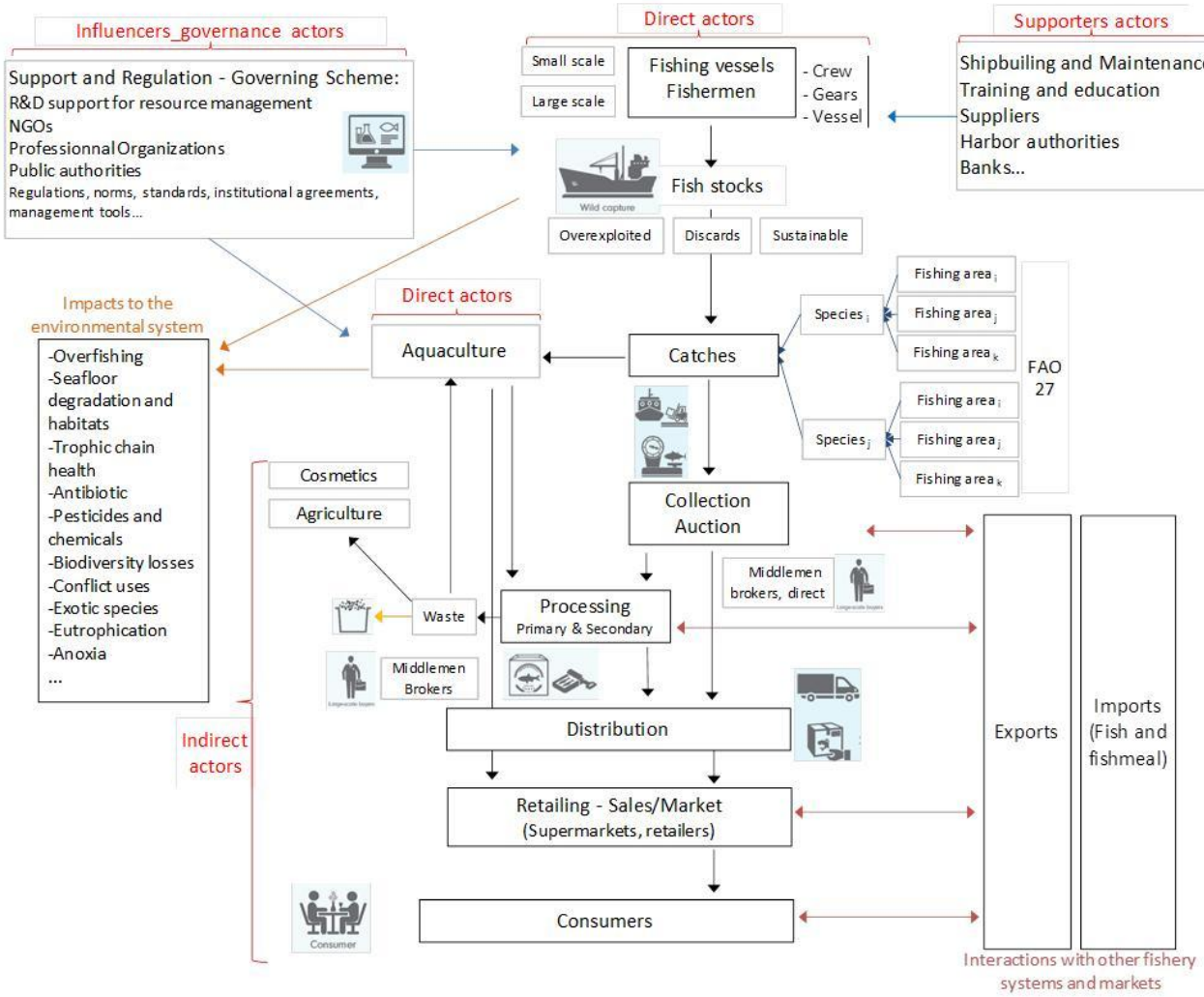


***Figure 15. Mapping the NEA fishery system and actors***



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## 3. Main actors of the value chain linked to invasive species

Figure 16 gives an overview of key actors, their relations with each other and the links they have with activities of the value chain, resulting to the introduction and spreading of IAS. Looking closer at this figure, one can identify the **shipowners** as one of the most influential category of actors in the IAS story. Their direct decisions can influence the marine ecology and the IAS problem in particular in many ways:

- Shipowner influence the construction of a ship and the technologies with which it is equipped. Decisions taken at this stage can have a major impact on the introduction of IAS through ballast water. Even for older vessels, retrofitting them with effective BWMS it is ultimately their call. They are likely to wait until national or international regulations force them to take action.

- Shipbowners are sole responsible for the coating and the paints which will be applied on a ship's hull retarding the accumulation of biofouling. Biofouling (hull fouling) is made responsible to a great extent for the introduction and spreading of IAS. Shipowners have an interest to remove biofouling from the hull and the propeller as this has a negative impact on the performance of the ship. However, there is currently no international treaty regulating the treatment of hull fouling. The treatment of hull fouling while the vessel is at sea may damage the marine environment by releasing IAS to the sea. The treatment of hull fouling on shore, although it is the safest method for the environment, it is not preferred by shipowners due to the associated high costs and time delays.

- Shipowners are the main responsible actors when it comes to planning the ship's routes and the ports they visit. Their decisions are influenced by global supply and demand, but other factors may play a role such as profit margin and route optimization.

- It is assumed, that due to their position and economic wealth, shipowners are able to take influence on the decisions of other key actors in favour of their interests.



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Ship officers and shipyards are two other actors directly influenced by the shipowners. National and European regulative actors such as governments and legislators may also be influenced by the interests of the shipping industry.

A second very influential group of actors are **national & European legislators** as they are able through agencies and their membership in international bodies to adopt treaties and impose regulations which would change the behaviour of other actors. More specifically, European and national legislators control or influence directly or indirectly agencies and other bodies, which play a major role in the IAS problem:

- They control port authorities and coastal agencies, whose responsibility is the implementation of regulations regarding ballast water management in the ports and coastal areas of their country.
- Through national registries, they exercise regulatory control over the vessels registered under the flag of the state.
- National legislators can influence decisions taken in European and international bodies, ratify international treaties and conventions such as the BWMC.
- Their national agencies approve important environmental systems such as BWMS
- They regulate the business sectors which are crucial for water transport
- Governments control the fleets of naval forces capable to operate in various seas.

As in most other countries, in Europe decisions taken by the legislators are influenced by public opinion. Thus, **European citizens** may be considered as one of the major category of actors of the value chain. Finally, **Marine Equipment Suppliers** (MES) are highly specialized companies offering innovative technological solutions for a variety of maritime problems related to the IAS story. They may play a major role in mitigating the problem by offering solutions such as retrofitting of older vessels with BWMS, improved hull coatings and effective and environmental friendly hull scrubbing processes.

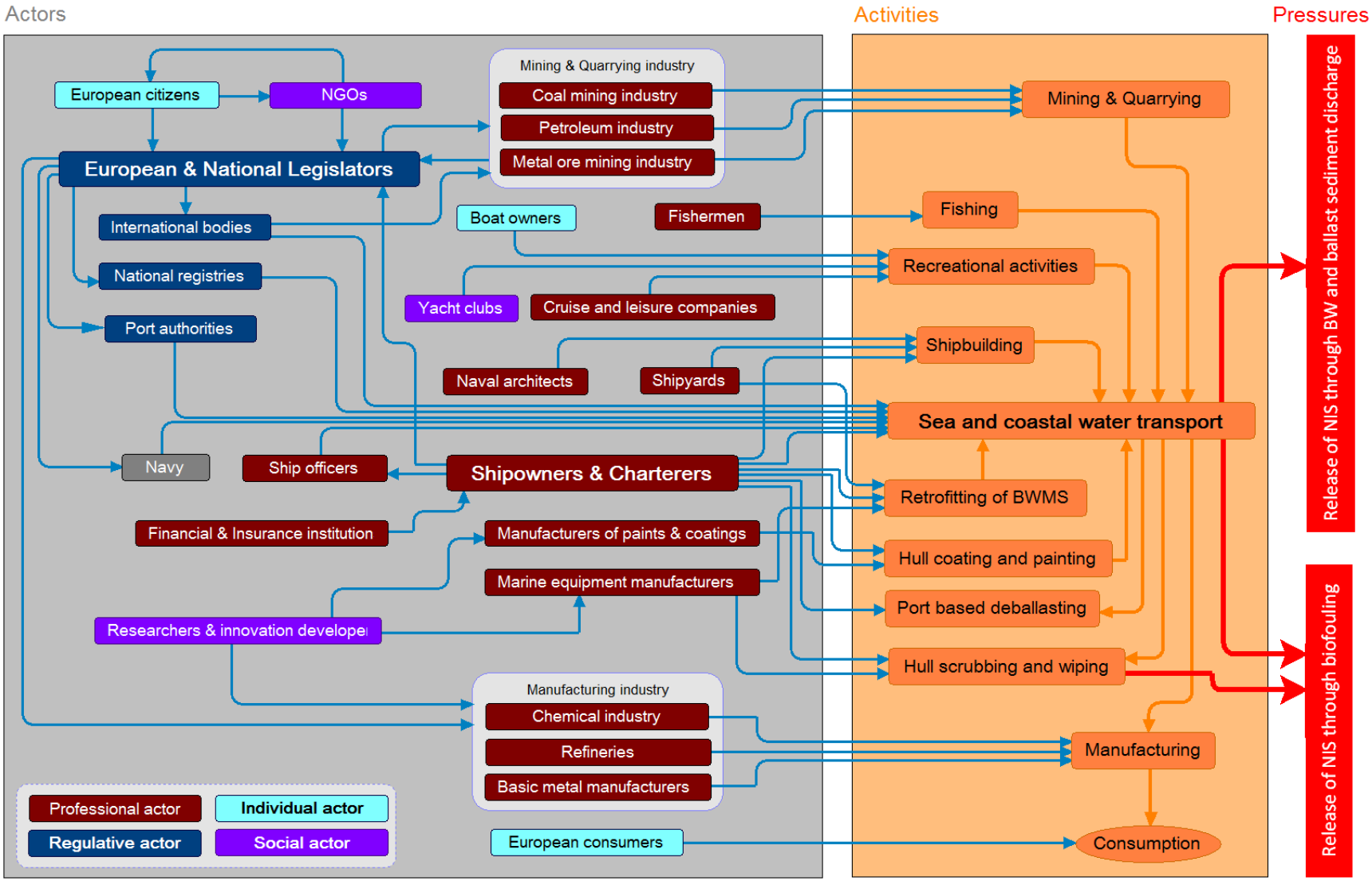


***Figure 16: Main activities and key actors of the invasive species value chain***



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# 4. Main actors of the value chain linked to eutrophication

Eutrophication's social and economic landscape is a complicated system with many actors and feedback loops. These actors are linked with eutrophication sources or are affected by eutrophication results directly or indirectly and with different strengths. They also have various possibilities, incentives and willingness to combat sources of marine pollution, and in our case their lined with agriculture are also very different. Given the character of the links with agriculture and eutrophication, there are two major groups of actors, i.e., direct and indirect actors. Direct actors are these individuals and organizations, whose actions might potentially have the highest influence on the eutrophication sources, and their personal and economic welfare can be strongly affected by changes in marine environment. Indirect actors are interacting with direct actors but their links with eutrophication and with the state of marine environment are less evident, their welfare is not directly dependent on agriculture resources but their actions could still contribute to solving the problem. Decision-makers and European and national legislators should perhaps be described as influencers as they do not directly fit to any of the two groups. However, we decided assign them into direct actors as food market in the European Union is highly regulated and Common Agricultural Policy (CAP) is an important driver (Spijkers et al. 2012, WWF 2007).

**Direct actors:**

Decision-makers: agriculture is one of the most important source of eutrophication and European food production sector is heavily influenced by CAP. Therefore, eutrophication is often considered as a political problem and a result of subsidies that are not linked with environmental measures. Therefore, changes in legislation, including promotion of agri-environmental measures, would probably be most influential tool to combat Baltic Sea pollution. However, European and national legislators need to balance the needs of the environment, profitability of farmers and low food prices (Spijkers et al. 2012, WWF 2007).

Farmers: are most important actors within eutrophication management with the highest direct impact on the amount and kind of fertilizers used (WWF 2011). So far, farmers have been the most important and most widely discussed target groups for awareness rising campaigns on sustainable agriculture, agri-advisory services, and on use of agri-environmental technologies. All the awareness rising campaigns focus predominantly, if not entirely, on the voluntary solutions, which are not only costly and difficult to implement but also pose a risk to negatively influence farmers' income. Their efficiency is, therefore, limited (Spijkers et al. 2012, WWF 2007), and can be further undermined by contract stipulations put forward by food processing companies or procurement organizations, who are the intermediate bodies between these actors (Archambault 2004). Therefore, there is a need for more holistic change starting from farmer, through retailers,



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food processing companies, to consumers and citizens. Such a change needs to be supported by decision-makers through legal and economic incentives to stimulate and accelerate this change.

Fertilizers producers: are important part of the agriculture value chain and fertilizers are important source of nitrogen and phosphorus in the marine waters. There are three main groups of fertilizers inorganic fertilizers, manure and compost (Wijnands and Linders 2013). However, the chemical industry itself (inorganic fertilizers) is a difficult target group to reach with education campaign. Farming activities, where manure is produced and used, are much easier subject for dissemination campaigns.

Consumers and citizens: are at the end of the value chain but they can play an important role in safeguarding marine environment. They can act as customers and their economic choices can stimulate – at least to certain extent – the way the food is being produced and processed. They can also act as citizens and their social choices can stimulate changes in legislation, public procurement or ultimately on farming practices (Archambault 2004, WWF 2011). Rapid development of organic products and framing is an example of effects that customer can have on markets.

Environmental NGOs: defend interests of the marine environment and actively disseminate knowledge and good practices among various groups of actors. Their welfare is perhaps not directly linked with marine environment but they often create the knowledge base that is needed for other actors to get involved (Archambault 2004).

Fisheries and tourism sectors: are negatively influenced by eutrophication which limits their business opportunities. These opportunities are negatively influence by algae and cyanobacteria blooms, changes is flora and fauna communities, decreased water transparency, floating algal mats or reduced aesthetic experience (SEPA 2008, SWAM 2013).

**Indirect actors:**

Food processing companies: buy products (meat and crops) from farmers, and they often set regulations and norms, by which farming has to be performed (Archambault 2004).

Procurement organization: are the main actors bargaining over price of agricultural produce and products. They are an extra layer between producers and retailers, often responsible for making purchasing decisions for retailers.

Retailers: include different types of entities that can be characterized as businesses that sell food directly to customers. They are various types of shops, markets, farmers' markets and restaurants (Archambault 2004).

Scientific community: has a role to provide research and new technologies to support conservation measures and profitability in agriculture at the same time (Archambault 2004).

Extension agents: is the overall name of the variety of entities (professionals, NGOs, and governmental agencies) that aim to translate science to practice and help different actors to practically implement new knowledge and new solutions into their daily activities. Extension agents might promote pro-environmental solutions but they can also disseminate knowledge on more traditional approaches to agriculture (Archambault 2004).

Certification and eco labels organizations: provide information on the environmental quality of the products and production processes. They can also be considered as extension agents as the certification process often includes training on sustainable production (Archambault 2004).

Financial institutions: provide necessary funds for investments for various businesses but they are outside the value chain as such (Archambault 2004).

## 5. Main actors of the value chain linked to coastal tourism

The assessment carried out on Coastal Tourism is still at a very early stage as compared to the investigation carried out for other issues. Nevertheless, a preliminary identification of key activities and actors in the two main touristic models identified above is already possible, and it is shown in the table below. The value chains of the two touristic models are very similar, so a common value chain is used to identify key activities and actors.



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***Table 4. Preliminary identification of activities and actors along the coastal tourism value chain***

| Blocks of the value chain | Main activities | Main actors | | |
|---|---|---|---|---|
| **Travel planning** | Travel booking via websites | Web booking agencies | **Transversal actors** | **Tourists (consumers), consumer associaitons, local/ regional/ national authorities** |
| | Travel booking via tour operator/ travel agency | Tour operators and agencies, and also associations if this applies | | |
| **Accommodation facilities** | Building of new hotels | Real estate companies, construction companies, producers of construction materials, transporters of construction materials (and associations of these actors) | | |
| | Textile supply (bed sheets, towels, curtains, etc.) | Textile industry, textile suppliers | | |
| | Laundry services | Hoteliers associations, or external laundry services | | |
| | Cleaning services | Hoteliers associations, hotel managers | | |
| | Reception and management of arrivals | | | |
| **Food and beverage** | Meals – Food and beverage in hotels | | | |
| | Meals – Food and beverage in hotels, bars and restaurant | Industry (production of furniture, kitchen equipment, etc.), distributors of equipment, transport enterprises | | |
| | Meals in restaurants, bars and beach resorts | Restaurant and bar managers, and their association, beach resort managers and their associations | | |
| | Food supply to restaurant, bars, beach resorts, hotels | Farmers and their associations, food and beverage industry/ producers (large industries and their associations, associations of SMEs), transport enterprises (and their associations) | | |
| | Shopping in supermarkets and shops | Supermarket chains, local associations of shops and minimarkets, Farmers and their associations, food and beverage industry/ producers (large industries and their associations, associations of SMEs), distribution companies (and their associations), transport companies (and their associations) | | |
| **Leisure activities** | Hanging on the beach, swimming, sunbathing | Beach resort managers and associations of them | | |
| | Beach and sea sports (sailing, kayaking, windsurf, kitesurf, etc) | Beach resort managers and associations of them, sport associations, sport schools and clubs, national federations | | |
| | Day cruises | Ferry boat operators and associations of them | | |
| | Trekking and visits to protected areas | Local hikers associations, hiking guides and/or their associations, managers of protected areas | | |
| **Transport** | Public transport | Local public transport enterprise/ managers | | |
| | Self-transport (private and rented cars) | Car rental companies (and/or associations of them), parking sites managers | | |
| **Support services** | Water provision and wastewater collection and treatment | Local water operator(s) | | |
| | Energy provision | Energy providers | | |
| | Public security and health | Doctors, pharmacists | | |

# 6. Main actors of the value chain linked to microplastics in cosmetics

The figure below presents the main actors that have an influence on the existence of microplastics in European seas- microplastics released by cosmetics.

- Cosmetic producers represent over 5,000 enterprises among which the big majority are Small and Medium Enterprises whereas a few firms are big ones. Among the 10 leaders of cosmetic production in the world, 5 are European.

- Interest groups are another key category of actors in this story. There are several ones representing cosmetic ingredient producers and Cosmetic producers at national and European levels.

- NGOs are also important actors in this story as they seem to have an important impact to favour behavior change of economic actors.

- Researchers and innovation developers are also key actors as improving technology to treat and collect wastewater could be an option to reduce the pressure. Furthermore improving scientific knowledge on the different points of pressure along the value chain would allow for better management.

- National and European policy-makers are another key actor as they can impact norms of production processes and interact with the different actors.

- Finally European consumers and citizens are directly linked to this story through their consumption of cosmetics.



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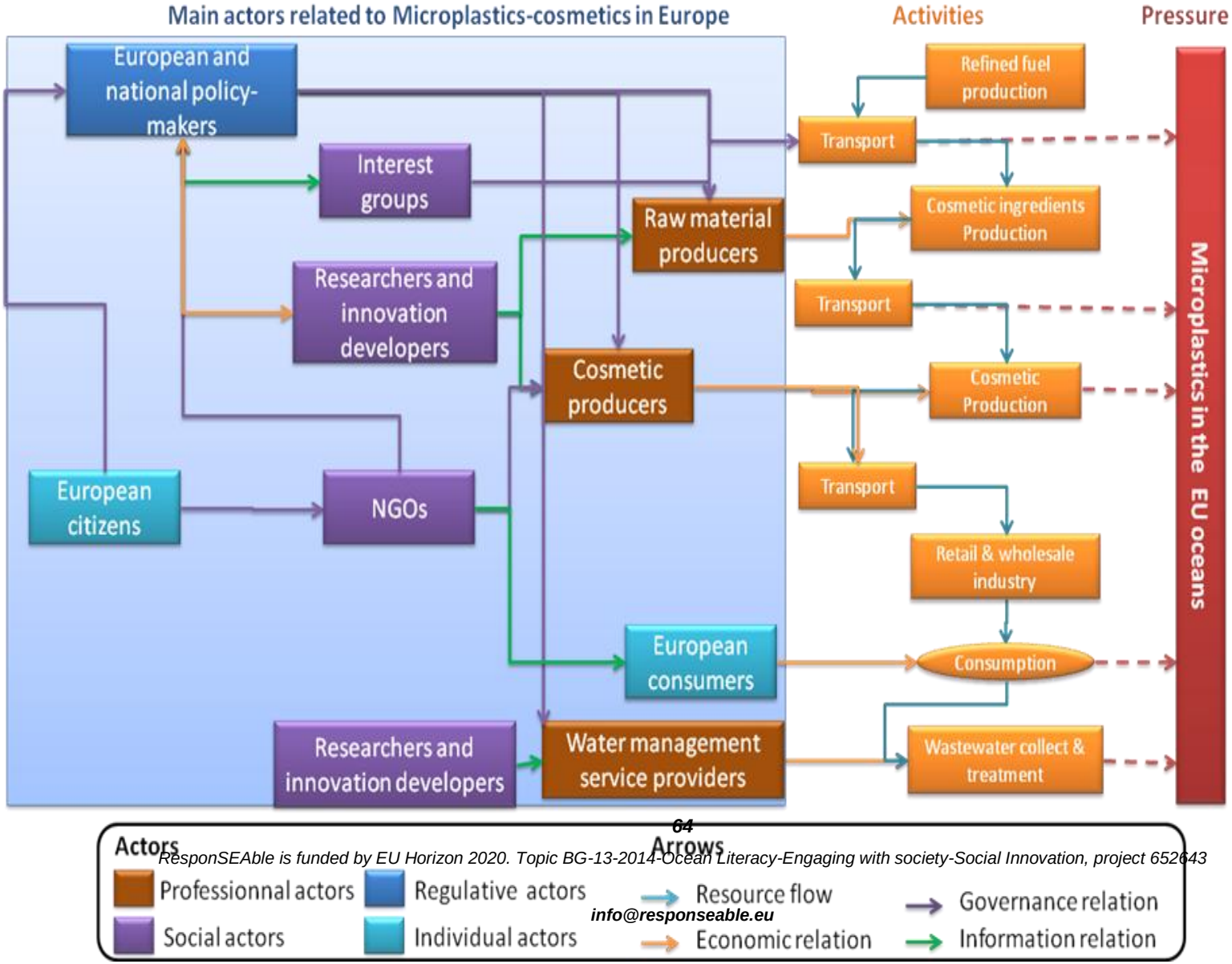


*Figure 17: Main activities and key actors of the cosmetic & microplastics value chain*



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# 7. Main actors of the value chain linked to the development of Marine Renewable Energies in all European seas

Actors have been mapped and grouped according to the following typology derived from Sundblad et al. (2014):

- Direct actors: individuals or organizations whose activities explicitly entail physical, chemical or biological disturbances of the environment.

- Indirect actors: individuals or organizations influencing the pressure on the environment by using products or services causing environmental disturbances (Sundblad, 2014).

- Supporters actors: services provided by actors who never directly deal with the product.

- Governance ("influencers") actors: regulatory framework, policies, infrastructures. People, organisations and institutions responsible for setting up and managing the regulatory framework.

The MRE sector was for a long time composed of a large number of independent SMEs and research centers (mostly universities). More recently, large European power companies as well as manufacturers entered into the industry, driven by incentives derived from the EC MSP and renewable energy directives. As an emerging industry, it already exist several MRE directories. Most of them were produced as facilitator means to network either national or European actors of the industry and facilitate the development of MRE in the EU and member States. Regarding MRE devices, Siemens is the main offshore wind turbine supplier in Europe (63.5% of total installed capacity in 2015), followed by MHI Vestas (18.5%), Senvion (7.4%), Adwen (5.7%) and BARD (3.6%). For 2015, E.ON is the largest developer in the European offshore sector with 17.1% of total connections (EWEA 2016). The top five developers include also RWE Innogy, EnBW, Stadtwerke München and DONG Energy. But DONG Energy remains the leader company in terms of total installed capacity (15.6%) followed by E.ON (9.6%) and Vattenfall (8.9%). The top five of European developers and owners counts for 44.3% of the total installed

capacity. Regarding substructures, the most important companies in 2015 were EEW,Sif, Baldt and Smulders.



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# 6. What are the main constraints and opportunities for more marine-friendly practices and behavior?

Building on the review of literature and interviews with relevant stakeholders, drivers to the different activities (what explain their strategies, their processes and production, their marketing decisions) were investigated and described. This helped to identify potential constraints and opportunities for more marine-friendly practices and behavior in the different sectors investigated. As indicated above, the term “marine-friendly” practices and behavior cover two different dimensions and issues:

- Measures and actions that reduce the pressures on marine ecosystems (e.g. a change of farm practice that would reduce nitrate pollution and thus eutrophication of the Baltic Sea)

- Measures and actions that would help seizing the opportunities offered by marine ecosystems (e.g. ensuring marine renewable energies are further developed and contribute significantly to the energy mix of Europe).

Drivers, constraints and opportunities were classified into different categories: Economic & financial; Regulation (linked to environment, economic and social issues); social demand (including market demands) and Technology, innovation & knowledge.

The following sections present the main drivers, opportunities and constraints of the main activities of the value chain presented above.

# 1. Main constraints and opportunities of activities of the value chain linked to sustainable fisheries

The dynamics of fishery products trade is characterized by the growing share of developing countries and the declining share of developed countries. Fishery exports of developing countries were valued at US$ 80 billion in 2014 (FAO 2016). But fishery industries of developing countries rely heavily on developed countries for their exports and their imports for processing industries. As a consequence, fish trade is largely driven by demand from developed countries. A fish can be produced in a country, processed in another one and consumed in third one. This makes the fishery sector complex and globalized. Drivers of change for fish demand and supply are identified below.

**Drivers of change on fish demand**

Demand is of course driven by price, income, income distribution, substitutes, tastes or regulation, but demographics characteristic are also key factors affecting the fish demand.

- **Demographics:** population growth rate, age distribution, but more specific factors can drive changes in the demand such as: Ethnicity(socio-cultural values, religious concerns, attitudes…) and Literacy: literacy rate about food safety and quality, sustainability concerns, stocks depletion, social responsibility

- **Consumer preferences:** Price, quality, convenience, year round availability (Aquaculture vs. Catches) and regular supply (seasonality makes consumers to search for substitutes); Variety and nutritional content (Omega 3), food safety; Environmental friendly products (consumer awareness through eco and organic labels, MSC); Fair trade: fair trade label calling for social responsible behavior of companies

- **Buyer specification:** Volume, presentation, labeling (origin, traceability), private standards and certification; Technology: marketing information systems,



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management of fish categories (fresh, processed…), supply chain management (exports, processing…), transport and handling

- **Regulatory changes:** Official standards and associated certification: regulations (fishing gears, effort controls, close seasons, controls…), voluntary standards (MSC, eco-labels, organic labels), Code of Conduct; Labeling regarding nutrition, country of origin, allergens; Environmental protection (biodiversity, habitats) through agreements, treaties and policies

- **Market access** (trade barriers)

- **Distribution and retailing**: energy, transport and labor are key factors cost in distribution and retailing

- **Economic growth**: GDP, disposable income, wealth distribution are key elements to sustain the fish demand especially in developed countries that are the main outlets for fishery products.

**Drivers of changes on fish supply**

Supply is driven by a more limited number of factors, some being the same than for demand such as prices or season, other being different such as climatic conditions. But rather than fishery products property (from raw fish to semi-processed and processed products), they will mainly characterize or depend on relationships between interacting enterprises and sectoral branches of the supply chain.

- **Product and Market conditions**: market demand, climatic conditions, stocks dynamics, inputs prices (fuel mainly), trade policy or legal environment will impact the fish supply. As a perishable product, market price is also an indicator of the quality of fish.

- **Procurement practices**: research, traceability, ethics and environment are key factors to improve responsible fish trade. This can go along with integration, private or corporate standards and arrangement strategies within the supply chain. This include: availability for production and shipping: infrastructures development

is one of the major factors to reduce trade costs; producer preference: fishermen have to bear all investment regarding fishing vessels and gears, as well as price volatility. It generates some incentives to overfishing. This is similar for aquaculture where farmers tend to overstock for the same reasons. It also impacts their choice in terms of gears and practices; technology that is one of the most important factors that will drive changes in producers' behavior. Its availability and substitutability at profitable levels can deeply reorient the supply chain strategy and its production. Technological choice can be also mandatory (regulatory change to cope with new standards, legal restrictions on inputs use, etc.) or constraint by the socioeconomic context (availability of seasonal labor, availability of fisheries labor forces, etc.). Subsidies are a key lever to adopt or constraint changes in technology. Certain forms of fisheries subsidies can contribute to overcapacity and overfishing through the increase of fishing effort.

**Labels and standards**

Among the drivers to changes, standards and labels are common to both side of the chain (supply and demand), even if different in terms of implementation and goals. If some drivers to change are exogenous to the industry on short term (e.g. some input prices, climatic conditions), labels and standards are drivers that can be designed, managed and applied of the fishery system. They can apply to both value and supply chains, to producers and consumers. They can be negotiated or imposed unilaterally, public or private and offer a wide range of implementation. Other such drivers and the most important ones are regulations. But being rather imposed and the last option in case of failure in implementing win-win agreements, the focus will bear over the labeling and standards.

There are signs that capture fisheries can be managed sustainably: diminishing fishing pressures in some area, better uses of fish products, existing innovations (discards and bycatch regulation, changes in quotas, new aquaculture feeds, FCP…)… Fish supply-chain and other improvements have also raised the share of world fish production utilized



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for direct human consumption to 87% (i.e. 146 million tonnes) in 2014 compared to 67% in the 60's. 76% of the non-food products were reduced to fishmeal and fish oil. The fish-processing sector also offers opportunities to improve the sustainability of the fish supply chain, as a host of by-products having multiple potential and actual uses (fishmeal for aquaculture, collagen for the cosmetics industry, small fish bones served as snacks...) (FAO 2016).

## 2. Main constraints and opportunities of activities of the value chain linked to invasive species

As the problem of IAS become obvious in the last decades, a number of national, European and international legislative initiatives emerged. The most significant one is the International Convention for the Control and Management of Ships'Ballast Water and Sediments (BWMC). It aims at preventing the spread of harmful aquatic organisms from one region to another, by establishing standards and procedures for the management and control of ships' ballast water and sediments. The BWMC, adopted in 2004, is ratified so far[10] by 51 contracting states, which represent 34.87% of the world merchant shipping tonnage. The convention is expected to enter into force soon, after being ratified by a number of states representing at least 35% of the world's tonnage. Several guidelines have been developed based on the BWMC covering a variety of technical issues on ballast water management and exchange as well as sediment control. As knowledge on IAS is still growing, the guidelines are kept under review by the IMO Marine Environment Protection Committee (MEPC) and will be updated as new technologies emerge and additional knowledge becomes available. The BWMC implies also control responses from the Port, Coastal, and Flag States in particular focusing on the development of new working procedures. It does not apply to warships, naval auxiliary or other ships owned or operated by a State and used only on government non-commercial service.

As a result of the BWMC and other national initiatives, it is expected that over the next years a number of ships will be retrofitted with effective Ballast Water Management

[10] http://www.imo.org/en/About/Conventions/StatusOfConventions/Pages/Default.aspx (13th June 2016)

Systems (BWMS). BWMS make use of combined technologies neutralizing or eliminating harmful aquatic organisms and pathogens during ballasting and/or deballasting. Until now, shipowners were reluctant to retrofit older ships with BWMS, or even build new ships having this technology onboard, as this costly investment would have no direct financial benefits for them. The costs to retrofit a vessel with a BWMS lie from a few hundred thousand euro for small systems up to two million euro for the largest ones. The operation of BWMS will result to additional costs. Nevertheless, the BWMC is a major driver for shipowners to retrofit their ships. Even then, it is expected that shipowners will calculate carefully before they decide to upgrade very old ships as in these cases they will not be able amortize the high costs for new, expensive technologies. For these ships they are more likely to consider alternative solutions to comply with the BWMC such as port-based ballast water treatment. Once in force, the Convention will require shipowners to install the necessary equipment for the proper treatment of ballast water by each vessel's next scheduled dry-docking. Regardless of when the Convention enters into force, the announcement will likely see many owners rescheduling dry-docks due in the immediate aftermath, in order to extend the deadline by which they will be required to install the necessary equipment.

Another sector closely related with the building of ships is the manufacture of paints, and coatings in order to prevent marine growth (biofouling) on the hull of the ships, which is one of the main vectors for the introduction of IAS. Marine growth affects the performance of ships as it decreases the maximum speed of the vessel, it is responsible for increased energy consumption to maintain the required speed and may cause severe damage to the hull over time. Therefore, shipowners have always had an interest to keep their vessel's hull clean. This is an important aspect as it combines environmental and economic interests. In contrast to BWMS, improved anti-fouling systems are not considered by shipowners as additional costs but as an investment that may lead to longer-term cost savings. However, current technologies and procedures for keeping the hulls clean do not always take ecological aspects into consideration. Using current conventional technologies, biocides are painted on the hull of ships to reduce the build-up of biofilm and other fouling organisms. Biocides and biofouling are slowly released to the marine



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environment. In the process of scrubbing a hull while it is in the water great quantities of biocides and the attached biofouling may be released into the environment. Significant technological opportunities addressing the problem can be found in some of the recent innovations in the field of anti-fouling technology, such as the following:

- Improved coatings allowing less biofouling to be attached
- Environmental friendlier anti-fouling paints using reduced biocides or even biocide-free.
- Less need for hull cleaning due to improved coatings
- High efficiency for in-water hull cleaning and filtration systems

In case of in-water cleaning, new improved suction systems, invented by marine equipment suppliers, are able to remove and dispose most of the fouling in a safe way. Even so, there is still a small percentage of fouling that escapes into the water. As these technologies are quite new in the market it is estimated that there is a significant potential for efficiency improvement. The more efficient these systems operate the more likely it will be that their systems will be approved to operate in certain ports, even in those regions which follow a restrictive policy (e.g. California, Australia).

Regarding the introduction of NIS through hull fouling, there is no adequate international regulation until now. The International Convention on the Control of Harmful Anti-Fouling Systems on Ships, which came into force in 2008, focuses on the prevention of adverse impacts from the use of Anti-Fouling Systems (AFS) and the biocides they may contain, rather than on the prevention of the transfer of NIS through hull fouling

# 3. Main constraints and opportunities of activities of the value chain linked to eutrophication

(Economic) choices different actors make are based on profitability, perceived well-being and values individuals and communities held. Many of these choices are in addition formed by external conditions and incentives provided. Economic and legal incentives can directly influence the actors' behavior but knowledge, interpretative and participative incentives can also create room for change. In fact, change based on the latter group of incentives might even be more durable in the long run as they have a greater opportunity to influence and change values and opinions, and not only actions based on obligation or pressure. In the below table we summarize constraints and opportunities to change the decisions undertaken by various eutrophication related actors.



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*Table 5. Constraints and opportunities for behavioral change for eutrophication related actors*

| Actors | Opportunities | Constraints |
|---|---|---|
| Decision-makers | Changes in legislation driven by e.g., public pressures for clean and healthy marine environment;<br>Including environmental criteria in public tendering<br>Inclusion of environmental criteria and farmers' financial security in the revised CAP<br>Incorporation of farmers' needs into local planning<br>Financial support for awareness rising campaigns | Need to balance environmental concerns with agriculture profitability and food prices<br>Elections and contradictory social pressures |
| Farmers | Implementation of agri-environmental measures<br>Involvement in sustainable farming through increased demand for organic products | Risk of losing income<br>Requirements and norms imposed by food processing industries and procurement organizations<br>Formal and informal regulations arising from market and current legislation, including CAP<br>Lack of knowledge and support to implement pro-environmental measures |
| Fertilizer producers (inorganic) | Social pressures for responsible business<br>Scientific development to invent more environmentally friendly fertilizers (?) | Indirect links with eutrophication and a wide range of products and activities (?) |
| Fertilizer producers (organic) | Implementation of agri-environmental measures<br>Involvement in sustainable farming through increased demand for organic products | Risk of losing income<br>Requirements and norms imposed by food processing industries and procurement organizations<br>Formal and informal regulations arising from market and current legislation, including CAP<br>Lack of knowledge and support to implement pro-environmental measures |



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| | | |
|---|---|---|
| Consumers/citizens | Supporting public procurement of local organic food<br>Supporting public purchasing of eco-labelled goods and services<br>Changes in consumption patterns, including limited meat consumption | Discouraging effect: limited direct influence when compared with subsidies and food processing industries and procurement organization<br>Level of income and limited availability of eco products<br>Lack of knowledge |
| Food processing industries | Changes in norms and requirements put on farmers<br>Increased share of eco/organic products | Possible loses in profitability<br>Higher costs related to mass production of eco/organic products<br>Actual demand for eco/organic products |
| Procurement organizations | | |
| Retailers | Increased share of eco/organic products<br>Active involvement in educating customers | Possible loses in profitability<br>Actual demand for eco/organic products<br>Lack of knowledge to properly educate customers |
| Scientific community | Focus on more practical research to directly address farmers' needs<br>Shift towards participator research together with farmers | Existing assessment schemes<br>Limited funding for participatory research |
| Extension agents | Promotion of agri-environmental measures instead of more traditional solutions | Limited interests in the new offer (?) |
| Certification and eco labels organizations | Cooperation and standardization of existing labels | Limits of markets for eco labels |
| Financial institutions | Offering better credit conditions for environmentally friendly customers and/or investments | Focus on profit |

*Own elaboration based on: Archambault 2003, Archambault 2004, Cordell et al. 2009, Larsson and Granstedt 2010, Spijkers et al 2012, WWF 2007, WWF 2011*

# 4. Main constraints and opportunities of activities of the value chain linked to coastal tourism

Information collected so far does not allow for the identification of drivers and constraints. Results from stakeholder interviews for individual coastal sites will bring specific knowledge on the main drivers, constraints and opportunities for coastal tourism.

In general, coastal tourism has large room of adaptation for all actions and actors involved in the value chain: everyone can contribute to more sustainable practices and to reducing the impact of tourism activities on marine ecosystems. Examples of such opportunities are provided in the table below.

***Table 6. Opportunities for behavioral change in the coastal tourism sector***

| Blocks of the value chain | Main actors | Example of possible behavioral changes | | |
|---|---|---|---|---|
| **Travel planning** | Web booking agencies | Promotion of sustainable tourism packages and eco-tourism activities | **Transversal actors** | Tourists (consumers): adopt an environmental-friendly conduct (e.g. throw waste in bins or bring it at home, avoid a wasteful use of water resources) - Consumer associaitons: promote responsible behavior (e.g; awareness campaigns) - local/ regional/ national authorities: sustainable urban |
| | Tour operators and agencies, and also associations if this applies | | | |
| **Accommodation facilities** | Real estate companies, construction companies, producers of construction materials, transporters of construction materials | Adopt eco-building techniques and practices | | |
| | Textile industry, textile suppliers | Adoption of sustainable and clean production technologies | | |
| | Laundry services - Hoteliers associations, or external laundry services | Purchase of machinery with low energy consumption, increase efficiency of laundry activities to optimize energy consumption and water discharges | | |
| | Hotel management and cleaning - Hoteliers associations, hotel managers | Adoption of sustainable practices to avoid unnecessary consumption of water and electricity (e.g. limit changes of bed sheets and towels, installation of low-consumption | | |



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| | | | | |
|---|---|---|---|---|
| | | electric devices), participation to a certification or labeling scheme for sustainable hotel management, installation of solar panels, installation of internal water recycling systems, separation of recyclable waste | | |
| **Food and beverage** | Hoteliers associations, hotel managers | Same as above, and adaptation of management practices to avoid food waste, purchase of organic, km 0 and short supply chain food and beverage products | | |
| | Restaurant and bar managers, and their association, beach resort managers and their associations | Adoption of sustainable practices to avoid unnecessary consumption of water and electricity (e.g. limit changes of bed sheets and towels, installation of low-consumption electric devices), participation to a certification or labeling scheme for sustainable hotel management, adaptation of management practices to avoid food waste, separation of recyclable waste, purchase of organic, km 0 and short supply chain food and beverage products | | |
| | Hoteliers associations, hotel managers | Adoption of sustainable production techniques (several possibilities, depending on the type of industry/ production) | | |
| | Food supply to restaurant, bars, beach resorts, hotels | Adoption of sustainable production techniques (several options, depending on the type of industry/ production) | | |
| | Supermarket chains, local associations of shops and minimarkets, Farmers and their associations, food and beverage industry/ producers (large industries and their associations, associations of SMEs), distribution companies (and their associations), transport companies (and their associations) | Avoid wasting food and beverage products, purchase of organic, km 0 or short-supply-chain products, adoption of low-consumption electric devices, adoption of sustainable production techniques, increase the efficiency of supply system (e.g. to reduce the number of deliveries) | | |
| **Leisure activities** | Beach resort managers and associations of them | Promotion of environmental-friendly behavior among tourists, provision of waste bins | | |
| | Beach resort managers and associations of them, sport associations, sport schools and clubs, national federations | Promotion of environmental-friendly behavior among tourists | | |
| | Ferry boat operators and associations of them | Adoption of environmental friendly practices (e.g. avoid fuel discharges into the sea) | | |

| | | | | |
|---|---|---|---|---|
| | Local hikers associations, hiking guides and/or their associations, managers of protected areas | Promotion of environmental-friendly behavior among hikers, provision of waste bin in natural areas, regular enforcement of behavior rules in protected areas, awareness campaigns | | |
| **Transport** | Local public transport enterprise/ managers | Improvement of service levels to encourage the use of public transportation, purchase of electric buses | | |
| | Car rental companies (and/or associations of them), parking sites managers | Promotion of environmental-friendly behavior among tourists, limit the number of available parking lots in natural areas | | |
| **Support services** | Water provision and wastewater collection and treatment | Improvement of wastewater collection and treatment (e.g. larger capacity, more advanced technologies), develop water reuse systems | | |
| | Energy provision | Increase the share of energy produced from renewable resources in the energy portfolio | | |

# 5. Main constraints and opportunities of activities of the value chain linked to microplastics in cosmetics

Cosmetic ingredients demand is growing and especially demand for natural products. Alternatives for microbeads exist. Cosmetics ingredients producers often manufacture other chemical ingredients for nutraceutical, food, agrochemistry industry and others. So some companies could potentially quite easily adapt their production. However there are uncertainties on the quantity of microplastics produced in Europe for cosmestic production.



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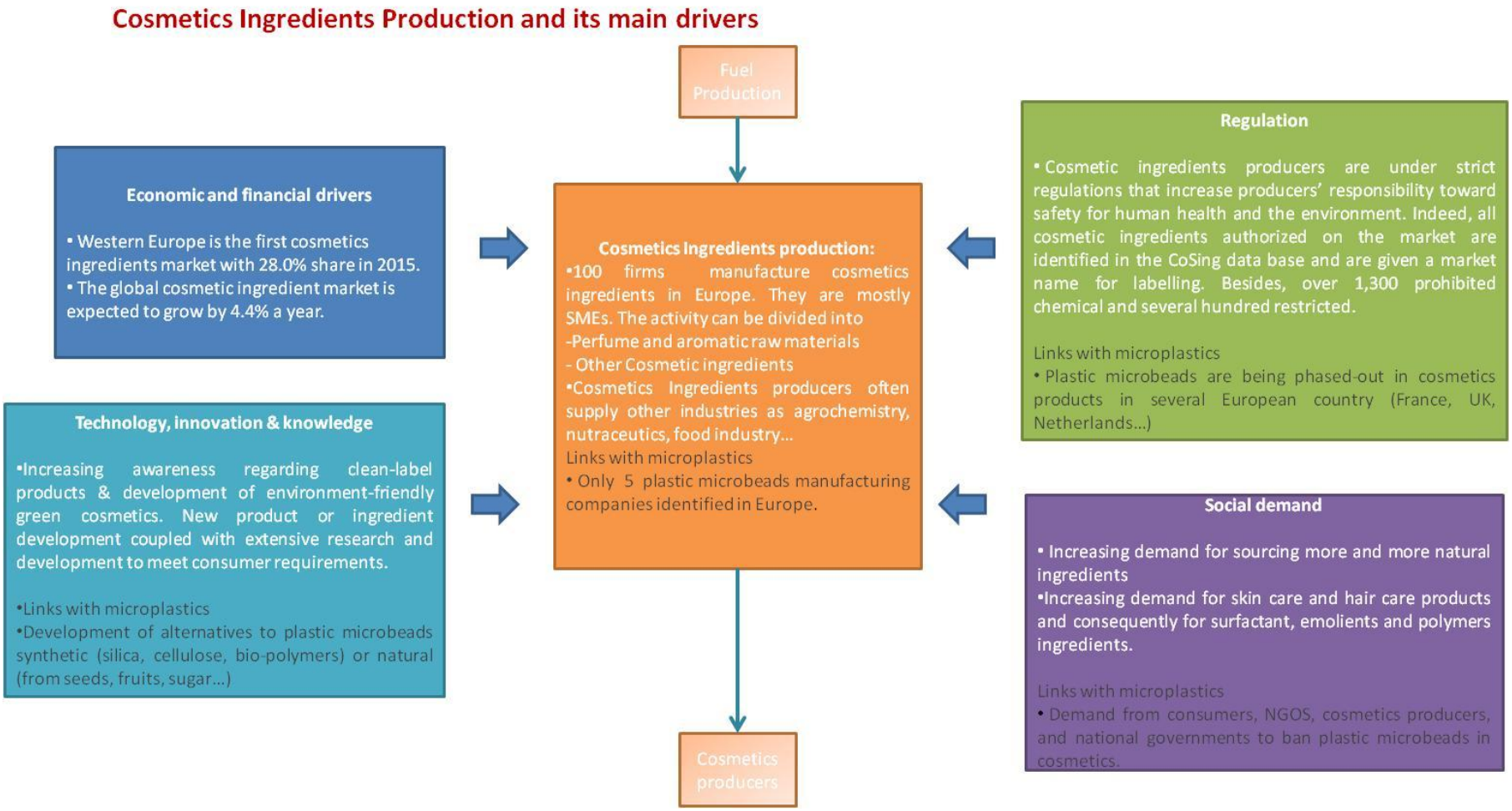


***Figure 18: Main drivers to cosmetic ingredients production***

**Cosmetic production** seems to be mainly “supply-driven”. In some specific cases a specific demand emerges from consumers. In the case of microplastics it seems that based on NGOs campaigns and a ban already adopted in the US, several European cosmetic companies declared to ban microplastics from their products in the coming years. Some governments are also in favour of a European ban of microplastics in cosmetics (e.g.UK, NL).



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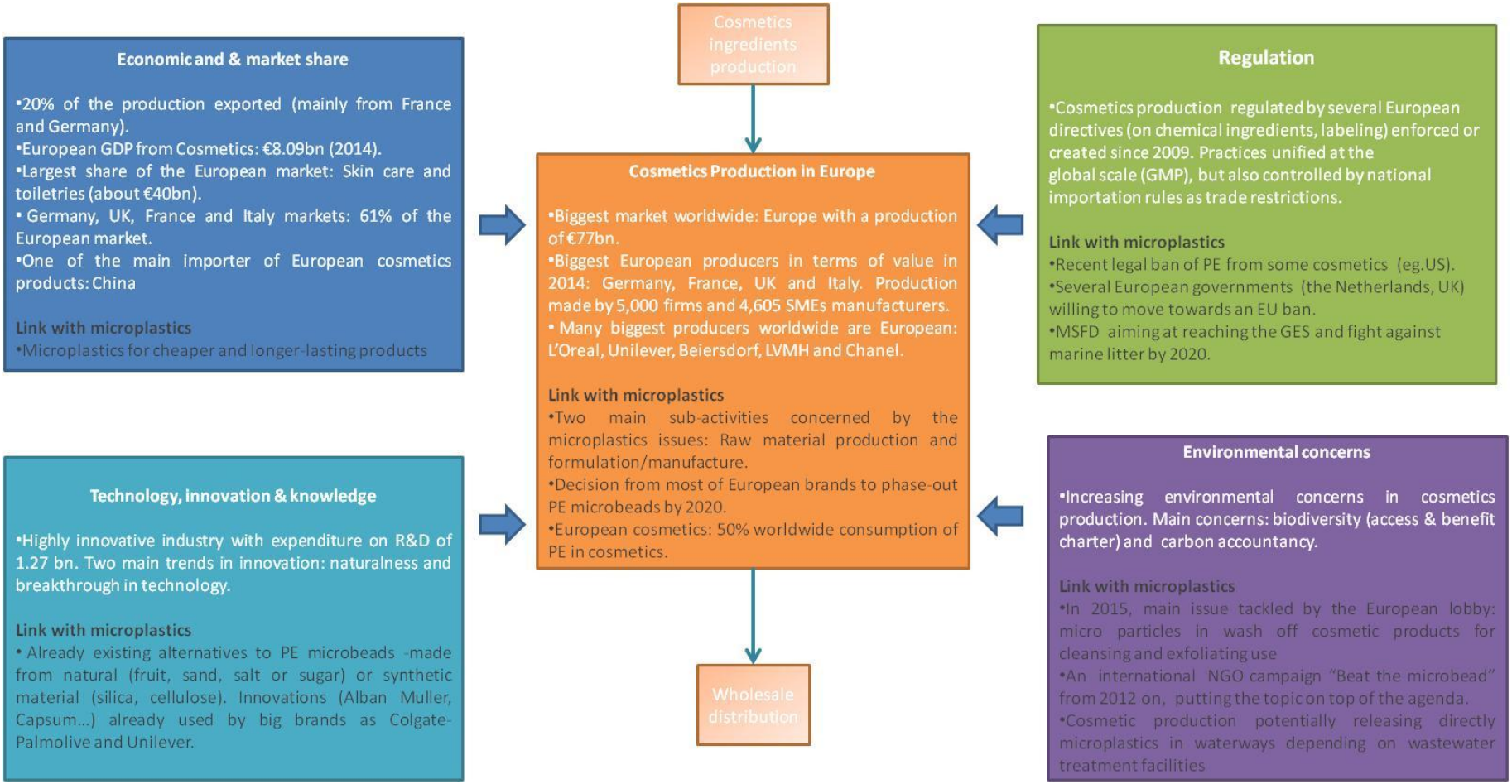


***Figure 19: Main drivers to cosmetic production***

# 6. Main constraints and opportunities linked to the development of Marine Renewable Energies in all European seas

If its potential is quite huge and developments important, compared to the initial deployment objectives expressed at EU and member States level, the present deployment of MRE in Europe is far below the initial 2020 development targets. From 50 GW planned and expected for the world fixed offshore wind power in 2020 (about 60% in Europe), the revised objective decreased to 30 GW corresponding however to a cumulative investment of 100 billion euros. For instance in Germany the offshore wind farms capacity was about 290 MW in 2012, about one third of the 2009 stated objectives. The trend is also the same for the MRE's 2020 objectives in most of European countries: from 18 to 11.5 GW in the UK, from 6 to 2 GW in France and from 10 to 6.5 GW in Germany (MERiFIC 2014).

The state of development of MRE already underlines a number of difficulties and constraints to commercial deployment. Despite the diversity of technologies and devices that have been already demonstrated, commercialization and implementation remain slow due to relatively high costs and concerns over environmental issues especially regarding marine mammals and habitats.

The credibility of long term development of MRE is in a critical step to induce significant investments. If MRE will significantly contribute to power production from 2020, it will rely on present decisions in order to incept and support new and relevant MRE industries. This phasing is crucial as a too early process without mature enough or too costly technologies will lead to take unnecessary risks to investors. On the opposite a too careful or slow process will leave room to new entrants or extra European competitors.



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# 7.Conclusions: moving ahead

The assessments carried out for the socio-economic values chains relevant to key marine challenges have stressed: (a) the large number of economic activities directly or indirectly connected to the pressures imposed on, and the benefits that can be drawn from, marine ecosystems; (b) the large number of actors that are connected to the value chains, and (c) the diversity of drivers (economic & financial drivers, regulation, Social demand and Technology, innovation & knowledge) that influence the strategies and practice of activities/actors. This stresses that any change in practice or behavior from activities that directly impact on marine ecosystems is likely to impact indirectly other activities and actors of the value chain. In some cases, activities of the value chain might be the main drivers for changes in the value chain that lead to the protection of marine ecosystems and their use as key factors of sustainable socio-economic development.

The knowledge presented in this report will be the basis for identifying activities and actors for which enhanced knowledge on marine ecosystems and on the human-ocean relationship is a pre-condition for change of behavior that can benefit marine ecosystems and society as a whole. More specifically:

- For each main issue/challenge, knowledge on the structuring and main components of the value chain **will be combined with information on pressures-state-impact-welfare that has been investigated in parallel in WP1**. This will contribute to the development of a wider picture on the human-ocean relationship, ensuring the main dimensions of the human-ocean equation (that could form the basis of content of literacy initiatives) are well captured;

- The knowledge produced will now be used to **identify the priority areas for "behavior change"**, i.e. the activities and actors which "change of behavior" are essential for the activities of the value chain to shift to more "marine-friendly" practices and behavior (or to capture potential benefits offered by marine ecosystems and thus contribute to Blue Growth). Depending on the issues

investigated, different approaches will be applied for identifying priority areas for "behavior change":

- The organization of so-called **PESTLE Workshops** mobilizing (5-10) stakeholder representing different activities of the value chain. These workshops will help consolidating the knowledge on the links between environment and human activities, and to identifying changes (in strategies and practices) that would help better accounting for marine ecosystems (protection and/or development opportunities). Part of the workshops will be also devoted to the i) co-construction of scenario as a way to structure expression of interests regarding potential changes and ii) hierarchy of these scenarios[11]. Depending on the issues and challenges, such workshops might involve local (e.g. for coastal tourism) or European (e.g. for cosmetics and microplastics) stakeholders. Scenarios building and classification of scenarios will be part of the PESTLE workshop that will deliver a story telling as a result;

- A **series of interviews** based on an interview guidance combining structured and semi-structured questions addressing the same issues as the ones discussed during the PESTLE workshop. The results of the interviews will help developing a SWOT analysis of different alternatives of "behavioural changes" within the value chain, or influence/interest grids that help capturing stakeholders and activities that are priority in influencing the functioning of the overall value chain, including decisions and practices of sectors that impose direct pressures on marine ecosystems.

[11] See section 4.3.2 of Deliverable D2.1 to gain a better understanding of the PESTLE approach and of the needs for such workshop.



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- The description of activities of the value chain, along with the assessment of their main drivers, constraints and opportunities for change, will help identifying the **main actors which decisions matter** (in reducing pressures or seizing opportunities offered by marine ecosystems in relation to Blue Growth). These will then be the focus of more detailed assessments (based on semi-structured interviews in the context of WP3) of their perception and understanding of their relation to marine ecosystems/to the ocean. This knowledge will contribute to the identification of media and content/knowledge that could contribute to enhanced literacy in the shorter term, and thus potential behavior change consistent to the protection and development of marine ecosystems;

In parallel to these activities, it is proposed to complement the assessments carried out by a dedicated assessment of final consumers' purchasing decisions. The analysis of the different values chains has stressed the role final consumers have in different value chains. An initial review of the literature on consumer behavior and the **role of knowledge in supporting consumers' behavioral changes**, combined with semi-structured interviews of citizens/consumers, have helped identifying the main issues at stake with factors influencing consumer's behavior, and their purchasing choices. It is proposed now to launch an internet-based survey for capturing the consumer choices in relation to food[12], seafood[13] and cosmetics[14]. The results of the survey will provide interesting results that will help targeting ocean literacy regional strategies (WP4) and products (WP5);

Overall, the results presented in the present report will be presented and discussed at the collective WP1 to WP3 European workshop[15] involving the three ocean knowledge, economic and ocean literacy communities.

[12] Linked to the issue of eutrophication in the Baltic Sea and the Black Sea

[13] Linked to the issue of sustainable fisheries in the Atlantic

[14] Linked to the issue of microplastics in cosmectics.

[15] Integrated into the activities of WP3

# Annex I – The value chain for sustainable fisheries in the Atlantic ocean

## 1. Sustainable Fish, what is the question?

The "DAPSIWR" analysis underlines four main areas addressing fish sustainability: fish stock depletion (overexploitation from legal or illegal fishing), sea floor integrity (habitats degradation mainly), biodiversity losses and foodwebs (especially fishing down the foodweb and its consequences in terms of healthy trophic chain). Aquaculture can also contribute to these environmental threats through additional pressures and impact of different processes (conflict uses, coastal settlement issues, waste management, fishmeal fisheries, exotic species…).

In the last issue of the State Of Fisheries and Aquaculture (SOFIA 2016, FAO) the FAO lists the major obstacles to achieving sustainable fisheries and aquaculture. These obstacles are "*poor governance, management and practices, including illegal, unreported and unregulated fishing and inefficient aquaculture operations, as well as poverty and labor abuses of fish workers communities*". The lost economic benefits from the fisheries sector due to overfishing are estimated to be around US$50 billion annually (UN Sustainable Development Knowledge Platform, 2016). Beyond of the solely fisheries sector, the UN Environment Programme estimates the cumulative economic impact of poor ocean management practices at least at US$200 billion per year.

Coping with these obstacles is one of the 17 Global Goals that make up the 2030 Agenda for Sustainable Development adopted by the UN's Member States on September 2015.



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The Sustainable Development Goal 14 "Conserve and sustainably use the oceans, seas and marine resources for sustainable development" explicitly refers to fisheries[16]. Addressing these obstacles is also the objective of the Blue Growth Initiative (BGI) launched by the FAO on 2013, supporting the implementation of the FAO Code Of Conduct for Responsible Fisheries and the Ecosystem Approach to Fisheries and Aquaculture (EAF/EAA).

Linked to the oceans' health expressed in reducing pressures responsible of ecological impacts, the approach developed by ResponSEAble doesn't address directly the social dimension of sustainable fish, such as decent work conditions, forced and child labor in the fishing and processing industry (outside Europe but potentially part of imports), or the patrimonial dimension of fisheries. Under this context, the issue attached to sustainable fish in the frame of reducing pressures to enhance oceans' health can be formulated in a simpler question: *"where do people get fish from?"* underlining related properties of fish.

Fisheries are traditionally acknowledged as a consumer and market driven value chain (De Silva, 2011). In the context of changes in behavior, the present key story is already oriented to consumers. But it is also necessary to develop and inform other actors too. Retailers and consumers seem to be the target, but they are not the same stories even if embedded. A whole story is then proposed to encompass these actors as well as producers.

## 2. Facts and figures

### *2.1 Fisheries dynamics*

Fisheries face a stagnating level of catches from the nineties (about 93 million tons the last four year including inland fisheries) when aquaculture production increases dramatically (73.8 million tons in 2014 with an estimated value of US$ 160.2 billion) (FAO 2016).

[16] https://sustainabledevelopment.un.org/sdg14

Marine capture fisheries counts for 81.5 million tons (2014), 87.3% of the total capture fisheries. Marine aquaculture follows the same growth than inland aquaculture and counts for 26.7 million tons (2014), 36.2% of the total aquaculture production. But in 2014 and for the first time, the supply of fish for human consumption from aquaculture overtook that of wild-caught fish for the first time.

In 2014, the European (beyond of EU) fishing fleet counts for 2.1% of the total number of fishing vessels and 3% of motorized fishing vessels, when Asia counts for 75.1%. This is even worst in terms of fishers and fish farmers where the number of European fishers decreased dramatically the last years counting for less than 1% of world fishers and 0.35% of fish farmers, when Asia counts respectively for 84% fishers and 96% fish farmers. But European aquaculture slightly continues to growth and European catches remain at similar levels over the last years underlining a higher concentration and intensification in European fisheries and aquaculture.

### *2.2 Status of fish stocks*

In 2013 a third of commercial fish stocks (assessed and monitored fish stocks) are still overharvested at biologically unsustainable levels. It is a level that had been stable since 2007 (FAO 2016), in spite of decreasing fish landings observed in some regions, especially in Northwest Atlantic. In the Mediterranean and Black Sea, 59% of assessed stocks are fished at biologically unsustainable levels (over the Maximum Sustainable Yield). Fish stocks such as hake, red mullet, sole and sea breams are overfished, catches declining from 2 million tonnes in 1982 to 1.2 million tonnes in 2013.

The ten most productive species accounted for about 27% of marine captures in 2013 and most of their stocks are fully fished with no potential for increases in production (FAO 2016).

### *2.3 Discards and industry wastes*



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If included in landings, discards prior to landings, fish losses and waste (post harvest) amount to 35% of landings (FAO 2016). Two global assessments of bycatch and discards were implemented by FAO in 1994 and 2005. The 1994 study provided a yearly mean global estimate of 27 million tonnes of discards, regarding an estimate of 7.3 million tonnes in 2005. While implementing different methodologies, theses assessments rather suggest a decrease in discards and changes in fisheries management to the inception and implementation of more sustainable practices (FAO 2016).

There are signs that capture fisheries can be managed sustainably: diminishing fishing pressures in some area, better uses of fish products… Fish supply-chain and other improvements have also raised the share of world fish production utilized for direct human consumption to 87% (i.e. 146 million tonnes) in 2014 compared to 67% in the 60's. 76% of the non-food products were reduced to fishmeal and fish oil. The fish-processing sector also offers opportunities to improve the sustainability of the fish supply chain, as a host of by-products having multiple potential and actual uses (fishmeal for aquaculture, collagen for the cosmetics industry, small fish bones served as snacks...) (FAO 2016).

### *2.4 Demand and consumption*

Fish counts for almost 20% of the animal food consumption in the World and demand for seafood products is still growing due to the combination of several factors: demographic growth, urbanization, increase of richness, international trade providing wider choices... World per capita apparent fish consumption increased from 9.9 kg in the 60's to 14.4 kg in the 90's and 19.7 kg in 2013 (FAO). According to a horizon 2022 scenario, FAO assessed a per capita fish apparent consumption ranging from 23.5 kg to 25 kg from the baseline scenario to the optimistic one (FAO 2014), with important disparities between developed and developing countries. It is then asked to aquaculture to fill in this gap by doubling its production to 2030. But it also depends on progress over the recovery of certain stocks following improved management regimes (FAO 2016) and the quantitative impact of climate change over fisheries and aquaculture productions remains largely unknown. Consequences are high pressures over fisheries to maintain a sustainable level of marine catches and develop marine and coastal aquaculture to balance catches stagnation and respond to the increasing demand for seafood products. But this pressure to aquaculture development often appears as disconnected from the existing bottlenecks to aquaculture development, being technical or social.

In addition, distribution of the increase in fish consumption is unequal among countries and within countries and regions in terms of quantity and variety (FAO 2016). According to the International Food Policy Research Institute (IFPRI) and the World Bank, the most important increase in fish consumption will take place in developed countries (North) and in China, reinforcing the regional unbalance between supply and demand. Asia and Africa could face important scarcities if proper investments are not made for the development of sustainable aquaculture.

FAO expects an increase of 17% of the world fishery production from 2013 to 2025 to reach a level of 196 million tonnes, but with a slower annual growth compared to the previous decade (1.5% vs. 2.5%). This increase is mainly expected from developing countries. Facing stagnating captures, the share of aquaculture in total fishery production is expected to grow from 44% to 52%, being the main provider of seafood products. But if expectation are high, little or nothing is said about the way for aquaculture to reach this objective, especially regarding socio-economic bottlenecks that seem completely disconnected from aquaculture development plans. Most of development plans remain based on marine spatial planning and carrying capacity, ignoring the social dimension of the carrying capacity.

### *2.5 Trade and prices*

Prices will decrease in real terms but remain on a high level. The average price for wild fish is expected to remain lower than that for farmed fish. This is mainly due to the increasing share of lower value fish in overall catches (FAO 2016), but also to better feed conversion ratio and productivity gains in aquaculture (reduced production and marketing costs). Average price of fish trade products is also forecasted to decline due to expected competitive prices of substitutes (chicken especially) and a lower economic growth impacting demand from key markets.

Fishery products are one of the most traded segments of the World food sector with 78% of the seafood products exposed to international trade (FAO 2016). Fishery trade is



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closely linked to the overall economic situation. Driven by a high demand, 36% of the total fish production is exported for a value of US$ 148 billion in 2014. China (the main fish producer), Norway and Vietnam are the top3 exporters, while the EU, the USA and Japan are the most important importers (63% in value) highly depending on imports to satisfy their domestic demand. The EU is the largest market for fish imports with a value of US$ 54 billion in 2014 with almost 50% due to intra EU-trade (FAO 2016).

The dynamics of fishery products trade is characterized by the growing share of developing countries and the declining share of developed countries. Fishery exports of developing countries were valued at US$ 80 billion in 2014 (FAO 2016). But fishery industries of developing countries rely heavily on developed countries for their exports and their imports for processing industries. As a consequence, fish trade is largely driven by demand from developed countries. A fish can be produced in a country, processed in another one and consumed in third one. This makes the fishery sector complex and globalized.

In terms of species, salmonids and shrimps are the main group of species in World trade (2013), followed by tuna and counting respectively for 16.6% and 15% of the total value. In volume cods, hakes and haddocks are the most important group (14.4%), followed by tunas and salmonids.

### *2.6 Aquaculture*

As already underlined, the foreseen growth of fisheries will largely rely on aquaculture for the next decades and as such aquaculture appears as an important pillar of the Blue Growth Strategy. The results of the FAO fish model for the period 2016-2025 project an expansion of the World fishery production to 196 million tonnes (+17%). Most of this increase will originate from developing countries and will mainly be met by aquaculture which is expected to reach 102 million tonnes (+39%), mainly through freshwater species (including *Pangasius* and tilapia) (FAO 2016). Annual aquaculture growth rate is estimated to decline from 5.4% to 3% on the same period.

But to maintain its production and continue its growth, aquaculture has to face a number of increasing constraints. The 2016 edition of the Sate Of Fisheries and Aquaculture

published by the FAO (SOFIA, FAO 2016) lists a series of factors that might affect the prospects for aquaculture. These are:

- Land and water and associated conflicts;
- Feed, seed supply and genetic resources;
- Environmental integrity and disease problems;
- Development and adoption of new and improved farming technologies;
- Market, trade and food safety;
- Climate change;
- Investment capital and impediments;
- Problems that can originate from unguided and unmonitored aquaculture practices, challenges in governance and regulatory framework.

Feed is widely regarded as becoming a major constraint to the growth of aquaculture (fish pellet and oil). Today half of the world aquaculture production in volume is realized without feeding (algae and shellfish mainly). But almost 70% of the world production of farmed fish is fed fish. There are concerns about the production of fishmeal and fish oil over the next decade, mainly due to the growing demand for human consumption of fish species previously used for reduction into fishmeal. The foreseen additional fishmeal production will originate from byproducts through an improved use of fish waste, cuttings and trimmings (FAO 2016). But this use of fish byproducts is likely to alter the quality and composition of fishmeal and fish oil, resulting in an increased use of fishmeal/oil in aquaculture, as well as in livestock farming.

## *2.7 The Northeast Atlantic fisheries*

### *2.7.1 Fishing and culture areas*

The Northwest Pacific remains the most productive area for capture fisheries, followed by the Western Central Pacific, the **Northeast Atlantic** and the Eastern Indian Ocean. The Northeast Atlantic FAO fishing area represents 10.6% of the marine capture for a total production of 8.45 million tons (fishing area code 27; see map).



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Figure 1 FAO Major Fishing Areas

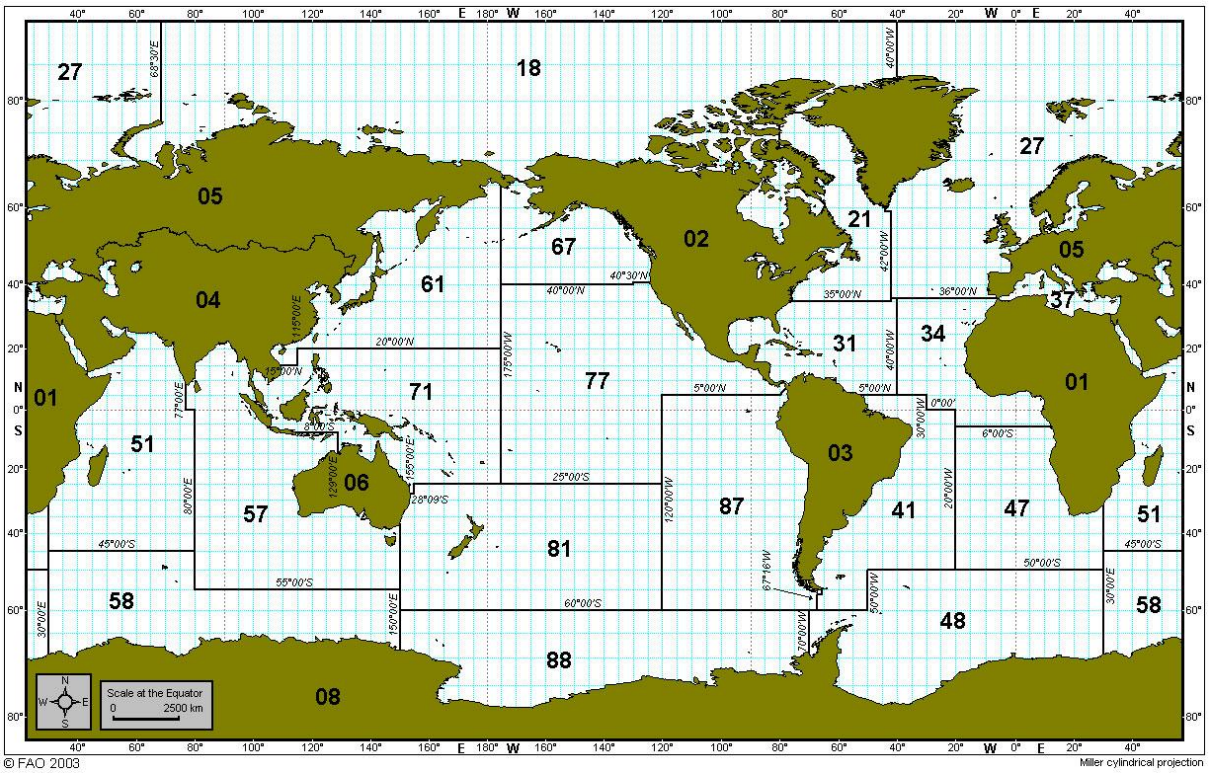



Figure 2 shows the boundaries of the Atlantic Northeast (Major Fishing Area 27) corresponding to the ICES fishing areas for statistical purposes. Figure 3 shows the detailed boundaries of the ICES subdivisions IV, V, VI, VII and VIII.

Figure 2 Atlantic Northeast Fishing Area (FAO Major Fishing Area 27)

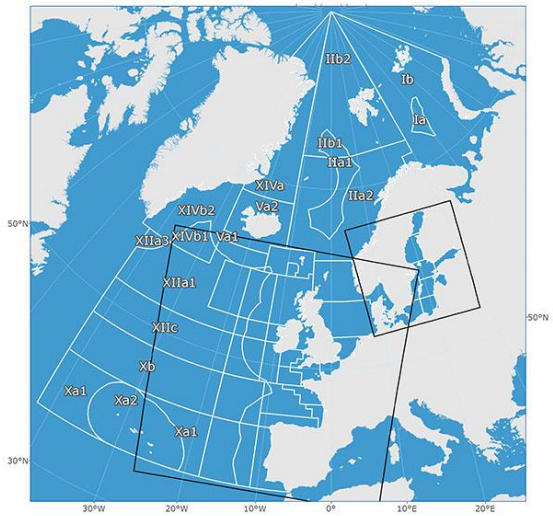
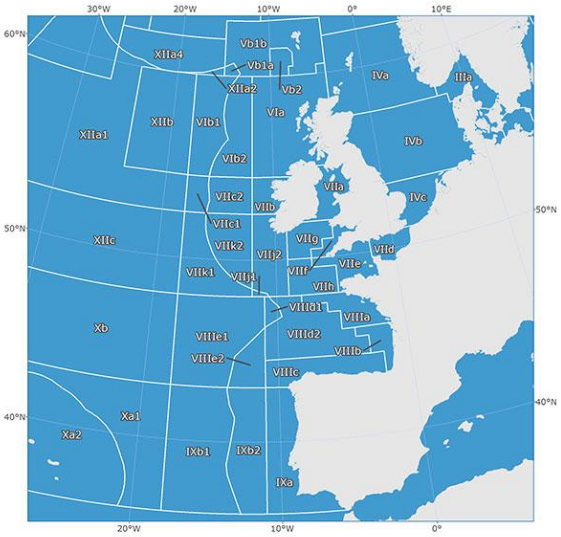



Figure 3 ICES subdivisions of the Atlantic Northeast fishing area




*2.7.2 Production*

The NEA fishery is the most important fishing area in the EU, counting for 71% of catches in 2014 (Eurostat 2016). It's the logical consequence of the most important European coastline length. Fishing pressure is the most widespread in the N-E Atlantic region, with demersal fish stock (plaice, cod, haddock) coming under significant strain. In addition, fishing affects habitats and seabird populations (Turner 2011). But there is already a number of existing innovations (discards and bycatch regulation, changes in quotas, new aquaculture feeds, FCP…)



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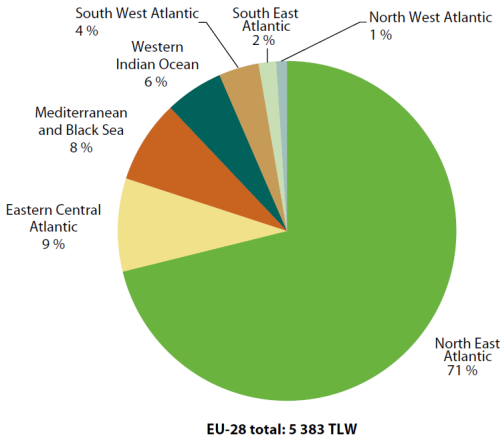
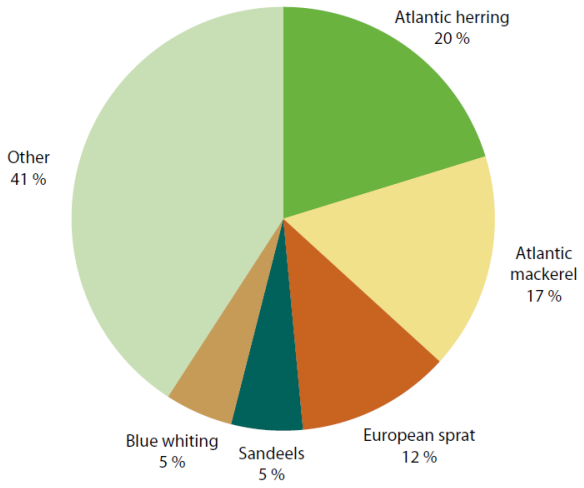
The five most popular species caught by EU Member States in 2014 in this area are Atlantic herring (one fifth of the total catch), Atlantic mackerel (17 %), European sprat (12 %), sandeels (5 %) and blue whiting (5 %). These top five species made up 59 % of the EU North East Atlantic catch in 2014 (Eurostat 2016).

Figure 4 Catches by fishing area, EU-28, 2014 (Unit: 1,000 tonnes live weight, %)




Eurostat (2016)

Figure 5 Top 5 species caught by EU Member States in the North East Atlantic, 2014 (%)




Eurostat (2016)



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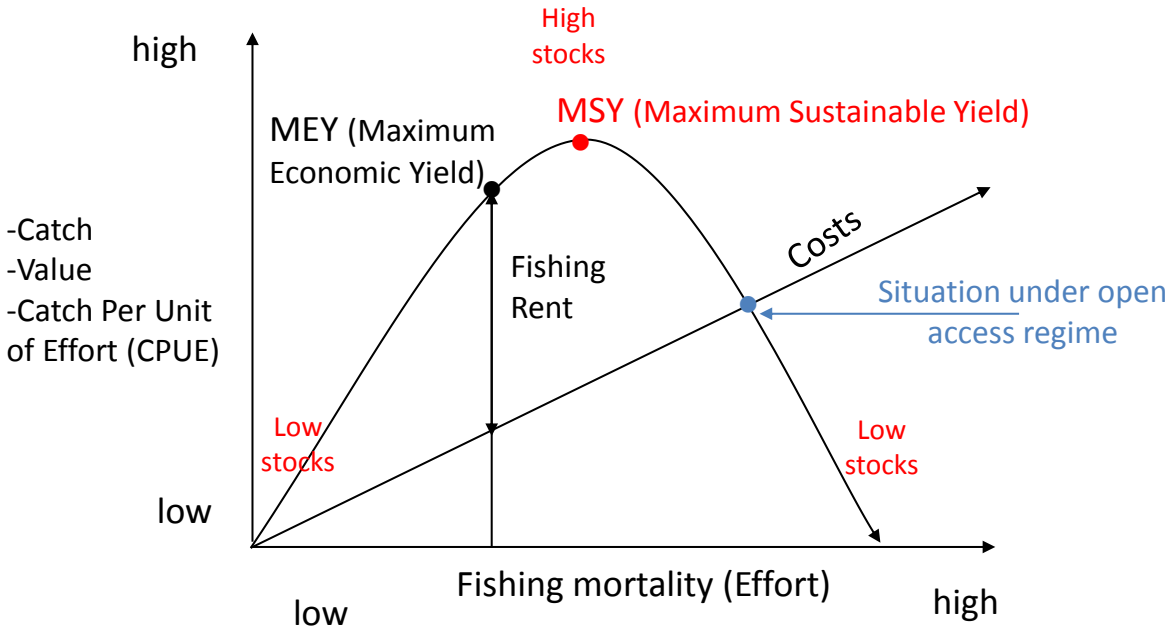
## 3. Mapping the fisheries system

### *3.1 Sustainable Fisheries – From Sustainable Yield to Sustainability*

From the EC MSFD Directive perspective Fisheries are addressed through the overexploitation issue. This translates the main concern attached to fisheries from the beginning of conventional fishery management and the lack of initial consideration for biodiversity and interactions with coastal economies and communities, despite the acknowledgement of the sustainability concept in fisheries. Primarily focusing on the level of harvested fish considered as a sustainable yield from the single-species concept approach, fishery management first addressed catch limitations and fishing effort restrictions. Expressed in terms of Maximum Sustainable Yield (MSY) and the related Total Allowable Catch (TAC), conventional fishery management was limited in terms of interaction with the broader marine ecosystem.

For fisheries policy and management purposes, the concept of Maximum Sustainable Yield (MSY) is well established and integrated into the UN Convention on the Law of the Sea, the UN Fish Stocks Agreement and the FAO Code of Conduct for Responsible Fisheries (FAO). The MSY defines a level of catches so that fishing mortality remains below or at this level of catches in order to ensure the stock abundance (Figure 6). Nevertheless, the MSY approach ignores multispecies and ecosystem interactions (FAO 2016).

Figure 6  Model of surplus production as a function of fishing effort showing the major reference points (MSY and MEY)




It is to note that a lower effort level than the MSY produces a maximum economic yield (MEY). MEY is built on evaluating only the revenue and cost structure for the fishing fleet, but according to Christiansen (2010), if the overall fishing sector is included (processing, distribution and marketing) MEY moves closer to MSY.

Beside the solely Total Allowable Catch (TAC) and its related quotas management which form the traditional fishery management, these assumptions have also led, for some of the fish stocks, to a management based on a precautionary approach, through the Harvest Control Rules. Figure 7 indicates how the principle is implemented in the cod fisheries management proposed by the International Council for the Exploration of the Sea (ICES). Fleet overfishing is the bioeconomic overfishing (fleet is no more profitable).

Figure 7 Visualization of a Harvest Control Rule (HCR) specifying when a rebuilding plan is mandatory in terms of precautionary and limit reference points for spawning biomass and fishing mortality rate.



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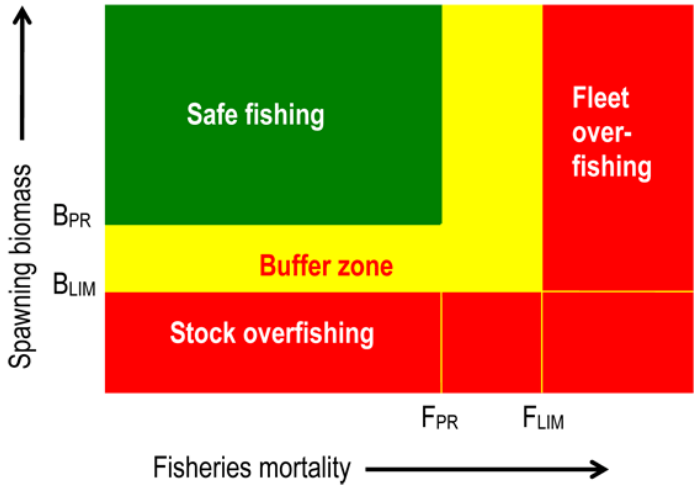


From Arnejohs 2006

The fishery's ideal state is in green where the fleet can fish at the target mortality rate ($F_{PR}$). The yellow buffer zone is the precautionary state. The buffer zone between $B_{LIM}$ and $B_{PR}$ is the rebuilding phase of biomass where fishing mortality should be reduced to reach the $F_{PR}$ target. Finally the red area is the state to avoid where fishing should be suspended (spawning stock biomass below $B_{LIM}$).

To address sustainability in fisheries, two main approaches were implemented, one focusing on the state of the system (abundance of fish, fishing pressure, quality of nutrition, profitability…) the other focusing on the management of the system (is the management system able to monitor changes in the state of the resources and able to take effective responding actions, is it able to reduce fishing pressure if stocks decline and allow recovery, is it able to increase incomes in case of poor incomes… (FAO 2016)). But as quoted by Charles (2005), "*this conception of fishery sustainability places too much attention on physical and economic outputs from the fishery and too little on sustaining key processes underlying the fishery"* (health of ecosystem, integrity of ecological interactions, social, cultural, economic and institutional components of fishery).

The Ecosystem Approach to Fisheries (EAF) *builds on conventional fisheries management but broadens its scope by taking into account social and economic aspects of sustainability* (FAO 2016). It is similar for the Ecosystem Approach to Aquaculture (EAA) which integrates a planning and management framework to integrate aquaculture in local planning, from a carrying capacity and conflicts use point of view. Nevertheless, both

remains insufficiently integrated with the human system, focusing on those doing the fishing or farming and neglecting the social and economic environment around the fishers and farmers. As a consequence, the last development of approaches in fisheries sustainability calls for "a full integration of fisheries and aquaculture into Ecosystem-Based Management or Integrated Coastal Zone Management" (FAO 2016), combining multisectoral and sectoral (EAF/EAA) approaches. This translates a focus on healthy ecosystems and human systems with multiple objectives: a balance of resource conservation and human concerns.

There was then a need to encompass these limits in what Charles (2005) calls "a bigger picture" by understanding and managing fisheries in the context of marine ecosystems and coastal human systems (Charles, 2005) and calling for a fishery system approach. A fishery system approach where both the ecosystem side (dealing with ecosystem impacts and going beyond of individual fish stocks, e.g. Ecosystem Approach) and the human side (integrating the interactions of fishery management with the social, institutional and economic environment of fishers, e.g. Livelihoods Approach) of fishery are taken into account. Fisheries and aquaculture then need to be considered within a system or region as well as their possible interactions with ecosystems or marine users (Micheli, 2014).

### *3.2 The fishery system*

The fishery system can then be mapped from the initial stocks and fleet interaction concerns and then extended to the other dynamics (fishers), the whole value chain, non-target species, habitats and the socio-economic environment of fishing communities and households (Figures and ).

Figure 8 depicts the rationale behind sustainable yield through a oversimplified view of the fishery system: fish are in the sea and fishers on boats catching and selling them. This conventional management focuses on a target fish stock and fishers catching that stock (e.g. managing the fishery through TAC). But in stock exploitation context it also crucial to maximize the benefits to society produced from each fish caught and then to pay attention



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to the post-harvest sector and the broader socio-economic environment. These additional interactions are captured by Figure 9 which integrates time underlining different dynamics between fish stocks (recruitment and mortality), fleets (investment and depreciation) and fishers and incorporate interactions with the other elements of the ecosystem and human system. The multidimensional benefits also feedback to the natural and human components of the system.

Figure 8 The interactions between a stock and a fishing fleet.

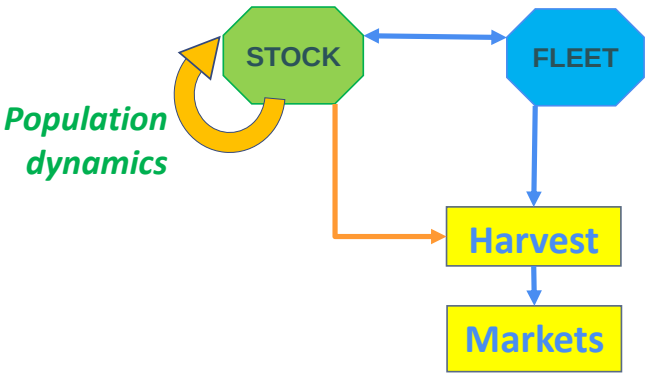
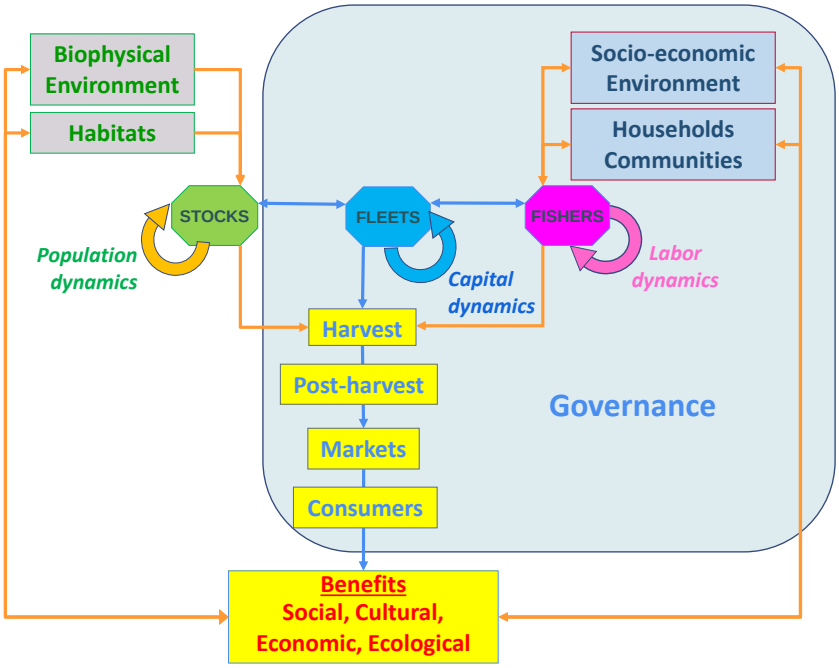



Figure 9 A view of a fishery system



Modified from Garcia (2016) and adapted from Charles (2001)

Fishery system appears as a complex adaptive system with a diversity of actors. But one of the most important shortcomings in this representation is the important difficulty and almost impossibility to forecast the reaction of fishers and farmers to new management options and constraints.

A series of six subsystems can then be identified (Figure 10): the Resources subsystem taking into account the interaction of the stock with its ecological environment (population dynamics, habitats, trophic chains and networks); the Production or harvesting subsystem figuring the fishing effort and production system for fishery and aquaculture (structure of the fleet and its dynamics, fishing gears, level of intensification of farms, settlements); the post-harvest, processing and retailing subsystem playing a role between the harvest and the market; the Trade subsystem characterizing the trade of seafood products to markets and consumers (international exchanges, supply and demand, properties of markets, prices of substitutes…); the Communities subsystem focusing on the interactions between actors and within the human system: fishers and farmers interacting with one other through their organization or fishing/farming technology, with their socioeconomic environment (demographic, sociocultural, economic and institutional); the last subsystem is the governance one encapsulating the other subsystems.



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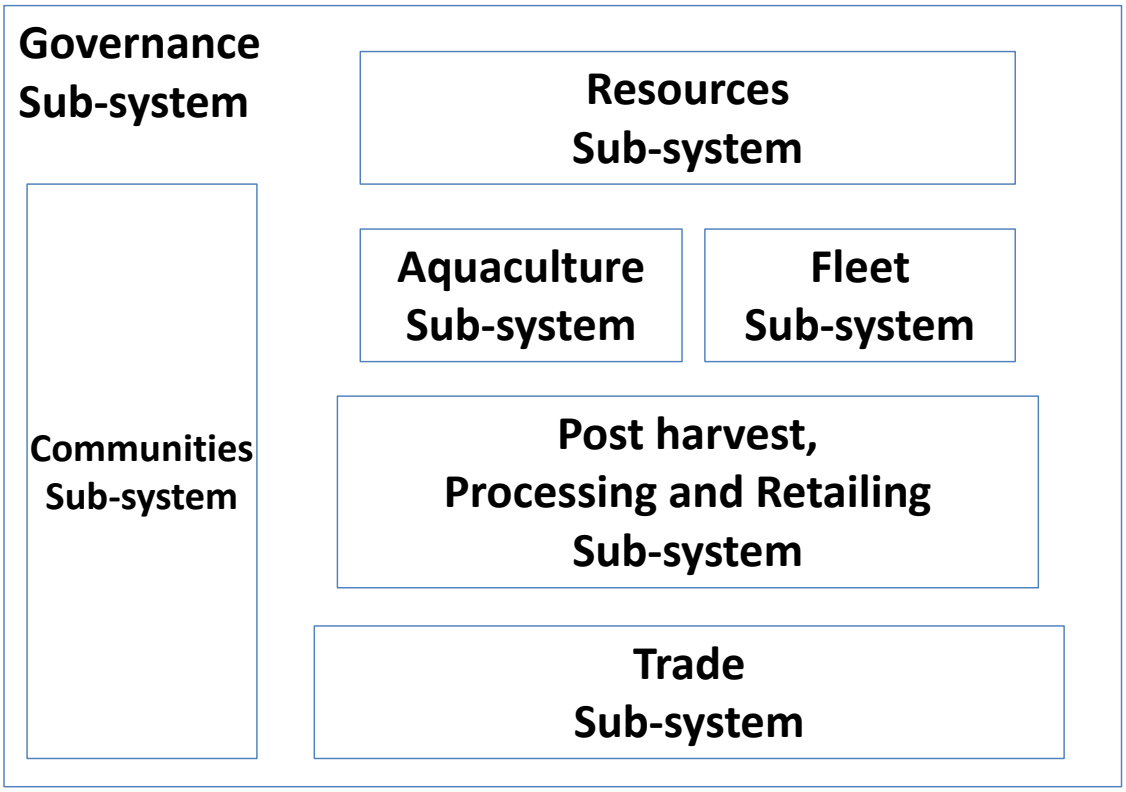
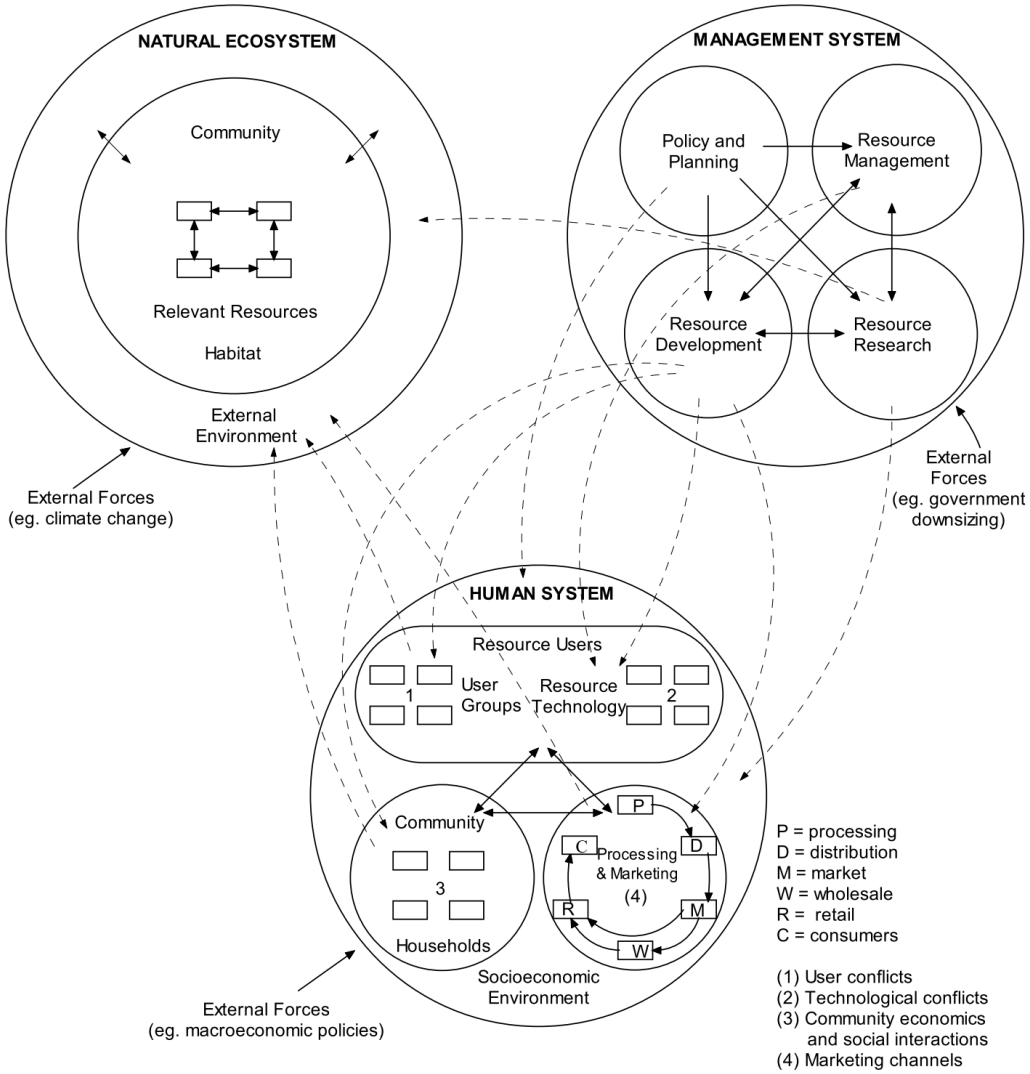
Figure 10 The subsystems of the fishery system




If beyond flow chart diagram, other alternatives exist to represent the fishery system such as pictures or strategic mapping, Charles (2001) proposed a more comprehensive and complete view of the fishery system. Figure 11 contains the idea of the fishery system, its structure and dynamics.

Figure 11 The fishery system, showing the structure of the three major sub-systems (natural, human and management), the major components within each of these, and the key interactions between sub-systems and their components. Also indicated are the impacts of external forces on each part of the system. (Charles 2001).




From Charles (2001)



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Fisheries system underlines a complex sectoral system, containing human as well as biological dimensions. The issue is then to derive a mapping that is enough simple but not simpler and as complex as needed without being too complex. This balance is also a function of the scales of the natural, human and management systems to be addressed.

*Characterizing the fishery system*

If there're common features to different fisheries, the important diversity between and within fisheries systems makes difficult the mapping exercise. Several factors are then important to characterize fisheries and aquaculture:

- the spatial scale both geographically and administratively (coastal vs. deep sea, local to regional and national, regional multinational organizations)
- the dimension of fishery systems: large scale fisheries and small scale fisheries
    - artisanal vs. industrial
    - fishing areas (coastal vs. offshore)
    - different nature of objectives, distribution of economic benefits and production systems:
        - food production vs. export production
        - local fall out and relation to the socio-economic environment
        - local fisheries turned to local and specific markets vs. market driven fisheries turned to export
        - labor intensive vs. capital intensive
        - relations to communities
    - different nature of ownership (individual, family, corporate)
    - fishing rights
    - perception of the activity
- the type of ecosystem and physical environment
- the nature and behavior of fishers and farmers (organization, specialization, gears and practices, species targeted…)
- the socio-economic environment

*Constraints regarding the North East Atlantic (NEA) fishery system*

The NEA fishery illustrates the huge diversity of fisheries and aquaculture over that scale. It mixes different environmental systems and ecosystems as well as different socio-economic environments and covers several regional seas. It is also the case for fleets and stocks reflecting the cultural and economic differences in fishing and farming practices.

Landing, processing and distribution areas strengthen again this diversity and induce internal exchanges within the EU and the EEA in terms of exports and imports, beyond of external exchanges between the NEA fishery and other systems ("the remaining world").

This important diversity calls for a more simplistic representation of the NEA fishery system to overpass the complexity driven by the multidimensional nature of fishery and scales.

In the following attempt to represent the NEA fishery system, several issues related to fisheries and aquaculture are not taken into account: the recreational component is not addressed as well as the integration of Marine Protected Areas as management tools. The scale of the analysis is the EU. Only marine and coastal aquaculture are taken into account, inland and freshwater aquaculture are excluded.

### *3.3 The NEA fishery system*

The NEA fishery can first be roughly described or mapped in a synthetic way in order to have a global view of systems components, interactions, activities and actors (Figure 12). Actors are expressed according to the following typology:

**Direct actors:** individuals or organizations whose activities explicitly entail physical, chemical or biological disturbances of the environment

**Indirect actors:** individuals or organizations influencing the pressure on the environment by using products or services causing environmental disturbances (Sundblad, 2014)

**Supporters actors:** services provided by various actors who never directly deal with the product



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**Governance ("influencers") actors**: Regulatory framework, policies, infrastructures. People, organizations and institutions responsible for setting up and managing the regulatory framework

Actors of the NEA fishery system

| Direct actors | Indirect actors | Supporters | Influencers |
|---|---|---|---|
| Primary Producers:<br>- Fishers<br>- Farmers | Secondary producers<br>- primary processors<br>- secondary processors)<br>Middlemen and brokers | | NEAFC<br>NGOs |

**Actors**

Regional Fishery Bodies (RFB): the North East Atlantic Fisheries Commission

(RFBs are a group of States or organizations that are parties to an international fishery arrangement – work together towards the conservation and management of fish stocks).

Other organizations involved over the NEA

CCAMLR / FAO / ICCAT / ICES / IOTC (imports of catches from European fishing vessels) / Naf-Format / NAFO / NASCO / Nordic Council of Ministers / OSPAR / SEAFO / TUNA-ORG

Fisheries Professional Organisations (Fishermen and farmers organizations):

EATIP, FEAP

*Actors' identification to be placed at the end of subsystems*



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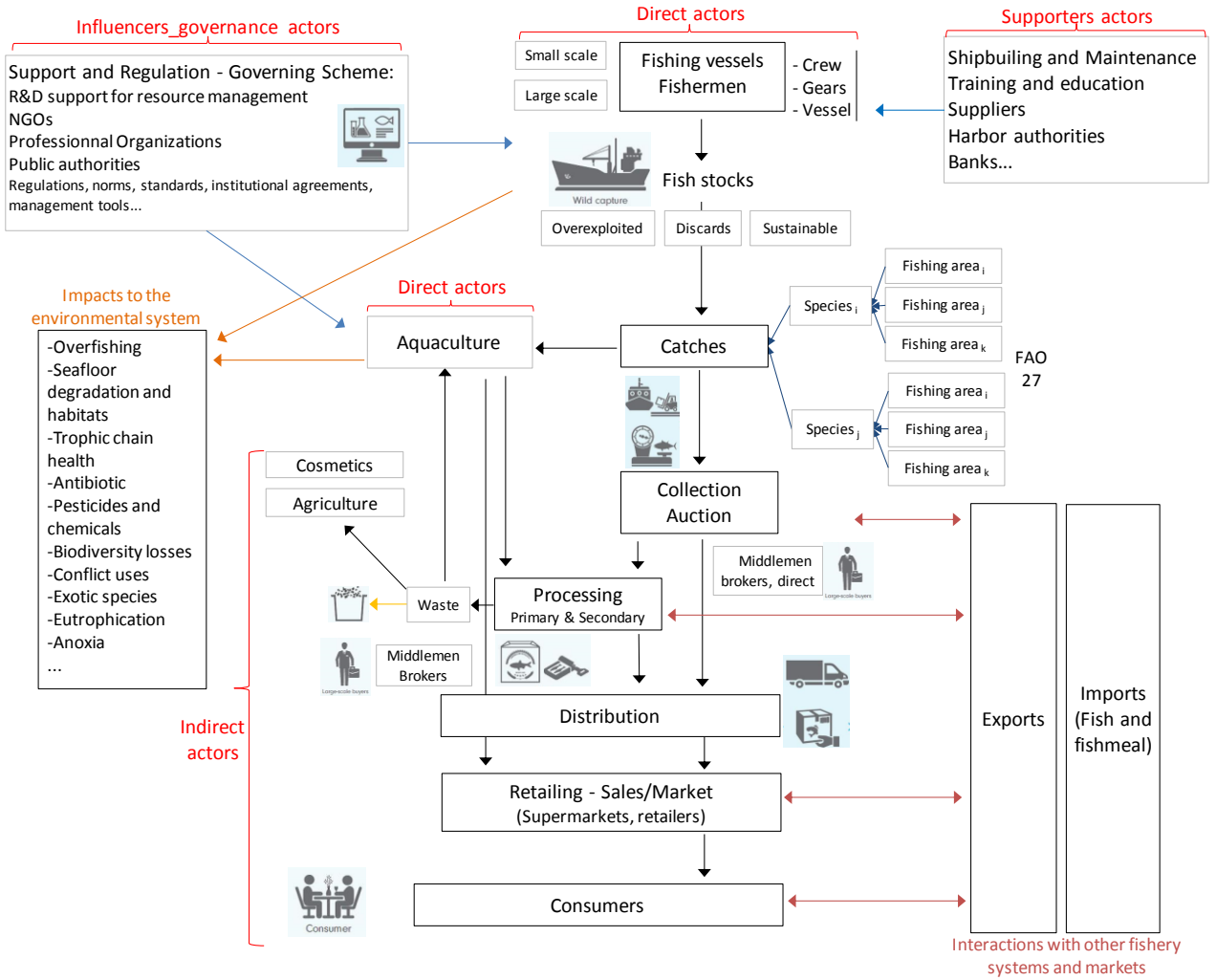
Figure 12 Global overview of the NEA fishery system



This preliminary overview of the NEA fishery system can be detailed according to three subsystems: the production and trade subsystem, the physical and ecological system and the management subsystem. The social and human subsystem, through the fishing communities especially, is not detailed hereafter according to the focus on ocean's health improvement.

*3.3.1 The production and trade system*

The NEA fishery production and trade system is mapped on Figure 12. Intra-EU trade between NEA fishing area's products and other EU fishing areas' products is not represented (no possible identification in databases).

*Description of catches, landings and harvests over the NEA*

*Processing sector: as usual data according to administrative scale and difficulties in rebuilding at the scale of NEA (fleet, processing sector, etc.).*

*Economic performance of the processing sector will be addressed through the EU average; for employment according to the share of catches of NEA in the total EU. Data from Eurostat and STECF. See also EUMOFA. No real meaning for the fleet (different countries, gears, species…).*



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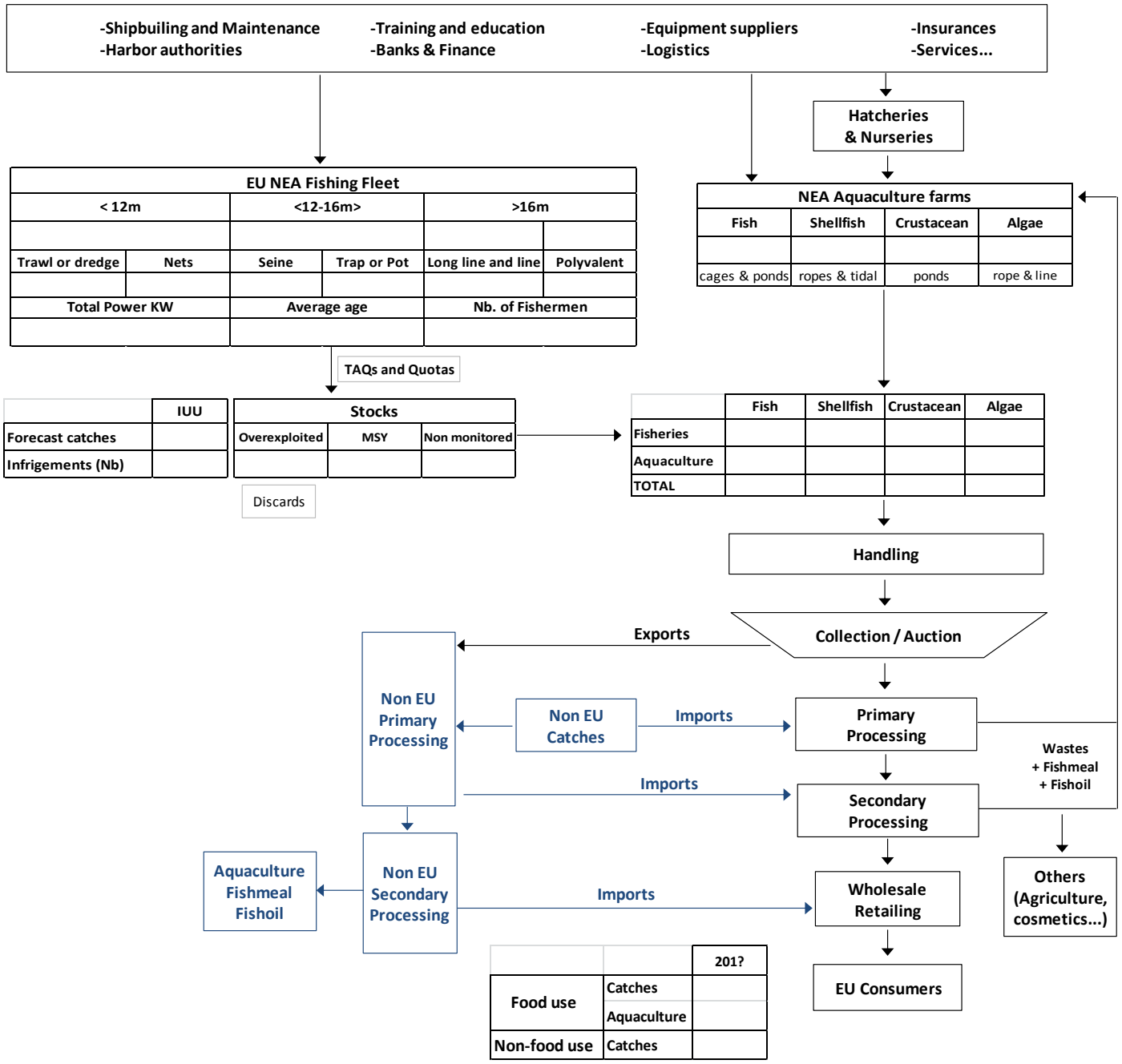
Figure 13 The NEA Fishery production and trade system




(Figure to be updated with statistics and value chain indicators)

In the fishery industry, added value is usually brought through handling, preservation and processing. Handling is a preprocessing aiming at delivering catches or harvests to the next segment of the value chain under good conditions from a sanitary and quality point of view (fresh and undamaged products). Handling (including sorting and grading) can take place on fishing vessels or in farms as well as primary and secondary processing for large scale fishery and farming. But handling and processing can also take place elsewhere (on a mother boat collecting catches avoiding fishing vessels to transit for landing in harbor, or in inland infrastructures).

EU catches and harvests can be processed within the EU or outside the EU. Most of seafood processed within the EU remains in the EU. In 2013, 80% of the EU processed fish products are directed to internal consumption (EUMOFA 2015). There're two dimensions in the European seafood trade: the Extra-EU trade and the Intra-EU trade. From 2014, EU has become the first seafood product importer, making up 24% of the total value of world trade (Figure 14).

Figure 14 Main trade flows of fishery and aquaculture products in the world (2014)



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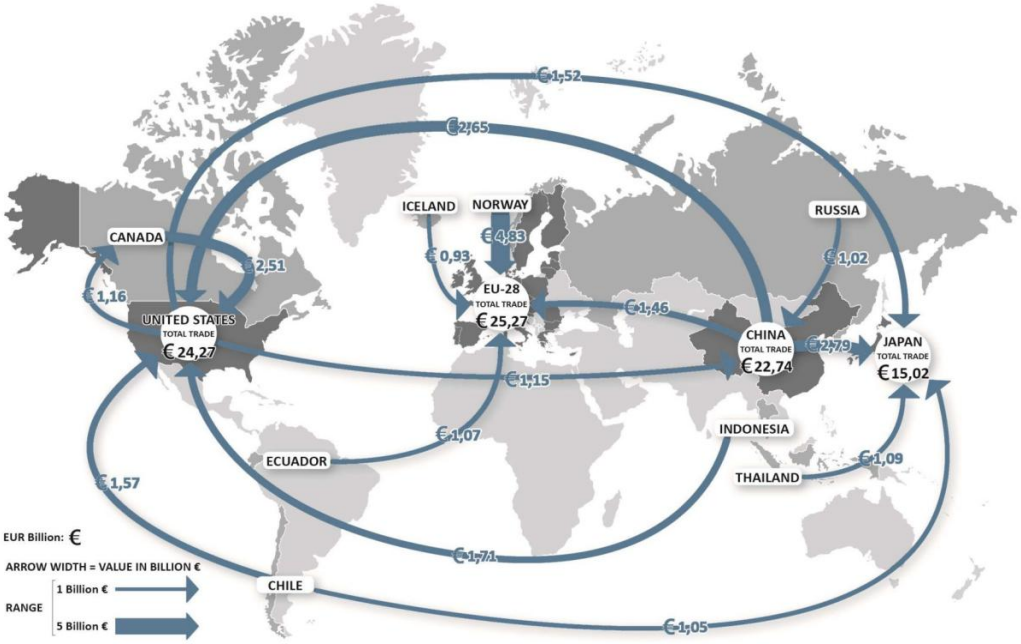


Source: EUMOFA – GTIS

But European raw materials (catches and harvest) can also be exported for processing. Once semi-processed or processed they can be imported to Europe where there had been initially exported. This is for instance the case for part of the Norwegian salmon (aquaculture) and cod (fisheries) production fileted in China and imported to Europe for secondary processing.

Finally intra-European imports and exports also take place between EU member States. Trade between EU Member States is the most important in the whole EU fishery trade. In 2014, it accounted for 86% of the total trade within and outside the EU (EUMOFA 2015). Salmon represents 11 of the 15 top flows within the EU in value. Denmark and Sweden act as trade hubs for Norwegian salmon exports to the EU.

## 4. Areas of changes

A number of factors and incentives can drive changes through the fishery system in general. Changes may occur either through demand and supply, but also through a combination of these drivers to change.

### 4.1 Drivers of change on fish demand

Demand is of course driven by price, income, income distribution, substitutes, tastes or regulation, but demographics characteristic are also key factors affecting the fish demand.

- **Demographics:** population growth rate, age distribution, but more specific factors can drive changes in the demand
    - Ethnicity: socio-cultural values, religious concerns, attitudes
    - Literacy: literacy rate about food safety and quality, sustainability concerns, stocks depletion, social responsibility
- **Consumer preferences:**
    - Price, quality, convenience, year round availability (Aquaculture vs. Catches) and regular supply (seasonality makes consumers to search for substitutes);
    - Variety and nutritional content (Omega 3), food safety
    - Environmental friendly products (consumer awareness through eco and organic labels, MSC)
    - Fair trade: fair trade label calling for social responsible behavior of companies
- **Buyer specification:**
    - Volume, presentation, labeling (origin, traceability), private standards and certification
    - Technology: marketing information systems, management of fish categories (fresh, processed…), supply chain management (exports, processing…), transport and handling
- **Regulatory changes:**
    - Official standards and associated certification: regulations (fishing gears, effort controls, close seasons, controls…), voluntary standards (MSC, eco-labels, organic labels), Code of Conduct
    - Labeling regarding nutrition, country of origin, allergens
    - Environmental protection (biodiversity, habitats) through agreements, treaties and policies
- **Market access** (trade barriers)
- **Distribution and retailing**: energy, transport and labor are key factors cost in distribution and retailing
- **Economic growth**: GDP, disposable income, wealth distribution are key elements to sustain the fish demand especially in developed countries that are the main outlets for fishery products.



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### 4.2 Drivers of changes on fish supply

Supply is driven by a more limited number of factors, some being the same than for demand such as prices or season, other being different such as climatic conditions. But rather than fishery products property (from raw fish to semi-processed and processed products), they will mainly characterize or depend on relationships between interacting enterprises and sectoral branches of the supply chain.

- **Product and Market conditions**: market demand, climatic conditions, stocks dynamics, inputs prices (fuel mainly), trade policy or legal environment will impact the fish supply. As a perishable product, market price is also an indicator of the quality of fish.
- **Procurement practices**: research, traceability, ethics and environment are key factors to improve responsible fish trade. This can go along with integration, private or corporate standards and arrangement strategies within the supply chain.
    - Availability for production and shipping: infrastructures development is one of the major factors to reduce trade costs
    - Producer preference: fishermen have to bear all investment regarding fishing vessels and gears, as well as price volatility. It generates some incentives to overfishing. This is similar for aquaculture where farmers tend to overstock for the same reasons. It also impacts their choice in terms of gears and practices.
    - Technology: technology is one of the most important factors that will drive changes in producers' behavior. Its availability and substitutability at profitable levels can deeply reorient the supply chain strategy and its production. Technological choice can be also mandatory (regulatory change to cope with new standards, legal restrictions on inputs use, etc.) or constraint by the socioeconomic context (availability of seasonal labor, availability of fisheries labor forces, etc.). Subsidies are a key lever to adopt or constraint changes in technology. Certain forms of fisheries subsidies can contribute to overcapacity and overfishing through the increase of fishing effort.

### 4.3 Labels and standards

Among the drivers to changes, standards and labels are common to both side of the chain (supply and demand), even if different in terms of implementation and goals. If some drivers to change are exogenous to the industry on short term (e.g. some input prices, climatic conditions), labels and standards are drivers that can be designed, managed and applied of the fishery system. They can apply to both value and supply chains, to producers and consumers. They can be negotiated or imposed unilaterally, public or

private and offer a wide range of implementation. Other such drivers and the most important ones are regulations. But being rather imposed and the last option in case of failure in implementing win-win agreements, the focus will bear over the labeling and standards.

There is a number of seafood guides, ecolabels or certification schemes aiming at informing stakeholders along the value chain. Table XX lists the main certification and recommendation lists in the field of fisheries (catches) and aquaculture.



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Table XX Comparison of seafood certification and sustainability assessment programs (Micheli 2014)

| Program | Certification or recommendation list | Wild-caught or aquaculture | Stock status | Stock welfare | Seafood safety and quality | Ecosystem impacts | Energy considerations and pollution | Socioeconomic considerations | Management systems | Website |
|---|---|---|---|---|---|---|---|---|---|---|
| Aquaculture Certification Council | Certification | A | X | X | X | X | X | X | X | www.aquaculturecertification.org |
| Blue Ocean Institute | Recommendation list | W, A | X | | X | X | X | | X | www.blueocean.org/programs/sustainable-seafood-program/seafood-choices |
| Environmental Defense Fund | Recommendation list | W, A | X | | X | X | X | | X | www.edf.org/page.cfm?tagID=13201 |
| FishWise | Recommendation list | W, A | X | | X | X | X | | X | www.fishwise.org/science/assessment-methods |
| Food & Water Watch | Recommendation list | W, A | X | | X | X | X | X | X | www.foodandwaterwatch.org/fish/seafood |
| Friend of the Sea | Certification | W, A | X | | | X | X | X | X | www.friendofthesea.org |
| Greenpeace | Recommendation list | W, A | X | | | X | X | X | X | www.greenpeace.org/international/en/campaigns/oceans/seafood/red-list-of-species |
| Marine Conservation Society | Recommendation list | W, A | X | X | | X | X | | X | www.fishonline.org |
| Marine Stewardship Council | Certification | W | X | | | X | | | X | www.msc.org/about-us/standards/standards |
| Monterey Bay Aquarium Seafood Watch Program | Recommendation list | W, A | X | | | X | X | | X | www.seafoodwatch.org |
| New England Aquarium | Recommendation list | W, A | X | | | X | X | | X | www.neaq.org/conservation_and_research/projects/fisheries_bycatch_aquaculture/sustainable_fisheries/corporate_partners/methods_and_criteria_for_evaluation.php |
| Sea Choice - Canada | Recommendation list | W, A | X | | X | X | X | | X | www.seachoice.org/seafood recommendations/seachoice methodology |
| Sustainable Fisheries Partnership(Fish Source) | Assessment of fisheries status | W | X | | | X | | | X | www.fishsource.org/faqs |
| World Wildlife Fund (WWF) | Recommendation list | W, A | X | X | | X | X | X | X | www.panda.org/what_we_do/how_we_work/conservation/marine/sustainable_fishing/sustainable_seafood/seafood_guides |

Modified from Micheli et al. 2014

In addition to certification, a number of seafood guides are targeting consumers in order to influence their preferences. Table XX lists the main seafood guides towards consumers in the EU and Norway.

Table XX List of European seafood guides toward consumers

| European country | Seafood guide name | Authors or Institution | Note |
|---|---|---|---|
| | | | |
| Netherlands & Belgium | **De Goede Vis Gids** | Stichting De Noordzee | in Dutch, French version |
| | **Vis-a-Card** and **Maak Schoon Schap** | Greenpeace Nederland | Printable credit card sized card and booklet(in Dutch) |
| United Kingdom | **Pocket fish purchasing guide** | Marine Conservation Society | Extensive purchasing guide |
| | **International seafood red list** | Greenpeace UK / International | Illustrations of what not to buy and better buys |
| Sweden | **WWFs Fiskguide – din guide när du ska köpa miljövänlig fisk (seafood guide)** | WWF Sweden | Printable credit card sized (in Swedish) |
| EU | **A pocket guide to the EU's new fish and aquaculture consumer labels** | European Commission | |



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| | | | |
|---|---|---|---|
| Finland | **Seafood Guide** | WWF Finland | in Finnish |
| France | **Et ta mer t'y penses?** and **Pêche: Conduites Dangereuses** | Greenpeace | in French |
| | Guide de poche | WWF France | in French |
| Germany and Austria | **WWF-Einkaufsratgeber Fische & Meeresfruchte (seafood guide)** | WWF Germany and Austria | Annotated purchasing guide (in German) |
| Switzerland | **Seafood Guide (German)** | WWF Switzerland | Guide in French, German and Italian |
| Norway | **Sjømatguide (Seafood guide, Norwegian)** | WWF Norway | Also a printable credit card sized (in Norwegian) |

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Turner et al. 2011

http://www.un.org/sustainabledevelopment/wp-content/uploads/2016/05/16-00055n_Why-it-Matters_Goal-14_2p.pdf

Arnejohs 2006, https://en.wikipedia.org/wiki/File:HCR.gif

The Our Oceans Challenge (OOC) partner network consists of influential companies committed to generating innovative business models that promote clean and healthy oceans, not only by providing financial support but by sharing expertise and know-how with entrepreneurs and start-ups.

# Appendix

## DPSIR indicators to inform the Fishery System

Aside catches, most of variables in public databases able to inform the D, P, S, I or R states of the Fishery System are not available at the scale of ecosystems, regional seas or fishing areas, but at the scale of countries or infra administrative levels (NUTS levels).

### Set of indicators and variables to inform the DPSIR fishery system

| | Indicators | Variables |
|---|---|---|
| **Drivers** | Consumer Demand | Fish consumption per capita |
| | Employment in the fishery sector | Employment on board |
| | Subsidies | Subsidies |
| | Contribution to GDP | % of the total GDP |
| | | Per capita GDP |
| **Pressures** | Fishing effort | Vessels power |
| | | Days at Sea |
| | | Energy consumption |
| | Fleet size | Fleet Number |
| | | Fleet vessels tonnage |
| | Investment | Investment in physical capital |
| | Fish catch | Landings |
| **State** | Income | Landed value |
| | Catch | Catch per unit effort |
| | Exploitation Status of fish stocks | Number of overfished stocks |
| | Fish abundance | Biomass of commercial species |



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| | | |
|---|---|---|
| **Impacts** | Change in net revenue | Net revenue |
| | Change in jobs | Employment in fishery sector |
| | | Employment on board |
| **Responses** | Quota management | Quota |
| | Fisheries restructuring | Numbers of vessels within specified categories (overall length, engine power or type of gear in use) |
| | Expenditure on fish stock monitoring | Expenditure on fish stock monitoring |
| | Taxes | Taxes |
| | Buy-back | Expenditure on buy-back |

Modified from Turner (2011)

Data sources and information regarding the DPSIR indicators and variables for the fishery system

| Indicators | Variables | Unit of measurement | Level of aggregation | Data sources | Notes |
|---|---|---|---|---|---|
| **Drivers** | | | | | |
| Consumer Demand | Fish consumption per capita | kg | By group of fisheries commodities and processed products | FAO Fisheries statistics and information department | Indicator of the demand of consumer on seafood |
| Employment in the fishery sector | Employment on board | Full-time Equivalent (FTE) | Total employment in fishery sector in each country | -Eurostat New Cronos database, Agriculture and fisheries, EAUF<br>-FAO FishStatJ | |
| Subsidies | Subsidies | USD/Euro | By sub-sectors/fleet/fishery | Sea Around Us Project (SAUP) subsidies database | |
| Contribution to GDP | % of the total GDP | % of the total GDP | By country | Eurostat | % of the total GDP contributed by fishing sector in each country |
| | Per capita GDP | Euro per inhabitant | Annual GDP per inhabitant in each country | Eurostat | |

| Indicators | Variables | Unit of measurement | Level of aggregation | Data sources | Notes |
|---|---|---|---|---|---|
| **Pressures** | | | | | |
| Fishing effort | Vessels power | Horse power per year | By country, By fishery segment | International Council for the Exploration of the Sea (ICES): http://www.ices.dk/<br>Sea Around Us Project (SAUP) database | |
| | Days at Sea | Days | By country, by fleet | Economic performance of selected European fishing fleets, Annual Report | |
| | Energy consumption | Litres | By country, by fleet | Sea Around Us Project (SAUP) database | |
| Fleet size | Fleet Number | Number of | By country, by type | Eurostat, DG MARE, Blue | Excess |



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| | | | | | |
|---|---|---|---|---|---|
| | | vessels | of vessel | Plan | capacity may lead to overfishing |
| | Fleet vessels tonnage | total tonnages | By country, by type of vessel | Eurostat, DG MARE, Blue Plan | |
| Investment | Investment in physical capital | Euro | By country, by fleet type | FAO<br>Eurostat EAUF | |
| Fish catch | Landings | Tonnes | Annual catch by country, species or higher taxonomic level, FAO major fishing areas | FAO FishStatJ<br>ICES<br>Eurostat EAUF | |

| Indicators | Variables | Unit of measurement | Level of aggregation | Data sources | Notes |
|---|---|---|---|---|---|
| **State** | | | | | |
| Income | Landed value | EUR/USD | By country, by species or higher taxonomic group, fishing fleet | Economic performance of selected European fishing fleets, Annual Report, Sea Around Us Project SAUP | |
| Catch | Catch per unit effort | Tonnes/horse power | Catch per unit of effort | ICES, FAO FishStatJ, Eurostat | |
| Exploitation Status of fish stocks | Number of overfished stocks | Number of species | | ICES | |
| Fish abundance | Biomass of commercial species | Tonnes | By species or higher taxonomic group | ICES | Indicator of the state and size of spawning stock |

| Indicators | Variables | Unit of measurement | Level of aggregation | Data sources | Notes |
|---|---|---|---|---|---|
| **Impacts** | | | | | |
| Change in net revenue | Net revenue | EUR/USD | By country, by species or higher taxonomic group, fishing fleet | FAO, Economic performance of selected European fishing fleets, Annual Report, SAUP | Landing value – variable cost |
| Change in jobs | Employment in fishery sector | Number of employees | Total employment in fishery sector in each country | Eurostat New Cronos database, Agriculture and fisheries | |

| | | | | | |
|---|---|---|---|---|---|
| | | | | Economic performance of selected European fishing fleets, Annual Report (2005, no update) | |
| | Employment on board | Full-time Equivalent (FTE) | Total employment in fishery sector in each country | Economic performance of selected European fishing fleets, Annual Report (2005, no update) | |

| Indicators | Variables | Unit of measurement | Level of aggregation | Data sources | Notes |
|---|---|---|---|---|---|
| **Responses** | | | | | |
| Quota management | Quota | Weight of fish (Tonnes) | TAC per area and season | EC DG MARE | |
| Fisheries restructuring | Numbers of vessels within specified categories (overall length, engine power or type of gear in use) | Number | By countries, fleet type | Eurostat EAUF, FAO | Number and size of vessels is a direct measure of fishing effort |
| Expenditure on fish stock monitoring | Expenditure on fish stock monitoring | Euro/USD, days at sea for research vessels, area covered by monitoring survey | By country | EC DG MARE | Indicate how much money each country is invested to ensure managemen t measures are followed. |
| Taxes | Taxes | EUR | By country | | |
| Buy-back | Expenditure on buy-back | EUR | By Country | | |



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# Annex II – The value chain for invasive species in the Mediterranean Sea

***Stage 1: Identification and first screening of economic sectors attached to the key story***

This section analyses the segments of the economy which are mainly responsible for the phenomenon of IAS in the seas, according to the value chain approach as described in (ResponSEAble D2.1, 2016). The service, which is at the centre of the analysis, is the transportation of persons and goods through vessels. This activity has been recognized as the main cause for introducing and spreading IAS. Following the value chain upstream and downstream, the analysis identifies other economic sectors and activities supporting the water transportation industry in various ways. The scale of the analysis is the European continent with focus on the Mediterranean Sea.

In ***Annex A***, Table 2 lists economic activities which are directly or indirectly important to the IAS story. The table is based on the Statistical Classification of Economic Activities in the European Community (NACE) and summarizes the possible contribution of each activity to the value chain.

**Mining and quarrying and the manufacturing industry**

There is hardly an economic activity nowadays which is not dependent to a certain degree from international seaborne trade either as exporter or as importer of goods from overseas. However, looking closer at the top of the value chain resulting to pressures such as discharging ballast water to the sea, we find mainly industries from the mining and quarrying sector which are heavily dependent on the worldwide transportation of their products as these can practically only be transported by ships. They account for the biggest part of the global seaborne trade. Figure 6 depicts the structure of international seaborne trade for the year 2014, indicating the most important industry sectors for the international water transport and their products as follows:

- Crude Oil and petroleum products
- Gas and chemicals

- Major bulk commodities, including iron ore, coal, grain, bauxite/alumina and phosphate rock
- Minor bulk commodities: agribulks, metals and minerals, and manufactures
- Containerized commodities

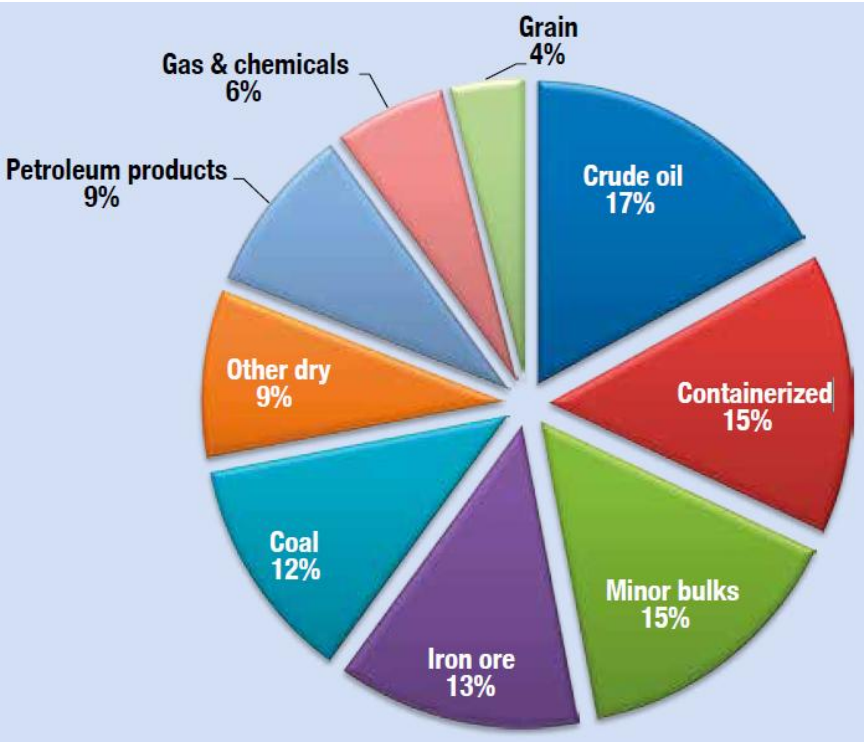


**Figure 6: Structure of international seaborne trade 2014 (UNCTAD, 2015).**

Dry cargo shipments increased by 5.0 per cent, while tanker trade contracted by 1.6 per cent within 2014. Although growth in coal trade is estimated to have decelerated significantly to 2.8 per cent as compared with over 12.0 per cent in 2012 and 5.0 per cent in 2013, dry bulk shipments continued to be supported by the rapid expansion of global iron ore volumes, which in turn, was driven by China's continued strong import demand (UNCTAD, 2015).

The above figures for the international trade differ slightly when focusing on the seaborne trade between European and non-European countries. Table 3 in ***Annex B*** lists the main



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products imported or exported by sea in 2015 from/to European countries (EU28). At the top of the list are crude oil and petroleum products, gas, coal and their by-products making 52.8% of the total seaborne trade. Ores make the second largest category with 7.2%, while iron ores account for 5.5% and other products containing iron and steel 4.2%. Cement, gravel, broken or crushed stones and other plastering materials make 4.5% and cereals 3.6% of the total quantity transported by sea.

From the above data it is obvious that the following activities and the corresponding NACE divisions of the **mining and quarrying** sector are mainly responsible for the largest part of imports or exports to/from European ports.

| Activities | NACE r.2 Division | Import | Export |
|---|---|---|---|
| II.1.1. Mining of coal and lignite | 05 | X | |
| II.1.2.Extraction of crude petroleum and natural gas | 06 | X | |
| II.1.3. Mining of metal ores | 07 | X | X |
| II.1.4. Other mining and quarrying | 08 | X | X |

Taking the quantity of products transported from and to European ports into consideration, one may conclude that the following activities from the **manufacturing** sector play the main role at the end of the value chain contributing to the IAS problem.

| Activities | NACE r.2 Division | Import | Export |
|---|---|---|---|
| III.10. Manufacture of coke and refined petroleum products | 19 | **X** | X |
| III.11. Manufacture of chemicals and chemical products | 20 | X | X |
| III.15. Manufacture of basic metals | 24 | X | X |

Looking from the perspective of the value of the transported products, one can recognize that the main industry sectors in Europe depending on seaborne trade are the following:

- Crude and refined petroleum products (16.9%)
- Machinery and mechanical appliances (13.3%)
- Cars and other vehicles as well as parts and accessories (11.9%)
- Electrical machinery and equipment (6.6%)
- Plastics (3.2%)
- Organic chemicals (2.4%)
- Iron and steel (2.3%) and their articles (2.1%)
- Pharmaceutical products (2.1%)

Table 4 in ***Annex B*** provides an extended list of the main products imported or exported by sea in 2015 from/to European countries (EU28) per product category ordered by value in bil. euros.

**Water transport**

Transoceanic shipping is widely recognized as the main cause of the IAS problem. Especially large commercial vessels moving over 80% of the word's commodities are responsible for the transfer of approximately 10 billion tons of ballast water annually



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(UNCTAD, 2015). It is proven that a large number of IAS transported either in the ballast water or accumulated as hull fouling manage to survive and to produce viable populations in foreign seas, causing significant damage to the local ecosystems.

**Sea freight transport** has been the largest carrier of goods throughout the recorded history. As the earth's population is expected to rise, this will result to greater trade demand. Rising trade flows around the world means that shipping industry will increase over the coming years. Figure 7 shows the gross weight of seaborne goods handled (inward and outward trade) in European ports over the last years. Based on data supplied by reporting countries and as published on the relevant government and port industry websites, and by specialist sources, UNCTAD suggests that Europe's share of the global seaborne goods handled in 2014 in percentage of world tonnage is 18% for loaded goods and 20% for unloaded goods (UNCTAD, 2015). The biggest global trading region is Asia with 41% and 58% respectively.

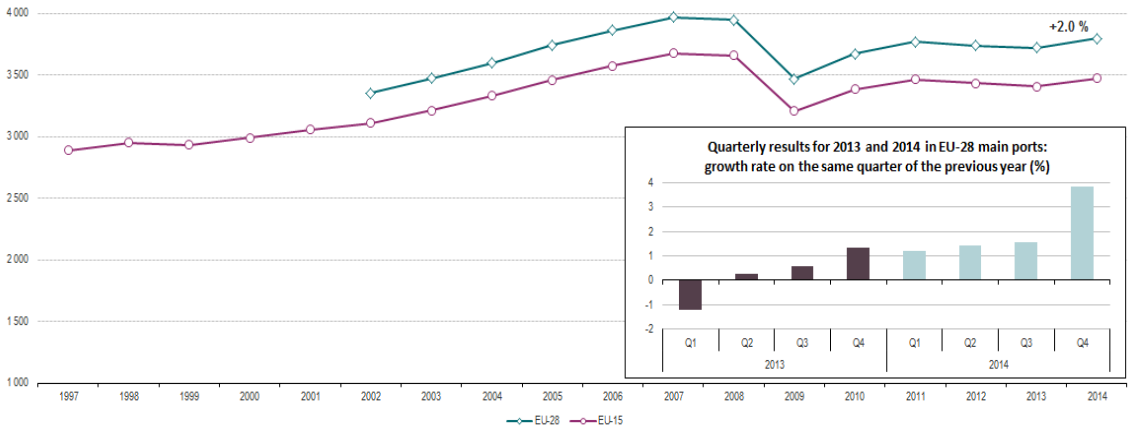


**Figure 7: Gross weight of seaborne goods handled in main European (EU-28) ports (in million tonnes). Source: Eurostat**

*Figure* illustrates the shares of goods transport from/to European ports. The sum of the national and international intra-EU transport of the EU would represent the "national transport of the EU", i.e. the internal EU transport if the EU was treated as one country. This sums-up to the total 47.1% of the whole trade in EU ports. Excluding the unknown areas, the remaining 51.6% represents the share of the goods transported to/from non EU countries.

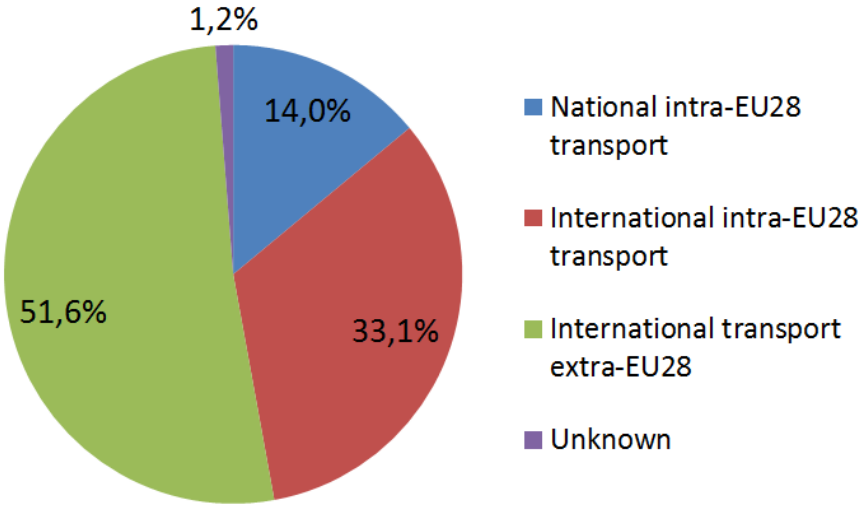


**Figure 8: Gross weight shares of seaborne goods transported to/from main European ports. Based on annual data 2014/Q4-2015/Q3 (Source: Eurostat - Maritime transport - Goods mar_go)**

Looking closer at the origin/destination regions of partner ports, one can conclude that seaborne trade of EU-28 with all other regions and continents is significant (Figure 9).

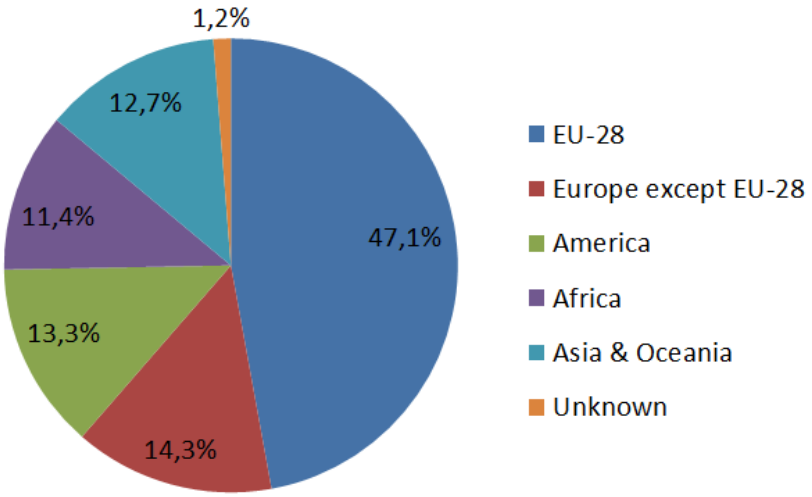


**Figure 9: Gross weight shares of seaborne goods transported to/from main European ports broken down by geographical areas. Based on annual data 2014/Q4-2015/Q3 (Source: Eurostat - Maritime transport - Goods mar_go)**



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Key players in the freight market are shipowners, charterers and brokers. The latter one mediates between the two first in order to conclude to an agreement. There are four types of contractual arrangements in the sea freight market:

- In a *voyage charter* the charterer hires a vessel and its crew for a voyage between a load and a destination port. The shipowner is responsible for costs related to the ship (fuel, crew, port costs) and the charterer pays a freight rate which typically is calculated on a per-ton basis.
- A *contract of affreightment* is a contract similar to a voyage charter. The difference is in this type of agreement lies in that the shipowner agrees to carry a number of cargoes within a specified period of time on a specified route.
- In a *time charter* the charterer has for a specific time period the control on where to go while the shipowner manages the ship.
- In a *bareboat chartering* the charterer hires the vessel and obtains possession of the full control of it for a predefined period.

During the period 2008-2012 a significant increase in ship construction has been registered (see Figure 17). Shipowners have placed new orders, anticipating a steady growth of the demand for freight transportation. However, the reality did not match the expectations and consequently charter rates have fallen steadily over the last few years (see Figure 10 and Figure 11).

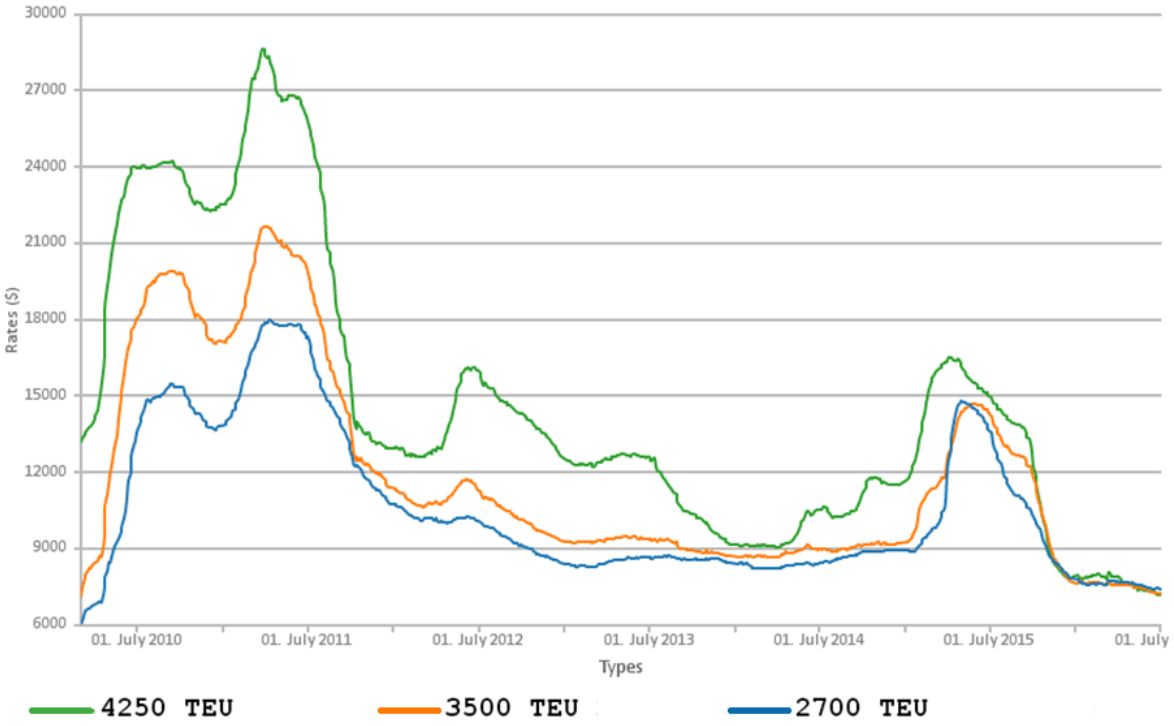


**Figure 10: Containership charter rates based on New ConTex (Hamburg Shipbrokers' Association, 2016). TEU: Twenty Foot Equivalent Unit**



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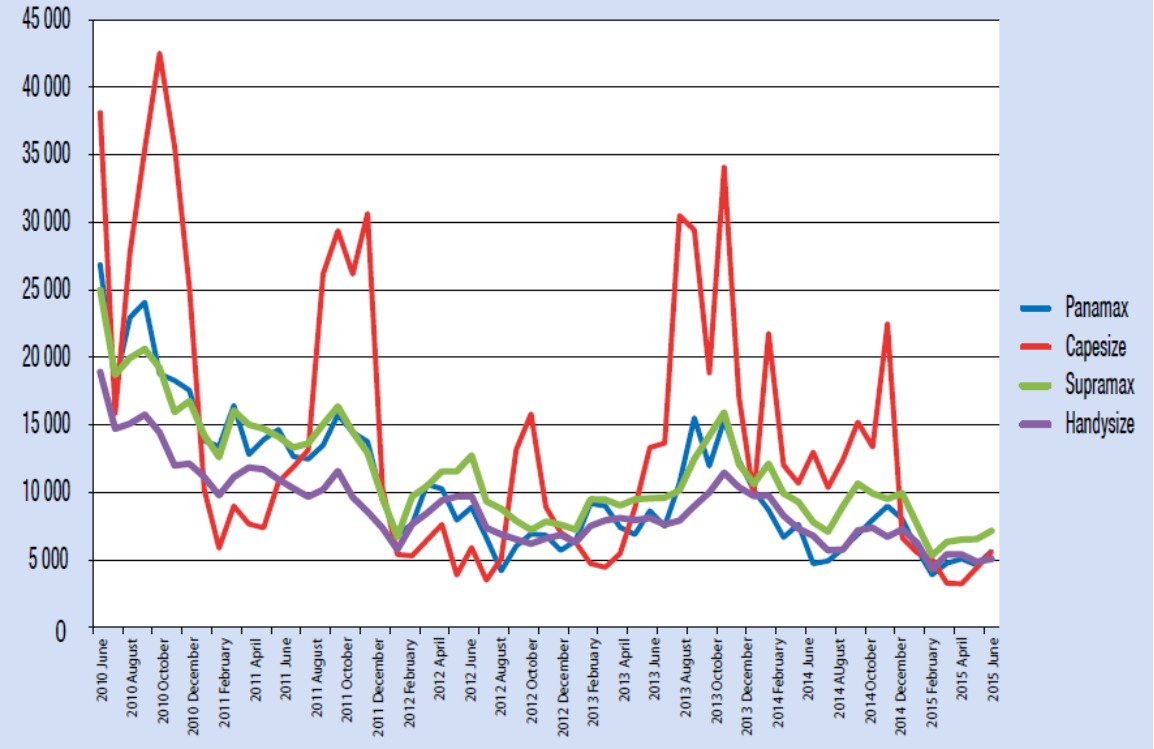


**Figure 11: Daily earnings of selected bulk carrier vessels types in USD per day (UNCTAD, 2015).**

The geographical maritime distance only has a small statistical correlation with freight costs. More than the geographical distance, it may be rather the economical distance, as for example captured by shipping connectivity and a country's position within global shipping networks, that emerges as the relevant factor for international transport costs (UNCTAD, 2015).

Many European ports are used as port of origin or destination for loading and unloading freight. Figure 12 shows that the main cargo ports are located in the North Sea and the Mediterranean Sea.

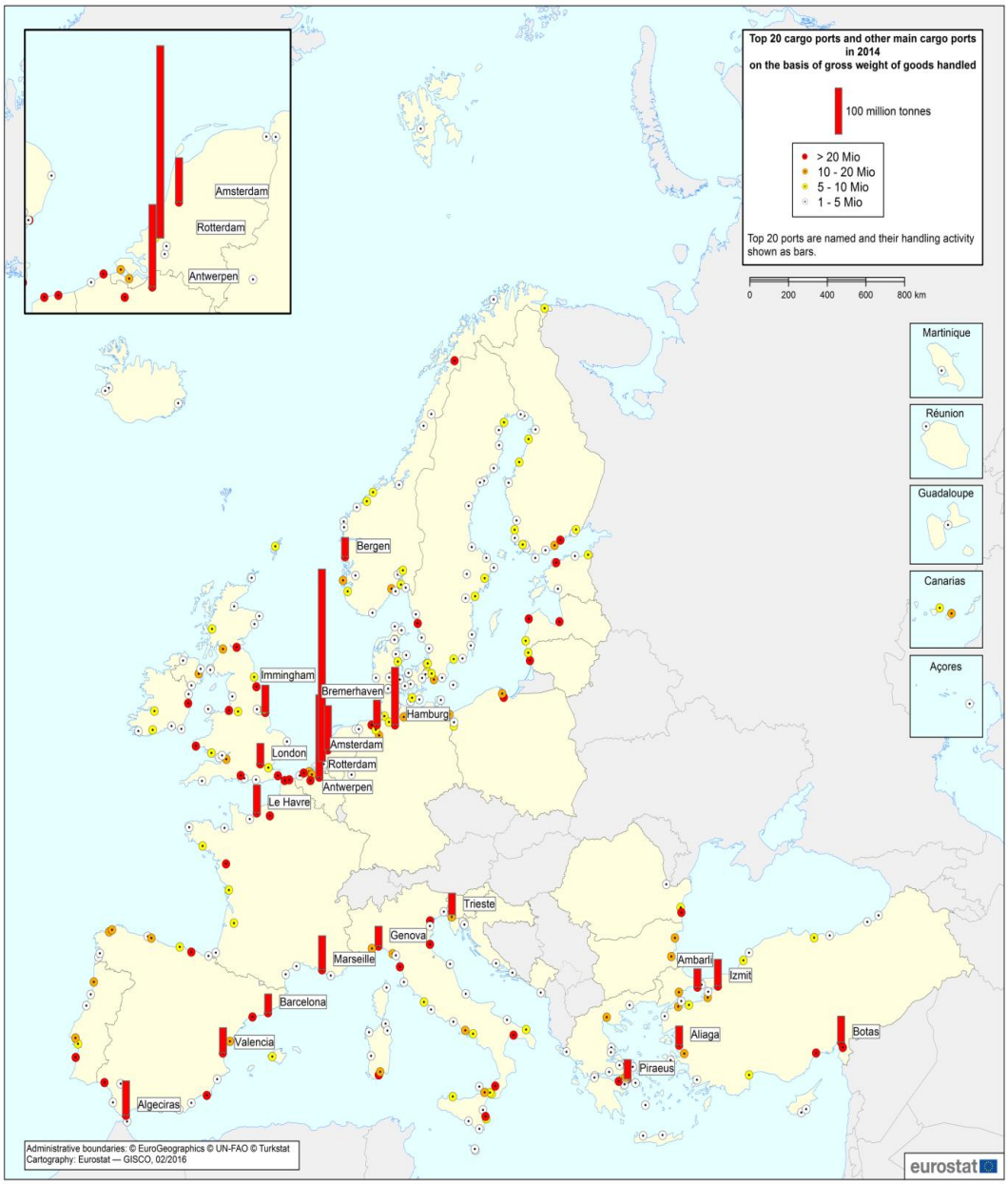


**Figure 12: Main cargo ports in the reporting countries 2014 by gross weight of goods handled. Source: Eurostat**



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The following economic activity is related with Sea freight transport:

| Activity | NACE r.2 Division |
|---|---|
| VII.2.2. Sea and coastal freight water transport | 50 |

**Passenger transport** services over the sea are mainly for recreational purposes. In larger scale these transports are made by oceanic liners and large cruise ships and ferries, capable to travel across seas They contribute to the problem of IAS through ballasting and deballasting of their tanks. Additionally, activities with smaller boats such as traveling with smaller ferry boats, cruising, yachting, traveling with pleasure ships, taxis and other kinds of coastal transport contribute to the spreading IAS from one region to another. Sea passenger transport seems to have decreased slightly in the last decade in Europe (source: Eurostat).

The following economic activity is related with passenger transport:

| Activity | NACE r.2 Division |
|---|---|
| VII.2.1. Sea and coastal passenger water transport | 50 |

**Port-based services**

Next to the water transport industry, additional **port-based services** have emerged, supporting the ships' voyage, the loading and unloading of goods, the maintenance of the ship etc. With respect to IAS two port-based services are playing an important role:

Port-based ballast water treatment: In case of deballasting, the ballast water is transferred from the ballast tanks to onshore treatment facilities where NIS are neutralized. Clean seawater can be used to fill the ballast tanks. The construction and design for this kind of facilities must be unique for each port as long as marine species are different between different marine environments (Tsolaki E., 2007). The installation of such a facility occupies a large area in ports.

Hull surface treatment: Over time, biofouling is inevitably attached to the ship's hull and propeller causing, next to the transportation of NIS, a number of undesirable effects, such as decreasing the ship's maximum speed, hampering the ship's ability to sail upwind and causing damage to the hull. It is estimated that vessel bottoms not protected by anti-fouling systems may gather 150 kg of fouling per square metre in less than six months of being at sea (IMO, 2002). Anti-fouling systems can only reduce or delay the development. Hull surface treatment removes fouling from the hull and is applied either in drydocks or in water. This treatment, also known as hull scrubbing and wiping, is highly specialized as it has to be effective enough to wipe out fouling substances from the hull and at the same time retain the remaining anti-fouling paint.

The following economic activities are related with port based services and are relevant to this story:

| Activities | NACE r.2 Division |
|---|---|
| VI.3.2. Waste treatment and disposal | 38 |
| VI.3.1. Waste collection | 38 |

**Fishing**

The **fishing industry** is involved in the story of IAS as various sorts of fishing boats, from small recreational boats to large commercial vessels are indirectly related to the spreading of IAS.

According to Eurostat, in the last decade the total number of European fishing vessels has been slowly and constantly decreasing by an annual average of 1.3%. When it comes to the Gross Tonnage (GT) the trend is more obvious, showing that the European fleet has been shrinking with a rate of 2,5% on average. About half of the European fishing fleet is



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located in the Mediterranean Sea but the average size of the boats is smaller than those operating in the Atlantic. In the Black Sea the fishing fleet is small in terms of numbers and GT.

The following economic activity is related with fishing:

| Activity | NACE r.2 Division |
|---|---|
| I.3.1. Fishing | 03 |

**Shipbuilding**

The sector closely related with water transportation, being “upstream” in the value chain, is the **shipbuilding industry**. Especially the construction of large vessels is of interest in this story as these ships are made responsible for causing ecological damage by transferring NIS in their ballast tanks. Ever since it has been invented in the late 19$^{th}$ century to use sea water as ballast to balance the ships, this concept has dominated the marine technology. The rise in the global trade pushes the shipbuilding industry to build larger vessels capable to transport enormous amount of goods. Figure 13 shows that in the last 15 years the world’s merchant fleet has more than doubled showing an average annual growth rate of over 5% (Figure 14).

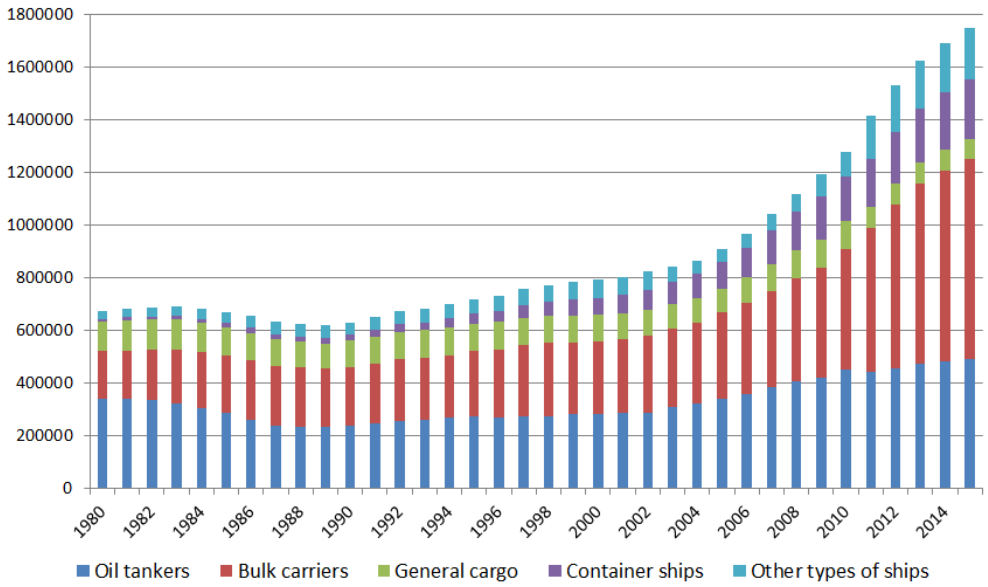


**Figure 13: Global merchant fleet by vessel type in thousands of dead weight tons (unctadstat, 2016)**

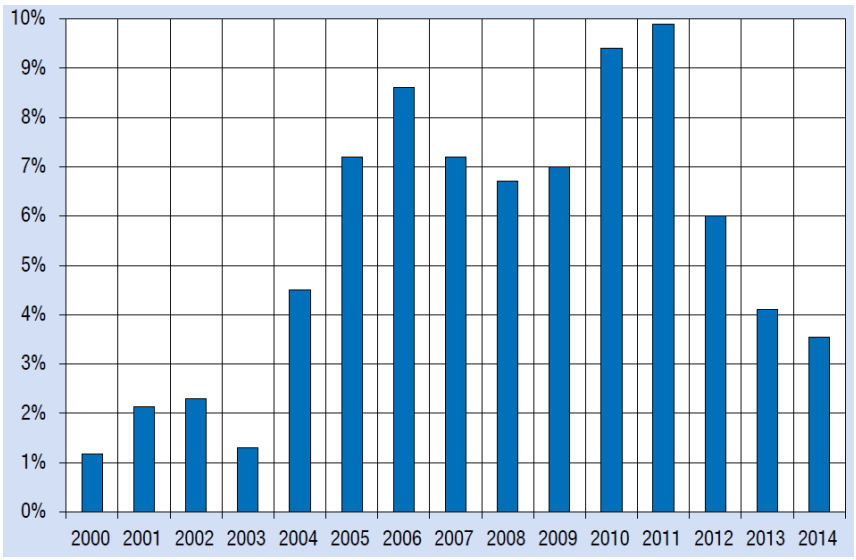


**Figure 14: Annual growth of the world fleet, 2000–2014 (per cent of dwt) (UNCTAD, 2015).**



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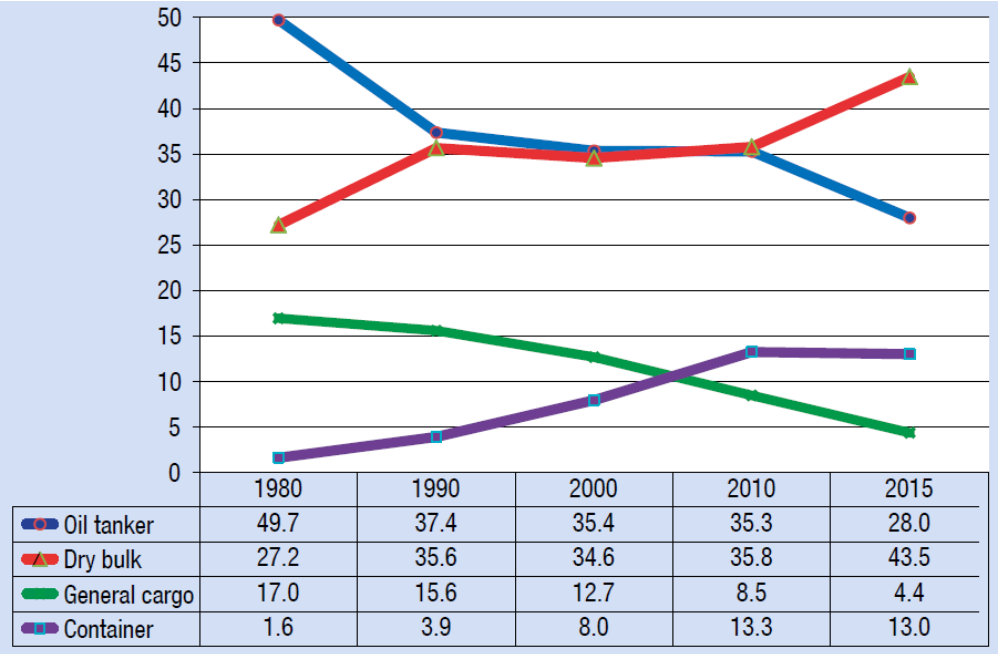
This development towards bigger ships has advantages for the enterprises due to economics of scale, i.e. the cost per unit of output decreases with increasing scale as fixed costs are spread out over more units of output. However, the bigger the ships the larger is the volume of ballast water they need to maintain stability.

The main ship types of transoceanic merchant vessels can be distinguished by cargo in the following:

a) *Bulk carriers* used to transport bulk cargo items such as ore or food staples (rice, grain, etc.) and similar cargo
b) *Container ships* that use the containerization technique to organize and transport freight. As of 2009, approximately 90% of non-bulk cargo worldwide is moved by containers stacked on transport ships (Ebeling, 2009).
c) *Tankers* capable to transport fluids, such as petroleum, liquefied petroleum gas (LPG), liquefied natural gas (LNG) and chemicals.
d) *Roll-on/roll-off* (RORO) ships, designed to carry wheeled cargo such as automobiles, trailers or railway carriages.
e) Other transporters such as Refrigerated ships and Multi-purpose ships.

The enormous growth of the international merchant fleet is mainly due to the growth of the bulk carrier sector, which makes now the largest of all ship types. Another ship type showing a steady growth is container ships Figure 15.




| | 1980 | 1990 | 2000 | 2010 | 2015 |
|---|---|---|---|---|---|
| Oil tanker | 49.7 | 37.4 | 35.4 | 35.3 | 28.0 |
| Dry bulk | 27.2 | 35.6 | 34.6 | 35.8 | 43.5 |
| General cargo | 17.0 | 15.6 | 12.7 | 8.5 | 4.4 |
| Container | 1.6 | 3.9 | 8.0 | 13.3 | 13.0 |

**Figure 15: World fleet by vessel type in percentage share of dwt (UNCTAD, 2015)**

Containerized trade was estimated to have increased globally by a strong 5.6 per cent, taking the total to 1.63 billion tons (UNCTAD, 2015). Containerized trade volumes carried on the Asia-Europe trade lane are estimated to have increased by 7.5 % (Clarksons Research, 2015b). Containerized Asia-Europe-Asia trade route has gained importance in the last years and is now about as important as the Trans-Pacific route.

Special refrigerated containers, commonly called reefers, can control the temperature and other parameters of the atmosphere in containers, allowing everything from meat, fruit, vegetables and dairy products, to chemicals and pharmaceuticals to travel across the world. The impact of reefer containers on society is significant, as it allows new economic sectors to use seaborne routes for the transportation of their products. Nowadays even sensitive goods such as bananas and flowers are transported via reefer containers over several days. Reefer container ships cover currently a niche of the total seaborne containerized trade (about 10% based on the total fleet capacities), but this sector shows a double-digit growth and it is expected that its young fleet will gradually replace older specialist reefer ships. Moreover, some of the most significant routes for reefer container ships have their ports of origin or destination in Europe (see Figure 16).

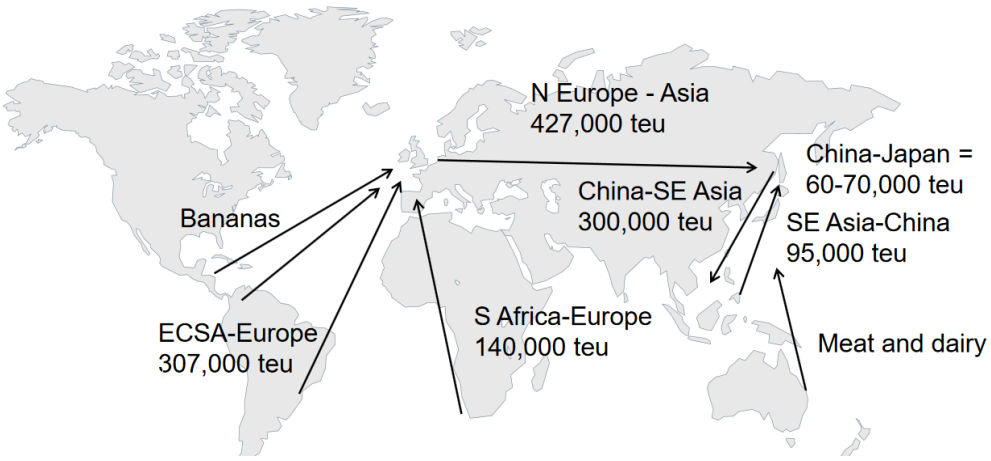



**Figure 16: Big reefer trades. Annual estimates (Source: Neil Dekker, Drewry, Global reefer trades 2014)**



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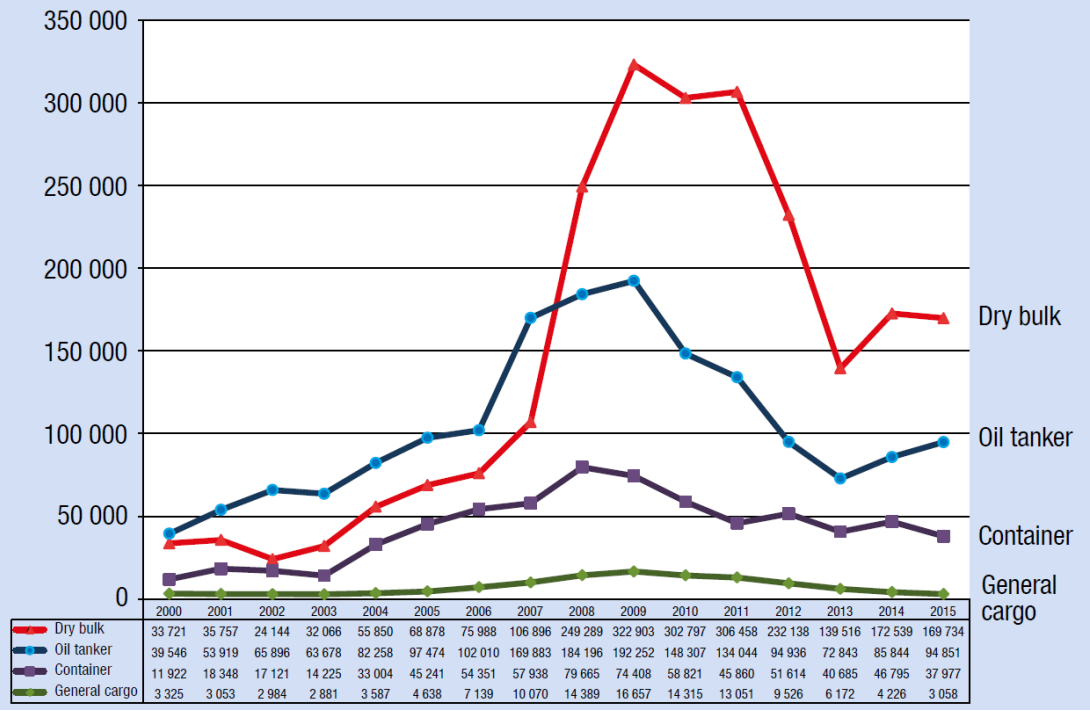
Although it is difficult to quantify the value of world seaborne trade and compare it with monetary-based statistics for the value of the world economy, it is estimated that the operation of merchant ships contributes about US$ 380 billion in freight rates within the global economy, equivalent to about 5% of total world trade (International Chamber of Shipping).

There is no exact number of other types of smaller vessels constructed for **coastal water transportation** as well as for **pleasure** and **sporting** such as for sailing, cruising, yachting, boat excursions, water taxis etc.

The following economic activity is related with shipbuilding of any kind:

| Activity | NACE r.2 Division |
|---|---|
| III.21.1. Building of ships and boats | 30 |




| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dry bulk | 33 721 | 35 757 | 24 144 | 32 066 | 55 850 | 68 878 | 75 988 | 106 896 | 249 289 | 322 903 | 302 797 | 306 458 | 232 138 | 139 516 | 172 539 | 169 734 |
| Oil tanker | 39 546 | 53 919 | 65 896 | 63 678 | 82 258 | 97 474 | 102 010 | 169 883 | 184 196 | 192 252 | 148 307 | 134 044 | 94 936 | 72 843 | 85 844 | 94 851 |
| Container | 11 922 | 18 348 | 17 121 | 14 225 | 33 004 | 45 241 | 54 351 | 57 938 | 79 665 | 74 408 | 58 821 | 45 860 | 51 614 | 40 685 | 46 795 | 37 977 |
| General cargo | 3 325 | 3 053 | 2 984 | 2 881 | 3 587 | 4 638 | 7 139 | 10 070 | 14 389 | 16 657 | 14 315 | 13 051 | 9 526 | 6 172 | 4 226 | 3 058 |

**Figure 17: World tonnage on order in thousands dwt (UNCTAD, 2015)**

**Marine equipment manufacturing**

It is expected that due to their cost-effectiveness onboard Ballast Water management System (BWMS) will in the long term prevail over port based facilities. However, most ships currently at sea are not equipped with any BWMS, although the lifetime of a modern merchant ship is about 25 to 30 years. **Marine equipment manufacturers** have developed a variety of BWMS that can be retrofitted to any existing vessel.

Onboard BWMS make use of combined technologies neutralizing or eliminating harmful aquatic organisms and pathogens. They usually consist of a filtration system followed by a mechanical or chemical treatment during ballasting and/or deballasting. The most common mechanical methods include ultraviolet radiation (UV), thermal, ultrasound (US), magnetic and electrical treatment. Chemical methods include the use of biocides, chlorine, ozone, hydrogen peroxide, chlorine dioxide and others (Tsolaki, 2010). Their effectiveness varies according to seawater salinity, temperature and sediment load.

Many manufacturers base their systems on UV treatment. UV light effectiveness as a sterilizer is determined primarily by the combined effects of UV light intensity, the exposure time of the system (defined by the flow rate of the system) and the UVT of the water which is a measure of UV energy actually transmitted through water. Efficient UV BWMS monitor the water quality (i.e. the UVT) before entering into the system and adjust the intensity of the UV lamps to the acceptable minimum. On water intake filtering and UV systems come into effect, while on discharge the water is treated only by the UV system.



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| Activity | NACE r.2 Division |
|---|---|
| III.19. Manufacture of machinery and equipment n.e.c | 28 |

**Manufacture of chemical products**

Another sector closely related with the building of ships is the **manufacture** of **paints,** and **coatings** in order to prevent marine growth (biofouling) on the hull of the ships. Marine growth affects the performance of ships as it decreases the maximum speed of the vessel, it is responsible for increased energy consumption[17] to maintain the required speed and may cause severe damage to the hull over time. In addition to this, special paints act as a barrier against corrosion of metal hulls.

A common technology which addresses the problem is to use a specialized coating such as anti-fouling paint applied to the hull of a ship. It has the ability to slow the growth of subaquatic organisms attached to the hull. In common practice, antifouling paints are formulated with biocides, toxic chemical substances usually based on copper, intended to control the growth of organisms. Biocides are held in the pores created by the paint and released slowly. Paints often include teflon and silicone coatings which are too slippery for biofouling to stick. "Sloughing bottom paints", are designed to create a hull coating which ablates slowly, exposing a fresh layer of biocides. Scrubbing a hull with sloughing bottom paint while it is in the water releases its biocides and the attached biofouling into the environment. One way to minimize the environmental impact from such a treatment is to haul out and clean the vessels at boatyards with a "closed loop" system. Environmental friendly technologies emerge including brushes which are able to clean the hull in the water and simultaneously suck the detached layer and contaminated water.

[17] It is estimated that just a small amount of fouling can lead to an increase of fuel consumption of up to 40% (IMO, 2002).

The following economic activity is related with the manufacture of hull coatings and paintings:

| Activities | NACE r.2 Division |
|---|---|
| III.11.3. Manufacture of paints, varnishes and similar coatings, printing ink and mastics | 20 |

**Other economic activities related to the introduction and spreading of IAS**

Directly or indirectly, almost all economic activities are dependent to a certain degree from the international seaborne trade. The mining and quarrying industrial sectors are heavily dependent on large bulk carriers to transport their products to foreign countries. Large manufacturing industries are dependent on the import of large quantities of coal, ores, oil and other petrochemical products which make the biggest part of the transoceanic sea freight transport. At the same time the shipping and shipbuilding industries provide the means for the transportation of people and goods overseas.

However, other sectors contribute as well to a smaller but not insignificant degree, directly or indirectly, to the release of NIS through BW and biofouling. Some of them are the following:

- Other manufacturing industries, especially the **food industry** related with the production of grain
- The **marine insurance** sector is involved in two main activities: a) building of ships by giving loans to shipowners and b) providing insurance which may cover the loss or damage of vessels and cargoes.
- **Marine consultants and service providers** offer their experience in the areas related with shipping to shipowners.
- **Scientific research and development** in various fields supported by private and public funding. Such activities may take place in the R&D departments of companies or academic institutions. The most promising brunches with innovative



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products have been introduced in previous sections (manufacturers of marine equipment and chemical products).

- A number of countries have significant **naval fleets** capable to operate in distant seas. The U.S.A. as the country with the biggest military power maintains a number of navy bases all over the globe including the Mediterranean Sea (Naples, IT; Souda, GR). Other types of vessels such as submarines use ballast water to control the buoyancy of the vessel. The world's total number of submarines used for military purposes is no more than 500.

**Mapping of economic activities and flow of resources**

Figure 18 and Figure 19 map the main economic activities as described in the previous sections to flow of resources resulting to the two dominant pressures related to the introduction and spreading of IAS, namely:

- Release of NIS through ballast water and ballast sediment discharge and
- Release of NIS through biofouling

The same main activities and other less influential activities are specified in more detail on the basis of NACE classification in the Annex.

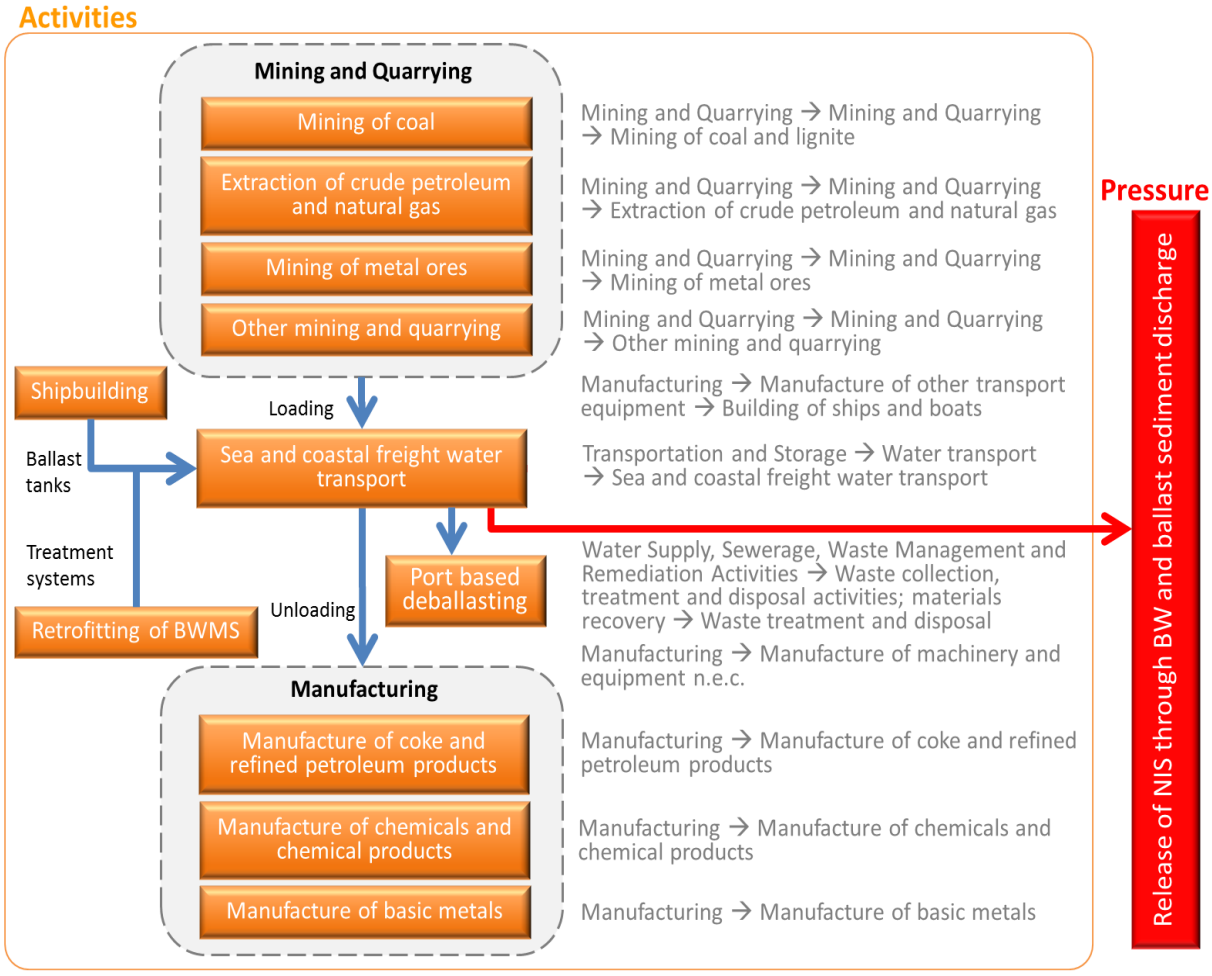


**Figure 18: Value chain map of main economic activities and flow of resources resulting to the release of NIS through ballast water and ballast sediment discharge.**



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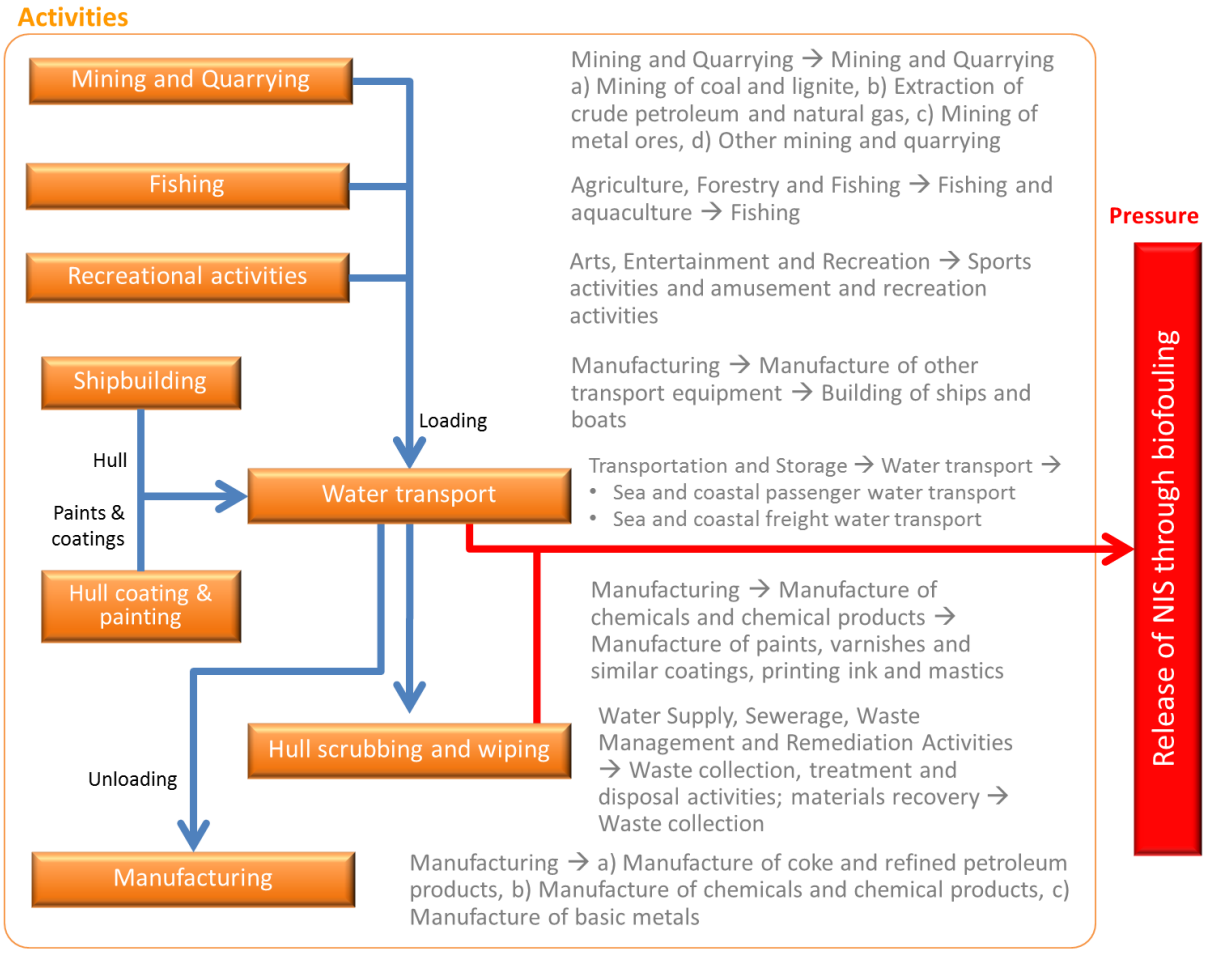


**Figure 19: Value chain map of main economic activities and flow of resources resulting to the release of NIS through biofouling.**

## *Stage 2: Assessing potential for behaviour change for decreasing pressure/ seizing opportunities*

Following the value chain approach, this section analyses further the economic activities related with BW and HF. It identifies the actors related with each activity and attempts to estimate their influence in the story. At the centre of the analysis is the **transoceanic transportation** of freight and persons through large vessels. This activity is mainly responsible for the introduction of IAS through ballast water. It can be divided in three stages:

a) **Ballasting**. The process of loading the ballast water in in the ship's ballast tanks

b) **Ballast water transportation**. During the voyage without cargo BW is needed in order to maintain the stability of the vessel.

c) **Deballasting**. On the destination port ballast water is discharged as the vessel is loaded with cargo.

During ballasting and deballasting ballast water treatment systems may be applied using chemical or mechanical methods. The aim is to neutralizing all organisms transported with the BW.

Going the value chain "upstream" other activities have been identified which are related with the **construction of ships**. Here the focus is on the design and construction of ballast tanks and Ballast Water Management Systems (BWMS), capable to treat ballast water onboard of the vessel. These systems may also be **retrofitted** in older vessels in order for the vessel to comply with national and international regulations. On the opposite end of the value chain, activities have been identified, which are primarily related with the **spreading of the IAS** to nearby water regions, including fishing, yachting and other seaborne recreational activities.

Figure 20 illustrates the stages of the invasion process (middle column) and major policy and management options (right column) as adopted from (Lodge, et al., 2006) in relation to processes that facilitate the introduction of IAS (left column). From the top to the bottom of the middle column, each arrow is thinner than the preceding one because the proportion of species that proceeds from one step to the next is less than the previous one. Nevertheless, because the number of species entering pathways is increasing as global trade increases, the number of species causing harmful impacts is increasing with time.



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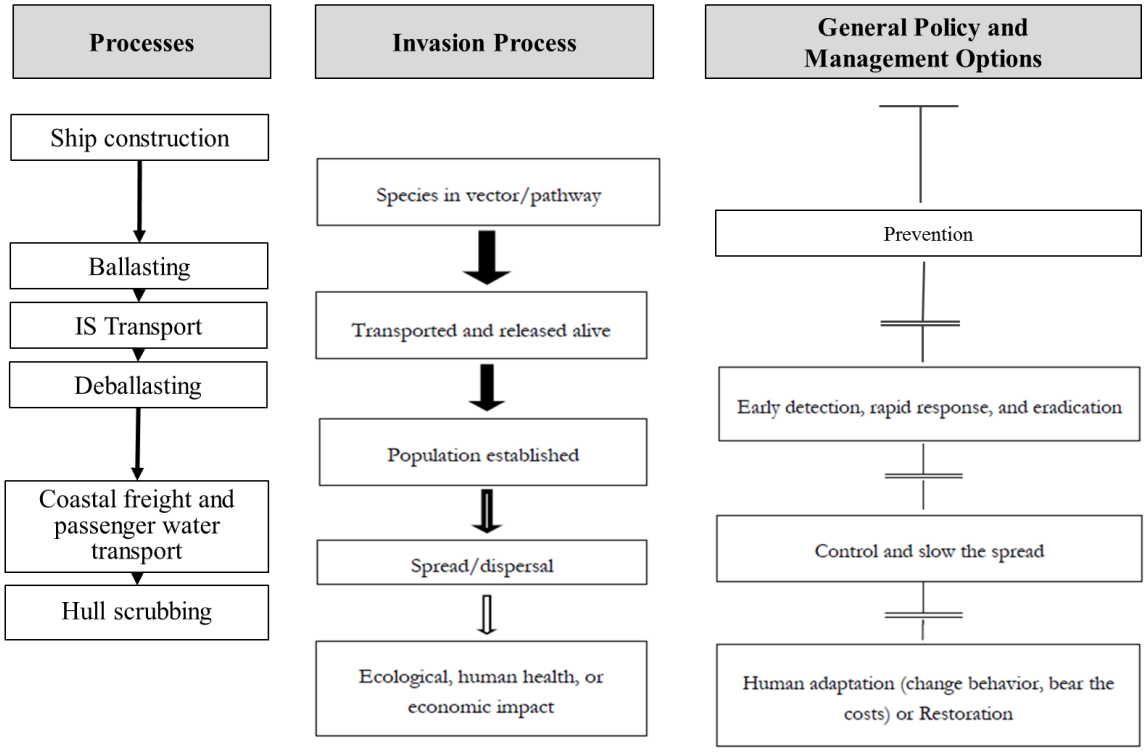


**Figure 20: Activities facilitating the introduction and spreading of BW in relation to the invasion process and general policy and management options.**

The following ***Figure 16*** illustrates the main activities related with the invasion of alien species and the way they are influenced by key actors. In this schema, only those activities are shown which might have a significant impact to the transportation, introduction and spreading of IAS through ballast water and hull fouling.

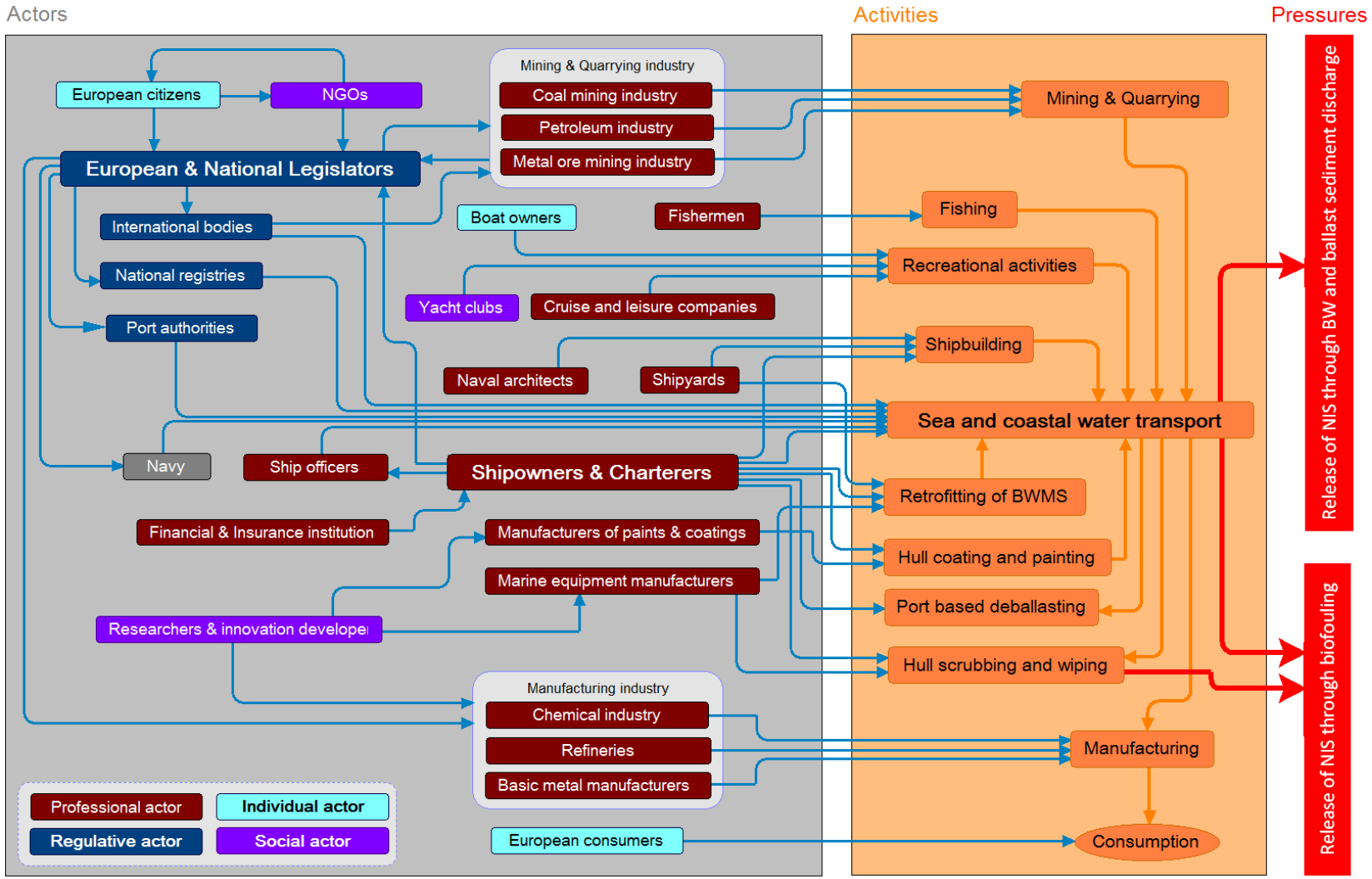


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***Figure 21: Main activities and key actors of the value chain***

The following key actors are physical or legal entities which play a significant role in the IAS story. In this section it is attempted to enlighten their role in relation to BW and HF.

| Key actor: **Shipyards and Dockyards**<br><br>Actor according to ResponSEAble classification: **II.2.1. Manufacturers** |
|---|
| **Shipyards** and **dockyards** are places onshore where ships are built or repaired. Dockyards are more associated with the maintenance of ships while shipyards are more associated with the initial construction. They are both related to the IAS story as they are capable to install BWMS in new ships or retrofit them in existing ones. In case the contractual agreement between the shipowner and the shipyard foresees a BWMS the task is accomplished by the shipyard and naval architects design the ship from scratch including ballast water treatment facilities.<br><br>The share of new merchant ships built with BWMS is still low but on the rise. Figure 22 illustrates this trend. More than half of new container ships were built with such systems in the years 2013 and 2014. The share is lower for other vessel types. |



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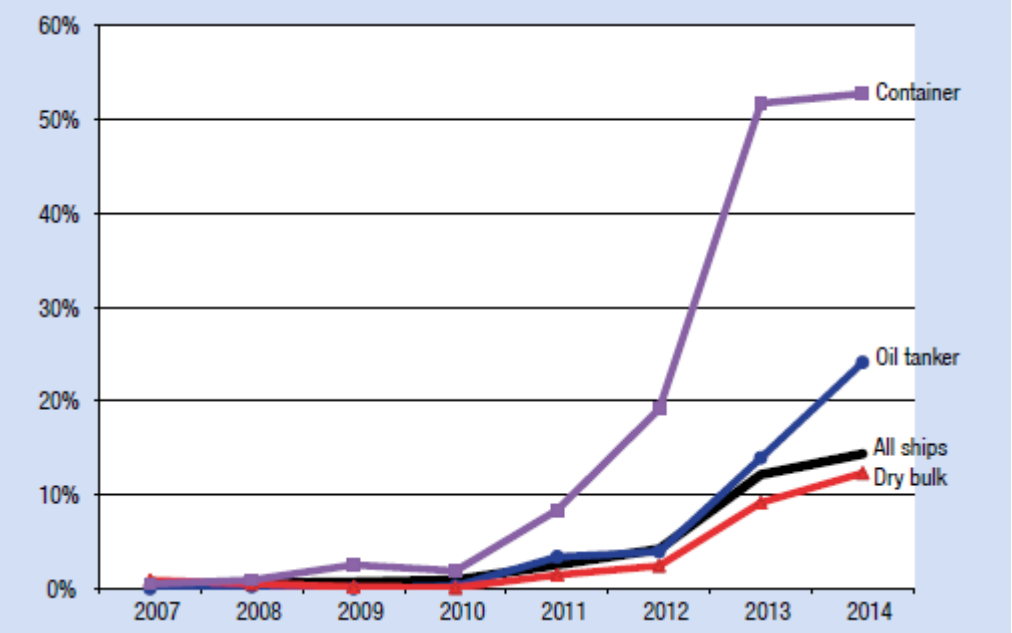


**Figure 22: Share of newbuildings (number of ships) with ballast water treatment systems, by main vessel type, 2007–2014 (UNCTAD, 2015)**

In the order of 40 BWMS have been IMO-approved and are available on the market according to Lloyd's Register. In contrast, only a little more than 2400 vessels are equipped up to date (2015) with a ballast water treatment system (IMO, 2015). Older ships may be retrofitted with BWMS in dockyards using technology provided by marine equipment suppliers. It is expected that when the BWMC enters into force a large number of ships will have to install BWMS the next time they will have to go to a dry dock for survey, typically every 5 years.

Shore-based ballast water treatment facilities are offered in some ports allowing ships with no BWMS onboard to deballast. This option though comes with a number of disadvantages in comparison with shipboard treatment technologies, such as: a) it requires large area for the installation of large-scale facilities, b) in the long term it is more expensive than on-board alternatives c) the treatment procedure may delay the ship d) the facilities may not always be available e) some ports do not offer adequate facilities in which case they may have to be avoided in order to comply with national or international regulations. Port-based ballast water treatment is therefore suitable for vessels operating on non-exempted fixed routes or for ships which are so old as to make any investment in retrofitting systems prohibitively expensive. Shore-based facilities are also required for ports that need to provide backup in

the case of emergencies when ships' on board treatment systems fail.

Dockyards are often used to brush the biofouling off the ship's hull and replace the coating with new anti-fouling paint. The procedure has to be repeated every few years. New technologies allow the treatment to take place while the ship is still in water, which is beneficial for the shipowner as it is relatively low in cost and allows avoiding time consuming stay in dry docks. However, this procedure poses greater risks for the marine environment. The polishing of the ship's propeller, on which biofouling is also attached, is needed in a shorter frequency e.g. 6 months to 1 year (Ordinana, 2016).

According to some sources, shipyards and dockyards are ready to implement the BWMC. The installation of BWMS will take a couple of days in a dry dock, which can be accomplished in parallel with other maintenance *operations during the next scheduled* dry dock for survey. Therefore, it is expected that the pressure on the number of dry dock slots will not be significant. However, the project management will be important as shipowners will need to inform the yards well in advance (In Depth: Ratification Just Around the Corner, 2016). Other sources suggest that the drydock capacity will be insufficient and that the IMO may have to give an extension (Latarche, 2016).

**Activities they influence:** Ship construction & Retrofitting

Key actor: **Naval Architects**

Actor according to ResponSEAble classification: **II.3.26. Architects and engineers**

**Naval architects** employed in shipyards are responsible for the design and construction of vessels. In particular they construct ballast tanks and other technologies which influence the problem of IAS.



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**Activities they influence:** Ship construction

Key actor: **Registries**

Actor according to ResponSEAble classification: **III.2.2. National administrators**

A ship is given the nationality of the country to which it has been registered (flag state) and is bound to the law of its **flag state**. A ship's flag state registers the ownership of the vessel, exercises regulatory control over the vessel and is required to inspect it regularly, certify the ship's equipment and crew, and issue safety and pollution prevention documents. The ship's flag determines the laws to which the operation and behaviour of the crew have to obey and the laws which are applied if the ship is involved in a case under admiralty law.

The flag under which vessels are registered is especially important when it comes to the ratification of international treaties. Conventions such as the BMWC will enter into force only if they are ratified by a certain number of states, representing a minimum percentage of the world's tonnage.

The organization which actually registers the ship is known as its **registry**. Registries may be governmental or private agencies. In some countries registration is not required for vessels traveling in local waters, but is always mandatory for ships crossing international borders. Registries charge a registration fee and annual fees.

*Closed registries* impose regulations favouring national interests. They typically require that a ship is owned and constructed by national interests and at least partially crewed by its citizens, whereas *open registries* have only few constraints. Some of them even offer fast completion of the registration procedure within a day. As for 2015, the top 20 registries represent 87,9% of the world tonnage (see Table 1). In the same year all European countries together represented 19.8% of the total world tonnage (incl. UK with 2.3%), broken down as follows: oil tankers: 22.6%, bulk carriers: 16.2%, general cargo: 19.4%, container ships: 25.5% and other types of ships: 17.8% (unctadstat, 2016).

**Table 1: Flags of registration with the largest registered fleets (unctadstat, 2016). States yet to ratify the BWMC are greyed[18].**

| No | Registry | Deadweight tonnage (1,000 dwt) | Share of world total (percent of dwt) |
|---|---|---|---|
| 1 | Panama | 352192 | 20.18 |
| 2 | Liberia | 203832 | 11.68 |
| 3 | Marshall Islands | 175345 | 10.05 |
| 4 | China, Hong Kong SAR | 150801 | 8.64 |
| 5 | Singapore | 115022 | 6.59 |
| 6 | Malta | 82002 | 4.70 |
| 7 | Greece | 78728 | 4.51 |
| 8 | Bahamas | 75779 | 4.34 |
| 9 | China | 75676 | 4.34 |
| 10 | United Kingdom | 40111 | 2.30 |
| 11 | Cyprus | 33664 | 1.93 |

[18] By 30th June 2016



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| | | | |
|---|---|---|---|
| 12 | Japan | 22419 | 1.28 |
| 13 | Norway | 20738 | 1.19 |
| 14 | Italy | 17554 | 1.01 |
| 15 | Korea, Republic of | 16825 | 0.96 |
| 16 | Denmark | 16656 | 0.95 |
| 17 | Indonesia | 15741 | 0.90 |
| 18 | India | 15551 | 0.89 |
| 19 | Antigua and Barbuda | 12753 | 0.73 |
| 20 | Germany | 12693 | 0.73 |

**Activities they influence**: Sea & coastal water transport

Key actor: **Marine Equipment Suppliers**

Actor according to ResponSEAble classification: **II.2.1. Manufacturers**

**Marine Equipment Suppliers** (MES) are highly specialized companies offering technological solutions for a variety of maritime problems. As the demand for BWMS was expected to grow, commercially sold water treatment systems started to appear in the market in the 2000s. Governmental institutions often initiated this trend by imposing stricter regulations and asking established MES to develop new technologies in this field. The technology is meant for new ships as well as for retrofitting existing ones.

Currently, a number of MES have applied for their BWM technologies to be approved by

national agencies, as well as by the IMO in the prospect of the ratification of the BWMC. However, in December 2015, the United States Coast Guard (USCG) declined applications to use the most probable number (MPN) method in testing protocols for evaluating the biological efficacy of UV treatment technologies. Based on this method the applications of the first four BWMS had been submitted in 2015. As a consequence of this decision all approval procedures have been delayed and although in the meantime several other manufacturers have applied for approval, until June 2016 no BWMS of any type has been approved by the USCG.

While MES are well prepared for the expected increase in demand for BWMS, only a few ships have been retrofitted so far, as this will mean significant costs for shipowners. The costs to retrofit a vessel with a BWMS lie from a few hundred thousand euro for small systems up to two million euro for the largest ones. Another cost factor that can over time accumulate to a significant amount is the energy consumption of the BWMS. Manufacturers are aiming at keeping the energy consumption as low as possible and still meet the requirements imposed by national and international regulations. In order for the systems to fit into the vessels, they are made as compact as possible and at the same time efficient and scalable by offering modular devices for every ship size.

The interest for BWMS is growing and MES are positioning themselves in the market, expecting it will open as soon as the BWMC will enter into force (interviews Posidonia 2016). In the last years this industry sector has anticipated the ratification and is prepared to cope with the expected demand. This not only includes developing relevant technologies and retrofitting existing vessels, but also being able to support a large maintenance and service network.

Other MES are specialized in hull coatings, offering a variety of solutions which help keeping the biofouling as much as possible of the ship’s hull. Using current conventional technologies, biocides are painted on the hull of ships reducing the build-up of biofilm and other fouling organisms. From the environmental point of view there is an obvious dilemma using these substances in anti-fouling systems as there is a trade-off between the use and



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continuing leaching of biocides into the aquatic environment and the accumulation of biofouling on the vessels hull. The input of copper into seawater from antifouling paints may conservatively be estimated to approximately 5000 tonnes per year, whereby the main concern is the localised scale of input in enclosed water bodies such as marinas, ports and harbours. Many hopes lie on new, biocide-free antifouling technologies (EU LIFE Project ECOTEC-STC, 2006).

This sector is older than the one for BWMS as for various reasons (ship's performance, saving of fuel, corrosion etc.), shipowners have always had an interest to keep their vessel's hull clean. This is an important aspect as it combines environmental and economic interests. In contrast to BWMS, improved anti-fouling systems are not considered by shipowners as additional costs but as an investment that may lead to longer-term cost savings.

In case of in-water cleaning, new improved suction systems, invented by MES, are able to remove and dispose most of the fouling in a safe way. Even so, there is still a small percentage of fouling that escapes into the water. As these technologies are quite new in the market it is estimated that there is a significant potential for efficiency improvement. The more efficient these systems operate the more likely it will be that their systems will be approved to operate in certain ports, even in those regions which follow a restrictive policy (e.g. California, Australia).

**Activities they influence**: Hull coating and painting, Hull scrubbing, Retrofitting of BWMS (apply during the ballasting and deballasting)

Key actor: **Researchers and innovation developers**

Actor according to ResponSEAble classification: **II.4.1. Scientific knowledge producers**

**Researchers** and **innovation developers** working mainly in the fields of marine technology (e.g. naval architecture, marine engineering, ship design, ship building) and chemical engineering in research institutions and in the industry are responsible for promising inventions which may reduce the risk of IAS.

Some of the recent innovations in the field of BWM and anti-fouling technology are the following:

- Efficient design of ballast water tanks
- A variety of BWMS based on chemical or mechanical methods (filtration, UV radiation, deoxygenation, ozone etc.)
- Improved coatings allowing less biofouling to be attached
- Environmental friendlier anti-fouling paints using reduced biocides or even biocide-free.
- Less need for hull cleaning due to improved coatings
- High efficiency for in-water hull cleaning and filtration systems

Another way researchers and engineers may influence the value chain is by developing new innovative products requiring less or different materials for the manufacturing of products which will reduce the need of overseas water transportation.

**Activities they influence:** Ship construction, Retrofitting, Ballasting, Deballasting, Manufacturing

Key actor: **International bodies**

Actor according to ResponSEAble classification: **III.1. Legislators**

International and intergovernmental organizations are significant global players in the IAS story.

The **International Maritime Organization** (IMO) is a specialised agency of the United Nations responsible for regulating shipping. Founded in 1948, IMO is the oldest and most influential international maritime organization. It has 171 member states, representing



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96.53% of the world's tonnage, while most UN member states that are not members of IMO are landlocked countries. Its primary purpose is to develop and maintain a comprehensive regulatory framework for shipping. Its remit today includes safety, environmental concerns, legal matters, technical co-operation, maritime security and the efficiency of shipping.

The governing body of the International Maritime Organization is the Assembly which meets every two years. In between Assembly sessions a Council, consisting of 40 Member States elected by the Assembly, acts as the governing body. The technical work of the International Maritime Organization is carried out by five main Committees which are supported by technical subcommittees. One of most influential Committee is the **Marine Environment Protection Committee** (MEPC). Among other tasks, the MEPC prepares and adopts guidelines for the uniform implementation of the BWMC. The IMO Secretariat consists of some 300 international civil servants headed by a Secretary-General (Wikipedia, 2016).

The IMO has been at the front of the international effort by taking the lead in addressing the problem of transferring IAS through shipping. In 1991 the IMO's MEPC adopted the first International Guidelines for preventing the introduction of unwanted aquatic organisms and pathogens from ships' ballast water and sediment discharges (IMO, 1991); while the United Nations Conference on Environment and Development (UNCED), held in Rio de Janeiro in 1992, recognized the issue as a major international concern. While continuing its work towards the development of an international treaty, the IMO adopted, in November 1997 guidelines for the control and management of ships' ballast water to minimize the transfer of harmful aquatic organisms and pathogens (IMO, 1997).

IMO is the source of approximately 60 legal instruments that guide the regulatory development of its member states to improve safety at sea, facilitate trade among seafaring states and protect the maritime environment. About 50 of them are conventions which have already entered into force and are binding for every IMO member state. The BWMC is one of the few conventions which have not entered into force yet.

The **European Sea Ports Organisation** (ESPO), founded in 1993, is the representative body of the port authorities, port associations and port administrations of the seaports of the member states of the European Union including ports from non-member states which are

| |
|---|
| admitted under observer status. |
| **Activities they influence**: Sea and coastal water transport |



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Key actor: **European and national legislators**

Actor according to ResponSEAble classification: **III.1. Legislators**

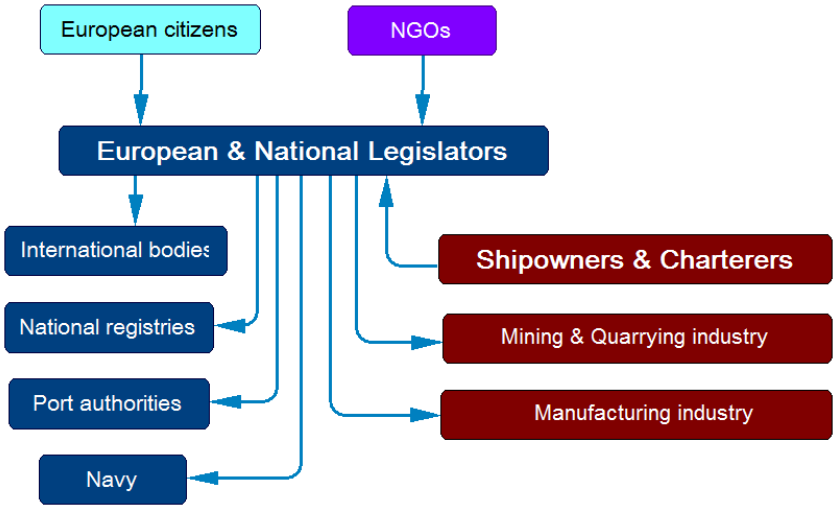


*Figure 23: Key actors related directly with European and national legislators with respect to the IAS story.*

European and national legislators control or influence directly or indirectly agencies and other bodies, which play a major role when it comes to:

- ratifying international treaties and conventions
- applying national or international regulations
- approving environmental systems such as BWMS
- regulating business sectors which are crucial for water transport
- controlling the fleets of naval forces capable to operate in various seas

More specifically, they control port authorities and coastal agencies, whose responsibility is the implementation of regulations regarding ballast water management in the ports and coastal areas of their country. Moreover, through their national registries, they exercise regulatory control over the vessels registered under the flag of the state. Depending on the fleet registered under their flag, registries and through them national legislators can

influence decisions taken in European and international bodies such as the ratification of the BWMC.

The importance of national legislators is even more evident when it comes to the behaviour of naval forces. According to Article 1 of the BWMC, the Convention does not apply to warships, naval auxiliary or other ships owned or operated by a State and used, for the time being, only on government non-commercial service.

The above dependencies make European and national legislators two of the most influential key actors in the IAS value chain. Various interest groups try to influence their decisions at European and national level, including NGOs and industrial lobbyists.

**Activities they influence**: Directly or indirectly almost all activities related with the IAS story.

Key actor: **NGOs**

Actor according to ResponSEAble classification: **IV.1. Institutionalized sector (e.g. NGOs)**

Many non-governmental organizations (NGOs) are active in the field of marine ecology and could potentially raise the awareness of the issue of IAS through their campaigns and also influence national and European legislators in their decisions. International NGOs which are traditionally active in the field of marine ecology (Greenpeace, WWF) are aware of the problem. However, it seems that the issue of IAS has not a high priority in their agenda. They prefer to concentrate their resources in other problems affecting marine ecology, such as overfishing and microplastics.

**Activities they influence**: European citizens, European & National Legislators



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Key actor: **Shipowners**

Actor according to ResponSEAble classification: **II.3.5. Maritime transport service providers**

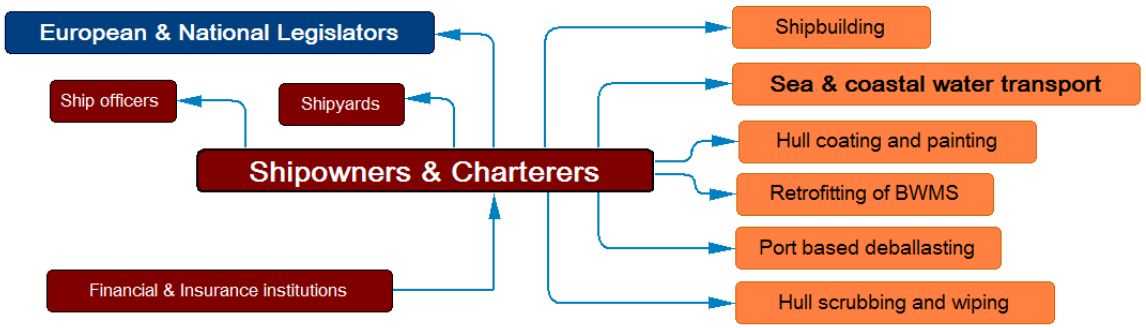


*Figure 24: Activities directly influenced by Shipowners and charterers and their relations with other key actors*

Shipowners of large merchant vessels play a key role in the story of IAS as they influence the value chain in many ways and they take important decisions which are directly or indirectly related with the introduction and spreading of IAS. In the context of the value chain of activities they influence the following:

a) **Shipbuilding**. The building of new ships by deciding on when and how they should be built and which technologies to install regarding hull coating and BWMS in particular.

b) **Retrofitting of BWMS**. For older ships in their fleet they can decide to retrofit them with effective BWMS, delay the decision as long as possible or even avoid this step until the ship ends its life cycle and is demolished. Until now, shipowners were reluctant to retrofit older ships with BWMS as this costly investment would have no direct financial benefits for them. The BWMC is a major driver for shipowners to retrofit their ships. Even then, it is expected that shipowners will calculate carefully before they decide to upgrade very old ships as they would not be able amortize the high costs for new, expensive technologies. For these ships they are more likely to consider alternative solutions to comply with the BWMC such as port-based ballast water treatment. Once in force, the Convention will require shipowners to install the necessary equipment for the proper

treatment of ballast water by each vessel's next scheduled dry-docking. Regardless of when the Convention enters into force, the announcement will likely see many owners rescheduling dry-docks due in the immediate aftermath, in order to extend the deadline by which they will be required to install the necessary equipment[19].
Similarly, the current strategy of shipowners regarding the USCG regulations is to dock older vessels one last time early enough, while there is no USCG approved BWMS available, and therefore they are able to maintain their ship and get an extension from the USCG without the need to install an expensive BWMS until the next time a dry dock is needed. By that time retrofitting some of the oldest ships will not be worthwhile and they will be scrapped (Interviews in Posidonia 2016).

c) **Hull coating** and **painting**. For all ships in their fleet they decide within the existing regulations, when and how the maintenance of the ship's hull will take place. Shipowners always had a strong interest in applying anti-fouling technologies, because marine biofouling affects the performance of ships and reduces their profitability. However, as mentioned in previous sections, during the process of **hull scrubbing** and **wiping** a significant portion of the microorganisms, plants, algae and small animals attached to the ship's hull can be released to the sea and become invasive.

d) **Water transport**. Shipowners and charteres are the main responsible actors for water transport issues e.g. the routes their ships take and the ports they visit. Their decisions are influenced by global supply and demand, but other factors play a role such as profit margin and route optimization.

e) **Deballasting**. Although it is not always clear it must be assumed that the decision of the release of untreated ballast water to the sea according or disregarding national and international regulations is taken by shipowners and charterers. It is unclear whether ship's officers play a major role in this decision.

On the other hand, shipowners are in the position to influence other key actors, such as the following:

[19] http://www.hellenicshippingnews.com/ballast-water-management-convention-likely-to-come-into-force-in-2016/



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- Due to their economic wealth the lobby organizations of shipowners influence the decisions of N**ational, European** and **International legislators**. Leaders of most Greek shipping organisations, counting to the most influential ones worldwide, are 'oppositionists'. They are opposed any tightening of ballast water regulations, anywhere in the world, other than those already agreed at the IMO. In fact, they reject any further regulation that will increase the cost of vessel operation.[20].
  Moreover, it is expected that in case the conditions for the BWMC entering into force will be met only marginally (i.e. ratified by states representing at least 35% the world merchant shipping tonnage), shipowners through their associations or national maritime authorities will require a recount of the tonnage, as they did in the past, to ascertain if it is enough to trigger the convention to come into force.

- As employers of **ship officers**, shipowners have direct influence of their decisions onboard of ships. In contrast to the past, nowadays modern telecommunication systems facilitate this trend reducing the autonomy of ship's captains.

- Shipowners are the main customers of **shipyards** (next to the navy) and thus take influence on their business sector.

- Shipping companies may have economic relations with **financial and insurance institutions** in order to finance their activities or insure the ships covering loss or damage of vessels and cargoes.

Shipowners are able to register their ships not in the **registry** of the country they are located but under a *flag of convenience* to reduce operating costs or to avoid more demanding regulations imposed by other countries. This discrepancy is obvious considering that the top four ship-owning countries (Greece, Japan, China and Germany) control 45.5% of the world tonnage, while the national registries of these countries have registered ships representing together only 10.8% of the world's tonnage. At the same time, the world's largest registry today, Panama, represents 20.1% of the world's dwt, the vast majority of which are foreign-owned (UNCTAD, 2015). The demand that there is a genuine link between a ship's owners

[20] From Posidonia 2016 exhibition: http://splash247.com/the-last-word-on-posidonia-2016/

and its flag state, although it has been formulated in 1986 by the United Nations Convention for Registration of Ships, it has never come into force[21].

Greece continues to be the largest ship-owning country, accounting for more than 16%of the world total, followed by Japan, China, Germany and Singapore.

**Activities they influence**: Shipbuilding, Retrofitting of BWMS, Hull coating and painting, Hull scrubbing and wiping, Water transport (incl. Deballasting)

Key actor: **Industrial sectors (Mining & Quarrying, Manufacturing)**

Actor according to ResponSEAble classification: **II.1.6. Miners and mining companies**

Mining and quarrying industries, as well as various brunches of the manufacturing industry are involved in the IAS problem either as supplier or as consumer of goods transported overseas. According to the statistics, petroleum, coal and metal ores make 64.2% of the European seaborne trade. This makes the following European industries heavily dependent on seaborne freight transport:

- Coal mining industry
- Petroleum industry

[21] The Convention will enter into force 12 months after the date on which not less than 40 States, the combined tonnage of which amounts to at least 25% of the world tonnage, have become Contracting Parties to it. By 20th of June 2016, only 15 states have ratified this treaty.



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- Metal ore mining industry
- Manufacturing industry and especially those brunches related with
    - Manufacture of coke and refined petroleum products
    - Manufacture of chemicals and chemical products
    - Manufacture of basic metals

**Activities they influence**: Mining & Quarrying, Manufacturing

Key actor: **European consumers**

Actor according to ResponSEAble classification: **V.1. Consumer**

Consumers might have an indirect influence to the transportation routes of the BW by changing their consumption behaviour for goods originating from overseas. The consumption behaviour has changed in the past for various reasons, such as economic crisis, nationalistic sentiments and ecological sensitivity. In these cases, public opinion has influenced the trade of selected goods usually by reducing the demand of selected goods coming from overseas in favour of local products.

However, the IAS problem is not caused by the trade of a limited number of products or countries. In the contrary, it is a global problem, mainly caused by international seaborne trade involving directly or indirectly the majority of human economic activities. Therefore, a lasting and significant change in the consumption behaviour that would have an influence on the IAS problem as a whole is unlikely to occur.

**Activities they influence**: Consumption

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## *List of acronyms*

| | |
|---|---|
| BW | Ballast Water |
| BWM | Ballast Water Management |
| BWMC | International Convention for the Control and Management of Ships‘ Ballast Water and Sediments |
| BWMS | Ballast Water Management Systems |
| DAPSIWR | Driving forces – Actions – Pressures – States – Impacts – Welfare - Responses |
| DWT | Deadweight Tonnage |
| EU | European Union |
| GT | Gross Tonnage |
| HELCOM | The Baltic Marine Environment Protection Commission (Helsinki Commission) |
| HF | Hull Fouling |
| IAS | Invasive Alien Species |
| IMO | International Maritime Organization |
| LNG | Liquefied Natural Gas |
| LPG | Liquefied Petroleum Gas |
| MEPC | Marine Environment Protection Committee (IMO) |



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| | |
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| MES | Marine Equipment Suppliers |
| MSFD | Marine Strategy Framework Directive |
| NACE | Statistical Classification of Economic Activities in the European Community (Nomenclature Statistique des Activités économiques dans la Communauté Européenne) |
| NIS | Non-Indigenous Species |
| NISA | U.S. the National Invasive Species Act |
| RORO | Roll-on/roll-off |
| TEU | Twenty Foot Equivalent Unit |
| UNCTAD | United Nations Conference on Trade and Development |
| USCG | United States Coast Guard |
| UV | Ultraviolet |
| UVT | Ultraviolet Transmittance |

***Annex A***

**Table 2: NACE classification of economic activities with relevance to the story of IAS**

| SECTION A: AGRICULTURE, FORESTRY AND FISHING | | |
|---|---|---|
| Division 03: Fishing and aquaculture | | |
| Activities | NACE Class | Relevance to the story |
| Fishing | 03.11 Marine fishing | Fishing may spread IAS already established in one region to nearby waters. |
| Aquaculture | 03.21 Marine aquaculture | Another vector for introducing IAS. |
| **SECTION B: Mining and Quarrying** | | |
| Division 05: Mining of coal and lignite | | |
| Activities | NACE Class | Relevance to the story |
| Mining of coal | 05.10 Mining of hard coal | Seaborne trade good |
| Division 06: Extraction of crude petroleum and natural gas | | |
| Activities | NACE Class | Relevance to the story |
| Extraction of crude petroleum | 06.10 Extraction of crude petroleum | Seaborne trade good |
| Extraction of natural gas | 06.20 Extraction of natural gas | Seaborne trade good |
| Division 07: Mining of metal ores | | |
| Activities | NACE Class | Relevance to the story |
| Mining of metal ores | 07.1 Mining of iron ores | Seaborne trade good |
| Division 08: Other mining and quarrying | | |
| Activities | NACE Class | Relevance to the story |
| Other mining and quarrying | 08.1 Quarrying of stone, sand and clay | Seaborne trade good |



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| SECTION C: MANUFACTURING | | |
|---|---|---|
| Division 19: Manufacture of coke and refined petroleum products | | |
| Activities | NACE Class | Relevance to the story |
| Refineries | 19.20 Manufacture of refined petroleum products | Dependent on goods from overseas |
| Division 20: Manufacture of chemicals and chemical products | | |
| Activities | NACE Class | Relevance to the story |
| Manufacturing industries | Various | Dependent on goods from overseas |
| Hull coating and painting | 20.30 Manufacture of paints, varnishes and similar coatings, printing ink and mastics | Anti-fouling paints and special hull coatings may reduce the risk of IAS which are attached to the ship's hull as biofouling |
| Division 24: Manufacture of basic metals | | |
| Activities | NACE Class | Relevance to the story |
| Manufacturing industries | Various | Dependent on goods from overseas |
| Division 28: Manufacture of machinery and equipment n.e.c.t | | |
| Activities | NACE Class | Relevance to the story |
| Retrofitting of BWMS | 28.12 Manufacture of fluid power equipment<br>28.13 Manufacture of other pumps and compressors | Retrofitting of existing vessels with Ballast Water Management Systems is the most promising technology for the prevention of transporting IAS through ballast water.<br>As most of the older ships currently in operation do not have such facilities on-board, this sector is expected to become important once the BWMC will enter into force. |
| Division 30: Manufacture of other transport equipment | | |
| Activities | NACE Class | Relevance to the story |
| Shipbuilding | 30.11 Building of ships and floating structures | Various aspects of shipboulding influence the risk introducing IAS, such as:<br>• The design of ballast tanks<br>• The installation of BWMS<br>• The application of anti-fouling coatings |
| Shipbuilding | 30.12 Building of pleasure and sporting boats | By applying anti-fouling coatings on the hull of small boats reduces the risk of biofouling being attached. |

| SECTION E: WATER SUPPLY; SEWERAGE, WASTE MANAGEMENT AND REMEDIATION ACTIVITIES | | |
|---|---|---|
| Division 38: Waste collection, treatment and disposal activities; materials recovery | | |
| Activities | NACE Class | Relevance to the story |
| Hull scrubbing and wiping | 38.12 Collection of hazardous waste | Brushing/wiping the fouling from the vessel's hull is a key activity in the IAS story. This way Non-Indigenous Species are detached from the vessel hull and released into the water where they may build viable populations and become invasive. |
| Port based deballasting | 38.22 Treatment and disposal of hazardous waste | In case of deballasting, the ballast water is transferred from the ballast tanks to onshore treatment facilities where NIS are neutralized |
| **SECTION G: WHOLESALE AND RETAIL TRADE; REPAIR OF MOTOR VEHICLES AND MOTORCYCLES** | | |
| Division 46: Wholesale trade, except of motor vehicles and motorcycles | | |
| Activities | NACE Class | Relevance to the story |
| Ship trade | 46.14 Agents involved in the sale of machinery, industrial equipment, ships and aircraft | Retrofitted ships have an increased resale value. Older ships with no ballast water management systems on-board have a smaller value and are more likely to be disposed earlier. |



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| SECTION H: TRANSPORTATION AND STORAGE | | |
|---|---|---|
| Division 50: Water transport | | |
| Activities | NACE Class | Relevance to the story |
| Cruising<br>Yachting<br>Boat excursion<br>Traveling with ferry boats<br>Traveling with pleasure ships<br>Traveling with water taxis<br>Coastal water transport | 50.10 Sea and coastal passenger water transport | Traveling with smaller ships in the same sea region will not introduce IAS. But such activities may spread IAS already established in one region to nearby waters. |
| Transport of freight overseas<br>Ship rental with crew for sea and coastal freight water transport | 50.20 Sea and coastal freight water transport | This is the main economic activity, responsible for the introduction of IAS through hull fouling and the transportation of ballast water. |
| **SECTION K: FINANCIAL AND INSURANCE ACTIVITIES** | | |
| Division 64: Financial service activities, except insurance and pension funding | | |
| Activities | NACE Class | Relevance to the story |
| Loan | 64.19 Other monetary intermediation | The risk calculated by institutions financing the new or older ships may take into account whether the vessel complies to regulations governing ballast water management and especially the U.S. Coast Guard regulations and the BWMC. |
| Division 65: Insurance, reinsurance and pension funding, except compulsory social security | | |
| Activities | NACE Class | Relevance to the story |
| Marine insurance<br>Transport insurance | 65.12 Non-life insurance | The risk calculated by insurance companies may take into account whether the vessel complies to regulations governing ballast water management and especially the U.S. Coast Guard regulations and the BWMC.<br>Retrofitted ships have an increased resale value. |

| SECTION M: PROFESSIONAL, SCIENTIFIC AND TECHNICAL ACTIVITIES | | |
|---|---|---|
| Division 72: Scientific research and development | | |
| Activities | NACE Class | Relevance to the story |
| Research and development | 72.19 Other research and experimental development on natural sciences and engineering | Protection from IAS can be increased with research and development efforts in various fields, such as filtering and neutralizing IAS in ballast water, improved anti-fouling paints etc. |
| Division 74: Other professional, scientific and technical activities | | |
| Activities | NACE Class | Relevance to the story |
| Marine consultant<br>Maritime consultant | 74.90 Other professional, scientific and technical activities n.e.c. | Marine/Maritime consultants provide a variety of services in the fields of marine commercialization and marine ecosystems.<br>Based on their expertise they are able to advise the marine business sector about what it should and shouldn't do, including all aspects that are related to IAS. |
| Division 77: Rental and leasing activities | | |
| Activities | NACE Class | Relevance to the story |
| Ship chartering without crew | 77.34 Renting and leasing of water transport equipment | Same as ship rental with crew (see 5020). |
| **SECTION O: PUBLIC ADMINISTRATION AND DEFENCE;COMPULSORY SOCIAL SECURITY** | | |
| Division 84: Public administration and defence; compulsory social security | | |
| Activities | NACE Class | Relevance to the story |
| Administration, supervision and operation of the navy | 84.22 Defence activities | Activities related to naval operations, contributing to the transport of IAS through ballast water and hull fouling. |



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| SECTION U: ACTIVITIES OF EXTRA TERRITORIAL ORGANISATIONS AND BODIES | | |
|---|---|---|
| Division 99: Activities of extraterritorial organisations and bodies | | |
| Activities | NACE Class | Relevance to the story |
| Guidelines, Treaties, Conventions, Directives etc. | 99.00 Activities of extraterritorial organisations and bodies | Intergovernmental and International organizations may have a significant influence in the prevention, monitoring and defence against IAS. |

***Annex B***

**Table 3: Main products imported or exported by sea in 2015 from/to European countries (EU28) per product category ordered by freight weight in mil. tons. Only those categories and subcategories are listed which amount to more than 0.5% of the total weight (Source:EUROSTAT )**

| Product Categories | IMPORT mil. tons | EXPORT mil. tons | TOTAL mil. tons | Percentage of total imports+ exports |
|---|---|---|---|---|
| **27 MINERAL FUELS, MINERAL OILS AND PRODUCTS OF THEIR DISTILLATION; BITUMINOUS SUBSTANCES; MINERAL WAXES** | **770,52** | **161,90** | **932,43** | **52,79** |
| 2709 PETROLEUM OILS AND OILS OBTAINED FROM BITUMINOUS MINERALS, CRUDE | 435,70 | 9,90 | 445,60 | 25,23 |
| 2710 PETROLEUM OILS AND OILS OBTAINED FROM BITUMINOUS MINERALS (EXCL. CRUDE); PREPARATIONS CONTAINING >= 70% BY WEIGHT OF PETROLEUM OILS OR OF OILS OBTAINED FROM BITUMINOUS MINERALS, THESE OILS BEING THE BASIC CONSTITUENTS OF THE PREPARATIONS, N.E.S.; WASTE OILS CONTAINING MAINLY PETROLEUM OR BITUMINOUS MINERALS | 121,11 | 125,78 | 246,89 | 13,98 |
| 2701 COAL; BRIQUETTES, OVOIDS AND | 161,13 | 1,46 | 162,59 | 9,20 |

| Product Categories | IMPORT mil. tons | EXPORT mil. tons | TOTAL mil. tons | Percentage of total imports+ exports |
|---|---|---|---|---|
| SIMILAR SOLID FUELS MANUFACTURED FROM COAL | | | | |
| 2711 PETROLEUM GAS AND OTHER GASEOUS HYDROCARBONS | 36,31 | 3,74 | 40,05 | 2,27 |
| 2713 PETROLEUM COKE, PETROLEUM BITUMEN AND OTHER RESIDUES OF PETROLEUM OIL OR OF OIL OBTAINED FROM BITUMINOUS MINERALS, N.E.S. | 7,68 | 5,64 | 13,33 | 0,75 |
| **26 ORES, SLAG AND ASH** | **114,31** | **12,75** | **127,06** | **7,19** |
| 2601 IRON ORES AND CONCENTRATES, INCL. ROASTED IRON PYRITES | 89,27 | 6,98 | 96,25 | 5,45 |
| 2606 ALUMINIUM ORES AND CONCENTRATES | 12,97 | 0,23 | 13,19 | 0,75 |
| **25 SALT; SULPHUR; EARTHS AND STONE; PLASTERING MATERIALS, LIME AND CEMENT** | **40,34** | **39,55** | **79,89** | **4,52** |
| 2523 CEMENT, INCL. CEMENT CLINKERS, WHETHER OR NOT COLOURED | 1,67 | 21,32 | 22,99 | 1,30 |
| 2517 PEBBLES, GRAVEL, BROKEN OR CRUSHED STONE, FOR CONCRETE AGGREGATES, FOR ROAD METALLING OR FOR RAILWAY BALLAST, SHINGLE AND FLINT, WHETHER OR NOT HEAT-TREATED; MACADAM OF SLAG, DROSS OR SIMILAR INDUSTRIAL WASTE, WHETHER OR NOT INCORPORATING THE MATERIALS CITED IN | 13,28 | 0,94 | 14,23 | 0,81 |



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| Product Categories | IMPORT mil. tons | EXPORT mil. tons | TOTAL mil. tons | Percentage of total imports+ exports |
|---|---|---|---|---|
| THE FIRST PART OF THE HEADING; TARRED MACADAM; GRANULES, CHIPPINGS AND POWDER, OF STONES OF HEADING 2515 AND 2516, WHETHER OR NOT HEAT-TREATED | | | | |
| **72 IRON AND STEEL** | **37,07** | **37,08** | **74,15** | **4,20** |
| 7204 FERROUS WASTE AND SCRAP; REMELTING SCRAP INGOTS OF IRON OR STEEL (EXCL. SLAG, SCALE AND OTHER WASTE FROM THE PRODUCTION OF IRON OR STEEL; RADIOACTIVE WASTE AND SCRAP; FRAGMENTS OF PIGS, BLOCKS OR OTHER PRIMARY FORMS OF PIG IRON OR SPIEGELEISEN) | 1,78 | 12,99 | 14,77 | 0,84 |
| 7208 FLAT-ROLLED PRODUCTS OF IRON OR NON-ALLOY STEEL, OF A WIDTH >= 600 MM, HOT-ROLLED, NOT CLAD, PLATED OR COATED | 7,47 | 4,05 | 11,52 | 0,65 |
| **10 CEREALS** | **19,06** | **44,90** | **63,95** | **3,62** |
| 1001 WHEAT AND MESLIN | 5,63 | 30,65 | 36,27 | 2,05 |
| 1005 MAIZE OR CORN | 11,17 | 3,17 | 14,34 | 0,81 |
| 1003 BARLEY | 0,26 | 10,53 | 10,79 | 0,61 |
| **44 WOOD AND ARTICLES OF WOOD; WOOD CHARCOAL** | **17,81** | **20,66** | **38,47** | **2,18** |
| 4407 WOOD SAWN OR CHIPPED LENGTHWISE, SLICED OR PEELED, WHETHER OR NOT PLANED, SANDED OR END-JOINTED, OF A THICKNESS OF > 6 MM | 3,57 | 13,10 | 16,67 | 0,94 |
| **23 RESIDUES AND WASTE FROM THE FOOD INDUSTRIES; PREPARED ANIMAL FODDER** | **29,00** | **4,39** | **33,39** | **1,89** |

| Product Categories | IMPORT mil. tons | EXPORT mil. tons | TOTAL mil. tons | Percentage of total imports+ exports |
|---|---|---|---|---|
| 2304 OILCAKE AND OTHER SOLID RESIDUES, WHETHER OR NOT GROUND OR IN THE FORM OF PELLETS, RESULTING FROM THE EXTRACTION OF SOYA-BEAN OIL | 18,97 | 0,17 | 19,14 | 1,08 |
| **29 ORGANIC CHEMICALS** | **18,78** | **8,81** | **27,59** | **1,56** |
| **39 PLASTICS AND ARTICLES THEREOF** | **11,12** | **14,72** | **25,83** | **1,46** |
| **28 INORGANIC CHEMICALS; ORGANIC OR INORGANIC COMPOUNDS OF PRECIOUS METALS, OF RARE-EARTH METALS, OF RADIOACTIVE ELEMENTS OR OF ISOTOPES** | **11,84** | **12,32** | **24,17** | **1,37** |
| **31 FERTILISERS** | **12,64** | **11,36** | **24,01** | **1,36** |
| 3102 MINERAL OR CHEMICAL NITROGENOUS FERTILISERS (EXCL. THOSE IN PELLET OR SIMILAR FORMS, OR IN PACKAGES WITH A GROSS WEIGHT OF <= 10 KG) | 6,43 | 4,16 | 10,59 | 0,60 |
| **84 NUCLEAR REACTORS, BOILERS, MACHINERY AND MECHANICAL APPLIANCES; PARTS THEREOF** | **9,98** | **11,98** | **21,97** | **1,24** |
| **47 PULP OF WOOD OR OF OTHER FIBROUS CELLULOSIC MATERIAL; RECOVERED (WASTE AND SCRAP) PAPER OR PAPERBOARD** | **8,08** | **13,53** | **21,61** | **1,22** |
| 4707 RECOVERED "WASTE AND SCRAP" PAPER OR PAPERBOARD (EXCL. PAPER | 0,36 | 10,34 | 10,70 | 0,61 |



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| Product Categories | IMPORT mil. tons | EXPORT mil. tons | TOTAL mil. tons | Percentage of total imports+ exports |
|---|---|---|---|---|
| WOOL) | | | | |
| 4703 CHEMICAL WOOD PULP, SODA OR SULPHATE (EXCL. DISSOLVING GRADES) | 7,13 | 1,96 | 9,09 | 0,51 |
| **12 OIL SEEDS AND OLEAGINOUS FRUITS; MISCELLANEOUS GRAINS, SEEDS AND FRUIT; INDUSTRIAL OR MEDICINAL PLANTS; STRAW AND FODDER** | **18,20** | **2,52** | **20,72** | **1,17** |
| 1201 SOYA BEANS, WHETHER OR NOT BROKEN | 13,89 | 0,07 | 13,96 | 0,79 |
| **87 VEHICLES OTHER THAN RAILWAY OR TRAMWAY ROLLING-STOCK, AND PARTS AND ACCESSORIES THEREOF** | **6,25** | **13,76** | **20,02** | **1,13** |
| 8703 MOTOR CARS AND OTHER MOTOR VEHICLES PRINCIPALLY DESIGNED FOR THE TRANSPORT OF PERSONS, INCL. STATION WAGONS AND RACING CARS (EXCL. MOTOR VEHICLES OF HEADING 8702) | 2,44 | 7,19 | 9,63 | 0,55 |
| **48 PAPER AND PAPERBOARD; ARTICLES OF PAPER PULP, OF PAPER OR OF PAPERBOARD** | **4,77** | **14,58** | **19,35** | **1,10** |
| **73 ARTICLES OF IRON OR STEEL** | **6,83** | **7,67** | **14,50** | **0,82** |
| **15 ANIMAL OR VEGETABLE FATS AND OILS AND THEIR CLEAVAGE PRODUCTS; PREPARED EDIBLE FATS; ANIMAL OR VEGETABLE WAXES** | **10,32** | **2,84** | **13,16** | **0,74** |
| **08 EDIBLE FRUIT AND NUTS; PEEL OF CITRUS FRUITS OR MELONS** | **10,88** | **1,44** | **12,33** | **0,70** |
| **69 CERAMIC PRODUCTS** | **2,38** | **8,43** | **10,80** | **0,61** |

| Product Categories | IMPORT mil. tons | EXPORT mil. tons | TOTAL mil. tons | Percentage of total imports+ exports |
|---|---|---|---|---|
| 22 BEVERAGES, SPIRITS AND VINEGAR | 2,23 | 8,55 | 10,78 | 0,61 |
| 85 ELECTRICAL MACHINERY AND EQUIPMENT AND PARTS THEREOF; SOUND RECORDERS AND REPRODUCERS, TELEVISION IMAGE AND SOUND RECORDERS AND REPRODUCERS, AND PARTS AND ACCESSORIES OF SUCH ARTICLES | 6,69 | 3,76 | 10,46 | 0,59 |
| 38 MISCELLANEOUS CHEMICAL PRODUCTS | 3,92 | 5,11 | 9,04 | 0,51 |

**Table 4: Main products imported or exported by sea in 2015 from/to European countries (EU28) per product category ordered by value in bil. euros. Only those categories and subcategories are listed which amount to more than 1% of the total trade value (Source:EUROSTAT)**

| Product categories | IMPORT in bil. euros | EXPORT in bil. Euros | TOTAL in bil. Euros | PERCENTAGE of total imports+ exports |
|---|---|---|---|---|
| 27 MINERAL FUELS, MINERAL OILS AND PRODUCTS OF THEIR DISTILLATION; BITUMINOUS SUBSTANCES; MINERAL WAXES | 233,76 | 67,11 | 300,87 | 16,91 |



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| Product categories | IMPORT in bil. euros | EXPORT in bil. Euros | TOTAL in bil. Euros | PERCENTAGE of total imports+ exports |
|---|---|---|---|---|
| 2709 PETROLEUM OILS AND OILS OBTAINED FROM BITUMINOUS MINERALS, CRUDE | 153,15 | 3,65 | 156,80 | 8,81 |
| 2710 PETROLEUM OILS AND OILS OBTAINED FROM BITUMINOUS MINERALS (EXCL. CRUDE); PREPARATIONS CONTAINING >= 70% BY WEIGHT OF PETROLEUM OILS OR OF OILS OBTAINED FROM BITUMINOUS MINERALS, THESE OILS BEING THE BASIC CONSTITUENTS OF THE PREPARATIONS, N.E.S.; WASTE OILS CONTAINING MAINLY PETROLEUM OR BITUMINOUS MINERALS | 53,16 | 55,36 | 108,52 | 6,10 |
| **84 NUCLEAR REACTORS, BOILERS, MACHINERY AND MECHANICAL APPLIANCES; PARTS THEREOF** | 81,45 | 156,07 | 237,52 | 13,35 |
| 87 VEHICLES OTHER THAN RAILWAY OR TRAMWAY ROLLING-STOCK, AND PARTS AND ACCESSORIES THEREOF | 49,06 | 162,72 | 211,79 | 11,90 |
| 8703 MOTOR CARS AND OTHER MOTOR VEHICLES PRINCIPALLY DESIGNED FOR THE TRANSPORT OF PERSONS, INCL. STATION WAGONS AND RACING CARS (EXCL. MOTOR VEHICLES OF HEADING 8702) | 24,87 | 111,58 | 136,46 | 7,67 |

| Product categories | IMPORT in bil. euros | EXPORT in bil. Euros | TOTAL in bil. Euros | PERCENTAGE of total imports+ exports |
|---|---|---|---|---|
| 8708 PARTS AND ACCESSORIES FOR TRACTORS, MOTOR VEHICLES FOR THE TRANSPORT OF TEN OR MORE PERSONS, MOTOR CARS AND OTHER MOTOR VEHICLES PRINCIPALLY DESIGNED FOR THE TRANSPORT OF PERSONS, MOTOR VEHICLES FOR THE TRANSPORT OF GOODS AND SPECIAL PURPOSE MOTOR VEHICLES OF HEADING 8701 TO 8705, N.E.S. | 10,39 | 28,05 | 38,44 | 2,16 |
| **85 ELECTRICAL MACHINERY AND EQUIPMENT AND PARTS THEREOF; SOUND RECORDERS AND REPRODUCERS, TELEVISION IMAGE AND SOUND RECORDERS AND REPRODUCERS, AND PARTS AND ACCESSORIES OF SUCH ARTICLES** | 69,77 | 48,78 | 118,56 | 6,66 |
| **39 PLASTICS AND ARTICLES THEREOF** | 25,46 | 31,82 | 57,28 | 3,22 |
| **29 ORGANIC CHEMICALS** | 25,33 | 18,04 | 43,37 | 2,44 |
| **72 IRON AND STEEL** | 20,70 | 21,23 | 41,93 | 2,36 |
| **30 PHARMACEUTICAL PRODUCTS** | 8,19 | 29,29 | 37,47 | 2,11 |



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| Product categories | IMPORT in bil. euros | EXPORT in bil. Euros | TOTAL in bil. Euros | PERCENTAGE of total imports+ exports |
|---|---|---|---|---|
| 3004 MEDICAMENTS CONSISTING OF MIXED OR UNMIXED PRODUCTS FOR THERAPEUTIC OR PROPHYLACTIC USES, PUT UP IN MEASURED DOSES "INCL. THOSE IN THE FORM OF TRANSDERMAL ADMINISTRATION" OR IN FORMS OR PACKINGS FOR RETAIL SALE (EXCL. GOODS OF HEADING 3002, 3005 OR 3006) | 3,70 | 25,56 | 29,26 | 1,64 |
| **73 ARTICLES OF IRON OR STEEL** | 14,71 | 22,58 | 37,29 | 2,10 |
| **94 FURNITURE; BEDDING, MATTRESSES, MATTRESS SUPPORTS, CUSHIONS AND SIMILAR STUFFED FURNISHINGS; LAMPS AND LIGHTING FITTINGS, NOT ELSEWHERE SPECIFIED OR INCLUDED; ILLUMINATED SIGNS, ILLUMINATED NAME-PLATES AND THE LIKE; PREFABRICATED BUILDINGS** | 18,55 | 10,83 | 29,38 | 1,65 |
| **90 OPTICAL, PHOTOGRAPHIC, CINEMATOGRAPHIC, MEASURING, CHECKING, PRECISION, MEDICAL OR SURGICAL INSTRUMENTS AND APPARATUS; PARTS AND ACCESSORIES THEREOF** | 12,90 | 13,93 | 26,84 | 1,51 |
| **22 BEVERAGES, SPIRITS AND VINEGAR** | 4,01 | 22,04 | 26,06 | 1,46 |
| **61 ARTICLES OF APPAREL AND CLOTHING ACCESSORIES, KNITTED OR CROCHETED** | 25,05 | 0,89 | 25,93 | 1,46 |

| Product categories | IMPORT in bil. euros | EXPORT in bil. Euros | TOTAL in bil. Euros | PERCENTAGE of total imports+ exports |
|---|---|---|---|---|
| **62 ARTICLES OF APPAREL AND CLOTHING ACCESSORIES, NOT KNITTED OR CROCHETED** | 24,29 | 1,31 | 25,60 | 1,44 |
| **40 RUBBER AND ARTICLES THEREOF** | 11,82 | 9,82 | 21,64 | 1,22 |
| **38 MISCELLANEOUS CHEMICAL PRODUCTS** | 6,65 | 14,19 | 20,84 | 1,17 |
| **76 ALUMINIUM AND ARTICLES THEREOF** | 13,81 | 6,67 | 20,48 | 1,15 |
| **26 ORES, SLAG AND ASH** | 16,32 | 2,47 | 18,79 | 1,06 |
| **48 PAPER AND PAPERBOARD; ARTICLES OF PAPER PULP, OF PAPER OR OF PAPERBOARD** | 5,25 | 13,44 | 18,69 | 1,05 |
| **33 ESSENTIAL OILS AND RESINOIDS; PERFUMERY, COSMETIC OR TOILET PREPARATIONS** | 3,49 | 14,62 | 18,11 | 1,02 |



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# Annex III – The value chain for eutrophication in the Baltic Sea and Black Sea

***SUMMARY***

Eutrophication is a complex problem, and many social and economic actors are directly or indirectly affected by its effects. Among different sources of pollution, agriculture is one of the most important origin of nitrogen and phosphorus in the Baltic Sea capture area. Therefore, farmers and the farming practices they use, are the sector where behavioural change would have the greatest and most instant impact on the status of marine waters and ecosystems. However, agriculture is not an easy sector to approach and change. It is not only highly regulated and subsidized (e.g., through the EU Common Agriculture Policy) but it is also a sector under a strong influence of large market players, such as food processing companies and procurement organizations that are strong enough to enforce their own regulations and quality standards. These regulations and standards are not necessarily set with conservation of marine environment in mind, but rather take into account the realities of a global food market, in which European products and companies have to compete. In addition, European legislation does not fully support agri-environmental measures and only a limited number of agricultural subsidies are linked to sustainable agriculture. Therefore, voluntary solutions undertaken by farmers may threaten their income, and cannot be widely implemented. Conservation goals for the Baltic Sea and sustainable agriculture are often presented as the goals opposing sustainable farmers' income and low food prices. Therefore, combating eutrophication needs to go beyond targeting the farming practices only, it needs to combine actions targeted at the actors whose room for change is larger but the effect on the environment less direct (e.g., food processing companies, retailers, customer, fishers, and tourism industry). These actors might together cause the change along the whole value chain and act as the change multipliers outside their own sector. Citizens/customers are perhaps the most interesting group here, as they might have a relatively strong influence not only on various economic sectors along the value chain, but also on the decision-makers who make the laws and who can impose solutions which would take much longer to occur if implemented on a voluntary basis.

# Identification economic activities with regard to the agriculture sector

The goal of WP2 is to is to identify the different actors of the ocean economy which change in behaviour is key to enhancing ocean health, focussing on key segments of the economy that are closely linked to the sea, be it as source of pressure or that benefit from the sea, accounting for all actors of the economy (including producers, consumers, intermediaries and supporting actors) and presenting the interrelationships and synergies that might exist between the choices and decisions made by each actor. Eutrophication is a complex problem, and many social and economic actors are directly or indirectly affected by its effects. Among different sources of pollution, agriculture is one of the most important origins of nitrogen and phosphorus in the Baltic Sea capture area. Therefore this economic activity has been selected as priority focus of the eutrophication key story. Its value chain with economic activities particularly valid for the eutrophication phenomenon and the related actors have been mapped and analysed within WP2.

## *Agricultural production*

The main components of the EU28's agricultural industry in 2014 were crop output (50.6% of the total) and animal output (40.9%); agricultural services and inseparable secondary activities, generally the processing of agricultural products, provided the residual shares (4.8% and 3.7%). The agricultural products accounting for the highest share of output value in the EU28's agricultural industry in 2014 were milk (14.8%) and cereals (12.6%), while pig and cattle output also accounted for relatively large shares (8.4% and 7.6%). While the **Baltic Sea Region** production of crops forms approximately 32%, and production of livestock event 38% from the EU28, the total agricultural output is less than 20% of the EU28 (Eurostat, 2015).

### *Crop production*

**Cereal production:** The European Union is one of the world's biggest cereals producers and an important cereals trader. About 15% of the EU's wheat crop is exported annually, while large quantities of oilseeds, animal feedstuffs and rice are imported. Nearly two-thirds of the EU's cereals are used for animal feed, with around one-third for human consumption, and 3% is used for biofuels. (http://ec.europa.eu/agriculture/cereals/index_en.htm)
The harvested production of cereals (including rice) in the EU28 was estimated to be around 334.2 million tonnes in 2014, which is about 13% of global cereal production (based on estimates made by the United Nations' Food and Agriculture Organization), making the EU one of the world's biggest producers of cereals. Common wheat and spelt, barley, grain maize and corn cob mix accounted for a high share (86.4 % in 2014) of the



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cereals produced in the EU28. The biggest cereal producers in the EU are France (21.8% of the EU-8's cereal production in 2014), Germany (15.6 %), Poland (9.6 %) and UK (7.3%). Nearly 34% of EU28 cereal production is produced in the BSR countries.

Triticale, which is a hybrid of wheat (Triticum) and rye (Secale), is mainly used for animal feed. Triticale production in the EU28 amounted to 13.2 million tonnes in 2014 and increased moderately (by 14.8 %) from 2013. Poland produced 39.9 % of the total EU28 triticale in 2014.

**Sugar beet production:** The EU28 produced 128.4 million tonnes of sugar beet in 2014 — 19.4 million tonnes more than in 2013. More than half of the EU-28 sugar beet production in 2014 came from France (29.5%) and Germany (23.2%) followed by Poland (9.0%) and the UK (7.3%). The EU is the world's leading producer of sugar beet, with around 50% of the global production (However, beet sugar only represents 20% of the world's sugar production).

**Oilseeds production:** Rape and turnip rape, and sunflower seeds are the main types of oilseeds produced in the EU28. An estimated 24.3 million tonnes of rape and turnip rape were produced in 2014, more than a quarter (25.7%) of it produced by Germany. Sunflower seeds are mainly produced in Bulgaria and Romania, so not relevant for the Baltic Sea region.

**Vegetable production:** The EU produces a broad range of fruits and vegetables thanks to its varied climatic and topographic conditions. The EU28 produced an estimated 5.5 million tonnes of carrots and 6.4 million tonnes of onions in 2014. Carrot production was relatively high in Poland (14.2%) and the UK (14.9%). Onions come mainly from Netherlands and Spain but from Baltic Sea countries Poland and Germany have the highest onion production. Potatoes for human consumption belong to the most competitive segments of EU agriculture. In 2007, with the share of 19,3%, the EU27 was the second largest producer of potatoes in the World (after China). (European Commission, 2016)

**Fruit production:** Around 14 million tonnes of apples were produced in the EU28 in 2014. Apples are produced in almost all EU Member States, although Poland, Italy and France are by far the largest producers. (Eurostat, 2015)

***Livestock production***

Animal production accounts for 43.1% (EUR 167 billion) of the total EU28 agricultural output. Animal production covers:

1) output for animals (57.5% of animal output) which is the value of animals produced either directly for slaughter, or used alive for herd renewal or for further growing and fattening;
2) animal products account for the remaining 42.5% and cover eggs, milk, wool, etc. (Eurostat, 2016)

In 2014, looking at EU Member States, Germany, Spain, France and the United Kingdom held the largest number of livestock. The largest number of pigs was recorded in Germany and Spain (28.3 and 26.6 million heads respectively), bovines in France (19.3 million heads) and sheep (23.0 million heads) in the United Kingdom. The biggest pig meat producers in EU are Germany (24.9% (5.5 million tonnes) of the EU28's pig meat in 2014) and Spain (16.4%). France (19.1%), Germany (17.0%) and the United Kingdom (13.7%)

made up almost half (49.8%) of total EU28 beef production in 2014. Germany, France, Poland, and the UK, each accounted for 12-14% of the total production of poultry meat in the EU28 in 2014. (Eurostat, 2015. Agriculture, forestry and fishery statistics (Eurostat, 2015).

**Beef and veal production:** The EU has a bovine herd of around 89 million heads and a total yearly production of nearly 7,6 million tonnes of beef and a self-sufficiency close to 100%. France, Germany, UK and Italy are the main producing Member States representing together 58% of the EU total beef and veal production (Eurostat 2015). The yearly beef production of the **Baltic Sea Region** states (Russia not included) is ca 2 million tonnes and number of cattle ca 23,7 million heads (Eurostat 2015).

Export and import: The total export of beef and veal from the EU28 was 385 641 tonnes (carcase weight), including ca 99 000 t from BSR (ca 26% of EU 28 beef export), so almost half of the BSR production is exported. The biggest exporters of beef in BSR are Germany (46 151 t), Poland (37 687 t) and Denmark (7266 t). The main beef export partners of EU are Turkey (26 131 t), Hong Kong (27 903 t), Lebanon (27 262 t), Ivory Coast (21 338 t), Ghana (19880 t), Bosnia-Herzegovina (19 256 t), Switzerland (15 812 t) and Philippines (10 256 t). The total import of beef from third countries into EU28 is 193 972 t, including ca 32 400 t into BSR countries (16,7% of EU28 beef import). EU imports beef mainly from South America (Brazil (83 978 t), Uruguay (28 810 t), Argentina (25 353 t)), Australia (18 431 t) and USA (11 427 t). (Estat Comext, 2016)

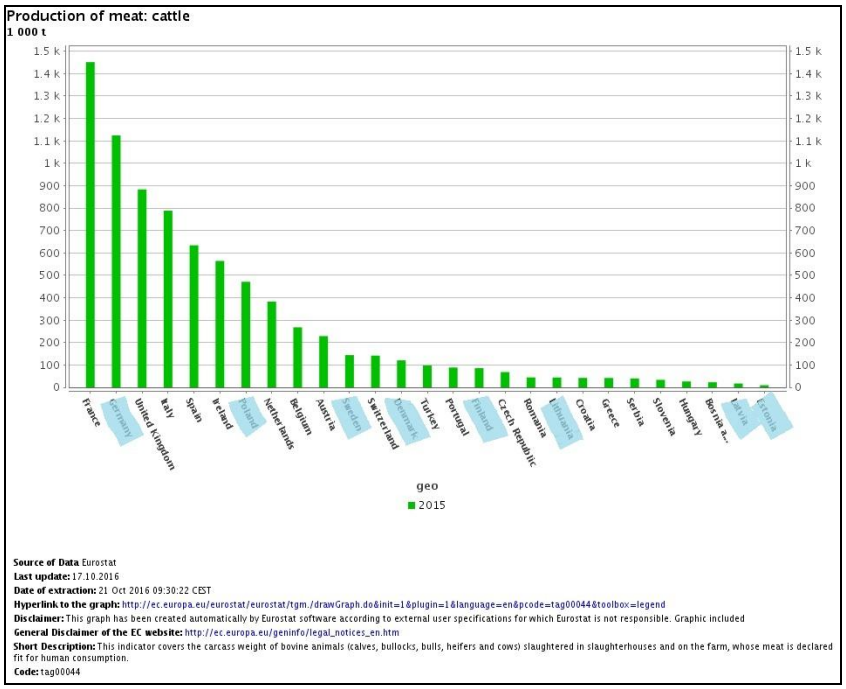


***Figure 1.*** *Production of meat: cattle (source: Eurostat, 2016)*



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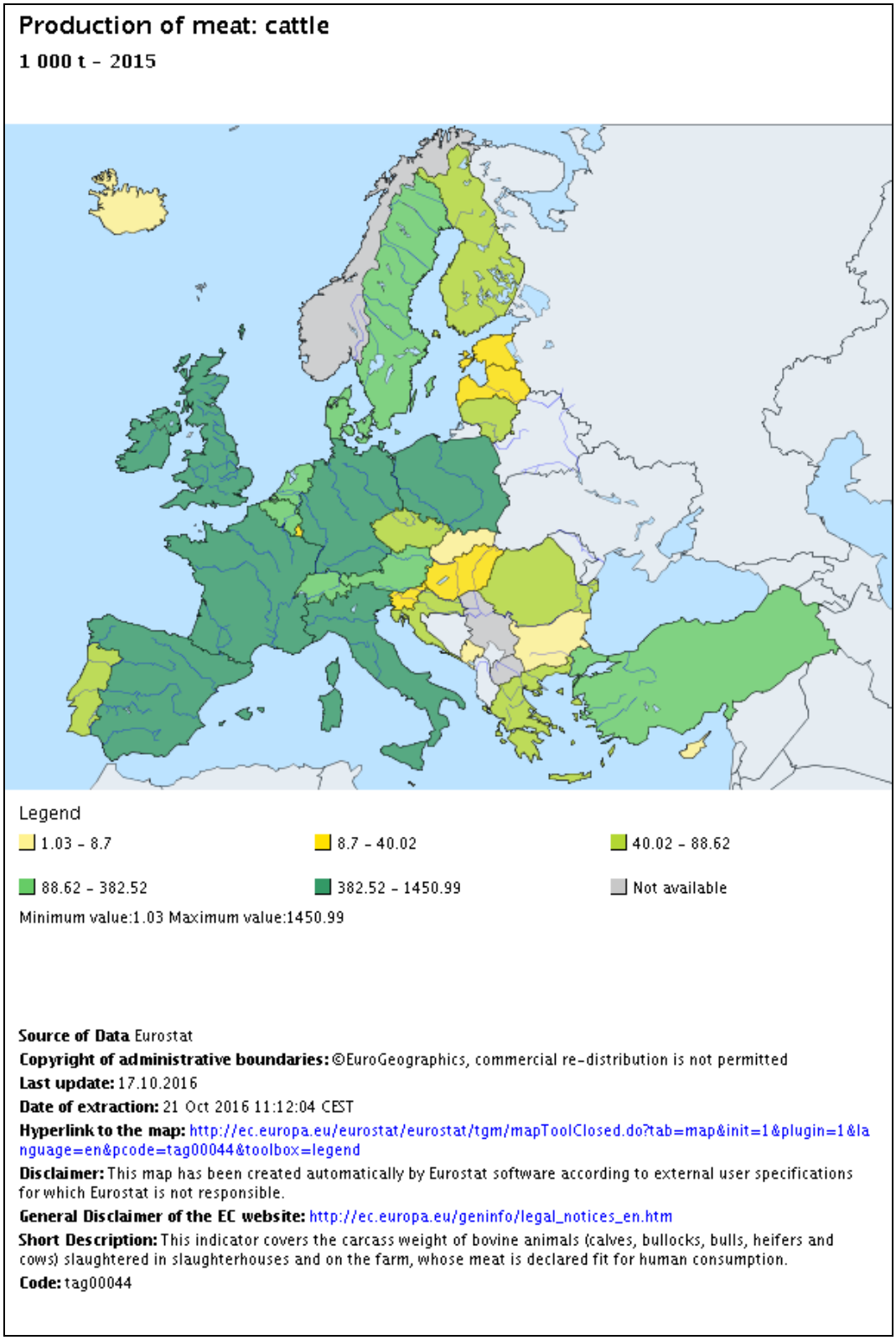


***Figure 2.*** *Production of meat: cattle (source: Eurostat, 2016)*

**Sheep and goat meat production:** With around 98 million heads in 2013 (85% sheep and 14% goats) and a total annual production of about 925 000 tonnes carcass weight, the EU is far from been self-sufficient for this sector. The UK, Spain, Greece and France are the main producing Member States representing together 68% of the EU's total production. Romania, Ireland, Germany and Italy count for another 22%, which leaves a small 10% for all the remaining Member States. With its 88% self-sufficiency, the EU exports around 8% of its total production, while imports are around 212 000 tonnes mainly from New Zealand and Australia (94%), which is around 23% the EU's own consumption. Over the last years, exports of live animals and meat increased. Live animals go mainly to the Middle East and North Africa. Exports of meat and meat products go to all destinations and in greater extent to the Far East.

**Pig meat production:** With 150 million pigs and a yearly production of nearly 23 million t carcass weight the EU is the world's second biggest producer of pigmeat after China and also the biggest exporter of pigmeat and pigmeat products. The EU's main producer countries are Germany, Spain and France, representing together half of the EU's total slaughter. The EU has a self sufficiency of about 111% and exports about 13% of its total production. Most of the EU's pigmeat exports go to East Asia, in particular China. The yearly pig meat production of the **Baltic Sea Region states** (Russia not included) is ca 9,6 million tonnes and number of cattle ca 55 million heads (Eurostat 2015).

Export and import: The total export of pig meat/pigs from EU28 is 1 624 185 tonnes, including ca 754 114 t from BSR (ca 46% of EU 28 pig meat/pigs export). The biggest exporters of pig meat/pigs in BSR are Germany (362 653 t), Denmark (284 983 t) and Poland (91 706 t). The main pig meat/pigs export partners of EU are China (1 156 931 t, almost half of the EU export), Japan (219 799 t), Hong Kong (199 034 t), South Korea (130 582 t and Philippines (128 831 t). Export to Russia is ca 4100 tonnes but it has decreased 47% compared to 2015 data.

The total import of pig meat/pigs from third countries into EU28 is ca 18 400 t, including ca 13 300 t into BSR countries (72,5% of EU 28 pig meat/pigs import). EU imports pig meat mainly from Switzerland (12 249 t), Chile (1831 t), Norway (1154 t) and USA (979 t). (Estat Comext, 2016)



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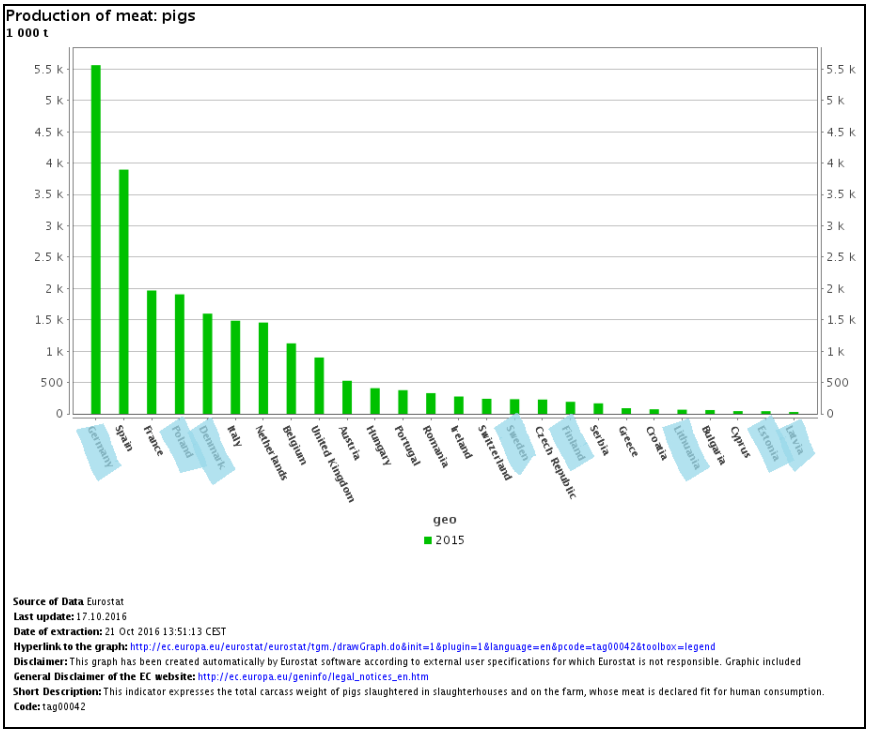


***Figure 3.*** *Production of meat: pigs (source: Eurostat, 2016)*

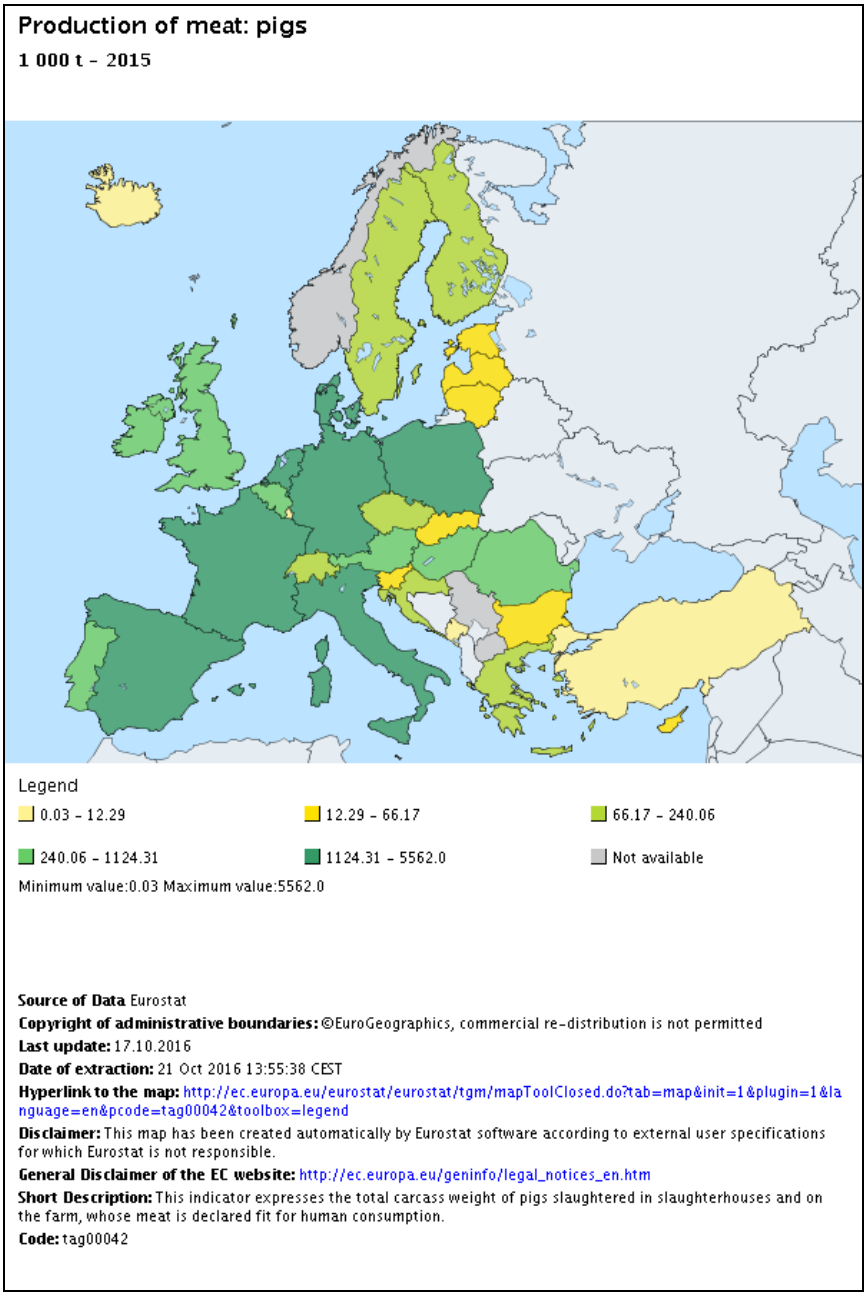


***Figure 4.*** *Production of meat: pigs (source: Eurostat, 2016)*

**Poultry meat and egg production:** In 2014 the 13.1 million tonnes of poultry meat production along with the imports (0.8 Mio T) and exports (1.5 Mio T) kept the self-sufficiency level in European Union at 103%. The leading countries in poultry meat



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production are Poland (13.7%), France (12.7%), closely followed by UK (12.4%), Germany (11.4%) and Spain (11.1%). These five countries ensure 61.3% of the EU production of poultry meat.

The EU imports high value products mainly from Brazil (60% of total EU poultry meat imports) and Thailand (30%), poultry breasts and other high value added products, such as cooked preparations etc. The average value of imports was 2.59 EUR/kg in 2014.

Exports are of lower value (1.37 EUR/kg) but the range of products as well as the range of destinations is much wider. Half of exports are shared between five destinations (South Africa, Benin, Hong Kong, Saudi Arabia and Ukraine) while the other half goes to a long list of countries.

The European Union is the world's second egg producer and a net exporter of eggs and egg products.

**Milk production:** Milk production takes place in all EU Member States and represents a significant proportion of the value of EU agricultural output. For some Member States' it forms a very important part of the agricultural economy. Total EU28 total milk production is estimated around 165 million tons per year (2014 data).

The EU's main milk producers are Germany, France, the United Kingdom, Poland, the Netherlands and Italy which together account for almost 70% of the EU production. The milk production in the BSR countries (Russia not included) is ca 56 million tons per year; the main milk producers in the BSR are Germany (ca 32 million t), Poland (ca 11 million t) and Denmark (ca 5 million t).

The EU dairy herd has been decreasing steadily during the last years, as the milk yield per cow has improved. In 2015 there were around 23 million cows in the EU28, including around 8 million in the BSR (4,3 million in Germany; 2,1 million in Poland; 0,5 million in Denmark). (Eurostat, 2015)

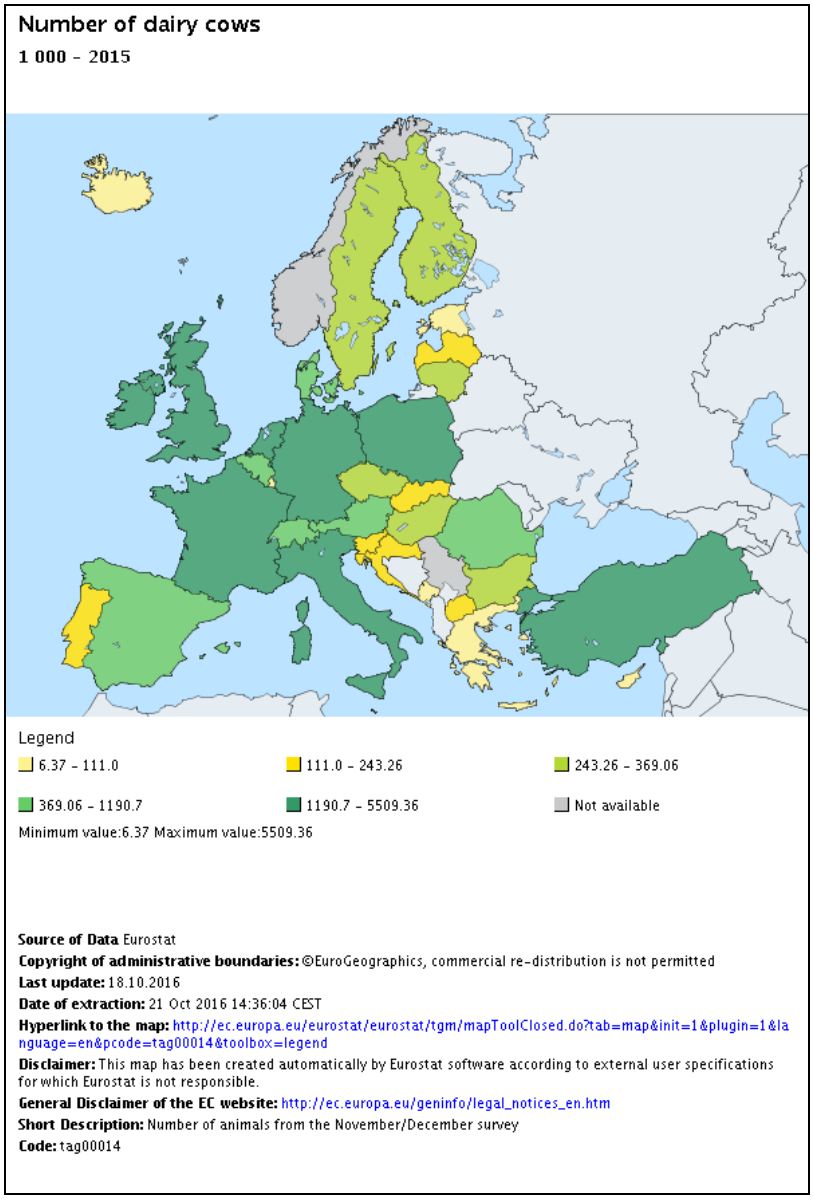


***Figure 5.*** *Number of dairy cows (source: Eurostat, 2016)*



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## *Fertilizers' production*

In the EU, there are approximately 1000 enterprises (1058 in 2013) producing inorganic fertilizers and at least 700 compost producers. In total the EU produces 9% of global nitrogen and 3% of global phosphate while consuming 10% of global nitrogen, 7% of global phosphate and 10% of global potash (Fertlizers Europe, 2016). The volumes of inorganic fertilizers consumed in the EU are estimated at 16 million tonnes of nutrients, at least 1600 million tonnes of manure, and 13 million tonnes of compost. In 2007 the turnover of the inorganic fertilizer producers amounted to 19.5 mEUR. Studies show that inorganic fertilizers can account for around 90% of farmers' expenditure on fertilizing materials (Netherlands example). (ECORYS, 2013)

Although the EU also produces mineral fertilizers it does not fulfill it needs. Therefor the EU is a net importer of nitrogen and phosphate fertilizers. In 2009 the Baltic Sea Region's N consumption formed 30.6% of the EU27 total and Phosphorus consumption formed 29.5% of the EU27 total. Germany and Poland are the biggest consumers of mineral fertilizers in the Baltic Sea region. (Eurostat, 2009)

***Table 1:*** *Mineral fertilizer consumption in the Baltic Sea Region (Eurostat, 2009)*

| | **N tonnes** | **P tonnes** |
|---|---|---|
| **EU 27** | **10 308 500** | **1 032 000** |
| Denmark | 190000 | 11000 |
| Germany | 1 569 000 | 102 500 |
| Estonia | 28 500 | 2 500 |
| Latvia | 59 500 | 7 000 |
| Lithuania | 144 000 | 15 500 |
| Poland | 1 027 500 | 154 000 |
| Finland | 156 500 | 12 500 |
| Sweden | 169 000 | 10 000 |

## *Food production*

In the EU, the food and drink industry is the largest manufacturing sector with the share of 14,6% (FoodDrinkEurope, 2014). The turnover of the industry is double of the one of the United States and China. In 2011, the EU exported about EUR 41.5 billion-worth of processed agricultural products to the rest of the world. By 2013, this figure had risen to EUR 43 billion (European Commission: Growth, 2016). The industry also plays an essential role in national economies with the share of industry's employment surpasses of 15% in more than half of the EU member states. From the Baltic Sea Region, the highest turnover from the food and drink industry is in Germany (also highest in the whole EU28) and Poland (5th after Germany and non-Baltic Sea Region countries such as France, UK and Netherlands) (FoodDrinkEurope, 2014). In 2009 the Baltic Sea Region contributed almost 29% of the EU27 total turnover from the manufacturing of food products. Russia is importer of processed agricultural products and has been an important market for the EU.

***Table 2:*** *Manufacturing of food products in Baltic Sea Region countries (Eurostat, 2009)*

| | **Number of enterprises** | **Number of persons employed** | **Turnover** |
|---|---|---|---|
| | **(thousands)** | | |
| **EU27** | **264.1** | **4091.5** | **813 590** |
| Denmark | 1.5 | 53.4 | 19 145.4 |
| Germany | 30.7 | 799.3 | 147 947.5 |
| Estonia | 0.4 | 12.4 | 1124.9 |
| Latvia | 0.7 | 23.2 | 1251.9 |
| Lithuania | 1.1 | 39 | 2676.7 |
| Poland | 13.6 | 396.6 | 37 959 |
| Finland | 1.7 | 34.4 | 8632.6 |



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| | | | |
|---|---|---|---|
| Sweden | 3.3 | 59.5 | 14 840.2 |

## *Distribution of farming products through retail and wholesale*

Modern retail has developed a lot across the EU over the last decade. Large modern retail chains (especially discounters) have been opening stores both in their domestic markets and in other Member States. Modern retail is predominant in the majority of the Member States which has decreased the number of traditional retail units (fruit and vegetable market, non-branded neighbourhood stores, butchers and bakers). Figure 6 shows that the modern retail concentration is especially high in the Nordic and Baltic countries.

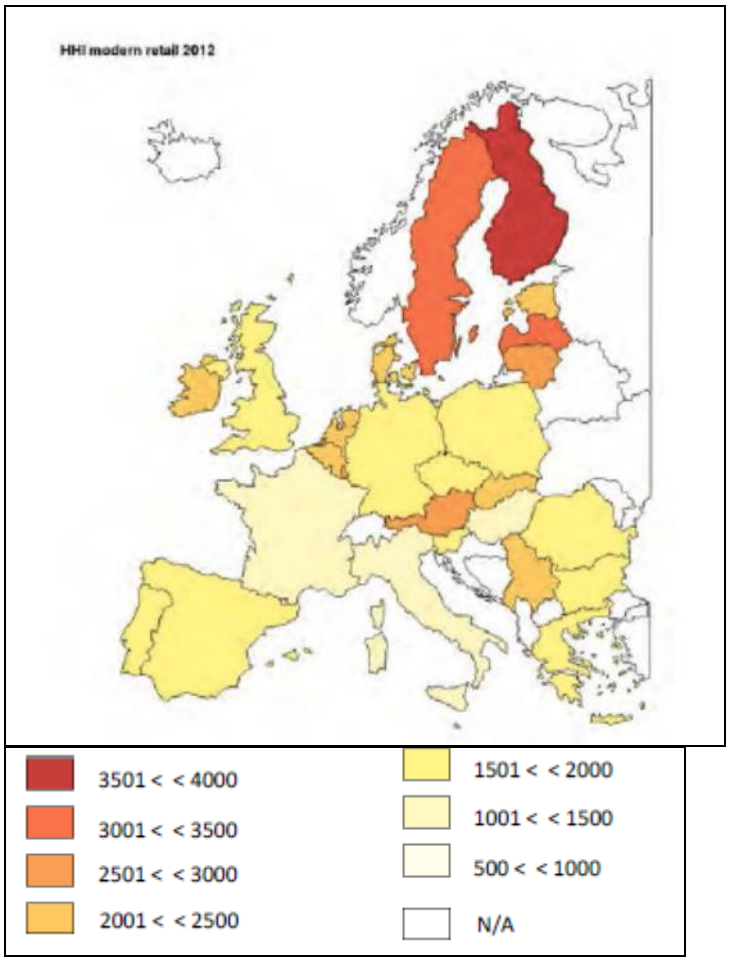


***Figure 6:*** *Concentration of modern retail across the EU member states (European Commission, 2014, pp 127)*

The increase of modern retail has impact on choice, and innovation in the food sector. The top 10 European food retailers accounted for 26% of edible grocery sales in the EU in 2000, compared to 31% in 2011. Another important factor that has shaped the sector is retailers' own brands or private label products that have become more and more successful in Europe over the last decade. Private label market share has increased across most product categories in most of the Member States. (European Commission, 2014)

Modern retail has also influenced increasing concentration at the procurement level. This allows retailers to improve their purchasing conditions and enhance market competitiveness. Procurement organisations have existed since 1930s but have developed particularly since 1980s and 1990s. Established cross-boarder groups have strengthen the retailers'' bargaining power through higher volumes with the aim of reducing purchasing costs. This is especially important for large international brands and for private labels. (European Commission, 2014, pp 50-51)

## *Consumption of farming products*

In 2012 the EU households spent on average 14,6% of expenditure to food and drink. This is second in the consumption expenditure of households after housing, water and energy, and significantly higher than the third expenditure group - transport (FoodDrinkEurope, 2014). Consumers have become more demanding in terms of food (e.g. product variety and price). The economic and financial crisis of 2008 had a significant impact on EU consumers' purchasing power which also affected their behaviour. Lower prices became a priority for many EU consumers. In addition, changes in household composition, an ageing population, increased interest in healthy food and increased environmental awareness have all had an impact on the food retail market in Europe. (European Commission: Competition, 2016) The EU agri-food trade balance is in surplus meaning that the EU food products export exceeds the numbers of import. In 2012 the recorded trade surplus was 23 billion EUR (Food Drink Europe, 2014).

## *Farming characterization*

**Organic farming:** In 2014, the mean share of organic farming area from total utilized agricultural area in EU 28 was 5.8%. The Member States with the biggest share of organic farming area were Austria (19.4%), Sweden (16.5%) and Estonia (16%), followed by Czech Republic (13.4%), Latvia (10.9%) and Italy (10.9%).



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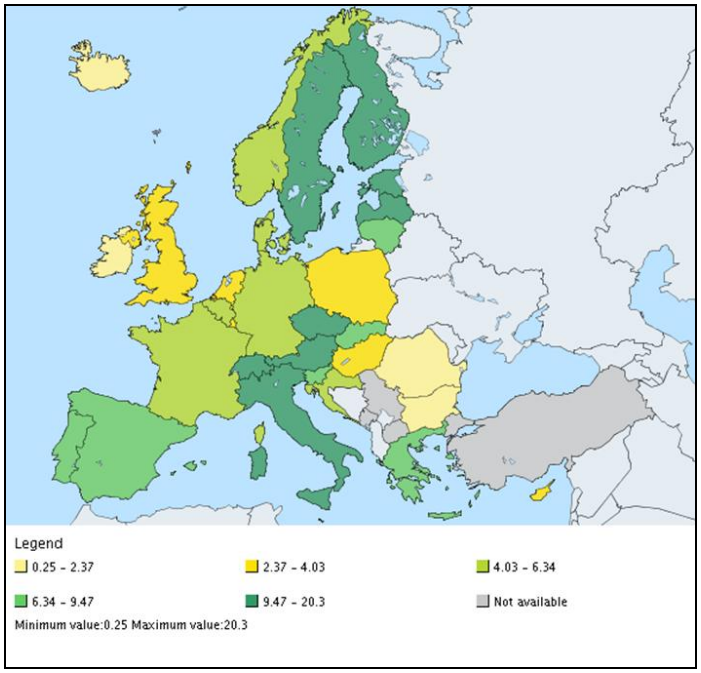
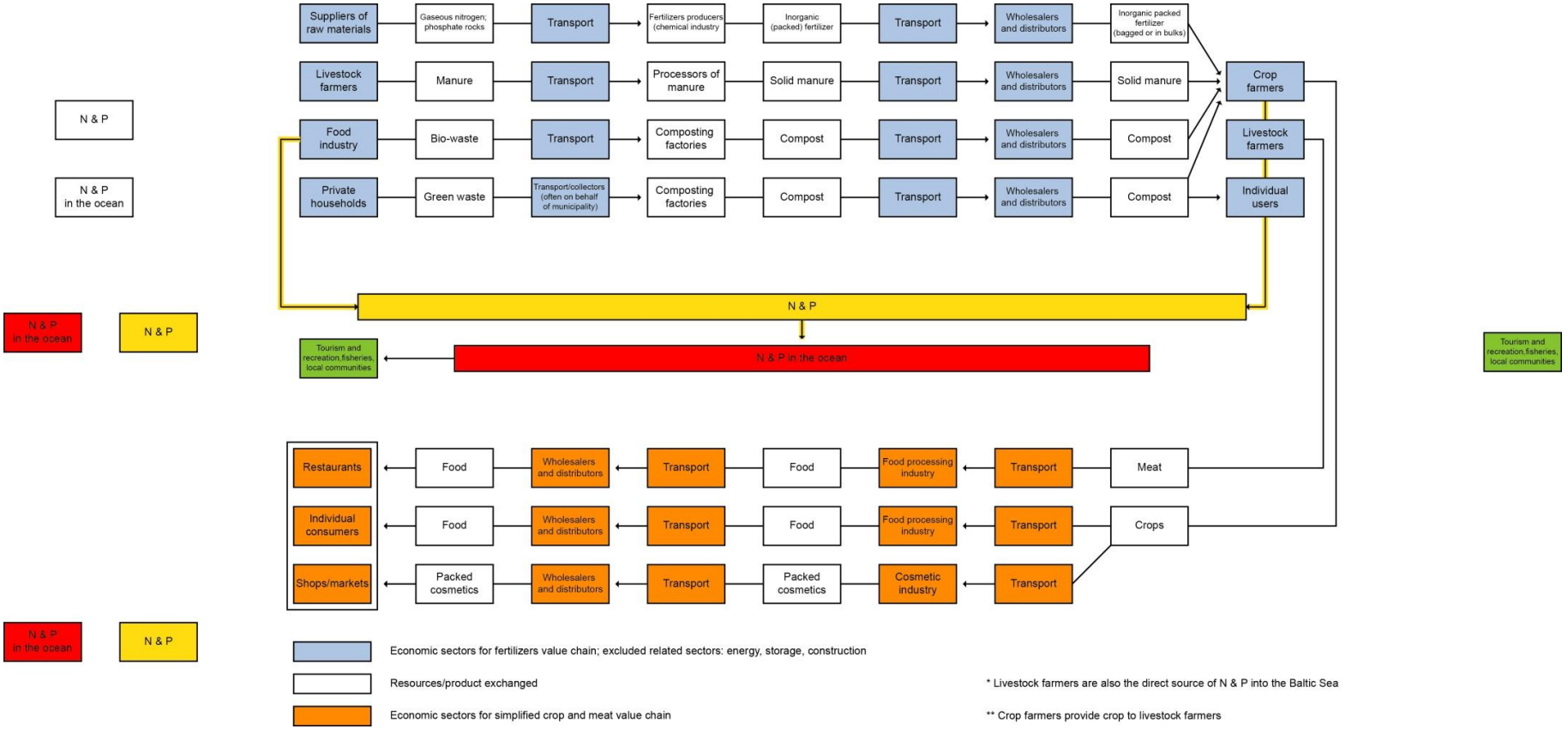



***Figure 7.*** *Area under organic farming (source: Eurostat, 2016)*

**Size of farms:** According to the Eurostat data 2005-2013, the total number of agricultural holdings has decreased in all BSR countries. If looking at the size of farms, only the number of large farms (100 ha or over) has increased. In 2013, from BSR countries, the share of small farms below 10 ha was biggest in Poland (76% of all farms), Lithuania (76%), Latvia (62%) and Estonia (54%), and smallest in Finland (17%). The share of large farms (50-100 ha and over) was biggest in Denmark (34%), Germany (30%) and Finland (28%), and smallest in Poland (2%), Lithuania (6%) and Latvia (7%). Medium size farms (10-50 ha) dominated in Finland, Germany, Sweden and Denmark. It is interesting to point out that the share of very large farms (100 ha and over) is biggest in Denmark (20%) and quite high also in Estonia (9%), which both are quite small countries compared to other BSR EU Member States.

***Figure 7. The Value Chain Scheme – Agriculture & Eutrophication***



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***Behavioural change: analysis of institutional context and actors linked to these activities***

Eutrophication is one of the most severe environmental problems in the Baltic Sea. It has not only impacted marine ecosystems, changing it from nutrient poor to nutrient rich, but also affected people's health, their well-being and ecosystem-based industries such as tourism or fisheries (SWAM 2013). Nutrient inputs to the Baltic Sea originate from various sources, including agriculture, husbandry, aquaculture, municipal sewage, industries, transport, erosion and airborne depositions (e.g., Haahti et al. 2010). Among these various sources, agriculture is a major source of eutrophication and is responsible for over 80% of diffuse nitrogen input (BalticStern2013). If eutrophication is going to be significantly reduced, it is necessary to limit and properly manage the use of fertilizers, and close the nutrient cycle from soil to crop and back to soil (Diaz and Rosenberg 2008).

Eutrophication is a complex problem that needs to be addressed jointly by all Baltic Sea region states. HELCOM's Baltic Sea Action Plan (BSAP) is one of the most important initiatives to combat the eutrophication threat. However, the major drawback of BSAP is that it can only work through 'soft recommendations' and not 'strong regulations' (Haahti et al. 2010). Its implementation is, therefore, strongly dependent on the voluntary commitments of the Baltic Sea countries. These commitments can be in turn reliant on political, economic and social situation in each of the contracting countries, and are greatly shaped by the EU Common Agriculture Policy (CAP), which in practice supports intensification and unsustainable agriculture policies (Spijkers et al. 2012, WWF 2007). Although CAP originally has focused on markets and increased productivity (Spijkers et al 2012), it now protects the European farmers and their benefits. It provides subsidies that equal about 35% of the total farm revenues. Only a small portion of these subsidies are used or paid in relation to responsible farming and pro-environmental measures (WWF 2007). As a result, agriculture and eutrophication objectives in the Baltic Sea region are in conflict so it is a matter of political choice to decide what is more important: marine environment (i.e., BSAP target reductions) or profitable agriculture and low food prices (i.e., CAP objectives; Spijkers et al. 2012).

Given the current legal and administration landscape, eutrophication is predominantly a political problem, and legal incentives would perhaps be the most influential tools to address it. Legal solutions are, however, rather difficult to implement and only limited number of economic and legal incentives support environmentally friendly agriculture (WWF 2007). Therefore, there is room for education and dissemination activities that might -- through rising awareness -- lead to behavioural change of the (economic) actors along the value chain (Figure 8).

Apart from decision-makers, farmers -- and agricultural practices they choose -- are most important actors within eutrophication management (WWF 2011). Farmers are also important targets for awareness rising campaigns on responsible and recycling agriculture, agri-advisory services, and on use of agri-environmental technologies (e.g., through Baltic Compass, BERAS Implementation, Baltic Manure or Baltic Deal projects). Voluntary solutions promoted and implemented through these projects are not only challenging but they can also negatively influence profitability of the individual farmers. Their efficiency is, therefore, questionable (WWF 2007). Meeting BSAP reductions plans might not be the priority for farmers but they do consider sustainable agriculture as important for the profitability of their sector (Spijkers et al. 2012). And sustainability within

agriculture must consider – at least in the long run – the effects and sources of eutrophication.

Farmers do not exist in the vacuum and their farming decisions are often shaped by the external conditions. According to Archambault (2004), there are three areas of interventions that could support sustainable farming: (i) increasing famers' financial security in implementing agri-environmental measures, (ii) capacity building, and (iii) incorporating farmers needs into local planning. Farmers' financial security could be increased through larger incorporation of financial incentives into CAP. This would allow farmers to try different pro-environmental solutions without putting their welfare and incomes at risk (Archambault 2004). These incentives have been on relatively low level: only about 10% out of € 11.6 billion subsidies transferred in 2005 to Baltic Sea region countries were linked to sustainable agriculture (WWF 2007). In addition, new EU Member States receive a significantly lower support per hectare or per farmworker when compared with old Member States (e.g., € 382 per hectare and € 16,755 per farm worker in Denmark and only € 87 and € 647 in Poland; WWF 2007), what can impact possibility and willingness to combat eutrophication more actively in these new Member States. Capacity building involves actions targeted at (i) farmers in order to assist them implementing environmentally friendly solutions and (ii) at scientific community and private businesses to stimulate them to actively seek new solutions that could further enhance agri-environmental measures or new organic technologies of food production (Archambault 2004). Finally, local planning could help farmers to better plan their actions and receive more individualized support through cooperation with local-communities and decision-makers (Archambault 2004).

Organic farming is a form of sustainable agriculture and a way of food production and farm management that aims to be environmentally friendly. It is a growing sector in the European Union with market value exceeding € 2 billion in 2013. Three Baltic Sea countries (i.e., Denmark, Sweden and Germany) are among five countries with the highest per capita spending on organic food and drinks in Europe. In addition, Germany is the Europe's largest market for eco food with total consumers' spending of € 7.6 billion in 2013. Organic food is so popular in Germany that even fast food restaurants chains – such as McDonald's – recognize market opportunities, and introduce organic products in their offer such as organic semi-skimmed milk and organic juice. Despite increasing popularity of eco food, organic farming has still a relatively small share within agriculture industry in Europe. Austria (with 18.6% of organic farming within total agricultural land in 2012) scores first within EU countries, and Sweden (15.8%) and Estonia (14.9%) comes second and third. In the Baltic Sea Region's organic farming rate varies between 15.8% in Sweden and 4.6% in Poland. Interestingly, in France and UK (the second and the third biggest organic food markets in Europe) organic farming constitutes respectively only 3.6% and 3.4% of total areas used for food production (Katsarova 2015).

Organic farming is a direct link between agriculture and consumers' choices. However, choosing eco-food is not the only way, in which consumers and citizens can influence food market. Their direct choices can not only stimulate development of organic food production but also can impact amount and kind of meat that is being produced (WWF



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2011). Civil society can further influence political decisions through values it puts on the marine environment, i.e., through supporting public procurement of local organic food or public purchasing of eco-labelled goods and services (e.g., Larsson and Granstedt 2010). Consumer and social choices have a great potential to influence both markets and policies, especially that about half of the citizens in the Baltic Sea region is willing to pay for the reduced eutrophication (Ahtiainen et al. 2014). We, therefore, believe that consumers and citizens are the second important group to target within the agriculture value chain. Increased consumption of vegetarian food is in fact one of the most cost-efficient way to reduce nutrient input from agriculture sources (Cordell et al. 2009) as more than 80% of crop production is used for fodder (Larsson and Granstedt 2010). The average vegetarian diet requires the usage of about 4.2 kilos of phosphate rocks a year while this amount increases to 11.8 kilos for meat-based diet. The most optimistic estimates show that a change from typical western diet to vegetarian diet could limit the demand for phosphate fertilizers by more than 45% world-wide, and in additional help to save other resources such as water, energy and land used for agricultural needs (Cordell et al. 2009). Choice between vegetarian and meat-based diet is not usually based on nutritional value only. Other factors come into play. Individual tastes and food prices are obviously very important elements, but fashion, advertisement, lifestyles, ethical positions and environmental concerns can also play important role in the European food market. These additional factors open new possibilities for communication and education campaigns to promote life choices that can limit use of fertilizers and promote healthy Baltic Sea (Cordell et al. 2009). Consumer choices will ultimately increase environmental awareness of other economic actors in the chain, such as wholesalers, shops and restaurants, and pursue the value change within the value chain back to farmers and their farming practices. However, consumers and citizen efforts need to be backup by legislation and other governmental incentives. Given the character and scale of the food market, the consumers preferences do not directly affect farming practices. Quotas and various quality requirements set by retailers or food processing companies as well as governmental subsidies are often more important factors that influence farmers' decision-making than the expectations of consumers (Archambault 2004).

The next possibly significant group includes commercial and recreational fisheries, and leisure and tourism sectors, which are negatively influenced by eutrophication, e.g., by algae and cyanobacteria blooms or altered flora and fauna communities (SWAM 2013). Although these groups are not a direct part of eutrophication value chain, their welfare is directly influenced by excessive nutrient loads. Eutrophication alters the food web and the (fish) species composition (Haahti et al. 2010), swimming bans -- due to algal blooms -- and related negative aesthetic experience and decomposition smell might prevent tourists from coming again, and reduce incomes of tourist service providers. Reduced water transparency and floating algal mats impact recreational fishing and boating (SEPA 2008). Swimming in blooming water can also cause allergic reactions (SEPA 2008) and eating accumulated toxins in shellfish can be dangerous for people's health (WHO 2002). Moreover, eutrophication increases survival of pathogenies bacteria in sea water which are a direct threat to human health (WHO 2002).

Fertilizer producers are possibly the fourth target group for rising awareness activities. There are three kinds of fertilizers in the EU: inorganic fertilizers, manure and compost

(Wijnands and Linders 2013). In the EU average expenditures on fertilizing materials equals 6.2% of farms' total expenses; they are even higher (7.2%) in the Baltic Sea Region[22]. The average use of fertilizers per hectare around the Baltic Sea is 63.0 kilos for nitrogen and 13.2 for phosphorous, the highest in Germany and the lowest in Estonia (Wijnands and Linders 2013). In absolute values Poland has the highest use of fertilizers among Baltic Sea countries; however, this is also the country[23] with the lowest use per capita (WWF 2007). Inorganic fertilizers are based on gaseous nitrogen or phosphorous rocks, have various nutrient contents, and are produced by about 1,000 companies in Europe. They are sold to farmers or wholesalers, which in addition sell other goods needed for agriculture such as chemicals, feed or farm equipment. Poland, Lithuania and Germany are the most important producers of inorganic fertilizers in the Baltic Sea region, with Germany being the European leader (Wijnands and Linders 2013). Manure is a by-product of animal husbandry, and it is in majority used on the same farm where it was produced. Very little information is available for the EU on manure production. Manure is transported for short distances only, and its use constitutes an important source of nitrogen (Wijnands and Linders 2013). Compost is the product of biological decomposition of degradable materials. There is no official data on compost producers in EU but 700 companies are assigned to formal quality assurance system. Compost is transported for short distances and its composition can hardly be controlled (Wijnands and Linders 2013), but in contrast to other types of fertilizers.

Other actors or sectors included in the value chain do not have a direct link to eutrophication issue, their welfare is not directly influenced by its effects, and they are not widely discussed in the literature. Therefore, we believe that the five groups discussed above show the greatest potential for dissemination and awareness-rising campaigns.

Apart from stakeholders directly affected or linked with eutrophication, there is a number of entities and organizations that can influence behaviour of various (economic) actors either by introducing legal solutions to mitigate eutrophication (i.e., decision-makers of various levels) or by raising awareness campaigns and pursuing voluntary measures and behavioural change (i.e., NGOs, formal or informal educators or media). Scientists are another stakeholder group that is not directly linked to the eutrophication value chain but is an important player. Scientists provide knowledge and advice on causes and effects of eutrophication and often (technological) solutions to move towards cleaner Baltic Sea waters (Archambault 2004). Table 3 presents the short characteristics of the other eutrophication related actors and their potential room for change.

[22] Excluding Russia.

[23] Germany and Russia excluded.



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***Table 3.*** *Description of businesses related to agriculture*

| Economic or social actors | Short characteristics and their room for change |
|---|---|
| Food processing companies | • Food processing companies are buying products from farmers, and they could potentially stimulate pro-environmental solutions by putting requirements and norms on the products they buy;<br>• Such initiatives are rare as incorporation of eco-products in mass food production is considered expensive, and companies expect losses in their income;<br>• Economic and legal incentives or larger societal pressure are needed to develop voluntary solutions for this sector; |
| Retailers | • Retailers include different types of businesses that sell food directly to customers. They include various types of shops, farmer markets and restaurants;<br>• They have possibility to directly react on customers' demands but could take on educational role and more actively inform consumers about advantages of eco or Baltic-friendly products; however, such actions are scarce, and large chains lack proper incentives to involve themselves in education activities; |
| Procurement organizations | • Buying groups are a type of retail purchasing alliance which can exist at a regional, national or international level. A buying group is an organization created by several shops or retailers with the aim of improving their purchasing conditions as well as enhancing their market competitiveness compared to other types of retail players. (European Commission, 2014) |
| Scientific community | • Scientific community provides research and new technologies for more environmentally friendly agriculture;<br>• There is a need for more practical research to support agri-environmental solutions;<br>• Research should be performed in cooperation with farmers (i.e., participatory research) and research results should be directly |

| | |
|---|---|
| | transferred to farmers or their organizations; such a shift towards participatory approach would, however, require changes in science funding and assessments of individual researchers; |
| Extension agents | • Extension agents are people and institutions that help farmers to practically implement scientific and technological solutions in their daily activities; this category can include businesses, non-governmental and professional organizations and governmental offices;<br>• Extension agents operate in various fields and support solutions that are not necessarily environmentally friendly; room for change would include promoting agri-environmental measures instead of more conventional solutions; |
| Certification and eco labels organizations | • These organizations provide information to customers if certain product or production processes are healthy and friendly to natural environment; in addition, they often act as extension agents as they inform interested farmers about requirements that have to be met to be awarded a label or certification;<br>• There is no clear room for change for certification and eco labels organization but given the number of various labels some cooperation and/or standardization would be beneficial to limit the consumers' confusion; perhaps more information campaigns on eco labels would support wider recognition and consumer acceptance; |
| Financial institutions | • Financial institutions, such as banks, provide funds for investments to farmers; such institutions could possibly offer better credit conditions for eco farmers; in practice such offers are rare (if existing at all) and not economically viable is the current market conditions. |

*Based on: Archambault (2003) and Archambault (2004)*



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Eutrophication is not a new challenge and a lot of actions have already been undertaken to combat eutrophication. Some of them have already been mentioned above. (Existing) activities can be divided into three major groups: (i) legal and political solutions, (ii) agri-environmental measures targeted mainly at farmers, (iii) societal solutions that require change in daily habits and lifestyles.

***Legal and political solutions:***

As mentioned above, HELCOM Baltic Sea Action Plan (BSAP) is perhaps the most important regional agreement that aims to achieve several ecological objectives and good ecological status by 2021. It is a Ministerial Declaration of all Baltic Sea region countries with specific objectives for each country to reduce the phosphorus and nitrogen loads. It is, however, an example of the soft legal instrument that does not provide tools and mechanism to properly assess progress towards its goals, and what is perhaps more important to enforce its implementation if countries are reluctant to undertake agreed actions (Chen at al. 2014).

European Union directives are the example of international law that is directly binding for all EU Member States. EU introduced a set of directives that has a direct impact on the ecological status of the Baltic Sea, and supports efforts to mitigate eutrophication. The most important legal acts include (Haahti et al. 2010, Chen et al. 2014):

- the 'Urban Waste Water Directive' (1991): it aims to protect natural environment including human health by putting standards concerning urban and industrial waste water treatment;
- the 'Nitrates Directive' (1991): it aims to protect ground and surface water quality and limit the nitrogen load caused by agricultural practices;
- the 'Water Framework Directive' (2000): it aims to achieve good environmental status of all European waters, i.e., surface, transitional, coastal and groundwater;
- the 'Marine Strategy Framework Directive' (2008): it aims to achieve good environmental status of European seas and oceans.

Common Agriculture Policy (CAP) opposes – at least to certain extent – stipulations of above directives. In practice, through direct payments to farmers, CAP supports unsustainable farming, and needs a rapid reform (Spijkers et al. 2012, WWF 2007).

At international level, International Maritime Organization and the MARPOL convention is relevant to meet the eutrophication goals. Annex IV of MARPOL Conventions puts forward measures to prevent sewage pollution by ships while annex VI deals with air pollution (Haahti et al. 2010).

***Agri-environmental measures:***

Agri-environmental measures are tools that can be used to make farming practices more environmentally friendly and less harmful to natural ecosystems and human well-being. Agri-environmental measures usually go beyond good farming practices as the latter -- as a rule -- do not need to include any solutions that are not required by law. Agri-environmental measures are often site-specific, require long-term implementation and monitoring, and promote cooperation between farmers and decision-makers. They are, however, more expensive than conventional practices so they should be accompanied by additional payments to farmers in order to compensate their losses (EU 2005). There are

variety of agri-environmental measures related to both productive and non-productive land management (EU 2005). Various agri-environmental measures can have different impacts on combating eutrophication, agriculture profitability or food prices (Spijkers et al. 2012). BALTIC COMPASS (http://www.balticcompass.org) aimed to assess and evaluate different agri-environmental measures in order to prioritize their use in the Baltic Sea region countries. Priority measures include (according to the BALTIC COMPASS web page):

- promoting long-term grass cultivation, including crop rotation;
- promoting vegetative cover (annual winter crops or catch crops) in autumn and winter;
- postponing tillage activities from autumn to spring;
- replacing deep ploughing with shallow one;
- proper fertilization management, including (i) establishing fertilization plan based on soil monitoring, (ii) evaluation of input/output nutrient balance for individual fields and farms, (iii) avoiding phosphorus fertilizers in the fields where soil is already rich in this element, and (iv) avoiding fertilization and manuring in certain times when risk of leakage is the highest;
- using the newest scientific and technological solutions for fields fertilization and manuring;
- avoiding using fertilizers and manures on lands with significant slopes, near river and lakes, or other land defined as high-risk areas;
- improving feeding farm animals, i.e., limiting amount of phosphorus and nitrogen in their diet;
- improving manure handling and storage;
- constructing sedimentation ponds, wetlands and buffer zones.

***Societal solutions:***

Societal solutions include educational campaigns, dissemination of knowledge, mutual learning, collaborative initiatives and active social involvement. Such initiatives can target all various groups of stakeholders and social actors to promote awareness about pro-environmental legislation or agri-environmental measures, but they can also strive to achieve behavioural change. Efforts to promote behavioural change could focus on (i) promotion of vegetarian food to decrease amount of the eaten meat, (ii) actions targeted to increase demand for eco and organic food, or (iii) including environmentally-friendly production as a part of tendering for public institutions. These actions would require a development and promotion of Baltic-friendly certification and labelling, and could increase the environmental awareness of related businesses such as food production industry, restaurants or tourism (Spijkers et al. 2012).

***Other ideas:***

There are also some other ideas that could support environmentally friendly agriculture. These solutions could be described as a mixture of legal and economic incentives.



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Tradable emission permits, increased tax on fertilizers, limited or no public investments in intensive animal production, limits on the use of fertilizers and on maximum animal density, special subsidies for catch crops or permit fees for sensitive leaking locations are most commonly mentioned in the subject literature (Spijkers at al. 2012; SWAM 2013). Their implementation is, however, uncertain as these solutions might have the direct impact on the food prices, what is in fact a sensitive topic, especially in the times of current economic crises.

***ANNEXES***

Table 4: Actors classified according to ResponSEAble criteria

| **Name of the sector** | **Classification** |
|---|---|
| Suppliers of raw materials | Primary sector |
| Livestock farmers | Primary sector |
| Food industry | Secondary sector |
| Transportation sector | Tertiary sector |
| Chemical industry (fertilizers producers) | Secondary sector |
| Processors of manure | Secondary sector |
| Composting factories | Secondary sector |
| Wholesalers and distributors of manure and fertilizers | Tertiary sector |
| Crop farmers | Primary sector |
| Cosmetic industry | Secondary sector |
| Restaurants | Tertiary sector |
| Shops and markets | Tertiary sector |
| Fisheries | Primary sector |
| Tourism and recreation industries | Quaternary sector |



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| | |
|---|---|
| Decision-makers of various levels | Legislators and administrators |
| Municipalities | Administrators |
| Scientific community | Quaternary sector |
| NGOs | Institutionalized sector |
| Media | Quaternary sector |
| Labelling and certification companies | Institutionalized sector |
| Local communities | Citizens or consumers |
| Private households | Citizens or consumers |

Table 5: List of potential stakeholders concerning eutrophication in the Baltic Sea:

**FARMERS:**

1. Committee of Professional Agricultural Organisations (COPA)
2. General Confederation of Agricultural Cooperatives in the European Union (COGECA, also includes fisheries organizations)
3. The Central Union of Agricultural Producers and Forest Owners (Swedish-speaking areas of Finland)
4. Federation of Swedish Farmers
5. The Danish Agriculture & Food Council
6. Estonian Chamber of Agriculture and Commerce
7. Estonian Farmers' Federation
8. Central Union of Estonian Farmers
9. German Farmers' Association
10. Latvian Agricultural Organization Cooperation Council
11. Latvian Farmer's Federation
12. Latvian Agricultural Statutory Societies
13. *Zemnieku Saeima - ZSA* (Farmers Parliament)
14. Chamber of Agriculture of the Republic of Lithuania
15. Lithuanian Farmer's Union
16. Lithuanian Association of Agricultural Companies
17. Lithuanian Association of Agricultural Cooperatives
18. *Federacja Branżowych Związków Producentów Rolnych - FBZPR* (Federation of Agricultural Producers Union)
19. *Krajowy Związek Rolników, Kólek i Organizacji Rolniczych - KZRKIOR*
20. *NSZZ RI Solidarność (Niezalezny Samorządowy Związek Zawodowy Rolników Indywidualnych)*
21. *Krajowa Rada Izb Rolniczych - KRIR* (National Council of Agricultural Chambers)
22. *Związek Zawodowy Centrum Narodowe Młodych Rolników*
23. Baltic Farmers' Forum on Environment (BFFE)

**CONSUMERS:**

1. *ECOCERT*
2. *Nordic Swan Ecolabel Organization*
3. *Polish Green Network (Polska Zielona Sieć)*
4. *Consumers cooperatives, retail companies/shop chains (e.g. European Community of Consumer Cooperatives – Euro COOP and its members in different countries, ICA/Rimi (SE, EE, LV, LT) ,Lidl, Maxima Grupé (EE, LV, LT, PL, BG), SELVER (EE);*

**COMMERCIAL FISHERS:**

1. Baltic Sea Advisory Council (relevant fisheries organization from Baltic Sea Region countries)
2. Federation of National Organisations of Importers and Exporters of Fish (and relevant organizations from Baltic Sea Region countries)
3. Fisheries Local Action Groups in respective countries

**TOURISM SECTOTR:**

1. *ARS Baltica*



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2. *Baltic Sea Tourism Forum*
3. *European Anglers Alliance*
4. *The International Federation for Sport Sea Fishing*
5. *Blue Flag organization*
6. *Local touristm organizations, e.g., Rural Tourism Organisation leading the Baltic Sea Food Project*
7. *The Baltic Sea Tourism Commission (BTC)*

**FERTILIZER PRODUCERS:**

1. *The European Consortium of the Organic-Based Fertilizer Industry (ECOFI)*
2. *Polish Chamber of Chemical Industry*

**DECISION-MAKERS:**

1. HELCOM
2. VASAB
3. Relevant ministries and their subordinated institutions (responsible for marine issues, agriculture, environment and fisheries in Baltic Sea Region countries)

**SCIENTISTS:**

1. BALTEX: The Baltic Sea Experiment
2. The Baltic University Programme (BUP)
3. Relevant national universities and research institutions
4. The Baltic Earth
5. BalticSTERN (Systems Tools and Ecological-economic evaluation - a Research Network)

**NGOs:**

1. Coalition Clean Baltic
2. WWF
3. OCEANA
4. Marine Stewardship Council
5. Foundation for a Living Baltic Sea
6. Baltic Environmental Forum Group
7. The Baltic Sea NGO Network

**OTHER, including international organizations:**

1. Union of the Baltic Cities
2. Baltic Region Healthy Cities Association
3. Baltic Ports Organization
4. Baltic Development Forum
5. The Council of the Baltic Sea States (CBSS)
6. The Nordic Council / The Nordic Council of Ministers
7. The Baltic Sea Parliamentary Conference (BSPC)
8. The Baltic Sea Action Group (BSAG)
9. The Baltic Development Forum (BDF)?
10. The Baltic Sea Chambers of Commerce Association (BCCA)
11. The Baltic Sea States Sub-regional Co-operation (BSSSC)

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WHO (2002) Eutrophication and health, Luxembourg, 14 p.

Wijnards J.H.M., Linders G-J. (2013) Competitiveness Proofing - Fertilising Materials, Rotterdam, 89 p.

WWF (2007) EU-trophication-linking tax money to eutrophication of the Baltic Sea, 11 p.

WWF (2011) Baltic Sea Scoreboard, 31 p.

# Annex IV – The value chain for coastal tourism in the Mediterranean Sea and in Black Sea

***Southern France***

**Table 5. Arrivals at tourist accommodation establishments by NUTS 2 regions, NACE I551-I553: Hotels; holiday and other short-stay accommodation; camping grounds, recreational vehicle parks and trailer parks (source: Eurostat)**

| Geographical scale | **2004** | **2014** |
|---|---|---|
| **France** | Residents: 79,567,112<br>Non-residents: 40,737,042<br>**Total: 120,304,154** | Residents: 106,884,663<br>Non-residents: 46,073,942<br>**Total: 152,958,605** |
| **Mediterranean** | Residents: 13,473,681<br>Non-residents: 6,675,053<br>**Total: 20,148,734** | Residents: 19,682,437<br>Non-residents: 7,967,469<br>**Total: 27,649,906** |
| **Languedoc-Roussillon** | Residents: 4,982,602<br>Non-residents: 1,624,981<br>Total: 6,607,583 | Residents: 6,734,068<br>Non-residents: 1,761,833<br>Total: 8,495,901 |
| **PACA** | Residents: 7,327,341<br>Non-residents: 4,447,700 | Residents: 11,109,188<br>Non-residents: 5,433,869 |



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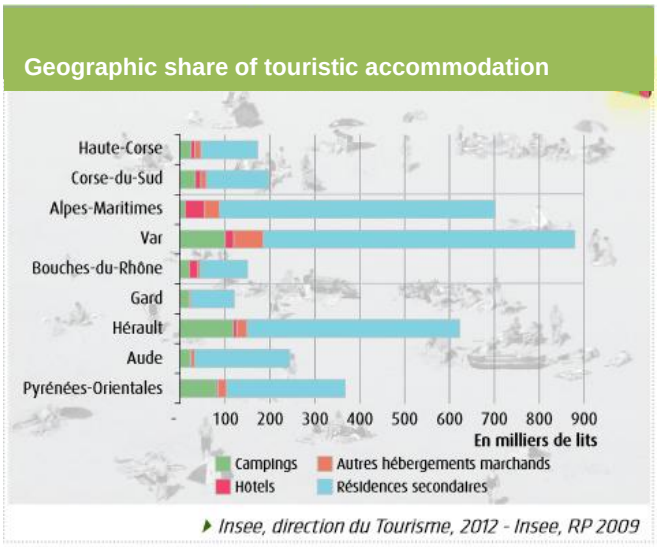
| | | |
|---|---|---|
| | Total: 11,775,041 | Total: 16,543,057 |
| **Corse** | Residents: 1,163,737<br>Non-residents: 602,372<br>Total: 1,766,109 | Residents: 1,839,182<br>Non-residents: 771,766<br>Total: 2,610,948 |

**Table 6. Arrivals at tourist accommodation establishments by NUTS 2 regions, NACE I551: Hotels and similar accommodation (source: Eurostat)**

| Geographical scale | **2004** | **2014** |
|---|---|---|
| **France** | Residents: 69,705,424<br>Non-residents: 33,987,943<br>Total: 103,693,367 | Residents: 76,972,426<br>Non-residents: 34,393,532<br>Total: 111,365,958 |
| **Mediterranean** | Residents: 10,670,671<br>Non-residents: 4,794,110<br>Total: 15,464,781 | Residents: 11,484,710<br>Non-residents: 4,911,451<br>Total: 16,396,161 |
| **Languedoc-Roussillon** | Residents: 3,582,619<br>Non-residents: 918,399<br>Total: 4,501,018 | Residents: 3,448,559<br>Non-residents: 806,969<br>Total: 4,255,528 |
| **PACA** | Residents: 6,343,780<br>Non-residents: 3,603,271<br>Total: 9,947,051 | Residents: 7,032,597<br>Non-residents: 3,765,177<br>Total: 10,797,774 |
| **Corse** | Residents: 744,271<br>Non-residents: 272,440<br>Total: 1,016,711 | Residents: 1,003,555<br>Non-residents: 339,305<br>Total: 1,342,860 |

**Table 7. Total capacity of tourist accommodation establishments for 2013 and 2016 in Metropolitan France (source: INSEE)[24]**

| | 2013 | 2016 |
|---|---|---|
| Total hotels capacity | 16,973 hotels for 621,757 bedrooms | 18,205 hotels, for 645,595 bedrooms |
| Total camping capacity | 7,753 campsite grounds, for 904,560 sites | 8,459 campsite grounds, for 916,624 sites |
| Total collective accommodation capacity | - | 3,470 tourist facilities, for 978,932 beds |




Mediterranean coastal municipalities have a high accommodation capacity with 3.5 million beds available (while the resident population was estimated at 3.2 million in 2010): 433 300 beds in campsites, 117 000 in hotels, 186 000 in collective accommodation and 2 718 000 beds in secondary residences (4/5$^{th}$ of

[24] Each camping site represents 3 beds; each hotel bedroom represents 2 beds and each secondary residence 5 beds.



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touristic accommodation on the Mediterranean coastline). Looking at departments, the Var department has the highest rate of accommodation capacity (followed by Alpes-Maritimes). Most hotels and commercial accommodation are located in the Alpes-Maritimes department, in municipalities such as Nice or Cannes (20 % of hotel rooms of the metropolitan coastline). While the number of secondary residences has risen between 2000 and 2012 (+296 500), touristic accommodation capacities have diminished (-800 beds in hotels and -13 800 beds in campsites).

**Cannes**[25]

| indicateur | Cannes (commune) | Communes Littorales |
|---|---|---|
| Capacité d'hébergement (lits), 2010 | 146 462 | 7 361 894 |
| Capacité d'hébergement (lits), 1999 | 128 031 | 6 646 147 |
| Différence (lits), 1999-2010 | 18 431 | 822 637 |
| Capacité en campings (lits), 2012 | 660 | 1 302 408 |
| Capacité en chambre d'hôtels (lits), 2012 | 10 872 | 208 648 |
| Capacité en res. secondaires (lits), 2010 | 135 162 | 5 937 495 |
| Evo. du nombre de rés. secondaires, en %, 1999-2010 | 14,7 | 12,3 |
| Evolution des places de camping, en %, 1999-2012 | 4,3 | 13,4 |

*source : Insee, RP 2010, Insee-Direction du Tourisme 2010-2012*

**Nice**[26]

[25] http://geoidd.developpement-durable.gouv.fr/

[26] http://geoidd.developpement-durable.gouv.fr/geoclip_stats_o3/GC_preport.php?lang=fr&codgeo=06088&nivgeo=com&id_rep=r01&profil=LITTORAL&profil=LITTORAL

| indicateur | Nice (commune) | Communes Littorales |
|---|---|---|
| Capacité d'hébergement (lits), 2010 | 143 032 | 7 361 894 |
| Capacité d'hébergement (lits), 1999 | 117 619 | 6 646 147 |
| Différence (lits), 1999-2010 | 25 413 | 822 637 |
| Capacité en campings (lits), 2012 | 0 | 1 302 408 |
| Capacité en chambre d'hôtels (lits), 2012 | 19 504 | 208 648 |
| Capacité en res. secondaires (lits), 2010 | 123 376 | 5 937 495 |
| Evo. du nombre de rés. secondaires, en %, 1999-2010 | 26,3 | 12,3 |
| Evolution des places de camping, en %, 1999-2012 | - 100 | 13,4 |

*source : Insee, RP 2010, Insee-Direction du Tourisme 2010-2012*

There are different types of touristic accommodation. The eastern part of Var and Alpes-Maritimes include large touristic centers and important coastal resorts. Camping sites are more present on the western part of the Mediterranean seaside (Languedoc-Roussillon region).

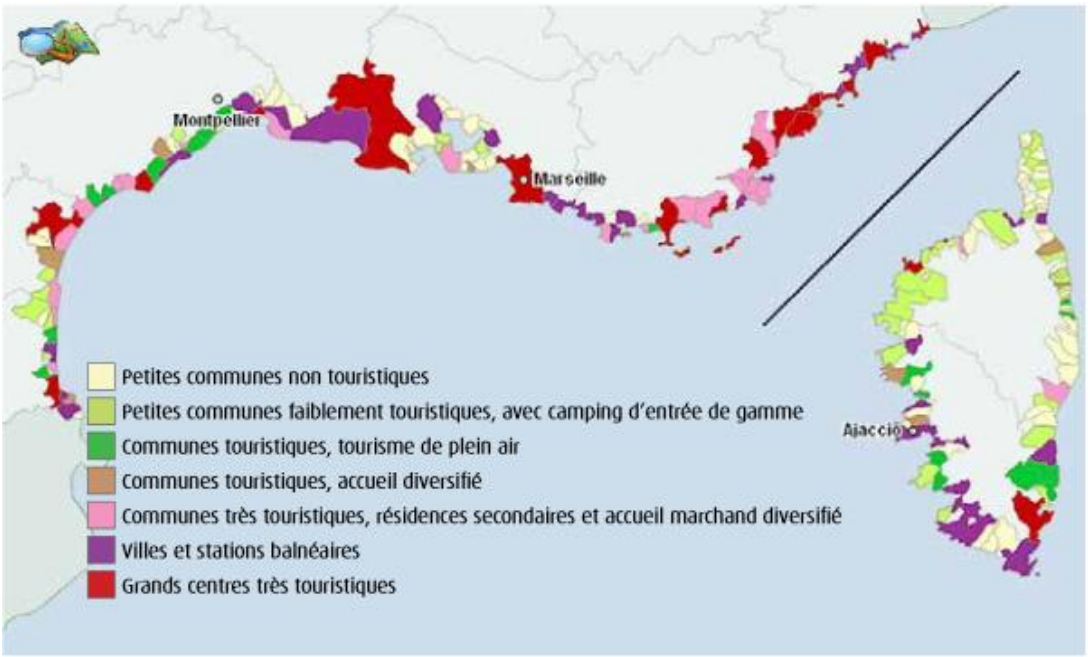


**Figure 25 : Typology of touristic accommodation of Mediterranean coastal municipalities**



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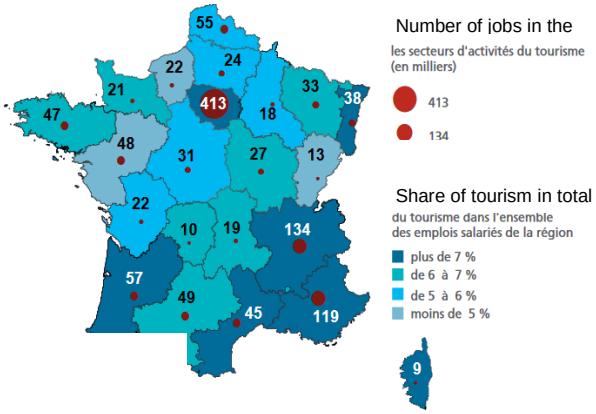
**Table 8. Economic weight of tourism in France (source: DGE[27])**

| | | |
|---|---|---|
| Gross domestic tourism consumption (billion Euros) | **2010**<br><br>Residents: 96,9<br><br>Non-residents: 43,4<br><br>**Total: 140,4 (7,02 % of GDP)** | **2014**<br><br>Residents: 106,4<br><br>Non-residents: 51,9<br><br>**Total: 158,3 (7,42 % of GDP)** |
| Total enterprises | 2013: 299 532<br><br>(7,3 % of the total economy) | |
| Total employees (full time equivalent) | 2013: 986 356<br><br>(7,7 % of the total economy)<br><br>On the coast:<br>200 000 average annually[28] |  |
| Total turnover before tax (million Euros) | 2013: 158 815<br><br>(4,1 % of total economy) | |

[27] http://www.entreprises.gouv.fr/files/files/directions_services/etudes-et-statistiques/stats-tourisme/memento/2015/2015-12-memento-tourisme-chap2-poids-economique.pdf

[28] http://www.onml.fr/uploads/media/texte-mediterranee.pdf

According to these elements, a focus could be made on large touristic centers (Nice, Cannes, Agde) and/or the French Riviera (côte d'Azur).

***Italy***

**Table 9 Tourism in Italy: overall figures and regional figures (regions with a large share of coastal tourism)**

| | |
|---|---|
| Total capacity of tourist accommodation establishments, 2015 | 158,412 tourist facilities, for 4.9 million beds |
| Hotels capacity, 2015 | 33,290 tourist facilities, for 2.2 million beds |
| Residence, campings, resorts, hostels capacity[29], 2015 | 125,122 tourist facilities, for 2.6 million beds |
| Arrivals at tourism accommodation establishments[30], 2015 | Total: 106.6 million; residents: 54.9 millions; non-residents: 51.6 millions |
| Arrivals at tourism accommodation establishments - Liguria[31], 2015 | 2.3 million residents |
| Arrivals at tourism accommodation | 6.7 million residents |

[29] Source : ISTAT http://dati.istat.it/

[30] http://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do

[31] http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=tour_occ_arn2&lang=en



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| | |
|---|---|
| establishments – Emilia Romagna[32], 2015 | |
| Arrivals at tourism accommodation establishments – Toscana[33], 2015 | 5.6 million residents |
| Arrivals at tourism accommodation establishments - Puglia[34], 2015 | 2.7 million residents |
| Arrivals at tourism accommodation establishments - Calabria[35], 2015 | 1.2 million residents |
| Total value added of the touristic sector[36], 2014 | 83 million EUR – 6% of total value added of national economy |
| Total enterprises, 2014 | 543.154 |
| Total employees[37], 2014 | 2.3 million employees – 10.7% of total employees<br><br>Of which: 1.7 million in accommodation, food and beverage, 0.6 million in transport, arts and entertainment, renting and intermediation activities, sports |

[32] http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=tour_occ_arn2&lang=en

[33] http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=tour_occ_arn2&lang=en

[34] http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=tour_occ_arn2&lang=en

[35] http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=tour_occ_arn2&lang=en

[36] http://www.confcommercio.it/documents/10180/5116803/SCHEDA+TURISMO.docx/b22e54f7-025f-4c5c-a405-b054126e374b

[37] http://www.confcommercio.it/documents/10180/5116803/SCHEDA+TURISMO.docx/b22e54f7-025f-4c5c-a405-b054126e374b

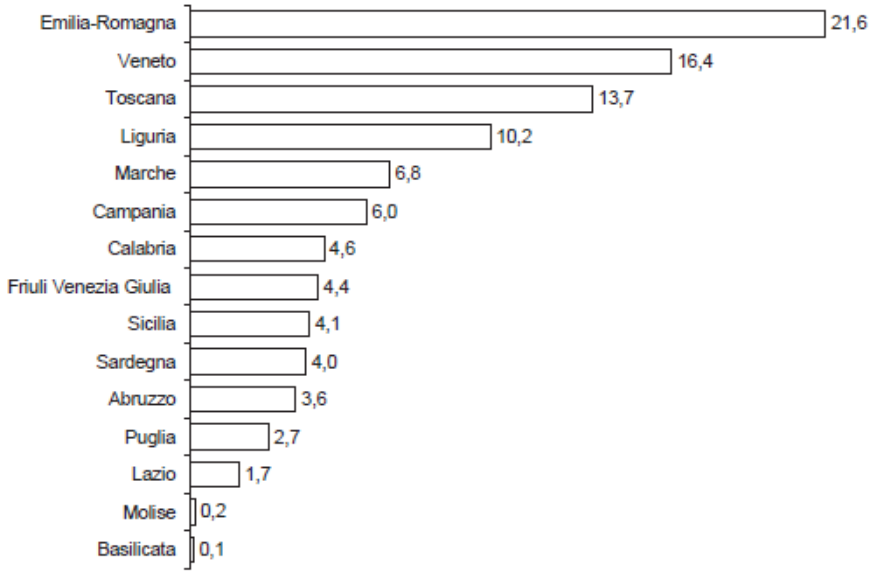
In Italy, two main touristic models were identified:

1. **Coastal touristic centers with high density of hotels and commercial accommodations**:

In these sites, the main accommodation types are hotels, often offering all-inclusive packages (accommodation and three meals per day). Tourist spend their days mostly in private beaches, renting beach chairs and umbrellas; private beaches also offer bar and restaurant service, as well as recreational activities.

In Italy, this model is very well represented by Rimini and the surrounding Riviera Romagnola. Emilia Romagna is the Italian region with the largest share of beach tourism, as illustrated in the figure below.

**Graf.4 Distribuzione del turismo balneare per regione. Anno 2007. Italia = 100**




Fonte: elaborazione dati ISTAT



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**Figure 26 Distribution of beach tourism by Region, Italy**[38]

Rimini and Riviera Romagnola also bear the highest (by far) coastal pressure, measured by number of tourists on the coastal areas. The index of coastal pressure data by province are presented below: Rimini and Riviera Romagnola (provinces of Forli'-Cesena and Rimini) are compared to data from other Italian provinces.

**Tab.29 Indice di pressione costiera su base provinciale - Anno 2007**

| Regione | Provincia | Totale costa (Km) | Costa balneabile (Km) | Presenze turistiche in aree costiere | Indice di pressione costiera (IPC) |
|---|---|---|---|---|---|
| | Imperia | 62,7 | 54,7 | 3.026.395 | 151,6 |
| | Savona | 80,5 | 68,5 | 5.672.849 | 227 |
| | Genova | 109,2 | 78,3 | 2.005.679 | 70,2 |
| | La Spezia | 96,9 | 78,4 | 1.504.550 | 52,6 |
| Liguria | | 349,3 | 279,9 | 12.209.473 | 119,5 |
| | Ravenna | 48,4 | 37,9 | 3.178.775 | 229,8 |
| | Ferrara | 39,8 | 20,3 | 1.984.937 | 267,9 |
| | Forli Cesena | 9,1 | 8,2 | 4.891.913 | 1.634,5 |
| | Rimini | 33,7 | 32,8 | 15.258.263 | 1.274,5 |
| Emilia Romagna | | 131,0 | 99,2 | 10.055.625 | 277,7 |
| | Venezia | 103,1 | 85,4 | 17.658.045 | 566,5 |
| | Rovigo | 55,8 | 13,2 | 1.383.138 | 287,1 |

[38] Source : http://www.ontit.it/opencms/opencms/ont/it/documenti/02059?category=documenti/altre_ricerche/temi/imprese_economia/promozione_commercial

| | | | | | |
|---|---|---|---|---|---|
| | Cosenza | 227,9 | 188,7 | 1.968.841 | 28,6 |
| | Vibo Valentia | 68,4 | 63,8 | 1.553.750 | 66,7 |
| | Catanzaro | 102,6 | 87,1 | 1.178.684 | 37,1 |
| | Crotone | 113,9 | 99,2 | 646.557 | 17,9 |
| | Reggio di Calabria | 202,9 | 165,0 | 656.025 | 10,9 |
| Calabria | | 715,7 | 603,8 | 6.003.857 | 27,2 |
| | Matera | 37,9 | 36,3 | 873.917 | 66,0 |
| | Potenza | 24,3 | 22,3 | 155.236 | 19,1 |
| Basilicata | | 62,2 | 58,6 | 1.029.153 | 48 |
| | Bari | 147,4 | 105,4 | 439.833 | 11,4 |
| | Brindisi | 115,8 | 83,0 | 896.780 | 29,6 |
| | Lecce | 260,9 | 214,6 | 2.207.023 | 28,2 |
| | Taranto | 118,0 | 85,5 | 615.965 | 19,7 |
| | Foggia | 222,9 | 211,3 | 3.389.101 | 43,9 |
| Puglia | | 865,0 | 699,8 | 7.548.702 | 29,6 |

**Figure 27 Coastal pressure index by Province in Italy**[39]

### 2. Coastal tourism characterized by a high density of summer houses

In France and Italy, besides some areas with a high density of hotels, the most common accommodation type are summer houses, be it own private house, parents' or friends' houses or rented houses. Official data do not necessarily fully reflect this phenomenon, as in many cases there is no financial transaction, or the transaction goes through unofficial channels.

[39] Source: http://www.ontit.it/opencms/opencms/ont/it/documenti/02059?category=documenti/altre_ricerche/temi/imprese_economia/promozione_commercial



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Tourists spend most of their days in private but also public beaches; private beaches normally offer food and bar service, as well as leisure activities. Tourists have their meals at home or in restaurants and bars.

In Italy, a region where this type of tourism is intensely practiced is **Liguria**, and in particular in **Riviera di Ponente**. As shown in the table below, in this region presences in private houses are around four times official presences in commercial structures (e.g. hotels).

**Table 10 Touristic demand of summer houses and accommodation by region and touristic area**

**Tab.22 Domanda turistica di abitazioni per vacanza per regione e area balneare omogenea - presenze nelle abitazioni e indicatori di impatto 2006**

| | Presenze ufficiali nelle strutture | Presenze nelle abitazioni per vacanza | Presenze stanziali (pernottam. completi) | Incidenza media giornaliera dei turisti nelle case sul totale presenti | Utilizzaz. media in termini di giorni | Percent. di utilizzaz. | Moltiplicatore del turismo ufficiale per stima presenze case |
|---|---|---|---|---|---|---|---|
| Balneare (627 comuni) | 156.238.606 | 331.072.010 | 487.310.616 | 9,1% | 86,1 | 23,6% | 3,12 |
| Liguria | 12.413.355 | 43.661.036 | 56.074.391 | 17,4% | 94,3 | 25,8% | 4,52 |
| Veneto | 23.733.919 | 14.958.222 | 38.692.141 | 25,6% | 93,8 | 25,7% | 1,63 |
| Friuli Venezia Giulia | 5.879.189 | 3.886.859 | 9.766.048 | 14,4% | 64,9 | 17,8% | 1,66 |
| Emilia Romagna | 25.367.845 | 14.717.591 | 40.085.436 | 11,9% | 112,8 | 30,9% | 1,58 |
| Marche | 9.241.269 | 7.393.845 | 16.635.114 | 4,2% | 72,4 | 19,8% | 1,80 |
| Toscana | 16.856.876 | 24.403.005 | 41.259.881 | 8,8% | 81,5 | 22,3% | 2,45 |
| Lazio | 3.688.840 | 35.067.543 | 38.756.383 | 16,3% | 120,1 | 32,9% | 10,51 |
| Campania | 15.489.661 | 29.468.652 | 44.958.313 | 6,9% | 181,3 | 49,7% | 2,90 |
| Abruzzo | 5.094.475 | 12.815.781 | 17.910.256 | 8,4% | 94,4 | 25,9% | 3,52 |
| Molise | 385.776 | 2.170.656 | 2.556.432 | 12,3% | 86,2 | 23,6% | 6,63 |
| Puglia | 7.660.280 | 33.411.603 | 41.071.883 | 9,1% | 81,7 | 22,4% | 5,36 |
| Basilicata | 1.231.520 | 1.080.158 | 2.311.678 | 4,4% | 86,3 | 23,7% | 1,88 |
| Calabria | 7.290.583 | 28.680.127 | 35.970.710 | 7,7% | 51,8 | 14,2% | 4,93 |
| Sicilia | 11.425.355 | 55.252.012 | 66.677.367 | 6,7% | 84,8 | 23,2% | 5,84 |
| Sardegna | 10.202.600 | 24.104.920 | 34.307.520 | 7,8% | 62,0 | 17,0% | 3,36 |
| Riviera ponente | 9.001.083 | 30.298.944 | 39.300.027 | 21,5% | 89,7 | 24,6% | 4,37 |
| Riviera levante | 1.954.521 | 10.478.496 | 12.433.017 | 18,6% | 118,0 | 32,3% | 6,36 |
| Cinque Terre | 1.457.753 | 2.883.597 | 4.341.350 | 5,4% | 79,3 | 21,7% | 2,98 |

This means that these houses are empty for most of the year, as shown in the Table below.

**Table 11 Occupation rate of houses in touristic coastal areas**[40]

**Tab.19 Le abitazioni occupate e non occupate al Censimento 1991 e ricostruzioni al 2001 – tasso di incidenza della non occupazione nei comuni balneari**

| Circoscrizione turistica | Abitazioni occupate da residenti 1991 | *Abitazioni non occupate 1991* | *Abitazioni non occupate % - 1991* | Abitazioni occupate da residenti 2001 | *Abitazioni non occupate 2001* | *Abitazioni non occupate % - 2001* | Var. % abitazioni non occupate 2001/1991 |
|---|---|---|---|---|---|---|---|
| Riviera ponente | 163.288 | 115.984 | 41,5% | 166.723 | *123.745* | *42,6%* | 6,7% |
| Riviera levante | 65.062 | 43.482 | 40,1% | 70.278 | *44.106* | *38,6%* | 1,4% |
| Cinque Terre | 62.758 | 16.262 | 20,6% | 64.116 | *17.209* | *21,2%* | 5,8% |
| Riviera Apuo – Versiliese | 107.839 | 39.150 | 26,6% | 120.501 | *39.808* | *24,8%* | 1,7% |
| Costa degli Etruschi | 100.004 | 27.196 | 21,4% | 108.000 | *22.465* | *17,2%* | -17,4% |
| Costa Maremmana | 58.060 | 38.833 | 40,1% | 64.785 | *43.725* | *40,3%* | 12,6% |
| Arcipelago Toscano | 10.868 | 11.461 | 51,3% | 12.709 | *12.837* | *50,3%* | 12,0% |
| Lidi Romani | 74.592 | 75.192 | 50,2% | 118.753 | *78.545* | *39,8%* | 4,5% |
| Litorale Domizio (incl. Caserta) | 78.310 | 73.106 | 48,3% | 89.025 | *80.417* | *47,5%* | 10,0% |
| Isole del Golfo di Napoli | 34.148 | 12.773 | 27,2% | 38.400 | *12.679* | *24,8%* | -0,7% |
| Penisola Sorrentino – Amalfitana | 192.348 | 38.256 | 16,6% | 193.592 | *31.750* | *14,1%* | -17,0% |
| Cilento | 84.950 | 33.888 | 28,5% | 92.031 | *38.969* | *29,7%* | 15,0% |
| Calabria Tirrenica Cosentina | 37.325 | 67.734 | 64,5% | 42.260 | *71.420* | *62,8%* | 5,4% |
| Calabria Tirrenica Catanzarese | 77.974 | 35.270 | 31,1% | 83.765 | *39.061* | *31,8%* | 10,7% |
| Calabria Ionica sud | 126.474 | 64.941 | 33,9% | 134.336 | *75.794* | *36,1%* | 16,7% |
| Calabria Ionica Nord | 74.962 | 55.276 | 42,4% | 84.914 | *73.155* | *46,3%* | 32,3% |
| Ionio Lucano Pugliese | 65.476 | 50.133 | 43,4% | 73.104 | *52.209* | *41,7%* | 4,1% |
| Salento | 62.269 | 65.878 | 51,4% | 69.820 | *68.504* | *49,5%* | 4,0% |
| Costa Brindisina – Barese | 146.265 | 56.191 | 27,8% | 160.264 | *60.651* | *27,5%* | 7,9% |
| Gargano | 53.605 | 40.748 | 43,2% | 54.513 | *39.702* | *42,1%* | -2,6% |
| Adriatico | 288.745 | 110.744 | 27,7% | 332.671 | *117.413* | *26,1%* | 6,0% |
| Riviera Romagnola | 95.862 | 37.591 | 28,2% | 111.854 | *41.716* | *27,2%* | 11,0% |
| Foce del Po | 43.197 | 40.722 | 48,5% | 47.159 | *40.764* | *46,4%* | 0,1% |
| Lidi Veneto Friulani | 46.959 | 76.515 | 62,0% | 57.491 | *84.019* | *59,4%* | 9,8% |

## *The Black Sea coast: Romania*

Romania is situated in the South Eastern part of Central Europe, inside and outside the Carpathians Arch, on the Danube (1075 km) lower course and on the Black Sea, being

[40] Source: http://www.ontit.it/opencms/opencms/ont/it/documenti/02059?category=documenti/altre_ricerche/temi/imprese_economia/promozione_commercial



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placed at a distance ranging between 1050 km and 2800 km from the continent extremities. The Romanian territory is situated at the crossing between the parallel 45° N and the meridian 25° E. Romania is a Carpathian and Danubian country, located on the Black Sea.

Romanian seaside stretches for 245 km along the Black Sea coast, between Musura brook (border with Ukraine) and Vama Veche locality (border with Bulgaria).

The exceptional tourism potential of Romania has two main components:

- the natural component, represented by spectacular landscapes, varied configuration of the relief, favourable climatic conditions and lots of natural therapeutic spas;

- the historical component, represented by traces of succeeding civilizations that had lived on Romanian territory since ancient times, monuments and lay or religious art objects, museums and museum collections, beautiful and original ethnographical and folklore elements and actual prestigious achievements.

All the above mentioned constitute very attractive elements of the Romanian tourism offer, presenting a wide variety of tourism types: stay (seaside, mountain, spa), hunting and sport fishing, cultural tourism at large, professional tourism a.s.o. Due to its geographical position and to the three natural elements defining its landscape structure and territory: the Carpathians, the Danube and the Black Sea, Romania has the status of a Pontian Danubian-Carpathian country.

Each natural element, by its specific, has a certain capacity of tourism potential, pursued on major steps of relief, increasing from the plain to the hills and plateaus up to the mountains, with the exception of the Romanian seaside of the Black Sea and the Danube Delta which present physical and geographical original aspects.

Romania holds a huge treasury of archaeological traces, historical, architecture and art monuments, as well as a valuable patrimony certifying the continuous labour and life evolution on these lands and the development of the Romanian culture and art.

- The Romanian seaside of the Black Sea –

This region is a complex one which increases its tourism value. It lies on 245 km in length, with the Danube Delta and the lagoon complex Razim-Sinoe to the North while to the South, on about 70 km, there lies the seashore itself. The seaside resorts which are well known at international level: Năvodari, Mamaia, Eforie Nord, Eforie Sud, Techirghiol, Costinești, Olimp, Neptun, Jupiter, Aurora, Venus, Saturn and Mangalia, have all modern accommodation, treatment centres and various entertainment opportunities. (NIS,2013)

The manner in which the entire tourist potential is revaluated, but also the accommodation units are evaluated through the tourist flows recorded. In this context, the tourist flow shows the actual request under different actions and it is analysed by three main indicators: tourist arrivals, overnight stays in the accommodation units, the degree of occupation and the average duration of the stay. The most relevant values are the ones for the overnight stays and the degree of occupation.

TABLE I

THE ANALISYS OF THE NUMBER OF TOURIST WHO ARRIVED IN THE TOURIST

ACCOMODATION UNITS

| Year | Total | Romanians |
|---|---|---|
| 2006 | 686502 | 624690 |
| 2007 | 796162 | 737971 |
| 2008 | 826747 | 791020 |

The source: The Annuals of tourist frequency recorded in Romania, 2006- 2008, The National Institute of Statistics, Bucharest, 2010.

The tourists who have wanted to spend their free time in the resorts from the seaside represent only 11 - 15% of the tourists total from Romania, which means that a weak



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revaluation of the existing endowments, but also the insufficient tourist services, especially for those who have higher incomes, whose requirements have grown a lot during the last few years. The number of foreign tourists is very low, many coming to the seaside, especially, at the beginning and the end of the season, when the crowdedness is reduced. The year 2008 is characterised by higher values for the arrivals and the overnight stays of the tourists.

The number of overnight stays shows a reduced share compared to the total recorded in Romania. Although here approx. 40% of the accommodation capacity of the country is focused, we cannot observe the same thing for this indicator. Very many are accommodated by relatives, friends and the unofficial tourism is also practised. The duration of the stay has reduced with every year and this is more and more obvious for many Romanian tourists. The foreign ones, beyond their presence, especially in Mamaia, Neptun, Jupiter, Eforie Nord resorts, have a longer stay because they visit other resorts as well, besides the ones they are accommodated and wish to know more tourist objectives in Constanta and Mangalia.

TABLE II

THE ANALISYS OF THE NUMBER OF THE OVERNIGHT STAYS IN THE TOURIST

ACCOMODATION UNITS

| Year | Total | Romanians |
|---|---|---|
| 2006 | 3745810 | 3300654 |
| 2007 | 4054625 | 3707860 |
| 2008 | 3990209 | 3790974 |

The source: The Annuals of tourist frequency recorded in Romania, 2006-

2008, The National Institute of Statistics, Bucharest, 2010.

The degree of occupation or the index of the capacity usage constitutes an important indicator in the analysis of the efficient exploitation of the accommodation units, which connects between the request (the number of overnight stays) and the offer (the operating accommodation capacity). In table III, the comparative data of the indexes evolution for

the net usage of the accommodation places from the units existing locally (the seaside) and nationally are presented for the period 2006-2008. The real period for practicing the seaside tourism is from May 15th to September 15th, although the season is officially opened on May 1st, every year, and it ends on October 1st.

TABLE III

THE AVERAGE DEGREE OF OCCUPATION, FOR THE UNITS IN THE SEASIDE

AREA AND THE TOTALFOR THE COUNTRY

| Year | The Seaside | Romania |
|---|---|---|
| 2006 | 39.8% | 33.6% |
| 2007 | 45.7% | 36.0% |
| 2008 | 49.2% | 36.4% |

The source: The Annuals of tourist frequency recorded in Romania, 2006-

2008, The National Institute of Statistics, Bucharest, 2010.

This indicator, compared to the period of a year, has an average value, but taking into account the period of the summer season of approx. 4 months, this degree of occupation reaches values of 65-85%; this phenomenon is observed especially for the months of July and August, when the request is maximum. In comparison with the data recorded nationally, the ones for the seaside have higher values, an extra proof that among the existing tourism forms, this is the most demanded by Romanian tourists.

## TOURISTS' ACCOMODATION CAPACITY

The number of establishments of tourists' reception with functions of tourists' accommodation includes establishments of tourists' reception existing on July 31 of the respective year, excluding those whose activity was interrupted for a long period of time in order to carry out capital repairs or important changes of their accommodation capacity or/and category.



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Existing (provided) tourists' accommodation capacity represents the number of beds used for the tourists' accommodation and registered in the last reception, homologation or classification document of tourists' accommodation establishment, the extra-beds which can be provided, if necessary, excluded. The number of beds was determined for the existing establishments on July 31 of the respective year.

The statistical surveys comprise establishments of tourists' reception with functions of tourists' accommodation having at least 5 beds as capacity of tourist's accommodation. The tourists' accommodation capacity in use (expressed in places-days) represents the number of accommodation beds put at the disposal of tourists by the establishments of tourists' reception, taking into account the number of days they are opened in the respective period. The beds from the rooms or establishments temporarily closed, due to lack of tourists, for capital repairs or for other reasons, are excluded. (INS,2013)

According to the 2007 travel & tourism economic research realized by WTTC, Romanian Travel and Tourism is situated on the 7th place in the world regarding the contribution of this industry to the Gross Domestic Product (2,1% in 2007, meaning 7,9 billion RON. The total growth for Romanian services in tourism generated RON 27.7 billion economic activity in 2007. The total demand would have an average annual growth of 7.7 per annum until 2017. Romania is a very large, least intensive, and fast growing Travel & Tourism economy. (Strategy, 2007).

In Romania, two main touristic models were identified:

- ✓ Model 1

Mass tourism in certain locations, characterized by several hotels offering full packages (food and accommodation), and independent beach resorts hosting large numbers of people → The local economy largely depends on summer tourism

- ✓ Model 2

Mass tourism in certain locations, characterized by rental of private houses and camping, independent beach resorts hosting large numbers of people → → The local economy largely depends on summer tourism

The entire tourist potential has allowed the development of tourist activities focused on certain types of tourism. In time, the following tourism forms have appeared:

• The tourism for rest and recreation is one of the oldest forms of tourism practiced, which has evolved together with the diversification of the tourist services, especially of those from entertainment. The tourists are interested in the sun and the beach, the sports with the ball, nautical sports - hydro-bicycles, scooters, aquatic sports, yachting, towing in different inflatable means etc., light cycling, diving. This is practised in all the seaside resorts, the most requested ones being the accommodation units with a comfort of 2 and 3 stars.

• The spa tourism for physical recovery, corporal and facial cosmetics, is the tourism form that has known the most rapid modernisation; before 1990 medical types of systems were used, but nowadays very modern techniques and endowments are used for the physical, aesthetic and psychological recovery; these units exist in some hotels in Mangalia, Neptun, Mamaia and they are classified among the 4 and 5 star hotels. In Eforie Nord, Mangalia and Techirghiol resorts there are sanatoriums with a medical profile, focused on the application of alternative treatments in the profilaxy and the treatment of some joints and muscular and neurological diseases.

• The social tourism for children and young people is offered in Costinesti resort, a place preferred by students and young people without families and children, as a fun place, and Navodari resort, focused on the most important camp for pupils. Moreover, the tourist offer from these resorts has started addressing to other tourist segments, but they are very few. Here the most dominant are the accommodation units of 2 and 3 stars, especially the hotels for young people -3, the tourist villas - 37, the bungalows - 90, the tourist hostels - 21, clubs and discos.

• The active tourism for leisure activities and sports is focused on the practice of light sports, from the need to move and for an active rest. This type of tourism has started developing in the last 15 years; the tourists preferring riding the bicycle, paragliding,



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yachting, sailing competitions like Cataramna and Caravelle, aquatic scooters, tennis, table tennis, badminton, horse riding (the horses farm from Mangalia), casino games etc. This type of tourism is very popular among the employed young people, with above average incomes who prefer the hotels of 3 and 4 stars.

• The business tourism and the congresses have known an ascending evolution in the last 20 years. Constanta and Mangalia cities have become important hosts for numerous economic reunions, economic contracts conclusions, seminars and conferences on social, medical and scientific themes. At the level of the tourist resorts, only Neptun resort has the best conditions for such type of events. This tourism has the merit of supporting accommodation, catering and leisure activities at the beginning and the end of the season, when the tourist demand is decreasing and the revenues are lower.

The resorts from the Romanian seaside face more problems, among which the most obvious is the reduction of the number of tourists, in the last decade, the tourist offer managing to rise only partially at the level of tourist expectancy. The Romanian seaside shall compete with other new offers of seaside, existing in the entire Black Sea basin.

Another negative, but continuous, aspect is the marine erosion. This phenomenon has always existed, but during the last five decades it has accentuated very much. We can mention a few aspects occurred because of the human interventions, with a negative effect on the beach areas:

• Pushing further into the sea the deposits carried by the Sulina Canal, in order to maintain the navigational depth;

• The large number of hydrotechnical buildings on the Danube, located on the middle and inferior course, which have reduced the deposits with approx. 50%.

• The extension and the modernisation of the harbor areas, from Midia and Constanta, Mangalia, which have diverted the seaside currents towards the open sea;

• The presence of some industrial activities from the harbor areas with accidental pollution impact on the natural environment;

• The tendency of the marine level to increase with 1.5 - 3 mm per year, as a consequence of the high volume of fresh water brought by the direct affluent rivers;

• The increase of the number of storms and their intensity, especially during the cold season, with devastating consequences on the beaches and the natural coasts;

• The illegal extraction of sand by the population from the nearby localities for constructions, fact that affects the thickness and the quality of the sand layer;

• The deterioration of the concrete dams that have the role of directing the deposits towards the shore.

Another problem is the manner in which the Romanian resorts have appeared and developed along the Black Sea coast. The majority has old accommodation and catering units that partially satisfy the current requirements of the tourists. The deficient aspect is that of the exterior architecture that is not adapted to the natural environment and to the regional specific, the small number of leisure spaces and the insufficient local transportation. During the last two decades, the modernization action of the numerous hotels and villas have intensified, and other have been built. We also notice the construction of very modern health centers, like SPA-Ana Aslan health Spa from Eforie Nord, Cocor Spa Centre, located between Neptun and Olimp.

In order to support the seaside tourism, the Seaside Association was constituted in 2006, which started the program "Seaside for everyone" (3000 places offered to the tourists) offering tourist packages at the beginning and at the end of the season at attractive prices. From 2009, this has become the Seaside-Danube Delta Association in order to develop common tourist packages. Meanwhile, its purposes have focused on the promotion and the tourist development, including all the city halls from the resorts and the localities on the coast line and in the delta of the river Danube. Moreover, from 2005, in September of every year, the Seaside exchange takes place and sets the evolution of the tourist products and the prices for the main tourist services.



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Among the tourism forms from Romania, the seaside tourism holds the highest share, because there is the tradition of spending at least a weekend at the seaside, or a part of the holiday. 40% - 120000 places are located on the seaside from the accommodation capacity of Romania, the majority being the 2 star and 1 star units. The tourist season is short, around 3 months a year, with reduced possibilities of extension as a consequence of the small number of recreational and entertainment activities. The tendency to extend the season in the months of May and September started in 2007, by organizing new activities and by involving the economic agents.

Moreover, the duration of the stay has been reduced from 7 days to 5 days on the Romanian seaside for the internal as well as external tourism. For the internal tourism, the weekend tourism has appeared in the last 2-3 years in almost all the seaside resorts, fact that agglomerates the Bucharest - Constanta highway, but also the road traffic flow between the resorts, as well as the accommodation and catering units or the beaches. Such a developed phenomenon brings a certain discomfort for the tourists on holidays and leaves. (Simon et al., 2011)

# Annex V – The value chain for microplastics in cosmetics

***Methodology***

Based on a first literature review (Shen et al., 2009; Gouin et al., 2015; GESAMP, 2015; UNEP, 2015), several activities are identified as linked to the Cosmetics-microplastics story. The transformation of plastics along the process has been briefly analysed (GESAMP, 2015) and assumptions have been taken, allowing to have a first overview on the process leading to the release of microplastics in the ocean through cosmetics (see figure below)

**Figure 1. First drawing of economic activities related to cosmetics-microplastics in European seas.**



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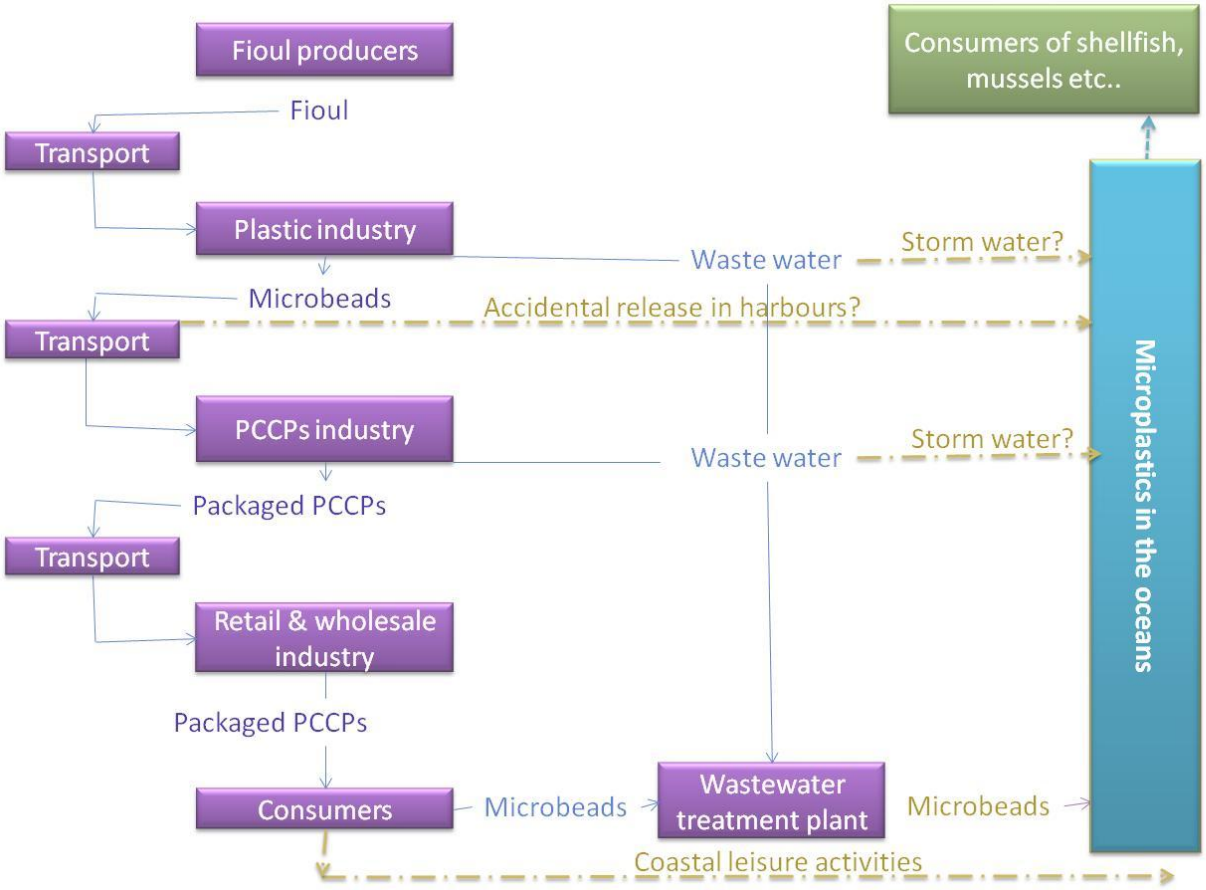


Further literature review for each economic activity allows to characterise each activity with key information and to identify: (1) What economic activities contribute directly to the release of microplastics; (2) What sub-activities are part of each economic activity and which one are particularly important in the process of using and releasing microplastic; and (3) What actors are especially important regarding the story of microplastics-cosmetics in the EU. A Fiche activity was then developed and updated to automatise the kind of information to collect for each economic activity. Economic activities were characterized through information coming from different sources (Eurostat, lobbies etc.) and should therefore be analysed as such (not all figures can be compared). Actors characterised were those linked directly to economic activities and sub-activities of the value chain, as well as actors related to the governance of these activities (institutional context) and influencing decisions related to the story.

The identification of most important actors relies on the identification of sub-activities and the links with microplastics release. An economic activity like Cosmetic production can for example entail sub-activities like research activities, packaging or cosmetics formulation.

Since packaging is not a direct source of primary microplastic release and is not related to the direct release of primary microplastics, it is not considered as an important sub-activity. So package producers are not identified as a key actor for changes in the microplastics-cosmetic story. Along the process, around 40 people have been contacted for an interview in order to improve our understanding of the story and get perceptions of actors on the microplastic issue and on constraints faced.

| Name of the person | Role | Organisation | Category | Date of interview | Mean |
|---|---|---|---|---|---|
| Ingo Sartorius | | PlasticsEurope | Representative association of EU plastic industry | May | Face-to-face (Athens) |
| Julien Romestant & Christophe | Economic intelligence director | Cosmetic Valley | Representative association of the French Cosmetic industry | 6th of July | Face-to-face (Chartres) |
| Maria Westerbos | Directive | Plastic Soup Foundation | NGO at the origin of "Beat the microbeads" | 11th of July | phone |
| Virginie d'ENFERT | Vice President Economic, Environmental and International Affairs | FEBEA | Representative of French Cosmetic industry | 28th of July | Face-to-face |

A survey was also undertaken in the Lanzarote workshop on Microplastics. Around 20 questionnaires were filled and analysed in a separate document.

### *Economic activities related to cosmetics*

Based on the ResponSEAble's classification and on the literature review the following economic activities have been identified as linked to the microplastic-cosmetic story.



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Several other economic activities could have been represented to illustrate the value chain of cosmetics. Activities represented here are those considered to be especially relevant in the process of producing (Fuel production) and releasing microplastics (Transport), as well as for potentially decreasing the release of microplastics (retailers) ending up in the European Seas.

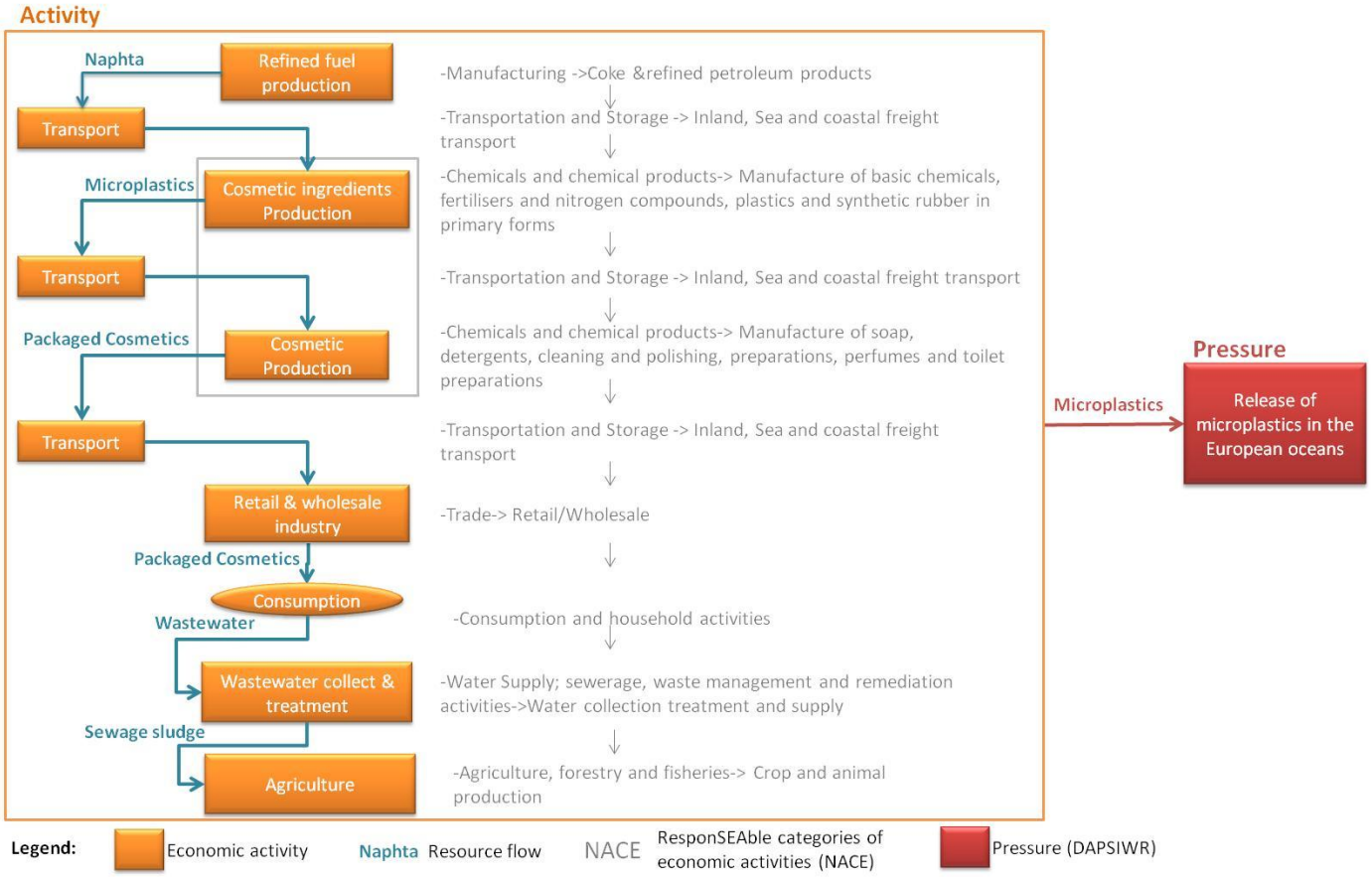


**Figure 2. Mapping of economic activities linked to the microplastics-cosmetic cas**

Each economic activity was then further characterised in order to identify links with releases of microplastics in the oceans and actors involved in decisions at the European scale in order to understand their margin of change.

***Identification of activities especially relevant for the Microplastic-cosmetic story***

"Fiche activity" were developed for each individual activity of the value chain. Some information of each economic activity and key learnings are summarized here.

### 12.3.1 Refined fuel production[41]

*From oil to naphtha*

Oil extraction, refinement and heating provide several substances by heating. One of them is called naphtha and is the necessary raw material for plastic production. Before being used to make plastics, naphtha is cracked (paprec.com). Naphtha production belongs to the "Manufacturing > Manufacture of refined petroleum products" (1920) in the NACE Rev 2 classification. From 1998 to 2015, the European production of oil has decreased from 3,606,000 to 1,507,000 barrels per day (statista, 2016). Europe is depending on oil imports. In 2013, this dependence represented about 88% of its consumption. Russia is the main supplier of oil and natural gaz in Europe. In 2013, 33.5 % of crude oil importation to Europe came from Russia. Norway is the second main supplier of Europe (Eurostat, 2016). At the global scale, plastic production only represents 4% of oil consumption[42].

[41] For the Knowledge base- Activity -> "manufacturing"-> "coke and refined petroleum products"

[42] http://www.bpf.co.uk/Press/Oil_Consumption.aspx



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⇨ Naphtha is used to produce plastics also as an ingredient for producing cosmetics. Therefore it is part of the value chain associated to the Microplastic-cosmetic story. However the share of European oil consumption used for plastic production is very small and the European production of oil is very dependent on imports. Consequently, **refined fuel production is not considered as an important economic activity at the EU scale for influencing impacts of microplastics coming from cosmetics released in the European seas**[43].

*Transport*

Transportation of products has no influence on the resource (only transportation of products rather than transformation), it brings products from one place to another, either through roads, waterways, or railway. Transportation of resin pellets between plastic producers and cosmetic producers can lead to release of microplastics in the seas through accidental loss of resin pellets/nurdles during transport, transshipment (UNEP, 2016[44] ). 75% of transport outside of Europe is through maritime traffic[45]. In 2014, European countries with highest gross weight of goods transported by short-sea shipping

[43] Fuel prices may have important impacts on decisions made by cosmetic ingredients producers, but fuel price can hardly be modulated atEuropean scale.

[44] Terrestrial transportation leads to release of microplastics from tyres dusts (UNEP, 2016), and three quarters of inland freight transport in Europe used roads as the main transport mode (Eurostat, 201344 - http://ec.europa.eu/eurostat/statistics-explained/index.php/Freight_transport_statistics ). However this story focuses on primary sources of microplastics

[45] http://ec.europa.eu/maritimeaffairs/policy/blue_growth/documents/com_2012_494_fr.pdf

are the UK (315 Mio tones), the Netherlands (272 Mio tones), Italy (265 Mio tones), Germany (177 Mio tones) and France (175 Mio tones)[46].

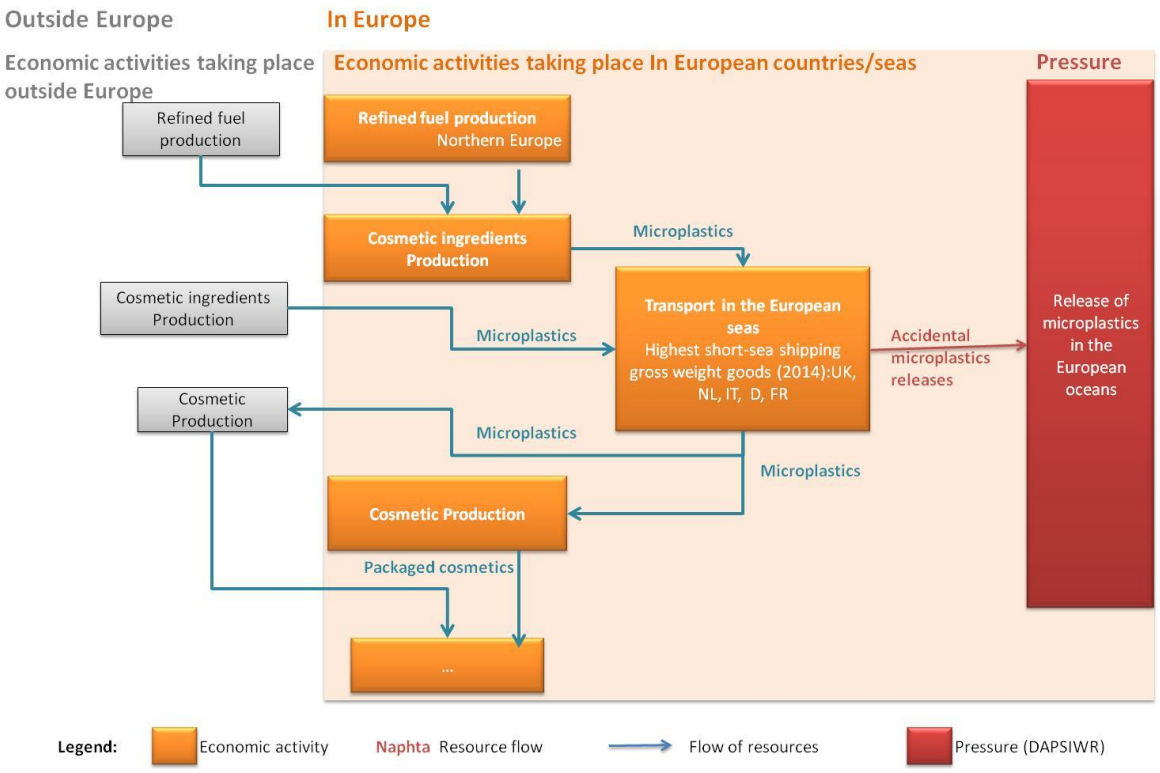


**Figure 28 Potential releases of primary microplastics in the seas, due to transportation along the cosmetics value chain.**

[46] http://ec.europa.eu/eurostat/statistics-explained/index.php/File:SSS_of_goods_by_reporting_country_and_direction,_2005-2014_(gross_weight_of_goods_in_Mio_tonnes).PNG

Cosmetic ingredients production[47]

*From naphtha to plastic microbeads*

From naphtha, plastic monomers are polymerized and other ingredients are added to make microplastics. Plastic industry was identified in the first draft mapping of economic actors. However plastic microbeads production is a very specific activity that seems to be undertaken by very little European companies. These companies do not seem to be part of the activities represented by Plastic association such as PlasticsEurope (Interview, Dr. Ingo Sartorius, PlasticsEurope, May 2016). Firms that manufacture microplastics for the cosmetics production belong to what the Cosmetics Industry calls Cosmetics ingredients producers (Cosmetics Europe, 2015). The Cosmetics Ingredients Suppliers provide aromatic raw materials and non aromatic materials (Interview, J. Romestant, Cosmetic Valley, July 2016). Microplastics are used as additives in cosmetics for their abilities to conserve, stabilize, perfume, color etc.

*Link with chemical industry*

Western Europe (France, Germany, Italy, UK) is the first producer market for cosmetics ingredients. North America is the second one[48]. Together Western Europe and North America represent 50% of the market. It is expected to grow thanks to an increasing demand. Microplastics production is a small part of this activity and seems to take place in Sweden, Norway, Germany and France[49]. Raw Plastic production can lead to

[47] For the knowledge base – Activity ->"Chemicals and chemical products"-> "Manufacture of basic chemicals, plastics in primary form"

[48] http://www.slideshare.net/SayaliTribhuvan/global-cosmetic-ingredients-market-to-grow-by-44-to-reach-us153139-mn-in-2016

[49] This is based on the location of companies identified so far as microbeads producers.

unintentional direct release in rivers and oceans through urban runoff[50]. There is a lack of data on diffuse inputs (UNEP, 2015) via losses from plastic pellets from processing plants (UNEP, 2015). Quantity of microplatics for cosmetics, produced in Europe have not been found. Several alternatives to plastic microbeads already exist and are being used. – firms producing alternatives to microplastics have been identified in the UK, the US and Canada. European cosmetic ingredient production is represented by two main European associations called the European Federation for Cosmetics Ingredients (EFfCI) and the European Organization of Cosmetics Ingredients Industries and Services (UNITIS).

[50] http://web.tuat.ac.jp/~gaia/ipw/en/what.html



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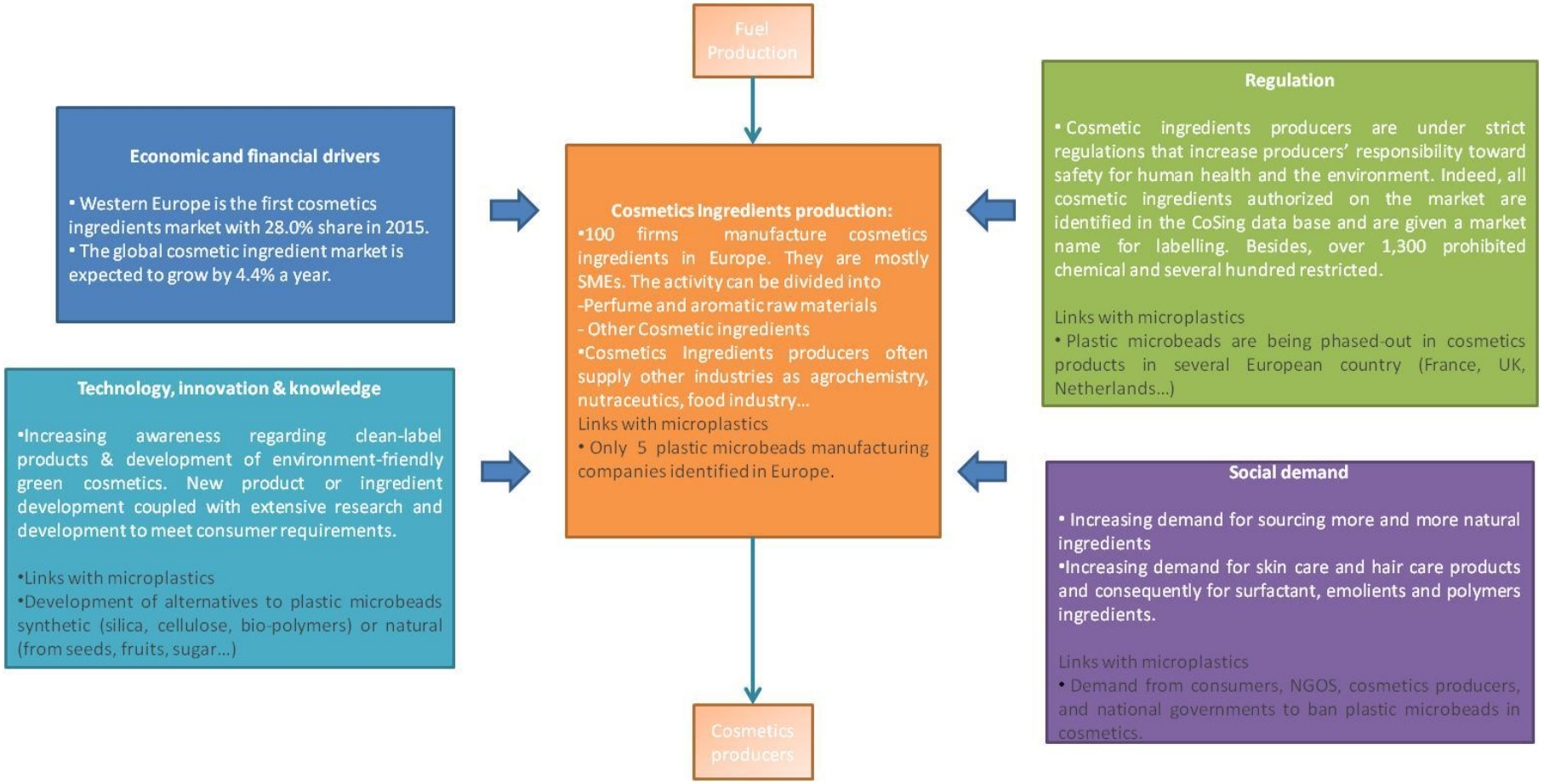
## Cosmetics Ingredients Production and its main drivers



*Cosmetics production*[51]

### *From plastic microbeads to cosmetics products*

The European Cosmetics production is the biggest of the world with €72 Bn far behind United-States (€ 37,8 Bn) and Japan (€29,3Bn). Germany, France and United Kingdom are the three main European producers (cosmetic-valley.com). Besides, exportations out of Europe represents one third of the global market and France is the first exporter and with Germany's exportation, theses two countries ensure 53% of total global exports from Europe. The European cosmetics provide both luxury and mass consumption. The largest shares of the European market are skin care (with €19.9bn), toiletries (€19.4bn), hair care (€15.0bn), fragrances & perfumes (€12.1bn) and decorative cosmetics (€10.7bn). Further characterization of this activity is summarized in the diagram below.

[51] For the knowledge base: "Manufacturing" -> "Chemicals and chemical products" -> "Manufacture of soap, detergents, cleaning and polishing, preparations, perfumes and toilet preparations"



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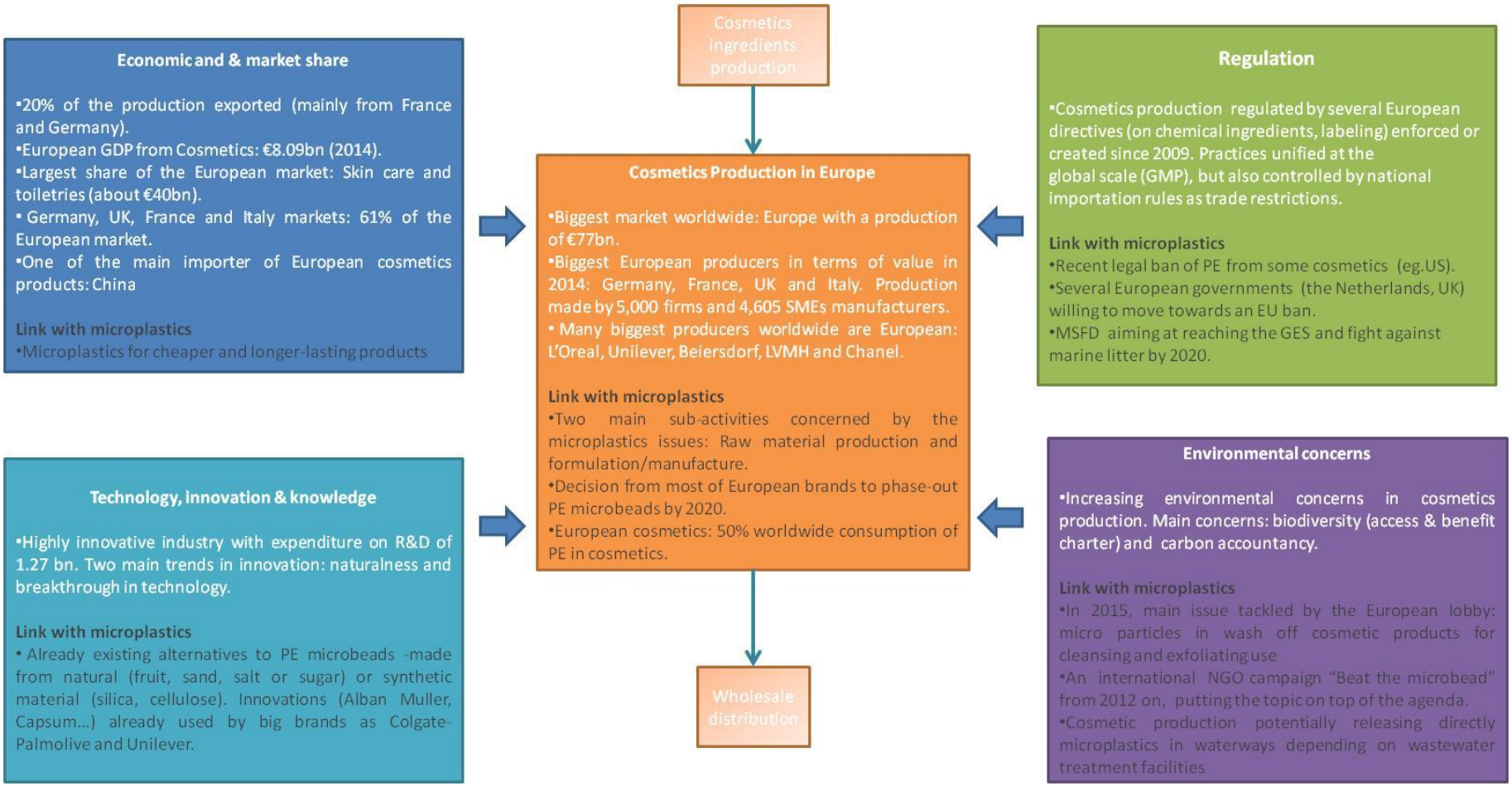
Economic and & market share
•20% of the production exported (mainly from France and Germany).
•European GDP from Cosmetics: €8.09bn (2014).
•Largest share of the European market: Skin care and toiletries (about €40bn).
• Germany, UK, France and Italy markets: 61% of the European market.
•One of the main importer of European cosmetics products: China
Link with microplastics
•Microplastics for cheaper and longer-lasting products
Technology, innovation & knowledge
•Highly innovative industry with expenditure on R&D of 1.27 bn. Two main trends in innovation: naturalness and breakthrough in technology.
Link with microplastics
• Already existing alternatives to PE microbeads -made from natural (fruit, sand, salt or sugar) or synthetic material (silica, cellulose). Innovations (Alban Muller, Capsum…) already used by big brands as Colgate-Palmolive and Unilever.
Cosmetics ingredients production
Cosmetics Production in Europe
•Biggest market worldwide: Europe with a production of €77bn.
•Biggest European producers in terms of value in 2014: Germany, France, UK and Italy. Production made by 5,000 firms and 4,605 SMEs manufacturers.
• Many biggest producers worldwide are European: L'Oreal, Unilever, Beiersdorf, LVMH and Chanel.
Link with microplastics
•Two main sub-activities concerned by the microplastics issues: Raw material production and formulation/manufacture.
•Decision from most of European brands to phase-out PE microbeads by 2020.
•European cosmetics: 50% worldwide consumption of PE in cosmetics.
Wholesale distribution
Regulation
•Cosmetics production regulated by several European directives (on chemical ingredients, labeling) enforced or created since 2009. Practices unified at the global scale (GMP), but also controlled by national importation rules as trade restrictions.
Link with microplastics
•Recent legal ban of PE from some cosmetics (eg.US).
•Several European governments (the Netherlands, UK) willing to move towards an EU ban.
•MSFD aiming at reaching the GES and fight against marine litter by 2020.
Environmental concerns
•Increasing environmental concerns in cosmetics production. Main concerns: biodiversity (access & benefit charter) and carbon accountancy.
Link with microplastics
•In 2015, main issue tackled by the European lobby: micro particles in wash off cosmetic products for cleansing and exfoliating use
•An international NGO campaign "Beat the microbead" from 2012 on, putting the topic on top of the agenda.
•Cosmetic production potentially releasing directly microplastics in waterways depending on wastewater treatment facilities

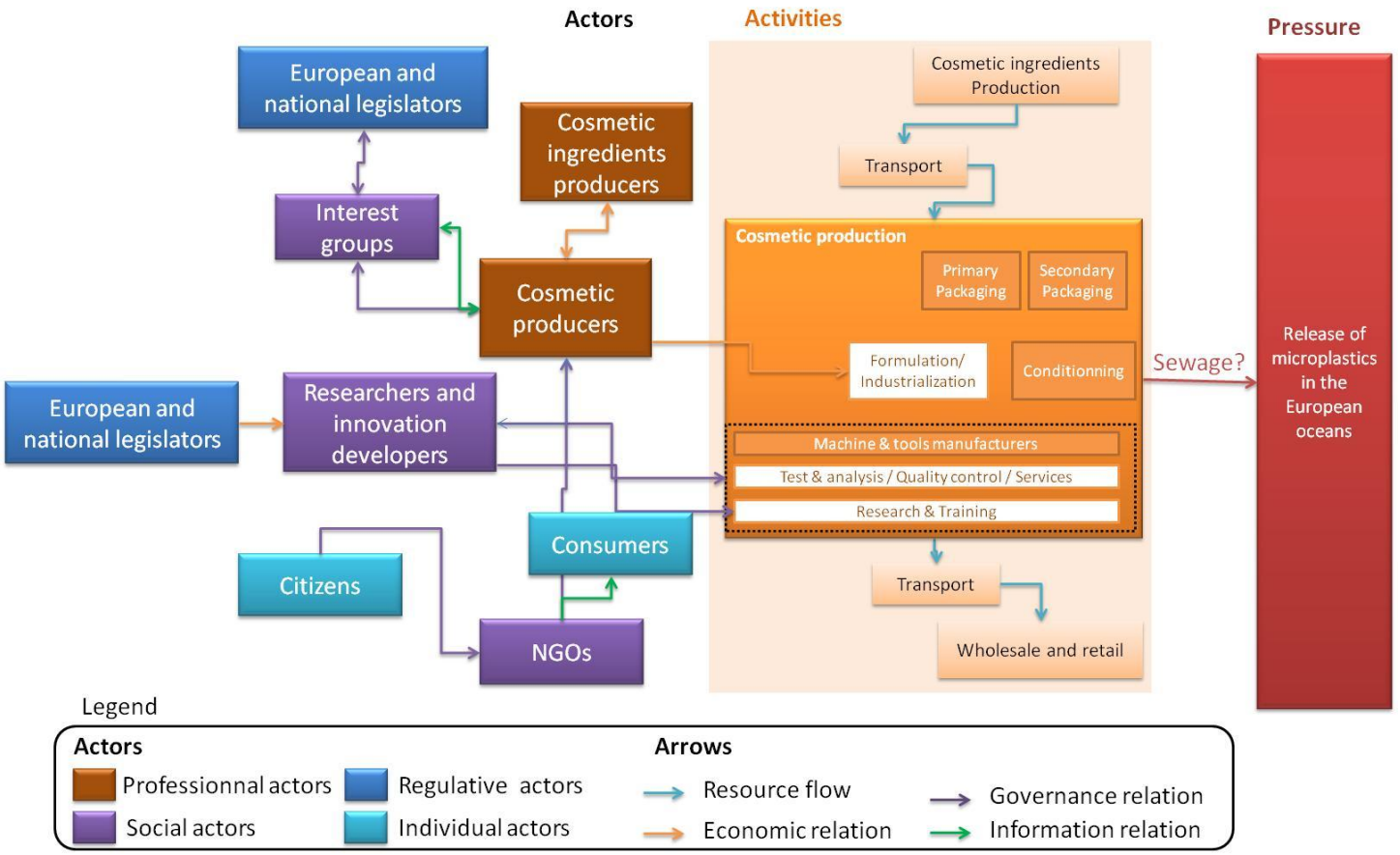


**Figure 29: Key actors related to cosmetic production in the microplastic-cosmetic story**




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- ⇨ EU cosmetics production mainly takes place in Germany, France, the UK and Italy.
- ⇨ Cosmetic production can include the production of cosmetic ingredients.
- ⇨ Cosmetic production seems to be mainly “supply-driven”, however from time to time specific demand of consumers might heavily drive production.
- ⇨ A lot of initiatives are underway in Europe to stop the use of specific microplastics in some cosmetic products (NGO’s campaigns, Voluntary agreement, emerging process for legal ban in some countries).
- ⇨ Information on the level of microplastics released **directly** from cosmetic production companies into water ways and finally oceans is almost not documented.

***The distribution of cosmetic products through retail and wholesale[52]***

In the NACE classification, the activity belongs to “Wholesale and retail trade; Repair of motor vehicles and motorcycles”. The main channels of cosmetics distribution are specialized market as perfumeries, pharmaceutical market, mass distribution, direct sell. Sales on the internet are increasing. In 2012, there were approximately 20,100 enterprises involved in the wholesale of cosmetics in Europe, the majority of which were located in Italy (18%), Spain (14%) and France (11%)[53].

Differences among countries: in France, cosmetic market is organized around brands – direct links between cosmetic producers and retailers (very little wholesale).

[52] For the knowledge base: Activities ->Trade-> Retail/Wholesale

[53] (Eurostat, 2012 from Cosmetics Europe, 2016)

## *Consumption of cosmetics products*[54]

*From cosmetics products to plastic microbeads releases through wastewater*

European **consumers spend, on average, €129** per year in cosmetic products. There is a close relationship between expenditure on cosmetics and national GDP (See the figure below). In 2014, consumers in Switzerland and Norway spent the most on cosmetics (about €250 per year) while consumers in Bulgaria spent about €45 per year (Cosmetics Europe, 2016). Highest spendings on cosmetic products by consumers are located in Germany, France and UK (Cosmetics Europe, 2016). According to Cosmetics Europe, 60% of European citizens think that using cosmetics have a positive impact on well-being, image, self-confidence and mood. Besides, more than 40% think cosmetics make benefits in social, love, family and professional life and health. The study found that women wear make-up because they like the way it makes them look (48% of respondents) and because cosmetic use makes them feel good (32%).

Overall, 33% women declare it is “hard to live without foundation or concealer”. 25% of men think it is “hard to live without aftershave”. Finally, 88% of people declare it is hard to live without cosmetics. About functional benefits, it is proved that handwashing with soap reduces risk of diarrhea by ~44-47% and acute respiratory illness by 23%. Besides, recent studies have shown that consistent and optimal use of sunscreen may prevent the incidence of melanoma (Cosmetics Europe, 2016).

[54] For the knowledge base: Activities -> Consumption and household activities



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***End of life of the product & waste water management[55]***

Despite wastewater treatment plants, substantial amounts of microplastics fom PCCPs will enter waterways and hence oceans. However some modern plants in Sweden and St Petersberg, for example, are reported to retain over 96% of microplastics by filtration (UNEP, 2016). Wastewater treatment plant in Europe has improved during the last 15-20 years. The European Commission has drawn two main directives to manage waste water: the Water Framework Directive and the Urban Waste Water Treatment Directive. It defines that every agglomerations of more than 2000 p.e. (population equivalent) must have collecting and treating systems. Moreover, all discharges from agglomerations of more than 2000 p.e. must have access to secondary treatment. Beside, every industry (from food industry) must have a pre-authorization to send their wastewater in urban one. The main directive that drives the industries water emissions is the Industrial Emissions Directive (IED) that takes into account emission in air, water and land, generation of waste, use of raw materials, energy efficiency, and noise. Tertiary treatment which allows reuse of water is almost absent in Eastern Europe because of its costs and know-how its implementation and use require.

*Agriculture*

Sewage sludge is used as fertilizer.

***Main results obtained so far and updated activities chain***

The value chain of the microplastics-cosmetics story allows to identify 8 main economic activities linked to this story at the European scale. Fuel production takes mainly place outside Europe, and as such is not considered as an activity whose actions can be "changed". Cosmetic ingredients production, Cosmetic production and maritime transport of microplastics are activities well developed in Europe with activities especially important

[55] For the knowledge base: Activities->Water Supply; sewerage, waste management and remediation activities->Water collection treatment and supply

in countries like France, Germany, the UK, Italy and the Netherlands is important in Europe compared to the worldwide market. According to this analysis, 6 activities may directly release microplastics in European seas:

- Cosmetic ingredients production through wastewater releases
- Maritime transport through accidental release while transporting microplastics
- Cosmetic production through wastewater releases
- Consumption through recreational activities like bathing
- Wastewater treatment through releases of sewage sludge and treated water
- Agriculture through the use of sewage sludge as fertilizer.

These different sources of release need to be further analysed. Information on the relative importance of these different links does not seem to exist. Cosmetic ingredients and cosmetic production in Europe may lead to very little releases thanks to industrial wastewater treatment facilities (Interview). Public wastewater treatment plants seem to capture quite well certain categories of microplastics at least in countries with highest cosmetic consumption.



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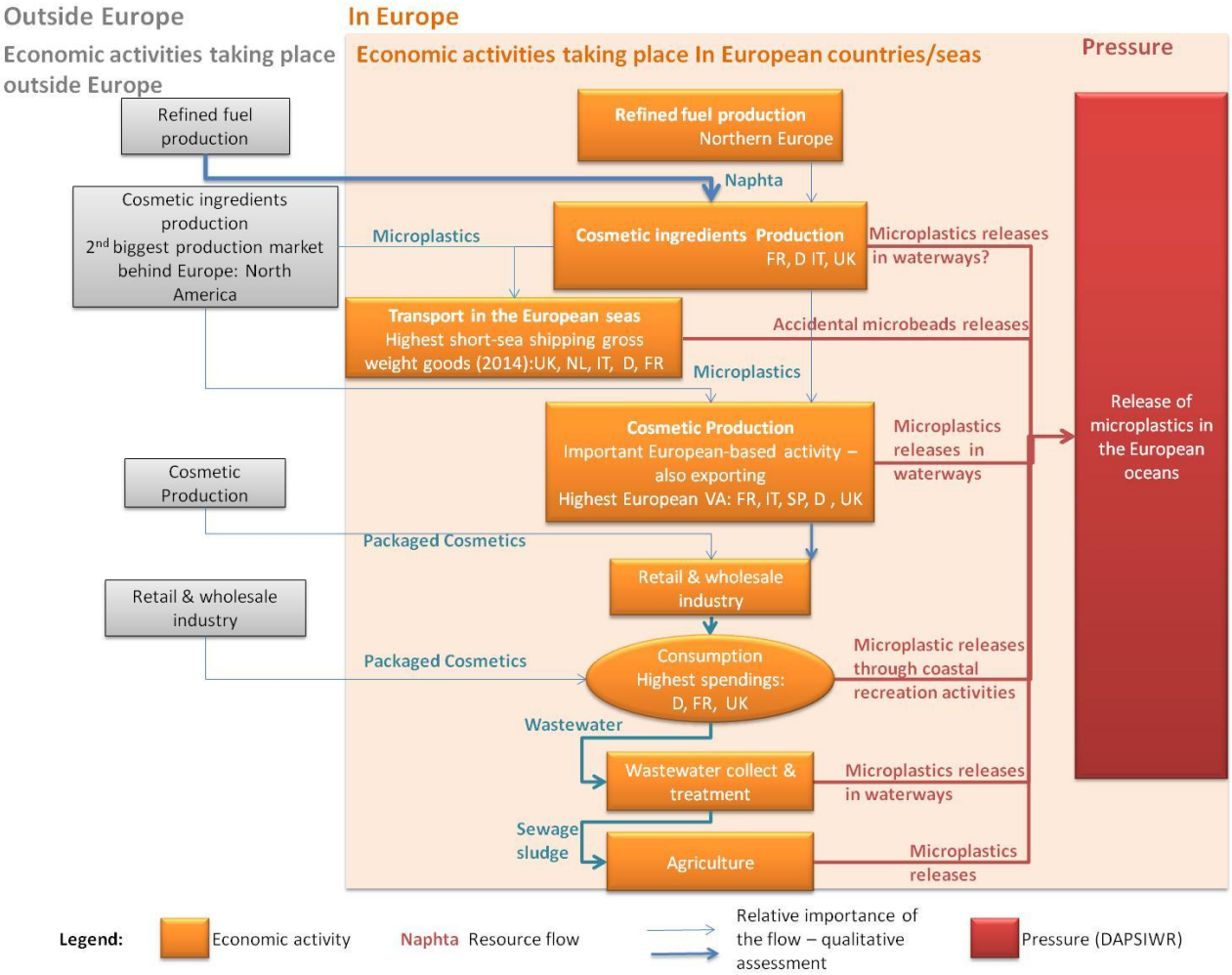


**Figure 30 European and non European activities leading to microplastic releases in European seas**

Note that thickness of arrows relies on characteristics of economic activities in general and not specifically to the portion of the activity related to microplastics. Cosmetic ingredients production for example is well developed in France, Germany and the UK. However microplastics production is a small part of this activity and seems to take place in Sweden, Norway, Germany and France.

***Analysis of institutional context and actors linked to these activities***

NGOs have been strongly mobilized since the start of the “Beat the microbead” campaign to move towards ban of the use of microbeads. Following the ban adopted in North America, and current pressures by national governments, it is likely that a ban of the use of some categories of microplastics will be adopted in Europe. For the moment differences in EU countries approaches can be noticed: cosmetic producers in Germany move towards a voluntary agreements , whereas the UK and the Netherlands governments are in favour of a legal ban. The relatively low importance of cosmetics compared to other sources of microplastics in the seas and the apparently high focus on microplastics makes it even more important to understand consumers perceptions and understandings on the links between cosmetics, microplastics and microplastics in the EU seas.



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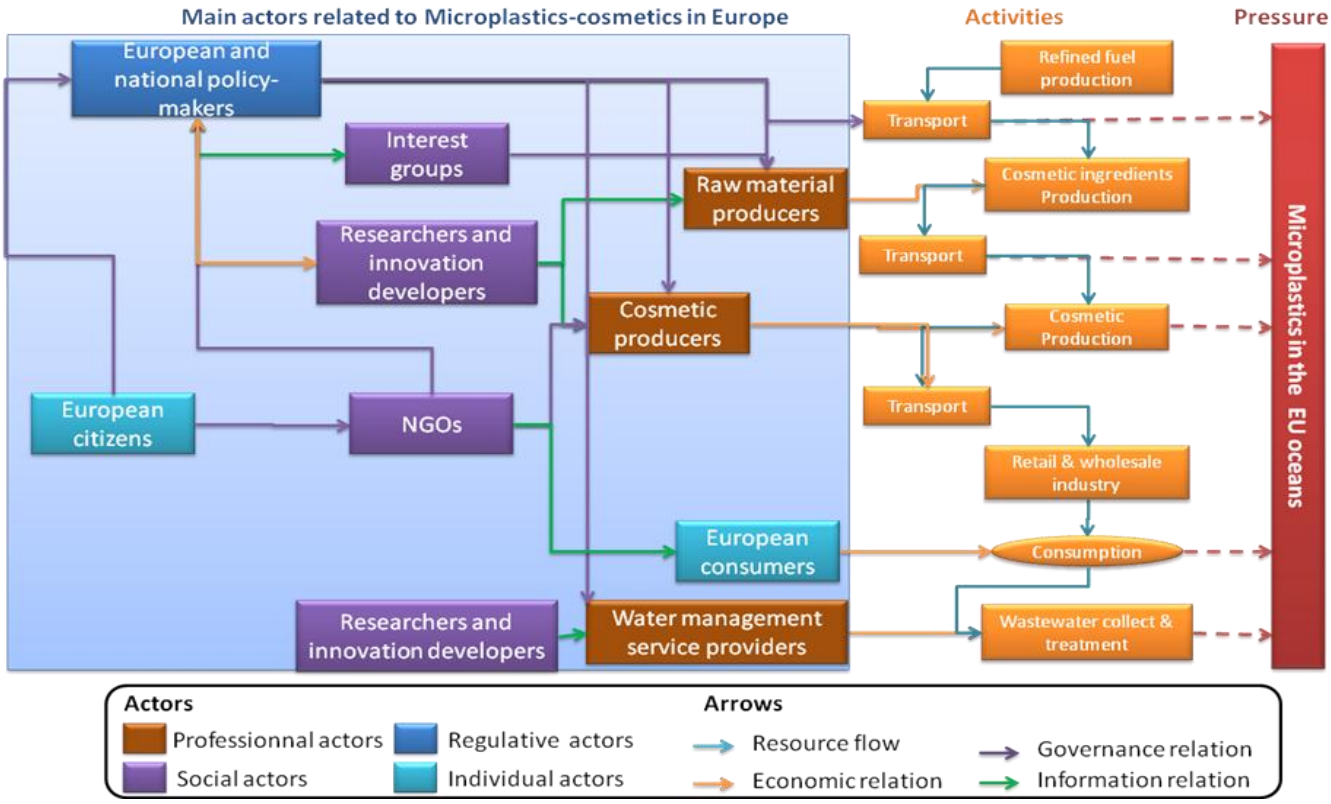


**Figure 31 Actors related to the microplastic-cosmetic story in the EU whose behavior seem influential**

***Margin of changes of actors for decreasing microplastics in the seas coming from cosmetics***

**Scenario 1- Strong legislative framework and shift to alternatives to microplastics**

Cosmetics use slowly less microplastics based on international trends through initiatives by UNEP, TAFTA and the US. National governments followed by the EU ban the use of some microplastics. Use of microplastics in comestics is then even more reduced and lead to a decrease in microplastics released in the seas. Legislation is the driver of change in this scenario. Strengths and weaknesses: microplastics realease coming from cosmetics is indeed reduced. However awareness on all other (and bigger) sources of microplastic is not increased and only the top of the iceberg is being dealt with.

**Scenario 2 – A lot of legislation and ongoing use of microplastics in cosmetics**

The European Commission decides to improve its understanding of the issue. Measurements of microplastics releases in Europeans seas are developed. An European process and indicators are defined and implemented in the frame of the MSFD and the WFD. Scientific knowledge on the sources of microplastic releases is improved. In parallel, microplastic use in cosmetics is constrained to a specific quantity, cosmetics using microplastics are also more taxed, and a label informs consumers on cosmetics free of microplastics. Wasterwater treatment plants also have to collect microplastics and spreading of sewerage containing a specific concentration of microplastic is forbidden. In this scenario it is a slower change towards a decreasing use of microplastics. First microplastic releases are decreased, knowledge (scientific and consumers') improved which leaves more time for cosmetics producers to adapt and stop using microplatsics.

**Scenario 3 – Low legislation and microplastics replaced by other ingredients**

Consumers get always more aware of ecological issues and of the impacts of microplastics in the seas. Consumers are concerned of eating fish containing



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microplastics. Social demand of legislating on the use of microplastics as well as demand of microplastic-free cosmetics increase. Globally use of plastic in the society is limited to specific uses. NGOs campaigns are very active regarding the issue of microplastics in cosmetics and diversify actions to have a bigger impact: raising awareness, boycott campaigns, development of a label widely used. In parallel, the general context leads to an increased relative cost of using plastics in cosmetics: increasing price of fuel, decreasing price of alternative ingredients. Cosmetic producers are getting organised to adapt to the demand and preserve their socially responsible reputation. A voluntary agreement is signed at the European scale among cosmetics producers to stop using microplastics and to increase transparency on ingredients used in cosmetics. Innovative alternatives to microplastics are found. Changes in this scenario is driven by society in general with low involvement of governments (no strong legislation, no subsidies).

**Scenario 4 – Low legislation and ongoing use of microplastics in cosmetics**

Several small initiatives are undertaken to decrease Microplastics. An application from NGOs allows to better identify products containing microplastics, but microplastics is not on the top list of environmental concerns of NGOs. Some retailers provide information to consumers on the presence of microplastics in cosmetics. A decreasing in fuel prices leads to a decreasing price of microplastics. Given a limited social demand for microplastic free cosmetics, microplastics are still used. However in a context of development of a circular economy, transportation processes are adjusted to reduce accidental releases of microplastics in the seas. Filtration processes are developed allowing for collecting and recycling some microplastics. Releases of microplastics in the oceans are therefore reduced. In this scenario change is mainly due to decreasing consequences of the use of microplastics. Industries and society are not very active on the specific case of microplastic. Several actors are aware of the microplastic scenario but it is not the priority for any of them. People are aware of/acting upon consequences but not so much on the causes. Change is more driven by a general change of paradigm of

the economy towards a more circular economy, in a world with growing environmental issues[56].

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[56] Note most of Environmental post-its have been placed in this scenario

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# Annex VI – The value chain for Marine Renewable Energy in Europe

The Marine Renewable Energies (MRE) key story is different from other ResponSEAble's key stories in that it is rather part of a prospective and enlisted in the European Blue Growth Strategy, when other are more related to existing impacting activities threatening the oceans' health as underlined by the EC MSFD directive. If aquaculture is also part of the same strategy, it mostly relies on the development of an existing industry rather than on the development of a new industry, going along with a number of uncertainties regarding its socio-ecological dimensions in a complex environment.

MRE refers to ocean energy, ocean power or marine hydrokinetic energy. MRE also refers to the Ocean Energy Systems (OES). OES often exclude wind power as wind is not considered as specific ocean energy. The present key story dealing with the ocean health will include all sources of renewable energy having the ocean as its production area or as a support for production. It will consider potential impacts over the oceans either through direct extraction or through physical support (floating or fixed infrastructures). Offshore wind power will then be part of the story.

Among the renewable energies, MRE remains an emerging but promising industry in terms of power generation potential. In addition to different technologies and origins of power, there is an important diversity in terms of design within the same MRE segment. This illustrates the low standardization rate and youth of the sector.



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The development of MRE is at the core of the European Blue Growth strategy. The Blue Growth strategy[5758] is the long term strategy to support sustainable growth in the marine and maritime sectors as a whole. Seas and oceans are undertaken as drivers for the European economy. They are seen as "the maritime contribution to achieving the goals of the Europe 2020 strategy for smart, sustainable and inclusive growth" (EC 2012). The European Commission has developed a two-steps action plan to support this emerging sector[59]. In the first phase (2014 – 2016), a secretariat and ocean energy forum has been set up (EC 2014).

European MRE development is also driven and supported by several EC directives. The first one is the EU's renewable energy directive which establishes an overall policy for the production and promotion of energy from renewable sources in the EU. It sets a binding target of 20% of final energy consumption from renewable sources by 2020. To achieve this, EU member States have committed to reaching individual national targets, from 10% in Malta to 49% in Sweden. All EU countries must also ensure that at least 10% of their transport fuels come from renewable sources by 2020. These national renewable targets were translated into national renewable energy action plans underlining actions to be intended to meet the targets. Progress toward targets is measured every two years through the publication of national renewable energy progress reports. Iceland and Norway as EEA members also produce action plans. These plans include the different mix of renewable technologies to be employed and the use of cooperation mechanisms amongst countries to meet their targets as promoted by the Directive (statistical transfers of renewable energy, joint renewable energy projects, joint renewable energy support

[57] Communication from the Commission: Blue Growth opportunities for marine and maritime sustainable growth COM(2012) 494 (13.09.2012)

[58] Communication from the Commission: Innovation in the Blue Economy: realising the potential of our seas and oceans for jobs and growth - COM(2014) 254/2 (13/05/2014)

[59] Communication from the Commission: Blue Energy - Action needed to deliver on the potential of ocean energy in European seas and oceans by 2020 and beyond COM(2014) 8 final

schemes). Last national renewable energy progress reports underline that the EU should exceed its 20% target by over 0.3%. EU countries have already agreed on a new renewable energy target of at least 27% by 2030.

But beyond of the renewable energy directive and the Blue Growth strategy, the triggering factor to the MRE development in the European Union was the adoption of the Marine Spatial Planning (MSP) Directive in 2014[60]. Even if not argued in that way, MSP is far from the Integrated Coastal Zone Management (ICZM) principles. MSP is rather closer to the 80's zoning approach than to an improved ICZM. It mainly addresses the issue of competition for maritime space and need for efficient management, by avoiding potential conflicts and creating synergies between different activities. The late exclusion of ICZM from the last draft of the MSP directive, initially thought as a MSP and ICZM directive, is a revelator of the incapacity of the European institutions to achieve the ICZM implementation. This apparent disintegration of coastal management processes for segmentation and delineation was thought necessary to secure some production rights over a common, shared and often free access area. MSP then aims at reducing conflicts, increasing coordination and protecting the environment through early identification of impacts (EC 2014), but also at encouraging investment by mitigating the previous issues and fostering licensing process.

The promising potential of MRE has to be faced with the higher engineering, manufacturing, installation and implementation costs compared to onshore renewable energies. For instance the investment cost of a wind farm is twice as high offshore than onshore. The connection and construction costs are especially much higher counting for 40% of total costs when it only counts for 15% onshore (IRENA 2012).

[60] Directive 2014/89/EU of the European Parliament and of the Council of 23 July 2014 establishing a framework for maritime spatial planning



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Then if incentives to development and energy potential forecasts in terms of energy production supply are strong, there're still concerns in terms of social, economic and environmental impacts. The higher production costs, at least in the initial development stage and market maturation, the social acceptance as well as the unknown ecological impacts on long term are challenging for the industry development, both in terms of designing new and suitable MRE devices as well as their deployment.

**Facts and figures of European MRE**

Several issues are attached to the development of MRE in the European Union. Among the most the most important ones are the following:

- Europe is the world leader in terms of MRE technology and should convert this leadership into an industrial success story.

- The European Union needs to secure its energy supply. The EU has to import 53% of its energy needs, mainly through fossil fuels and mostly from politically unstable and unsecured regions where tensions are growing.

- MRE will play a core role among renewable energy to contribute to the objective of a low carbon economy energy and to the reduction of greenhouse gas emissions (GHG) to achieve the EU's 2050 target: 80% below 1990 levels through domestic reductions alone (40% below by 2030 and 60% below by 2040).

- Coastal areas were MRE take place are often regions severely affected by the economic crisis and important restructuration in their traditional activities. MRE offer an opportunity of regional economic development for these areas in line with the Blue Growth Strategy, providing new uses for under used infrastructures such as harbors.

- It can be expected a technological transfer from the MRE industry into other industries that could benefit from the development of new technologies initially developed for MRE.

### *A diversity of technologies at different maturation stages*

The European Union is the world leader in MRE production and experiment sites and is on the way to industrial development on large scales, especially regarding the offshore wind technology which is the most mature.

As a young sector in terms of development, MRE encompasses a diversity of technologies and designs. For instance wave energy convertors may be designed and structured into very different ways depending on the way energy is absorbed (water depth and location). This results in a low standardization rate of equipment affecting production costs and different maturity degrees according to technologies. MRE rely on 7 main technologies:

- Wind energy
- Wave energy (Wave Energy Convectors WECs)
- Marine current power: tidal and ocean (wind driven and thermoaline ocean circulation) currents
- Tidal energy
- Ocean thermal energy (Ocean Thermal Energy Conversion OTEC or Thermal Gradient)
- Osmotic power (Salinity Gradient Power)
- Microalgae culture for biofuel (marine biomass)

In the following microalgae won't be considered any long as it belongs to a completely different process in terms of energy production and carbon energy. For the other sources of energy, power is directly extracted from the oceans' energy, when it is an indirect source for microalgae more related to the aquaculture field as it requires an initial culture process of microalgae to be turned later into biofuel.

Most types of technologies are currently under development, either through demonstration or initial commercialization stage (Figure 1). The most promising technologies for industrialization and commercialization are fixed and floating offshore wind and marine current power. Tidal energy is more mature and operated for a long time at an industrial



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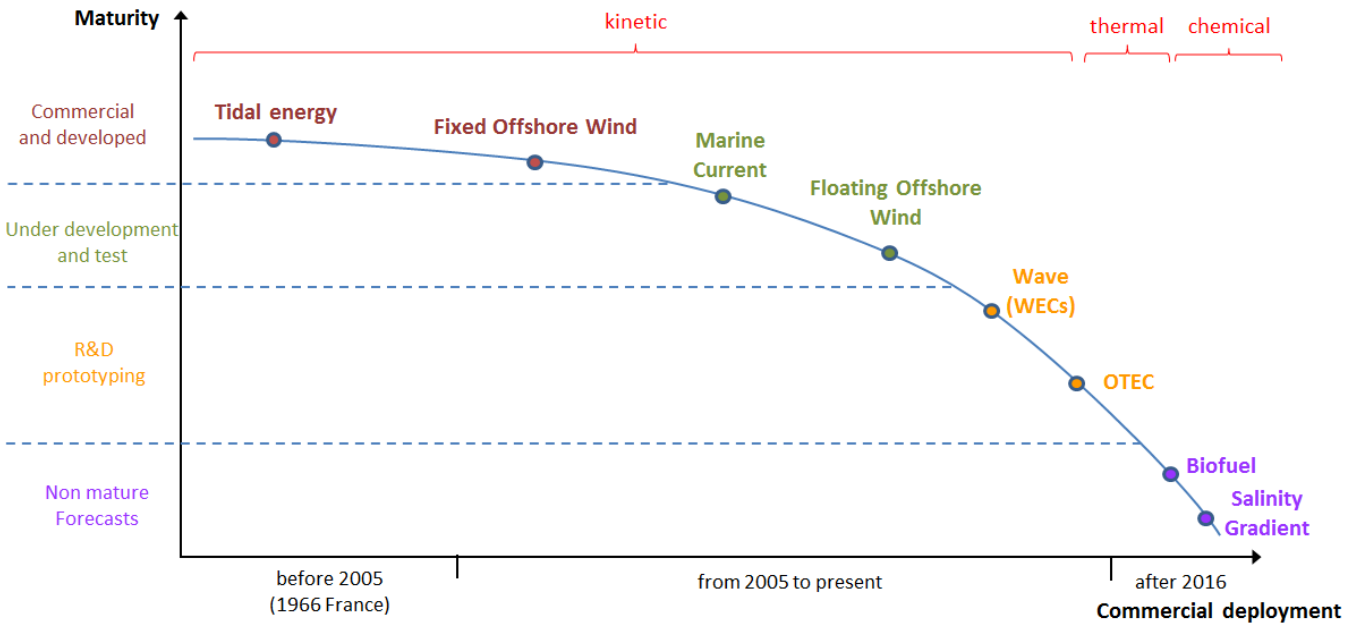
scale (the Rance river estuary dam in France since 1966), but in spite of a high global potential it has to face weak growth prospects due to the limited number of location which could be exploited. The fixed offshore wind energy is the most mature of the remaining technologies, being operated for more a dozen of year in Norway, Scotland or Germany principally. Marine current power and floating offshore wind are still under development, but some operational deployments have already been initiated and are grid-connected. Wave energy (WECs) and Ocean thermal energy (OTEC) still give rise to numerous research and development of prototypes with further commercial production beyond of 2020. Biofuel and osmotic power are non-mature segments with low prospects for short and medium terms development.

Figure 1 State of development of Marine Renewable Energies




***Forecasted potential for European MRE***

The maturity of MRE also underlines advantages and constraints of technologies according to each other.

**Offshore Wind Power:** offshore wind is the most widespread technology among MRE. Its maturity in terms of technology allows for a large scale commercial deployment. At the end of 2014, 3,230 turbines at 84 offshore wind farms across 11 European countries had been installed and grid-connected, making a total capacity of 11,027 MW. According to

the European Wind Energy Association (EWEA 2016), 3,019 MW of net installed, grid-connected capacity of offshore wind power was added in 2015, 108% more than in 2014 and a net addition of 754 new offshore wind turbines in 15 wind farms. Interest in offshore vs. onshore wind power relies in a more important social acceptance regarding negative impacts such as noise and landscape impacts. Today solely the **fixed offshore wind power** is commercially deployed. The average water depth of offshore wind farms where work was carried out in 2015 was 27.2 m, slightly more than in 2014 (22.4 m) (EWEA 2016). The average distance to shore for those projects was 43.3 km, significantly more than in 2014 (32.9 km). But this trend to be deployed offshore where it is no longer visible and where wind resources are higher is costly and requires continuous development and innovations. **Floating offshore wind power** aims at overcoming the balance between increasing costs and distance to the shore. But this alternative technology is not yet ready for a commercial deployment and investments and technological development are still under way.

**Tidal:** tidal energy is more predictable compared to wind and solar power for instance and it also provides energy storage through tidal basins. But suitable location is critical and such sites are limited (no more than 40 potentials site at the world level according to the existing technology requiring at least 7 m high between low and high tides). The solely significant production site in Europe was deployed in France in 1966 in the Rance river estuary[61]. The Rance tidal dam implements 24 turbines with a capacity of 240 MW for an annual output of 600 GWh. There are two projects under development in Europe:

[61] The other existing tidal power station of significance is the Sihwa Lake tidal power station in South Korea with an output capacity of 254 MW (ten 25.4 MW submerged bulb turbines), making use of a seawall constructed in 1994 for flood mitigation and agricultural purposes. The power station was completed in 2011.



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- the Swansea Bay Tidal Lagoon in UK with a full commissioning expected in 2018 for a planned investment of € 1.26 billion, a capacity of 240 MW and an annual power generation capacity of 400 GWh;
- the MeyGen Tidal Energy Project in Scotland with a 86 MW first phase development (initially expected in 2015, but toward an intermediate 6 MW capacity for 2016) and a second phase development expected to raise the total installed capacity to 398 MW by 2020.

**Marine current power:** the other mean to harness tidal energy is to exploit tidal currents. Compared to other renewable energies it is a consistent source of kinetic energy and The UK has one of the largest marine energy resources in the world, estimated to be more than 10 GW, representing about 50% of Europe's tidal energy capacity. In Europe the potential for marine current is mainly located in the UK and France. The inherent predictability of tidal power is highly attractive for grid management, removing the need for back-up plants powered by fossil fuels (Marine Current Turbines Ltd. 2016). Tidal turbines (horizontal or vertical) are usually installed on the seabed or suspended from a floating structure at locations with high tidal current velocities. The economic viability is yet to be proven but it is anticipated that the production costs will decrease as the technology advances. Concerns are related to effects on marine life through the device's turbines and noise. Regarding limits, corrosion and fouling of devices are also important challenges as they occur more easily in areas of high tidal currents characterized by a high biological productivity.

**WECs:** production is much smoother and more consistent than wind and solar power (ECORYS 2012). But difficulty remains in designing a device able to address the diversity of wave patterns (amplitude, phase and direction) and the intensity of potential hurricanes and storms generating power beyond of the level to what they are normally matched. Noise and visible impact are the most important criticisms towards wave energy.

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There is another large tidal power station under construction (begun in 2011) at the Incheon Bay. Upon its completion planned for June 2017, the facility is expected to top 1,320 MW for a production of energy up to 2.41 TWh annually.

**OTEC:** thermal gradient power is based on the temperature difference between cooler deep (generally below 1,000 m) and warmer surface (solar energy stored as heat in upper ocean layers) ocean waters. OTEC is rather limited to tropical areas as a temperature difference of 20 to 25°C is considered as desirable to work properly (ECORYS 2012). It is then mostly devoted to European oversea territories, but has still some challenge to overcome to reach a better maximum efficiency in spite of high potential in terms of energy available.

**Salinity gradient power:** similarly to OTEC, osmotic power has still to overcome a number of difficulties to reach an operational and commercial deployment. Based on the difference in salt concentration between seawater and fresh water (lakes, river mouths), the production costs are still too high due to the costs of the required membranes for osmosis. Ongoing developments are implemented on pilot sites.

### *European MRE production and market*

It is estimated that if deployed worldwide, ocean technologies could meet the world's current electricity demand of close to 20,000 TWh (IAE/OES 2015). 20,000 TWh is equivalent to the present world power production, all sources of energy included, for an installed power around 5,000 GW.

Table 1 World Potential for MRE (Ref. )

| Power sources | Potential | Dimension | Nuclear reactor eq. |
|---|---|---|---|
| Floating Wind | 3,000 to 4,000 GW | World level | 2,000 |
| Fixed Wind | 1,000 to 1,500 GW | World level | 800 |



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| | | | |
|---|---|---|---|
| Wave | 1,000 to 1,500 GW | World level | 800 |
| Marine current | 75 to 100 GW | World level | 60 |
| Ocean thermal | 100 to 150 GW | Tropical areas<br>(present available technologies) | 80 |
| **MRE** | **about 20,000 TWh/year** | | **3,740** |

In Europe the solely potential for wave resource is estimated to be at least 2,800 TWh/year, corresponding to 80% of the EU electricity production in 2010 (EC 2014). But from the current deployment of MRE to this theoretical potential, there are still a number of constraints and issues to cope with. The technical potential of ocean energy is constraint by high technology costs and as a consequence these estimates also vary widely according to fluctuation of carbon energy costs.

**Wind power** presents the most important potential (> 4,500 GW) due to a more mature technology fed by inshore wind power experience. Fixed offshore wind power is the relay of the onshore wind power growth. According to the European Wind Energy Association (EWEA) offshore wind accounted for 24% of total EU wind power installations in 2015, double the share of annual additions in 2014. This confirms the growing relevance of the offshore wind industry in the development of wind energy in the EU (EWEA 2016). Offshore wind power installations represented 24% of the annual EU wind energy market, up from 13% in 2014. Germany, the UK and the Netherlands were the most active countries in the deployment of new offshore wind farms these last years. The North Sea is the main deployment area counting for respectively 86% and 69.4% of new and existing installations in European waters (EWEA 2016). The Baltic Sea and Irish Sea count respectively for 17.6% and 12.9% while the Atlantic Ocean counts only for 0.1% of the installed capacity. For the coming years, the North Sea will remain the most important area with 78% of the consented offshore wind farms in terms of capacity. The Mediterranean Sea will slightly develop with 1% of consented capacity while Baltic Sea and Irish Sea will be the place of significant developments (respectively 12.4% and 8.6%).

Fixed structure is the rule in terms of infrastructures and monopile substructures dominates largely (80%) compared to other substructures (jacket and tripods mainly). Floating substructures are marginal (2 operational turbines) and count for 0.1% of the total offshore wind substructures. Inter-array cables represent another important segment of the offshore wind industry and more largely of the MRE industry. Having a leadership over the activity, European manufacturers also export cables. First decommissioning operations were initiated over old small scale offshore wind farms, completing the entire steps of the value chain.

With a capacity of 11,027.3 MW, the 84 European offshore wind farms are able to produce about 40.6 TWh/year, that is to say 1.5% of the EU's total electricity consumption (2,707 TWh/year). The UK counts for 45.9% of the total offshore wind installation, followed by Germany (29.9%) and Denmark (11.5%) (Table 2).

Table 2 Installed capacity for European offshore wind power (2015)

| Country | UK | Germany | Denmark | Belgium | The Netherlands | Sweden | Finland | Ireland | Spain | Norway | Portugal | **Total** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nb. of farms | 27 | 18 | 13 | 5 | 6 | 5 | 2 | 1 | 1 | 1 | 1 | **80** |
| Nb. of turbines | 1,454 | 792 | 513 | 182 | 184 | 86 | 9 | 7 | 1 | 1 | 1 | **3,230** |
| Capacity (MW) | 5,061 | 3,295 | 1,271 | 712 | 427 | 202 | 26 | 25 | 5 | 2 | 2 | **11,027** |

Source EWEA 2016

The UK and Germany are also the countries having the highest share of consented offshore wind farms in terms of capacity for the coming years.



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**Tidal and waves.** Aside the offshore wind power, the most promising and advanced ocean energy technologies are **tidal** and **wave energy**. But their deployment doesn't meet the expectations stated by European member States in the 2009 National Renewable Energy Action Plans (NREAPs). Objective for tidal and wave energy was set to 2,250 MW, 0.5% of the electricity capacity of the EU by 2020 and to 100 GW by 2050. But present forecasts assess a capacity about 170 MW by 2020, 7% of the NREAPs target (Magagna et al. 2015). Beyond of trials and tests a first tidal project is expected in 2016 in the UK as well as a wave project in Sweden. A 10 MW OTEC plant is expected later in Martinique as well as a 50 kW salinity gradient plant in the Netherlands.

These ocean energy technologies have not yet achieved a technological level allowing them to be commercially profitable or competitive regarding other renewable energy sources. One on the main constraints relies in the technological development. Offshore wind power benefited from inshore wind power technology and replicated the technology through the choice of fixed substructures when floating ones still claims for reliability and tests design. Most of tidal energy devices deployed are also based on technology from wind energy (power take off, power electronics gearbox and moorings) (Magagna et al. 2015). But wave energy devices were not able to benefit from such transfer and require further R&D and testing to achieve reliability. They will also require new designs and developments to cope with more extreme conditions than other MRE devices. The lack of design consensus doesn't play as an incentive for potential investors too. Several designs are under development corresponding to different technological choices: point absorber, attenuator, oscillating wave surge, oscillating water column, bulge wave, rotating mass… If the three first ones count for 82% of the R&D efforts, no consensus emerges from the different designs.

EU has also the leadership in tidal and wave projects (Figure 2) counting for more than 50% of R&D investments (50% from the industry and 20% from EU funds), but it represents only 10% of the R&D investment in offshore wind (Magagna et al. 2015). These ocean energy technologies are characterized by High Capital Expenditures (CAPEX) often more important than for wind power, even if high CAPEX is general to MRE in general compared to carbon energies.

Amongst the most important barriers to ocean energy systems are technology development, delays in market formation and the grid availability and integration issue. As

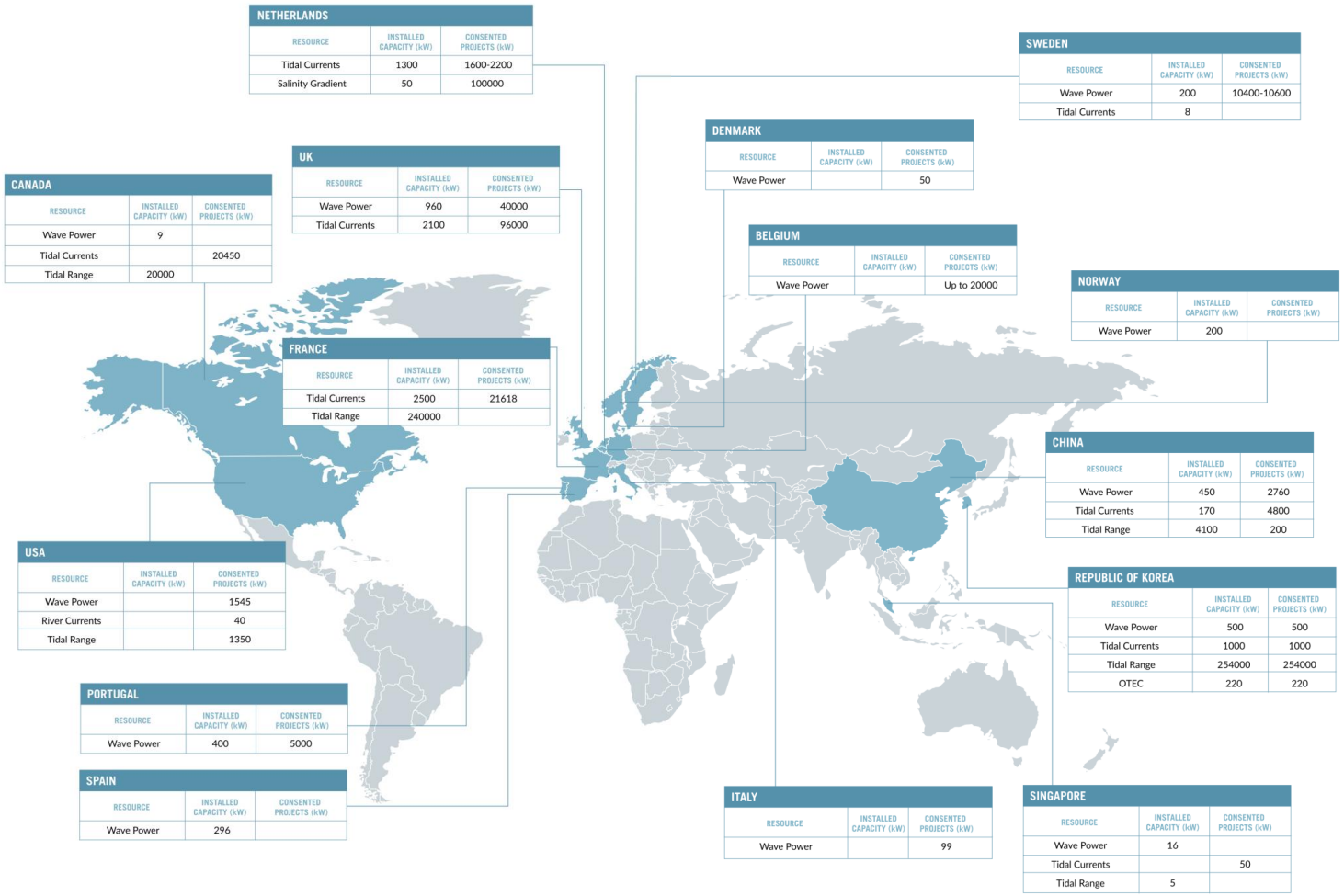
a consequence, potential investors still perceive high risk associated with projects and it often leads to projects downsize or withdraw from some technology developments.

If today Europe represents most of the MRE power, it is forecasted to count for 60% by 2020 as development are also foreseen in China, the US and Japan. In 2030, the European Union MRE capacity is forecasted to go beyond of 140 GW, that to say 50% of the expected world capacity. Fixed offshore wind power will still dominate, but emerging MRE (marine current, floating wind and wave) will significantly increase counting for 25% of the European MRE capacity, i.e. 350 GW vs. 1,100 GW for fixed wind (MERiFIC 2014).

Europe has the leadership in MRE pilot and exploitation sites. This is particular true for offshore wind power largely dominated by the EU. This also the case for R&D where 44% of the MRE related publications in the world have been released in the EU between 200 and 2010 (EC 2014). In Europe most active countries in R&D are the UK, Ireland, Denmark, Norway, Spain and Portugal, France followed by the Netherlands, Germany and Sweden. Scotland, where the European Marine Energy Centre (EMEC Ltd., a non-profit private company) is settled, has the highest potential for marine current followed by France. EMEC is focusing on wave and tidal energy converters. According to EMEC, with its 14 grid-connected test berths it deploys more marine energy converters than any other single site in the world.

Outside Europe Japan, Canada, the US, Australia and China are also active countries in R&D. Following the Fukushima event, the involvement of Japan in offshore wind power will strongly increase, rather targeting floating wind power due to average seabed depth.

Figure 2 Overview of MRE excluded offshore wind power – 2015 (IAE/OES 2016)




IEA/OES 2016

### *Preliminary prospects and trends for European MRE*

If potential is quite huge and developments important, compared to the initial deployment objectives expressed at EU and member States level, the present deployment is below the initial 2020 development targets. From 50 GW planned and expected for the world fixed offshore wind power in 2020 (about 60% in Europe), the revised objective decreased to 30 GW corresponding however to a cumulative investment of 100 billion euros. For instance in Germany the offshore wind farms capacity was about 290 MW in 2012, about one third of the 2009 stated objectives. The trend is also the same for the MRE's 2020 objectives in most of European countries: from 18 to 11.5 GW in the UK, from 6 to 2 GW in France and from 10 to 6.5 GW in Germany (MERiFIC 2014). The state of development of MRE already underlines a number of difficulties and constraints to commercial deployment. Despite the diversity of technologies and devices that have been already demonstrated, commercialization and implementation remain slow due to relatively high costs and concerns over environmental issues especially regarding marine mammals and habitats. The credibility of long term development of MRE is in a critical step to induce significant investments. If MRE will significantly contribute to power production from 2020, it will rely on present decisions in order to incept and support new and relevant MRE industries. This phasing is crucial as a too early process without mature enough or too costly technologies will lead to take unnecessary risks to investors. On the opposite a too careful or slow process will leave room to new entrants or extra European competitors.

### *Mapping the European MRE system*

The European MRE system can first mapped and described through a comprehensive and global view, underlining the succession of operations to be completed in order to settle and develop a MRE project, from site selection to operation (Figure 3). It includes the different actors, potential impacts foreseen over and between subsystems (especially regarding the ecological and human system) as well as market and distribution.



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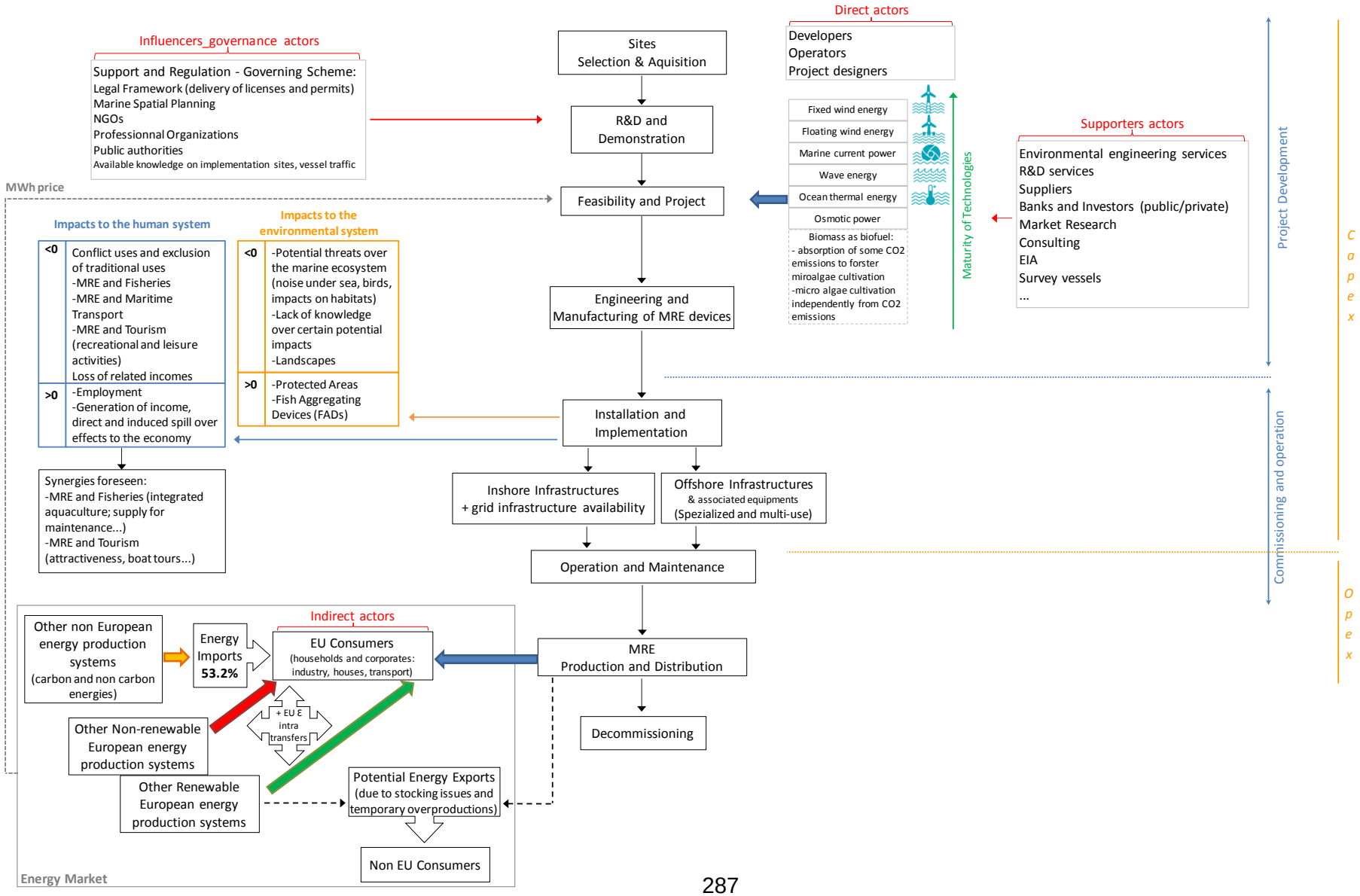
Figure 3 the European Marine Renewable Energy system



***Production and operation system***

Part of the production system was already informed when describing technologies and production.

**Actors**

Actors are mapped and grouped according to the following typology derived from Sundblad et al. (2014):

- **Direct actors**: individuals or organizations whose activities explicitly entail physical, chemical or biological disturbances of the environment.
- **Indirect actors:** individuals or organizations influencing the pressure on the environment by using products or services causing environmental disturbances (Sundblad, 2014).
- **Supporters actors**: services provided by various actors who never directly deal with the product.
- **Governance ("influencers") actors**: regulatory framework, policies, infrastructures. People, organisations and institutions responsible for setting up and managing the regulatory framework.

The MRE sector was for a long time characterized by a large number of independent SMEs and research centers (mostly universities). More recently, large power companies in Europe as well as manufacturers entered into the industry mostly pushed by the incentives derived from the EC MSP and renewable energy directives. As an emerging industry, it already exist several MRE directories. Most of them were produced as facilitator means to network either national or European actors of the industry and facilitate the development of MRE in the EU and member States.

Regarding MRE devices, Siemens is the main offshore wind turbine supplier in Europe (63.5% of total installed capacity in 2015), followed by MHI Vestas (18.5%), Senvion (7.4%), Adwen (5.7%) and BARD (3.6%). For the year 2015 and in terms of developers and owners, E.ON is the largest developer in the European offshore sector with 17.1% of total connections (EWEA 2016). The top five developers is completed with RWE Innogy, EnBW, Stadtwerke München and DONG Energy. But regarding the total installed capacity

DONG Energy remains the leader company (15.6%) followed by E.ON (9.6%) and Vattenfall (8.9%). The top five of European developers and owners counts for 44.3% of the total installed capacity. Regarding substructures, the most important companies in 2015 are EEW,Sif, Baldt and Smulders.

Main activities for each phase of a lifecycle of an MRE Park (Wilhelmsson et al., 2010)

| Project life cycle | Planning | Construction | Operation & Maintenance | Dismantlement |
|---|---|---|---|---|
| **Principals Activities** | – Site selection<br>– Machine design (gear type, anchor)<br>– Licenses and permits<br>– Implementation of appropriate mitigation measures | – Site preparation, dredging and leveling<br>– Installations of foundations/ piles<br>– Cabling<br>– Maritime Traffic<br>– Transport (Air) | – Repairs<br>– Painting and sandblasting<br>– Change Oil in transformer substations | – Dismantle<br>– Maritime Traffic |
| **Disturbance Factors** | | – Noise<br>– Disturbance of ground<br>– Increased activity | – Physical presence of machinery<br>– Noise<br>– Maintenance<br>– Electromagnetic fields | – Noise<br>– Disturbance of ground |

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