UNIVERSITY OF TARTU
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1632

FPCUP ACTION 2021-2-33:

COPERNICUS FOR MARINE SPATIAL PLANNING AND EU DIRECTIVES

1st Reporting Process//SGA#20/WP21

Country report for Estonia

- Task 1. Review of the official implementation of EU marine Directives
- Task 2. Data gaps analysis in the implementation of EU Directives
- Task 3. Identification on how to use Copernicus Data in the implementation of EU

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BACKGROUND

Marine sectors face several challenges regarding management and sustainability. It is becoming evident that these challenges are even more noticeable during the implementation of specific policies and strategies, particularly those related to marine data and information availability in the context of certain European Directives.

The Copernicus program is dedicated to deliver global data in a reliable and sustainable way. Numerous nations encounter difficulties in ensuring sustainable growth in specific industries, and the Framework Partnership Agreement for Copernicus User Uptake (FPCUP) focuses on harnessing Copernicus data for different maritime sectors within the framework of some EU Directives implementation.

The FPCUP aims at a better integration of Copernicus data in the European regulatory framework by increasing the number of users and applications derived from Copernicus through different actions. This report relates to Action 2021-2-33: *Copernicus for Marine Spatial Planning and EU Directives* that pursues "to promote the use of Copernicus data in the implementation of the EU Marine Spatial Planning Directive (Directive 2014/89/EU; MSP) and EU Marine Strategy Framework Directive (Directive 2008/56/EC; MSFD), while contributing to the standardization of methodologies in the implementation process".

This objective will be achieved through 3 specific objectives:

1. To examine the implementation of EU Directives by Member States using as pilot sites Spain, Portugal, Estonia, Cyprus, and France, and to identify data gaps.
2. To analyse how Copernicus satellite data products can improve those data gaps.
3. To use Copernicus data services in the implementation of EU marine Directives.

To address these objectives within Action 2021-2-33, the following duties should be carried out:

- In **Task 1** (*Review of the official implementation of EU marine Directives*) is dedicated to carry out a review of the application of the two EU marine Directives in each country.
- **Task 2** (*Data gaps in the implementation of EU marine Directives*) is dedicated to identify data gaps and needs within the maritime sectors that are actively engaged in the implementation of the EU marine Directives mentioned earlier.
- In **Task 3** (*Identification on how to use Copernicus Data in the implementation of EU marine Directives*) the requirements of the Marine

Directives and the data gaps detected in Task 2 will be contrasted with the benefits and opportunities offered by Copernicus data services. As a final result, a jointly standardized set of protocols leading to the implementation of improved methodologies for use in national reporting will be compiled.

- In **Task 4** (*Copernicus data to generate high spatial information for the implementation process*) Copernicus spatial data will be analysed and processed to generate spatial maps related to specific maritime activities and uses required by the national authorities and stakeholders.

TASK 1. REVIEW OF THE OFFICIAL IMPLEMENTATION OF EU MARINE DIRECTIVES

1. Introduction to Task 1

The Baltic Sea is a brackish inland sea bordered by eight EU Member States and Russia. It consists of the Baltic Sea proper and three large gulfs (i.e., Gulf of Bothnia, Gulf of Finland and Gulf of Riga) and is connected to the North Sea through the Kattegat and the Danish Straits (Szymczycha et al. 2019).

On June 17, 2008, the European Parliament and the Council adopted Directive 2008/56/EC, which establishes an action framework for the Community's marine environmental policy (Marine Strategy Framework Directive; hereinafter MSRD). This document was amended by the Commission Directive (EL) 2017/845. The member states of the European Union are obliged to to implement the necessary measures to achieve good environmental status of the marine environment according to MSFD (Marine Strategy Framework Directive), whereas criteria and methodological standards on good environmental status of marine waters and specifications and standardised methods for monitoring and assessment were described in Commission Decision (EU) 2017/848. The MSRD (Article 1(2)) obliges each Member State to develop and implement a marine strategy in its marine area, based on an ecosystem-based approach, which aims to:

a) protect and preserve the marine environment, prevent its deterioration or, if possible, restore marine ecosystems in areas where they have been damaged;
b) prevent and reduce discharges into the marine environment in order to gradually eliminate pollution, with the aim of ensuring that it does not significantly affect or threaten the diversity of marine life, marine ecosystems, human health or the legitimate uses of the sea.

Member States are required to follow a common approach which involves in reiterative six-year cycles assessing the current state of the marine environment (MSFD 2008) via:

- determining good environmental status,
- establishing environmental targets to guide progress towards achieving good environmental status,
- establishing monitoring programmes for ongoing assessment and regular updating of targets,
- developing programmes of measures to achieve or maintain good environmental status.

For this a national marine strategy in accordance with the MSFD requirements was developed, consisting of a monitoring program and a program of measures for the Estonian marine waters. In Estonia in marine areas following activities are taking place (Eesti mereala, 2019):

- Identification of the present status of the environment, whereas assessment includes ecosystem elements, structure, functioning and processes,
- analysis of pressures and impacts, including human activities,
- an economic and social analysis of the costs associated with the use of the marine area and the deterioration of the marine environment, which addresses pressures from human activities, use of the sea and the areas of human activity at sea that affect the state of the marine environment.

State monitoring program follows closely the needs stated in MSFD (2008), monitoring physico-chemical parameters in water, sediments, biota, biological parameters (plankton, benthic organisms, macrophytes, fish, seals, birds), macro-litter in water, coastal area, marine bottom and micro-litter together with micro-plastic in biota, sediments and water; dangerous substances in biota, sediments, water. Quality parameters of Estonian marine areas are assessed periodically to determine, whether the proxies are met or not and how effective are the measures undertakes for reaching to a good status.

2. Description of the Estonian marine area

2.1 Territorial division

Baltic Sea area under Estonian jurisdiction (36.622 km^2) is divided into 3 categories (Figure 2-1):

1. **Internal waters** (coastal water area): area, which is between territorial sea baseline and coast. Territorial sea baseline is an imaginary line, which connects with straight lines the farthest points from the coast of land, islands, shoals, rocks and single rocks protruding out of the water (approximately 14.487 km^2).
2. **Territorial sea**: part of the sea area, which the sea area adjacent to the internal waters, which width is from the baseline of the territorial sea up to 12 nautical miles outwards and the average water depth is 30 m (app. 10.714 km^2);

3. **Economical territory**: situates outside of the territorial sea, adjacent to this, with borders determined according to legal agreements between Estonian Republic and neighbour countries, with average depth around 80 m (app. 11.421 km^2).

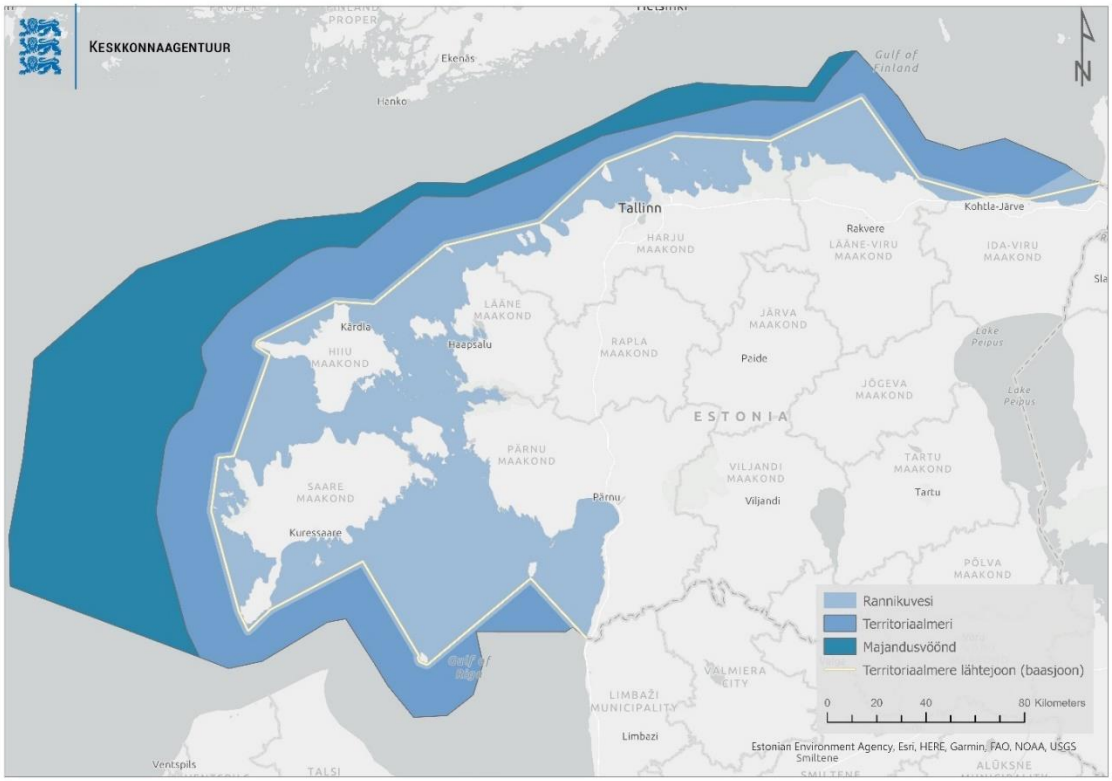

Figure 2-1. Categories of the sea area under Estonian jurisdiction (light blue – coastal waters, Yellow line – baseline for territorial sea, blue- territorial sea, dark blue – economical region). Source: Estonian Environmental Agency, 2018 acquired 14.03.23 from https://keskkonnaportaal.ee/et/teemad/vesi/meri)

Member States' official MSFD reporting is done by using marine reporting units (MRU) The MSFD marine reporting units (MRUs) are of varying size and follow the sub-regional approach in the MSFD and the sub-divisions used by the Regional Seas Conventions (Andersen et al, 2021).

2.2 Categorization of marine and coastal areas

Estonian coastal water area is divided into 16 coastal water bodies surrounded by 4 Baltic Sea sub-basins (Table 1). In this table Gulf of Finland is not divided, but from 2023 onwards the Gulf of Finland is divided into eastern and western part. Coastal water areas were divided into 6 types (Table 2) according to specific natural features according to the regulation 19. by the Minister of the Environment 16.04.2020 (RT 2020).

Code	Coastal category subtype	Name	Category
EE_1	1	Narva-Kunda bay	Coastal
EE_2	1	Eru-Käsmu bay	Coastal
EE_3	3	Hara and Kolga bay	Coastal
EE_5	3	Muuga-Tallinna-Kakumäe bay	Coastal
EE_6	3	Pakri bay	Coastal
EE_7	4	Hiiu Shallow area	Coastal
EE_8	5	Haapsalu bay	Coastal
EE_9	5	Matsalu bay	Coastal
EE_10	4	Soela Strait	Coastal
EE_11	4	Kihelkonna bay	Coastal
EE_13	2	Pärnu bay	Coastal
EE_14	5	Kassari-Õunaku bay	Coastal
EE_16	5	Väinameri	Coastal
EE_17	6	Northwestern part of Liivi bay	Coastal
EE_18	6	Northeastern part of Liivi bay	Coastal
EE_19	6	Central basin of Liivi bay	Coastal
EGB		Eastern Gotland Basin	HELCOM marine area
GOF		Gulf of Finland	HELCOM marine area
GOR		Gulf of Riga	HELCOM marine area
NBP		Northern Baltic Proper	HELCOM marine area

Table 1. Division of Estonian coastal water bodies and HELCOM marine areas.

2.3 Short description of the coastal bays

Description of the bays is taken from the report, submitted 28.02.23 to Estonian Environmental Agency (Kangro et al., 2023). Narva Bay is highly influenced by currents and waves due to its openness, ensuring high water exchange rate. Salinity varies 3-5.5 PSU and depends partly of river inflows, which are also the source of pollution. Eru-Käsmu Bay is also in hydrologically active area, but the effect of human activities and freshwater inflow is rather negligible. In type 3

there are Hara-Kolga, Muuga-Tallinna-Kakumäe and Pakri bays, representing both half-enclosed bays and deeper marine areas, which are open the waves and currents. Area in the east of Tallinn may be influenced by less saline and nutrient-rich water of open Gulf of Finland. Main polluters are Tallinn city (Estonian capital city) and intensive marine traffic. The salinity varies in surface layer between 5-7 PSU.

Type 4 represents the type of the Western islands in Western Estonia, with salinity 6-7 PSU. Majority of those waterbodies are open, and influenced by the open waters of Northern Baltic Proper. Only the area south of Vilsandi bay consists of relatively closed bays.

Väinamere coastal area type 5 includes waterbodies of Haapsalu, Matsalu, Väinameri and Kassari-Õunaku. Haapsalu bay is shallow and with salinity gradient from 2 to 7 PSU due to freshwater inflow. It is influenced also by wastewaters of the Haapsalu City, causing high nutrient concentrations due to low water exchange rate. Matsalu bay is the typical estuary, with nearly freshwter in the river inflow and brackish water in the outlet of the bay (5-6 PSU). Väinameri is the location of active transportation of the water masses to Southern or Northern direction depending on the wind direction. This has an effect to hydro-chemical parameters, since the Southern part of Väinameri is connected to Liivi bay, which is less saline and with higher nutrient loads. Average salinity is in the range of 5.5-6.5 PSU.

Coastal water body type of Liivi bay was divided 3 (north-eastern, north-western and central part) during 2019 (Martin, 2022). Liivi bay is generally closed to waters form Northern Baltic Proper. Salinity varies between 4-6 PSU; depth is more than 10 meters without permanent vertical stratification. Liivi Bay gets nutrient inflow from Daugava river, leading to higher nutrient amounts in comparison with other Baltic Sea subbasins surrounding Estonia.

Lahe Pärnu has its own type. Pärnu Bay is shallow, with lots of loose sediments mixed into water due to storms and stronger wind surges, decreasing transparency. This bay is highly influenced by the nutrient inflow from Pärnu City and Pärnu River.

Type	Code of the area	Water type properties
Rv1	EE_1, EE_2	Oligohaline, open coastal waterbody
Rv2	EE_13	Oligohaline, half-closed coastal waterbody
Rv3	EE_3, EE_5, EE_6,	Mesohaline, deep coastal waterbody
Rv4	EE_7, EE_10, EE_11	Mesohaline, shallow coastal waterbody, open to the waves
Rv5	EE_8, EE_9, EE_14, EE_16	Mesohaline, shallow coastal waterbody, covered from direct waves, mixed
Rv6	EE_17, EE_18, EE_19	Mesohaline, shallow, covered from direct waves, seasonally stratified coastal waterbody

Table 2. Subtypes of the coastal area are divided by salinity, openness, depth and mixing properties.

2.4 The main environmental problems and pressures in Estonian marine area

The main problems in the Baltic Sea marine environment are **eutrophication** and the **pollution by various contaminants**. Estonia is not an exception. List of the main problems in Estonian sea area and main pressures causing them and related human activities are (Eesti mereala 2019):

- **Eutrophication.** Excessive input of nutrients (nitrogen and phosphorous), both from point sources or diffuse pollution. Nutrients enter mainly from land via rivers, but also from human activities near the coastal area and nitrogen also via air; human activities include agriculture, transport, industry, waste treatment;
- **Hazardous substances.** Mainly coming from land via rivers (locally also direct inputs) and atmospheric deposition; from industry, transport, everyday life, the risk of marine pollution (i.e., oils, motor fuel) from shipping;
- **Non-indigenous species.** Mainly from shipping via ballast water;
- **Habitat's disturbance and loss.** Mainly the construction and use of transport and other infrastructure (development of ports, mining, dredging and dumping, offshore facilities);
- **Marine litter**. Mainly from land via rivers, rainwater, waste water, but also recreation, shipping, fishing;
- **Underwater noise**. Mainly shipping, infrastructure construction.
- **Extraction of living resources**. Fishing for living resources directly affects marine life by disrupting their population structure and natural reproductive capacity:
    - Fishing. The most economically important species for Estonia are herring, perch, whiting, cuttlefish, flounder, pike, roach, grayling, and pike. Fishing reduces the number of species caught, the use of certain fishing gear, such as bottom trawls, damages the seabed biota. Fishing can result in the bycatch and death of unwanted fish species, marine animals and birds.
    - Collecting sea bed vegetation. In addition to fishing, marine vegetation, primarily red algae, are collected in the Estonian sea area, which are used in the food and pharmaceutical industries.

- **Growing of living resources**
    - **Aquaculture.** Growing fish, shellfish, aquatic vegetation, using technologies allowing to grow in bigger quantities than natural

environment conditions allow, i.e., a fish farm can be a significant burden of nutrients and antibiotics.

- **Marine transportation** via polluting air with various contaminants, noise, pollution to the sea, and potential oil spill hazard, which can affect marine biota
    - **Ports**. For operating ships is necessary of construction of ports, dredging of waterways and water areas. With these activities, mining of construction materials for the use of port facilities, emission of pollutants into the air by burning fuels and their deposition in the marine environment, as well as noise and ship traffic accompanying construction works.
    - **Ship building**. Generally, takes place in land, but still might cause pollution and waste water reaching to sea.

- **Digging of natural resources** (sand, medicinal mud). In Estonia the sand is excavated for construction purposes. Medicinal mud is used in medicine, spa procedures and cosmetics production.
- **Energy production.** There are numerous cable lines in the Estonian sea area - both electric and communication cables. The construction and operation of marine infrastructure increase the pressure on the marine environment. Above-water cables cause death of migratory birds. Wind farms can affect the movement and feeding areas of birds and mammals.
- **National defense activities in the sea.** The main goal of the Estonian Navy is the protection of Estonian territorial waters and mine countermeasures, using the sea as a practice area for manoeuvres and shooting exercises. The national defense use of the sea is accompanied by activities such as the noise of the shots and explosions of mines and munitions, the shock wave of explosions, and the release of chemicals from the operation of munitions into seawater, which exert pressure on marine life.
- **Tourism and recreation.** Causing noise, pollution and effect to the natural environment by disturbing animals and birds

Estonian economy is highly dependent on maritime activities, since around 60% of import and export involves marine transportation (merenduspoliitika_2011_2020_eelnou). This represents an ongoing challenge to use the maximal potential of marine resources together with conservation and preservation activities for unique marine habitats.

3. Marine Strategy Framework Directive (Directive 2008/56/EC) in Estonia

3.1 Overview of the marine monitoring program

3.1.1 Background

Estonian marine monitoring program is covering the data gathering about 11 qualitative characteristics and human activities, which affect the marine environment, based on the requirements stated by MSFD (2008/56/EC).

3.1.2 Qualitative descriptors of good environmental status according to the EU Marine Strategy Framework Directive (HELCOM 2013)

D1 – Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.

D2 – Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems

D3 - Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock

D4 - All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity.

D5 - Human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters

D6 - Sea-floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.

D7 - Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems.

D8 - Concentrations of contaminants are at levels not giving rise to pollution effects.

D9 - Contaminants in fish and other seafood for human consumption do not exceed levels established by European Union legislation or other relevant standards.

D10 - Properties and quantities of marine litter do not cause harm to the coastal and marine environment

D11 - Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.

For every characteristic is formulated the monitoring strategy, except for D1, where monitoring strategies are formulated for major species groups and habitat types - birds, mammals, fish, and pelagic habitats, whereas cephalopods and reptiles are not included (Seletuskiri). Overview and comments about monitoring subprograms are presented in table 2, in Seletuskiri.

In general, the majority of monitoring actions (present environmental goals and assessment of the effectiveness of methods) in monitoring strategies were already compatible with MSFD requirements during 2014, and during period 2018-2020 majority of monitoring performed in Estonia was according to MSFD requirements. The indicators for hydro-morphological changes in coastline, marine litter and underwater noise are still under development.

3.1.3 Relations with other directives

There are several directives and regulations for governing the protection of marine life and environment, stating the need for improvement of the environmental status besides MSFD, which are accounted for in Estonian marine monitoring:

- Directive by EC 2000/60/EÜ - water framework directive (WFD) the purpose of which is to achieve a good condition of all surface waters, including coastal waters
- Directive by EC 2008/105/EÜ, changed with the directive 2013/39/EL (directive of environmental standards), stating the limits of environmental quality for the protection of water environment;
- Directive by EC 92/43/EMÜ (nature directive), for the protection of species and their habitats (including marine environment)
- Directive by EC 79/409/EMÜ (bird directive), within which bird monitoring is carried out on the basis of the wildlife monitoring sub-program and which provides for the protection, management and monitoring of naturally occurring bird species (including seabirds);
- European Parliament and Commission regulation from October, 22th, 2014. no. 1143/2014 about prevention and control of introduction and spread of non-indigenous species, who are potentially affecting natural balance, which obliges member states to assess the presence and spread of non-indigenous species that threaten the natural balance and to detect non-indigenous species early (including in the sea)
- Different regulations for fisheries data collection, gathering and use together with the use of fish supply (1004/2017, 40/2013, 39/2013 etc.).

3.2 Overview of the Estonian monitoring program

Marine monitoring is carried out within the framework of the national environmental monitoring program (Figure 3-1). Besides water also the coastal area is monitored for the effect of natural and human-induced processes (depletion and accumulation) and collected data are used to forecast the development of the coast. In addition, marine monitoring data provides an input for planning and evaluating the effectiveness of environmental protection measures. Overview from Mereseire allprogramm (2019):

1) Monitoring in coastal waters

- Data from monitoring the ecological state of the coastal sea are the basis for assessing the state of coastal water bodies, necessary for monitoring ongoing processes and changes. Monitoring is conditionally divided into permanent and overview monitoring, which means that the monitoring network consists of permanent monitoring stations (including permanent transects of benthic communities), which are monitored every year, and review monitoring stations (including transects of benthic communities), which are monitored at least once every 6 years.
- The purpose of alien species monitoring is to identify the presence of possible new invasive alien species and to clarify the abundance and distribution of already existing alien species and to assess their ecological impact. Monitoring of alien species is carried out at permanent monitoring stations, in addition to which the round goby, the Chinese mitten crab and the Harris mud crab, and wharf-side life of Muuga harbor are monitored.

2) Monitoring of the open sea area.

- The state of the Baltic Sea marine environment in Estonian territorial sea and economic zone is assessed based on the data collected as part of the monitoring of the open sea. The variability of the physico-chemical and hydrobiological indicators are evaluated in relation to natural or human-induced dynamics, and the influence of the open sea on the state of Estonian coastal water bodies is also explained.
- Ferrybox monitoring collects the same data as offshore seasonal monitoring, but with a significantly closer time step using automatic measurement and sample collection devices (Ferrybox) installed on regular passenger ships. Measurements are carried out in the central and western part of the Gulf of Finland and in the northern part of the Baltic Sea on the shipping lines Tallinn-Helsinki and Tallinn-Stockholm.

3) The monitoring of hazardous substances in the marine environment in the coastal sea and open sea provides an overview of the chemical status, pollution loads, long-term changes and spatial distribution of the Baltic Sea, including Estonian coastal **water** bodies and territorial waters. During the overview monitoring of the chemical state of coastal water bodies and specific pollutants, the content of hazardous substances in water, sediment and living organisms is determined.

4) **Remote sensing** methods are used for mapping Chlorophyll a and transparency, allowing to characterize long term dynamics. Information about physical parameters i.e., water temperature and ice cover initiation and **movement** can be given. Information about vegetation coverage, in-depth distribution and composition for the shallow sea bed can also be given, but the algorithm development for retrieving all those components is still an ongoing process.

5) Monitoring of **hydro-morphological changes** of the coastal waters **and** coastline.

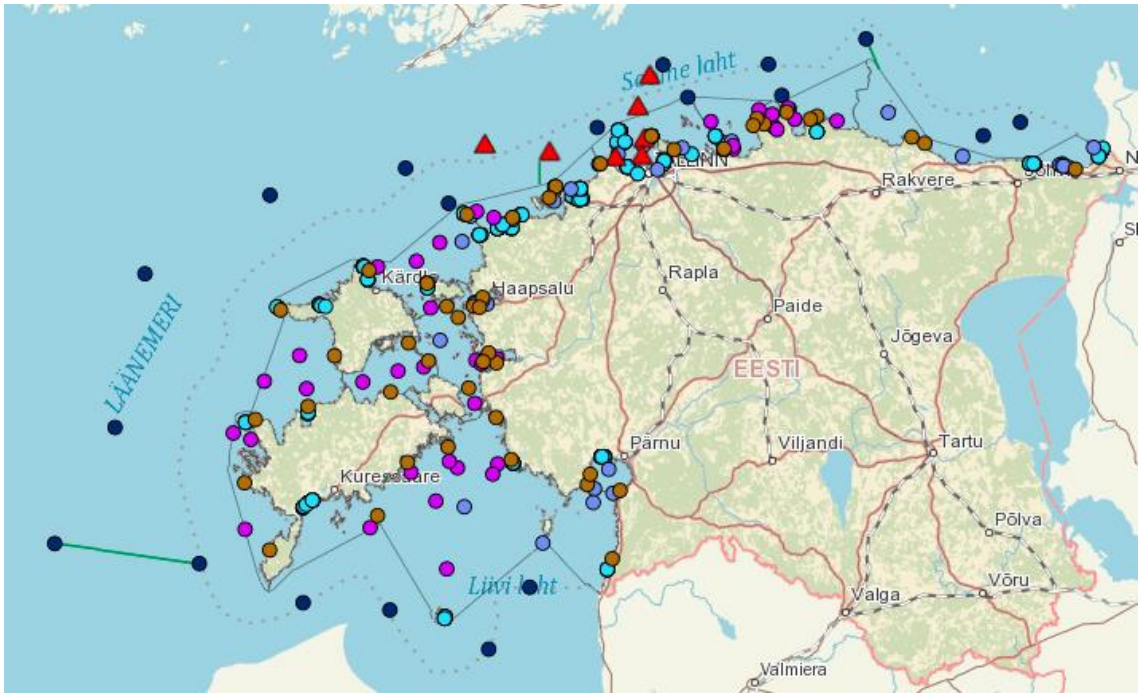

Figure 3-1. Monitoring stations around Estonia: red triangles – Ferrybox stations; green transect monitoring transect for benthic communities, brown dots – sea-bed vegetation monitoring transects, light blue dots- monitoring places in coastline, dark blue dots – monitoring stations in the open sea area, blue dots- permanent monitoring stations in coastal waters; purple dots- overview monitoring of coastal waters (1x per 6 years). Dotted line shows the border of the territorial sea. (Estonian Environmental Agency (2023). Source: https://storymaps.arcgis.com/stories/2fc7f74485ca45858dabd933ffc6443e)

Monitoring frequencies, locations and parameters of the monitoring of Estonian coastal area, open water area, chemical substances and non-native species are listed in tables in Mereseire program (2019b), Lisa 1-5. Overview of the used methods and methodologies is given in section 3.2.1 in Mereseire program (2019). Quantitative thresholds for D1C3.1, D4C1.1, D4C2.2, D4C3.1 and D4C3.2 were developed in the frames of the project "Development of thresholds for assessment of the status of Estonian marine area ". Collected data allows to:

1) estimate ecological status of coastal water bodies on the basis of the condition classes given in the Regulation No. 44 of the Minister of the Environment on July 28th, 2009 "The procedure for the formation of surface water bodies and the list of those surface water bodies whose condition class must be determined, the condition classes of surface water bodies and the values of the quality indicators corresponding to the condition classes and the procedure for determining the condition classes",
2) estimate the status of Estonian marine area and the entire Baltic Sea according to requirements from MSFD and HELCOM.

Some examples regarding monitoring program in Estonia

Examples about parameters measured during monitoring of coastal waters

- In the frames of the overview monitoring **physical-chemical parameters** total nitrogen, total phosphorous, conductivity, temperature, salinity, dissolved oxygen content, pH, and transparency are recorded 6 times per year once in six years.
- In the frames of pelagic habitat permanent monitoring these parameters and additionally NO_2^-+NO_3^-, NH_4^+, PO_4^{3-} and SiO_4 are monitored 10 times per vegetation period.
- **Phytoplankton** is monitored by Chlorophyll a concentration (mg/m^3), abundance per species or taxa (units per litre), biomass per species or taxa (wet weight mg/m^3).
- **Zooplankton** abundance per species or taxa (individuals per m^3), biomass per species or taxa (wet weight mg/m^3).
- **Zoobenthos** is monitored 1 per year, abundance per species or taxa (individuals /m2), biomass (dry weight g/m2) and the content of organic matter in bottom sediments (% of dry weight) are recorded.
- Benthic community (see table 3), additionally nutrients (N and P), water density, photosynthetically active radiation and water temperature as supporting physico-chemical variables are registered.

Parameter	Unit	Minimal frequency per year	Timing	Measuring technique	Base for the monitoring needs
Vegetation coverage by species/taxa	%	1	July-September	Observations and gathering of the material from the transect at an angle of 90° to the shoreline, quantitative samples with 20x20 cm frames	WFD: species composition and abundance of other in-water plants, species composition and abundance invertebrates and benthic animals MSFD: good environmental status criteria D5C1, D5C4, D5C5, D5C6, D5C7, D6C5, and indicators characterizing the corresponding environmental targets
Vegetation biomass by species/taxa	Dry weight g/m^2	1	July-September		
Vegetation coverage	%	1	July-September		
Abundance of macroinvertebrates by species/taxa	individuals/m^2	1	July-September		
Biomass of macroinvertebrates by species/taxa	Dry weight g/m^2	1	July-September		
Coverage of macroinvertebrates by species/taxa	%	1	July-September		

Table 3. Parameters, units, monitoring frequency, timing and measurement technique for benthic community monitoring

An example of monitoring activities in 2022 (Martin, 2022).

Permanent monitoring was done in 3 coastal waterbodies (Muuga-Tallinna-Kakumäe, Narva-Kunda ja Pärnu bay). In each water body is 3 stations for measuring pelagic parameters, 3-4 stations for zoobenthos gathering and 3 areas for sea-bed vegetation mapping. Videotransect was made for detection of benthic communities in Pärnu bay. Long-term monitoring points are monitored each year (in Liivi Bay), 3 benthic communities are monitored (Eru, Küdema, Pasilaid) and zoobenthos was collected from 6 points. Non-native species were monitored from Muuga and Sillamäe ports, for non-native species in benthos were studied additionally from background monitoring areas in Tallinn bay and Narva-Jõesuu. Round goby and Chinese mitten crab were monitored in the Muuga bay and the Harris mud crab from Pärnu and Muuga Bays.

Overview monitoring was performed in north-eastern and north-western Liivi bay areas, where situate 3 stations for pelagic parameters and benthic biota and 3 areas for monitoring of the benthic vegetation.

Highlights of selected parameters

a) Marine litter (Kaldma, 2022): 80% of litter found in marine areas originates from land. The main sources are sewage system of settlements, garbage disposal places, industrial waste and garbage dropped to coastal area, also abandoned or storm-affected fishing gear.

   In Estonia the first pilot projects to monitor micro-plastic started on 2016 and continue with investigations of the biological influence on organisms. Studies of macro-litter started earlier – 2014. Estonian beaches are in the 5th place in Europe, 43 items were found for 100 m beach, which is twice that much as "good" condition requires.

   Microplastic content in the water column varies a lot. The highest amount of marine micro litter was found in the surface of Gulf of Finland (0.13-0.53 particles/m², with microplastic 0.09-0.13 particles/m²), and the lowest amount was found form Liivi Bay (micro-litter 0.06-0.29 particles /m², with microplastic 0.03-0.1 particles /m^2).

b) Seals (https://keskkonnaagentuur.ee/uudised/eesti-vetes-loendati-tanavu-rekordarv-hallhulgeid). In 2022, a record 6,031 gray seals were counted in the coastal sea of Estonia. This is the highest result since 1999, when gray seals were monitored on the basis of the same methodology in all Baltic Sea countries. The increase in numbers was detected primarily in the northern part of Hiiumaa (Selgrahu region and Hari kurk) and in western Saaremaa, but also in the monitoring areas of Gulf of Finland.

3.3 Status assessment

The environmental indicators involved in the MSFD are binomial; good environmental status is either reached or not. The boundary value between these two classes defines the environmental target value to which current status is compared, and "one out-all out" principle is considered. The assessment is given by aggregating the indicators (i.e., as Figure 3-2 shows for eutrophication).

For majority of indicators the equal weight is given, but in Estonia nutrient assessment in Liivi bay is an exception, where total phosphorous and phosphates are with heavier weight. The same goes with assessment of direct indicators, where *Chl a* and phytoplankton biomass have heavier weight than Secchi disc transparency (Eesti mereala 2019).

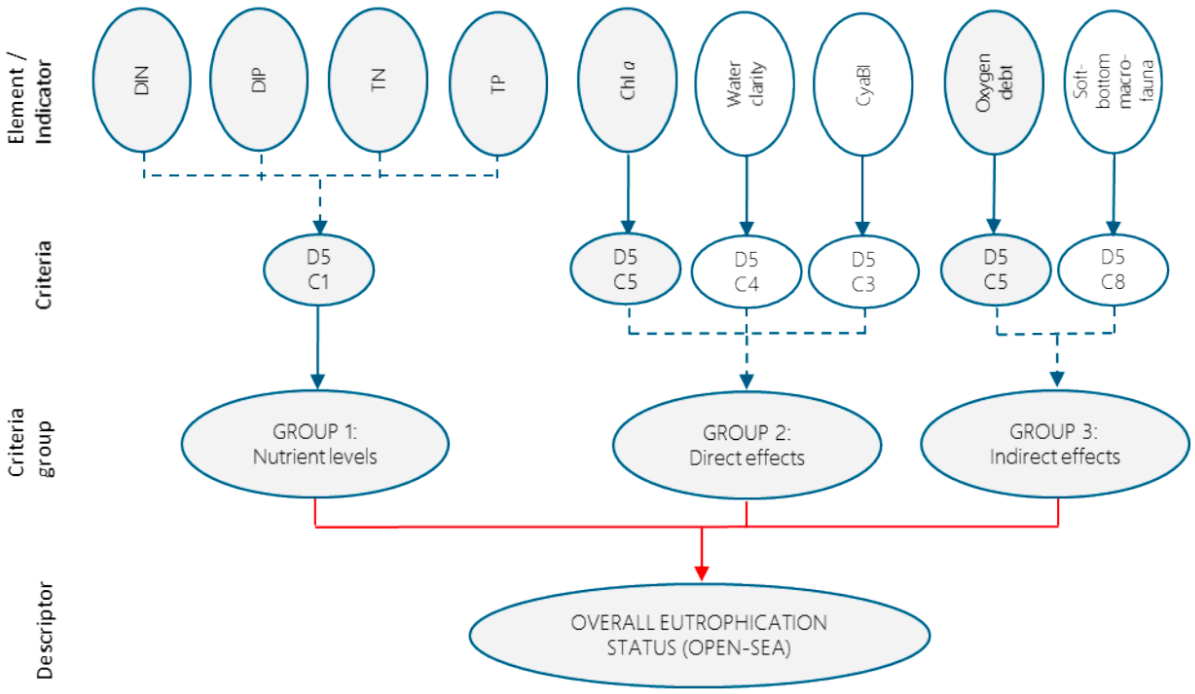

Figure 3-2. Structure of the eutrophication assessment for open-sea areas (HELCOM 2017). Primary elements (indictors) associated with primary criteria are shaded grey, whereas the secondary criteria and their elements (indicators) have no shading. Dashed blue lines indicate a process of weighted averages and solid red line indicates where a One-Out-All-Out process is adopted.

In Estonia the data integration is done by using an application MEREK (http://www.sea.ee/merek/). This allows to integrate different indicators into one assessment, combining values of different indicators between 0 to 1 scale, using minimum and maximum values and the limit of good ecological status. Normalized indicator value is an index of environmental status, whereas **0.6 is the threshold for good ecological status**.

Documentation about 18 indicators is given in Martin & Torn (2018). Biological diversity assessment was performed based on 10 indicators, ecosystems and food webs based on 5 and sea-bed habitats based on 3 indicators. Good ecological quality was achieved in ecosystem components assessment section for birds, benthic habitats and seals; whereas Fish and pelagic did not pass threshold. In section Biological diversity (D1) only D1C4 was above the threshold. D4-ecosystems and food webs – all indicators stayed below the threshold. Criteria for sea-bed habitats was over the threshold, the indicators for assessment of sea-bed integrity are under development. Due to lack of data and sufficient cooperation with neighbouring countries indicator development was not suggested for D1C1 all ecosystem components, criteria D1C2 and D1C4 for fishes and criterion D1C5 based on seals.

3.4 Marine strategy and programme of measures

3.4.1 Introduction

Marine strategy (MS) is basically an action plan for fulfilling MSFD requirements, updated after every 6 years (Protokoll, 2011). In Estonia the requirement to compile marine strategy's programme of measures is established in the Water Act (§ 349) and in the national development plan „Estonian maritime policy 2012-2020", adopted by the Government in 2012. The composed programme of measures covers the whole Estonian marine area, including internal waters, territorial sea and exclusive economic zone. Programme of measures was compiled by a consortium consisting of experts in the fields of marine environment and social-economic analysis (SEI Tallinn, TUT Marine Systems Institute and Institute of Economics, UT Estonian Marine Institute) together with Estonian Fund for Nature, Environmental Agency, Police and Border Guard Board, Estonian Maritime Administration, Geological Survey of Estonia, Estonian Environmental Research Centre, Environmental Board, and Environmental Inspectorate. Governmental institutions included Estonian Ministry of Environment, Ministry of Rural Affairs, Ministry of Economic Affairs and Communications, Ministry of Finance, and Ministry of Interior (Lips 2019). Overview of actions for these measures is brought in Nurmik (2019) (Table 4). These measures are necessary to achieve specified environmental targets for the year listed in the action plan, although it is obvious that at least for the eutrophication and for dangerous substances in the Estonian sea area it is not possible to achieve a good status, mainly due to limited water exchange through Danish Straits. Specialized research is planned to continue, to specify the sources, spreading and biogeochemical processes leading to leaching out of the dangerous substances from sediments (Lips 2019).

No	Code	Title of a measure	GES descriptor
22	BALEE-M001	Developing a network of MPAs in the Estonian EEZ	D1, D4, D6
23	BALEE-M003	Increasing knowledge on non-indigenous species to control their spread	D2
24	BALEE-M004	Ratification and implementation of the International Convention for the Control and Management of Ships Ballast Water and Sediments (BWMC), and participating in the regional information system	D2
25	BALEE-M005	Developing regional fishing restrictions and updating the size limits of commercial fish	D1, D3, D4
26	BALEE-M006	Supporting the marketing/the use of limited value fish	D2, D3
27	BALEE-M007	Adjusting the fishing effort not to compromise achieving GES	D3
28	BALEE-M009	Creating the readiness to use liquefied natural gas (LNG) as ship fuel	D5
29	BALEE-M010	Management of direct discharges of stormwater to minimise the load of nutrients, contaminants and litter	D5, D8, D9, D10
30	BALEE-M012	Managing environmental risks accompanying bunkering at sea	D8, D9
31	BALEE-M013	Pilot study analysing the organisation of marine litter reception, including abandoned fishing gear, in ports and preparing an action plan	D10
32	BALEE-M015	Addressing the topic of marine litter in the National Waste Management Plan and in the waste management plans of local authorities in the coastal area	D10
33	BALEE-M016	Developing a registry of impulsive sounds	D11

Table 4. Estonian Marine Strategy Action Plan measures for the period 2016-2022, still ongoing and continuing.

3.4.2 Implementation

Actions for implementation of all these measures have started. The interim report on the implementation of the Estonian MS action plan was prepared in 2019 (Eesti mereala 2019). According to this document of the new measures established by the Estonian Maritime Strategy Action Plan approved in 2017 only two measures were implemented by October 2019: measure No. 8 – notification of fishing data implementation of the electronic system and measure No. 14 – notification of the problem of marine litter. According to this document, measure No. 4 (International Ratification of the Ballast Water Convention and participation in the regional information system) will be implemented by the planned deadline. There are delays in the implementation of the remaining 13 measures, the main reasons for delays are: lack of data or knowledge and lack or renewal of national implementation tools (Keskkonnaministeerium 2020).

A list of new measures for the period 2022-2027 has been compiled (Table 5). The technical feasibility, cost and efficiency of the measures to achieve environmental targets and good environmental status, as well as the sufficiency of the measures, was analysed. The analysis has been carried out for nine marine strategy descriptors – D1&D4 Biodiversity and food webs; D2 Non-indigenous species; D3 Fisheries; D5 Eutrophication; D6 Seabed integrity; D7 Hydrographic changes; D8&D9 Hazardous substances; D10 Marine litter; D11 Underwater noise.

An analysis of the socio-economic impact of the measures and a strategic environmental impact assessment have been carried out. If, as a result of the sufficiency analysis, the conclusion has been reached that the environmental targets or the good environmental status of the marine area cannot be achieved by 2030, corresponding exceptions are justified. Exceptions in terms of non-achievement of good environmental status and/or environmental targets are suggested in the areas of eutrophication, hazardous substances and biodiversity (in terms of the abundance and distribution of ringed seals) due to the natural characteristics of the Baltic Sea (enclosed sea area, long residence time) and climate change (reduction of ice cover).To fill in the gaps of knowledge, a list of necessary studies has been proposed, their descriptions have been compiled and the cost of research needs has been assessed.

No	Code	Title of a measure	GES descriptor
1	BALEE-M017	Improving the effectiveness of the existing network of marine protected areas	D1, D4, D6
2	BALEE-M020	Improving the condition of fish spawning areas and migration routes, stimulating populations and updating protection measures	D1, D3, D4
3	BALEE-M021	Applying technologies to reduce and prevent bycatch for the protection of Baltic Sea species	D1, D3
4	BALEE-M026	Reducing fishing efforts to GES level and development and implementation of the corresponding concept	D3
5	BALEE-M032	Developing compensatory measures for disturbing or destroying the integrity of the seabed	D6
6	BALEE - M035	Preparing and implementing minimum requirements for EIA and impact monitoring of blue economy development projects	D6, D1, D2, D3, D4, D5, D7, D8, D11
7	BALEE-M036	Construction of the openings of the dam in Väike Väin to improve water exchange and to open the strait as a fish migration route	D7, D1, D3
8	BALEE-M039	Enhancing the management of hazardous pharmaceutical waste and raising awareness of environmentally friendly disposal of pharmaceuticals	D8, D9
9	BALEE-M040	Increasing pollution response capacity through the design and construction of a new buoy and research vessel with pollution control abilities (oil and other hazardous chemicals) and ensuring the comprehensive development of pollution response	D8, D1-D11

10	BALEE-M046	Litter clean-up campaigns (incl. raising awareness on marine litter impacts)	D10, D6
11	BALEE-M047	Environmentally friendly waste management on beaches and coasts with flood risk	D10
12	BALEE-M051	Treatment of stormwater and wastewater to reduce the amounts of microplastics	D10, D8
13	BALEE-M053	Reducing the input of tire debris	D10
14	BALEE-M055	Implementation of the HELCOM regional action plan on underwater noise and necessary regulations in Estonia	D11, D1
15	BALEE-M056	Management of marine data, improvement of data exchange and availability of environmental data, including the development of relevant services	D1-D11
16	BALEE-M057	Updating the regulations	D1-D11
17	BALEE-M058	Participation in international cooperation in the field of marine environmental protection	D1-D11
18	BALEE-M059	Informing and involving stakeholders in marine environment protection activities	D1-D11
19	BALEE-M076	Changing hydromorphological conditions for local improvement of environmental status	D5, D7
20	BALEE-M079	Ensuring environmental safety of shipping	D8, D5, D2, D10
21	BALEE-M002-02	Preventing a potential increase of hazardous substances input from marine aquaculture	D8, D9

Table 5. New measures of the Estonian Marine Strategy Programme of Measures (2022-2027)

Marine strategy plan has close links to following documents describing sectoral development and the fundamentals of politics in Estonia:

As HELCOM is the coordinating platform for implementing the MSFD, HELCOM Baltic Sea Action Plan and Estonian plan for its implementation (2008-2011, 2011-2016 and lastly updated at 2021) is also important in the frames of MSFD.

3.4.3 Baltic Sea Action Plan

The overall objective of the Baltic Sea Action Plan (BSAP) is to reach good environmental status of the Baltic Sea by 2021 (Figure 3-3), which was not reached, but deadline was extended towards the future. Nevertheless, the BSAP has shown promising results towards improving the state of the sea. The adjustments will allow to (BSAP update 2021, https://helcom.fi/baltic-sea-action-plan/2021-update-process/):

- Increase the integration of cross-cutting issues, such as the ecosystem approach, reaching good environmental status, or climate change
- Better reflect the current topics addressed in HELCOM such as marine litter, underwater noise, seabed loss and disturbance, and conservation measures for biodiversity together with required actions for improvements
- Facilitate the inclusion of ocean-related SDGs, Aichi targets and MSFD descriptors
- Get closer to the overall goal: achieving good environmental status

- Give maximum allowable nutrient inputs of nitrogen and phosphorous for the sub-basins to reach pre-defined desired target, whereas all nutrient input reduction measures should be fully implemented by 2027 at the latest, to take into account the time-lag associated with the reduction of nutrient inputs to the sea

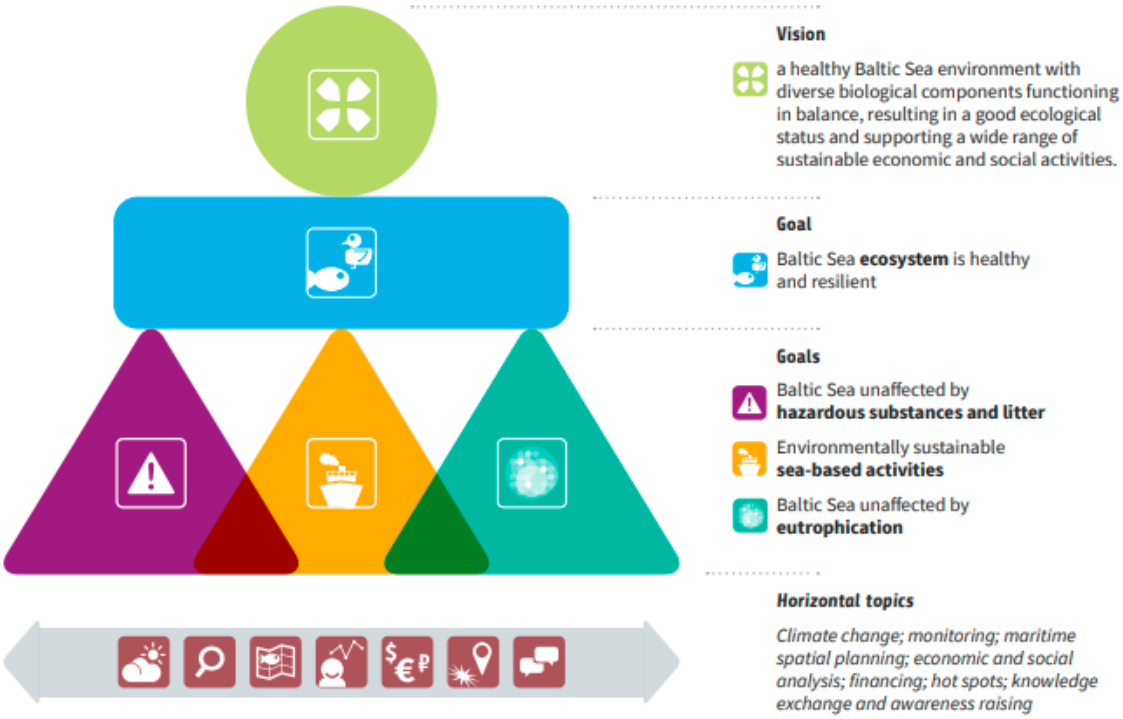

Figure 3-3. Updated Baltic Sea Action Plan – its vision, goals and specific topics (BSAP 2021)

Estonia is closely following Baltic Sea Action Plan and its updates. Marine litter is monitored by Estonia Marine Institute, Tartu University. Different coastal areas are monitored for plastic litter abundance and composition, microplastic is monitored in the water column, sediments and inside living organisms (fish and benthos).

The marine strategy consists of five activities, the schedule of which is as follows (https://envir.ee/keskkonnakasutus/merekeskkonna-kaitse/el-merestrateegia-raamdirektiiv):

For 15th July 2024:

- preliminary assessment of the environmental condition of the marine area and the environmental impact resulting from human activities;
- defining the good environmental condition of the marine area
- establishing a set of environmental targets and related indicators;

For 15th July 2026:

- establishment and implementation of a monitoring program for continuous evaluation and regular updating of targets
- For 2027:
- development of the programme of measures for achieving or maintaining the good ecological status

For 2028:

- implementation of the programme of measures

4. Maritime Spatial Planning Directive (Directive 2014/89/EU) in Estonia

The aim of the maritime spatial plan (MSP) is to agree on the long-term principles of Estonian marine area use in order to attain and maintain a good status of the marine environment and promote the maritime economy. The Estonian MSP is a national strategic document of spatial development, which covers the entire Estonian marine area: both the coastal sea, territorial sea as well as the exclusive economic zone. The need for MSP partly rises from EC directive 2014/89/EL, which establishes a framework for maritime space planning, which, among other things, stipulates the obligation for member states to establish marine area plans by March 2021 at the latest. This directive establishes a framework for marine area planning in order to promote the sustainable growth of the economy of marine areas, the sustainable use of marine resources and the sustainable development of marine areas.

The MSP focuses on the principles of spatial development and the activities are not planned in detail. The spatial plan provides guidance and conditions for the next steps in the planning of activities, including those at a local government level. The planning solution is based on environmental considerations and the best knowledge available. This knowledge was provided by a broad-based expert group of planning authorities, cooperation with other countries, agencies and stakeholders, and additional analyses (RT III, 17.05.2022). The areas and conditions in which activities can be carried out are defined by the plan, whereas besides exploitation of marine resources, value of the sea and coastal areas as nationally and internationally protected natural areas together with socially and culturally important areas are considered.

In Estonia, 15 different base analyses were performed for generation of MSP (list can be found from http://mereala.hendrikson.ee/uuringud.html), requests and wishes of local municipalities were clarified beforehand (survey was conducted in 2018-2019). A combined effect of the already ongoing activities and those still under consideration in the sea area, and effect across borders was assessed. In addition, a new innovative tool PlanWise4Blue (http://www.sea.ee/planwise4blue), which assess the cumulative effect of planned human activities to various natural values, was used.

All these activities and international cooperation in frames of projects Baltic Scope and Pan Baltic Scope for wider harmonizing approaches led to the draft version of Estonian MSP.

This document gives an overview of the activities, guidelines and requirements for actions taking place in the sea area, and can be found at: http://mereala.hendrikson.ee/dokumendid/Eskiis/Estonian_MSP_draft_plan_ENG.pdf

This plan was endorsed by the government in May, 2022 (RT III, 17.05.2022, 2).

According to this draft major activities and factors affecting Estonian sea area (*Figure 4-1*):

1) Fishing
2) Aquaculture: fish, seaweed and shellfish farms
3) Maritime transportation, including ice roads
4) Energy production
5) Infrastructure on the seabed
6) Maritime tourism and recreation
7) Protected natural objects
8) Marine culture
9) National defence
10) Natural resources
11) Dumping
12) Permanent connections

For all these activities current situation is described, spatial layout is presented and planning solution is offered together with preliminary impact assessment. A separate impact assessment report, which determines the mitigation measures to avoid significant impacts, has been prepared for the spatial plan with expectation of plan lasting up to 2035 (Eesti mereala planeering 2021).

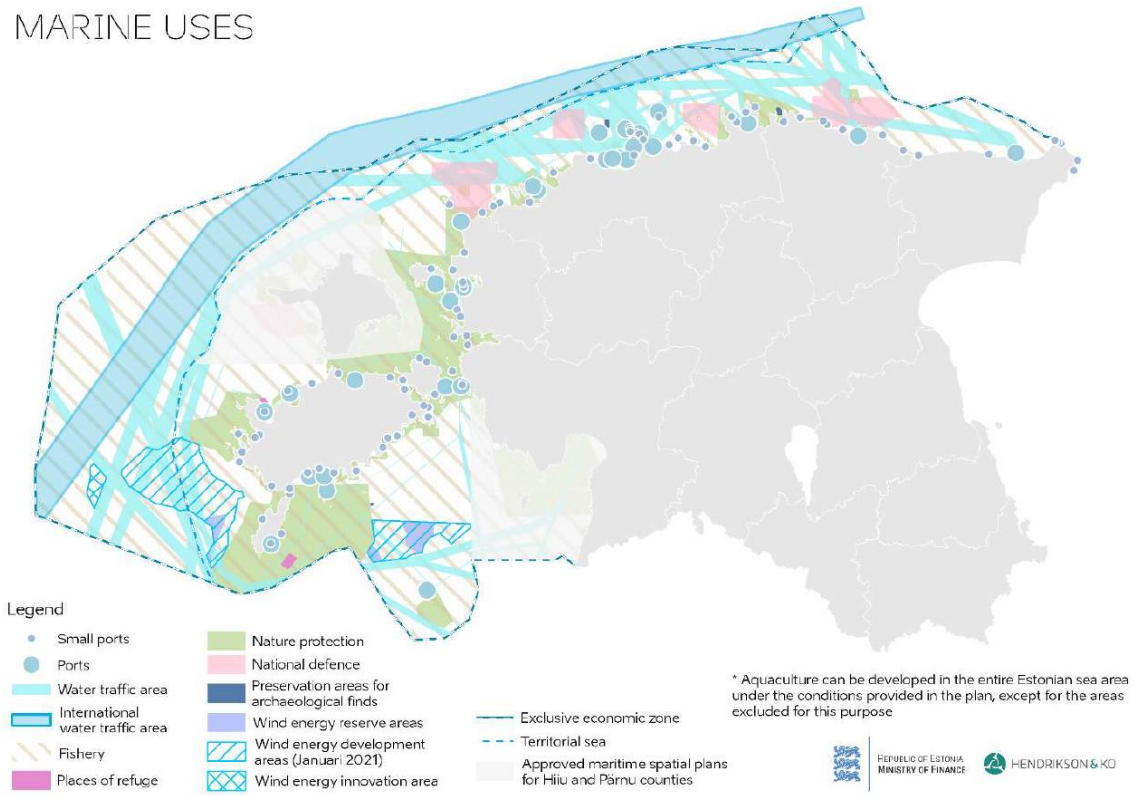

Figure 4-1. The use of Estonian marine areas. Map by Hendrikson & Ko, (acquired from https://www.fin.ee/en/state-local-governments-spatial-planning/spatial-planning/maritime-spatial-planning).

2 new activities, which potentially affect large areas in Estonian waters, are wind parks for energy production and aquaculture farms. Amount of wind parks is increasing in Europe – at 2030 are planned to have 290 GW wind parks in land and 100 GW parks at sea (https://tuuleenergia.ee/tuuleenergia/). This sector is quickly developing in Estonia, since via "green turn" wind energy farms are seen as one possibility to get energy without release of CO_2 i.e., from burning shale, and thus several windfarms are planned to be developed in the nearest future. By wind energy association´s list there are 6 companies at the moment, which have started superficies process to build wind parks with total capacity of 9864 MW to the sea and coastal area.

At first, the suitable conditions for wind energy had to be considered (wind, depth of sea, formation of ice, etc.) and on the basis of these, the un-protected areas in principle suitable for the construction of wind farms were selected. Wind energy farms can be combined with aquaculture sites as aquaculture is one of the fast-growing sectors of blue economy in the entire world (FAO, 2018, 2022). Wind energy farms will be located 6 nautical miles from land and inhabited

islands, which should lead to reduction of the noise problem (RT III, 17.05.2022).

Multiple projects were conducted to assess the potential for blue economy about the potential of shellfish/algae farming (Selgrootute), estimation of ecosystem services (Nõmmela, 2019), estimation of benefits coming from the use of marine resources (Merekeskkonna, 2017), and the attention towards this field is increasing. So far majority of cultured fish production (rainbow trout), comes from inland.

By preparing and establishing MSP, Estonia has fulfilled the requirement arising from the EC directive 2014/89/EL. In order to accommodate the sea space for all different uses of the sea, the plan determined in which areas and under which conditions activities can be carried out in the sea area. The guidelines and conditions set by the plan will be the basis for decisions concerning the Estonian sea area in the future. This brings about a change in the current practice based on individual decisions, because after establishing the marine area plan, there are both general principles and clear guidelines and conditions for how activities can be spatially planned. As a result of the studies carried out in the next stage, taking into account the particularities of the specific location and the technological solutions, it will become clear in what volume and parameters, and where exactly within the areas specified in the plan, it is possible to build various objects. Given that the planning, including impact assessment, is based on the so-called ranking principle, the plan provides a framework for further activities. Therefore, the plan provides guidelines and sets conditions that must be followed in the next stages (especially when processing building and construction permits). In addition, the interaction of various activities has been considered and evaluated during the preparation of the plan, which creates the basis for the expansion of parallel activities in the marine area, including the use of renewable energy in the future.

TASK 2: DATA GAPS ANALYSIS IN THE IMPLEMENTATION OF EU DIRECTIVES

5. Introduction to Task 2

Data gaps have been analysed through a consultation with practitioners, stakeholders and relevant administrations in the context of the Marine Strategy Framework Directive or the Marine Spatial Planning Directive.

This technical report presents the results of the survey conducted among Spanish stakeholders to fulfil Task 2. Additionally, it provides initial insights for Task 3, examining how the identified data gaps among Spanish stakeholders could potentially be addressed using Copernicus data. Moreover, it also provides preliminary results for Task 4, exploring services of higher interest required by the different marine sectors. The **objectives of the survey** are:

- To identify the current needs and gaps of Spanish stakeholders to better understand their current usage of Copernicus data, across different marine sectors, in the implementation of both EU Marine Directives (Task 2 and Task 3).
- To identify the Copernicus services of higher interest for the marine sectors involved in the implementation process (Task 4).

6. Methodology

The survey was compiled from contributions, by the different action partners, and a final English version with 34 questions was agreed upon (Annex I). It should be noted that this action is being coordinated with other actions, part of Working Group Oceans, namely, Action 2021-2-42 (Copernicus uptake for the maritime sector) and Action 2021-2-47 (Coastal coordination of user needs and methodologies), and, therefore, the survey included questions that contributed to all three actions, to improve efficiency and avoid stakeholder fatigue. The final survey was then translated to the different languages of the participating countries for dissemination. Survey questions were organised in the following sections:

- GENERAL INFORMATION (Q.1)
- MARINE SECTORS (Q2-Q13)
- MARINE SECTOR & MSP GAPS (Q14-Q16)
- EU MARINE DIRECTIVES (Q17-Q23)
- MARINE STRATEGY FRAMEWORK DIRECTIVE GAPS (Q24-Q27)
- COPERNICUS (Q28- Q34)

The identification of stakeholders and dissemination of the survey was done independently by each partner leveraging contacts, partners, previous email campaigns, social media outreach, as well as personalised invitations to encourage participation. The objective was to gather diverse perspectives, maximise participation and enrich the outcome of the project.

The scope of this document is to present the Copernicus data usage, gaps and needs for Estonian stakeholders, mapped via survey. This survey was conducted among Estonian stakeholders with a focus to the implementers of Marine Strategy Framework Directive. The survey for Estonia was conducted in UT LimeSurvey.

To present information, retrieved via survey, about Copernicus data usage, gaps and needs of various stakeholders and end-users with a focus to the implementers of Marine Strategy Framework Directive (MSFD) in Estonia.

7. Results for survey conducted in Estonia

7.1 General overview of stakeholder's profile for the maritime sector in Estonia

The survey for Estonia received a total number of 6 responses. All respondents are from the Baltic Sea region. Regarding their entity type (Figure 7-1), they are mostly from public administration (3), followed by academia (2) and private sector (1).

A list with the stakeholder's participant in the survey is presented in Annex III.

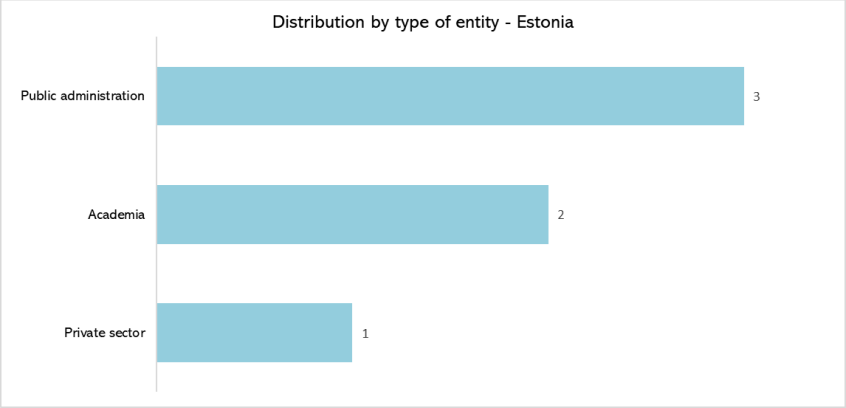

Figure 7-1. Stakeholder's profile by type of entity and by area of activity - Estonia

Regarding their area of activity (coastal, marine, inland), most of the entity's activities are located in marine (6) and coastal (3) areas. Gulf of Finland was of the most interest, but also Gulf of Riga and coastal areas of Estonia.

The overall **relation of stakeholders to the various sectors** was evaluated with a multiple answer question, so that respondents could select more than one sector of their interests or involvement (Figure 7-2). Interests laid in ports and harbours, species protection and protected areas, coastal protection, energy sector and underwater cable/pipeline routs.

Figure 7-2. Stakeholder's relationship to various sectors and EU Directives implementation

The overall **relation of stakeholders to the EU Directives implementation** was evaluated with a multiple answer question, so that respondents could select more than one Directive of involvement. The total of 4 stakeholders have participated in the implementation of one of these Directives in Estonia.

7.2 Stakeholder's services of interest in the implementation process of EU Directives in Estonia

The overall **services of interest to the various sectors** were evaluated with a multiple answer question, so that respondents could rate services by order of interest (Figure 7-3).

As there were relatively few responses for Estonia, users did not answer about several sectors. There were no answers about Aquaculture sector, Fisheries, Services for Maritime transport routs, Energy sector and Raw material extraction sector. Higher interests for Ports and harbours sector were about maritime climate and environmental monitoring. For Species conservation and protected areas, the users were most interested in environmental monitoring and map of the sea use. For energy sector the only interest was noted to lay in environmental monitoring. For Coastal protection sector the most interest were pollution and environmental monitoring and maritime climate.

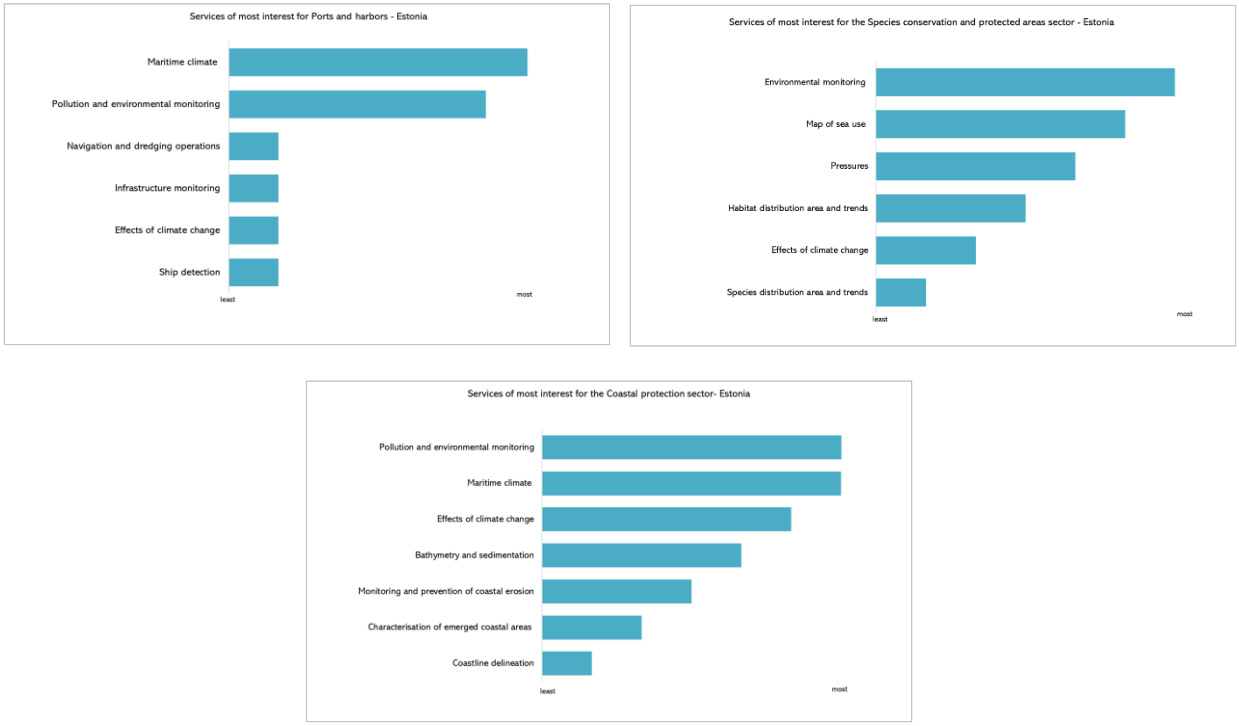

Figure 7-3.Stakeholder's services of most interest according to sectors.

7.3 Data gaps and needs in the implementation process of EU Directives in Estonia

7.3.1 Stakeholders involved in EU MSFD implementation

4 stakeholders have participated in the implementation of the EU Marine Strategy Framework Directive in Estonia, all of them during the second period of implementation and 3 of them during the first period of implementation (2012-2018).

Regarding their participation in the different implementation phases for the EU Marine Strategy Framework Directive (Figure 7-4), almost all of them have participated in the elaboration of the Monitoring programmes (3) and Determination of the good environmental status. In the definition of the Programme of measures participated 2 of them and 1 in the initial assessment and in the Establishment of environmental targets and associated indicators.

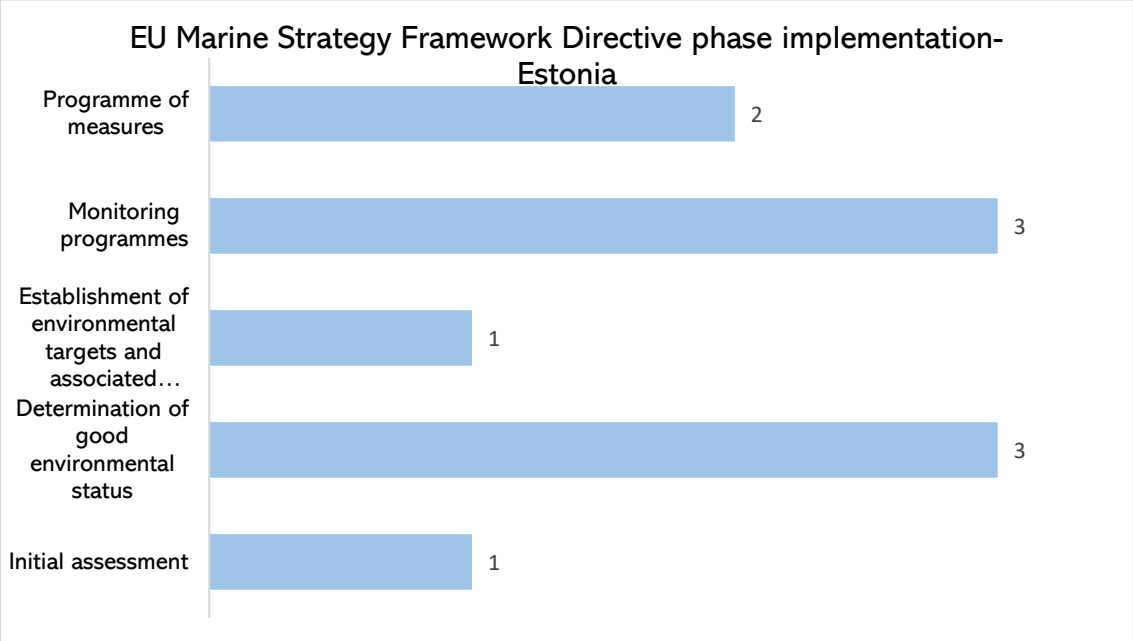

Figure 7-4. Stakeholder's participation in the different implementation phases for the EU Marine Strategy Framework Directive in Estonia.

Problems encountered when working with the available data

Regarding general data usage, when analysed all answers from Estonia (Figure 7-5), most stakeholders, when asked about the most common problems encountered when working with data, mentioned the challenges associated with Incomplete Temporal (4) and Spatial (4) distribution together with the Data Format (4). These answers highlight the need for improved data availability, coverage and uniformity. No problems were found in heterogeneous sources.

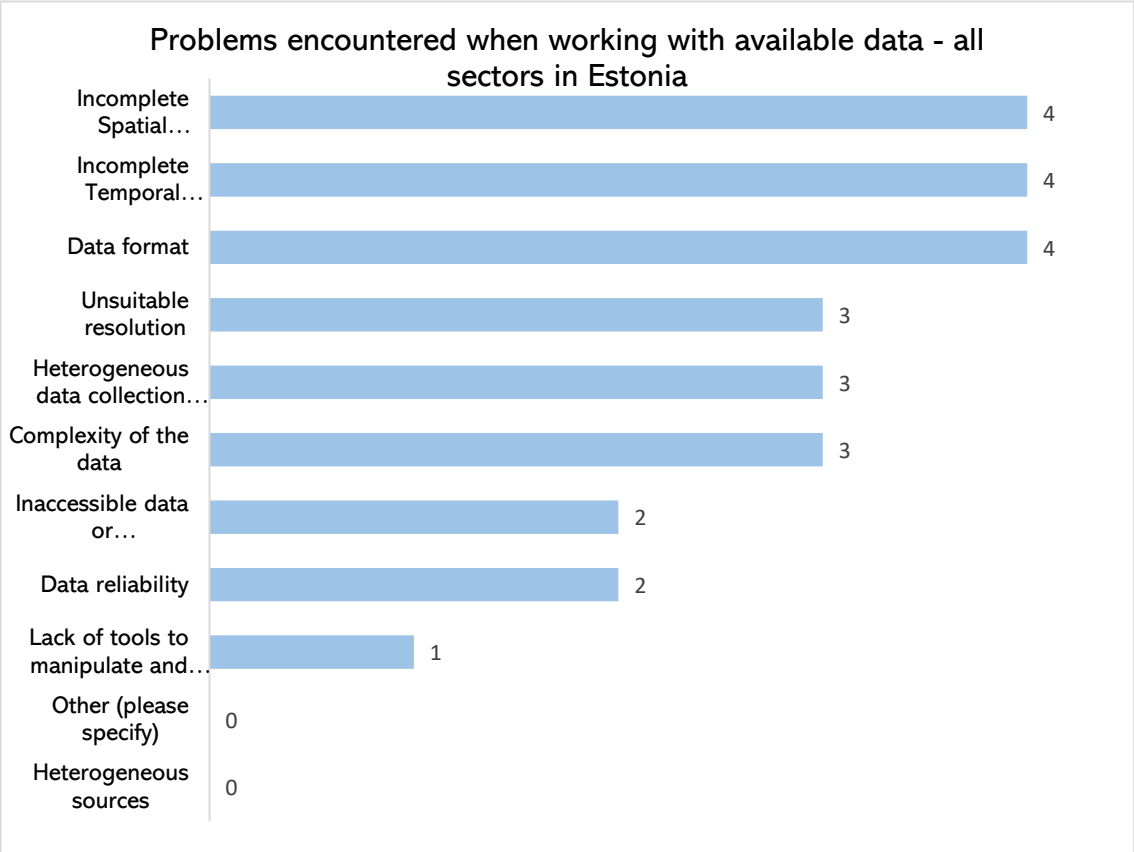

Figure 7-5. Stakeholder's main problems encountered when working with the data available in the implementation process of all marine sectors in Estonia

Estonian stakeholders involved in MSFD implementation (5), when asked about the most common problems encountered when working with data/parameters related to the descriptor/criteria specified in Figure 3-6, all mentioned the greatest challenges encountered were those associated with Temporal distribution. Also, Spatial extent and distribution were problematic (4). Genetics, Duration and Abundance were not problematic (Figure 7-6).

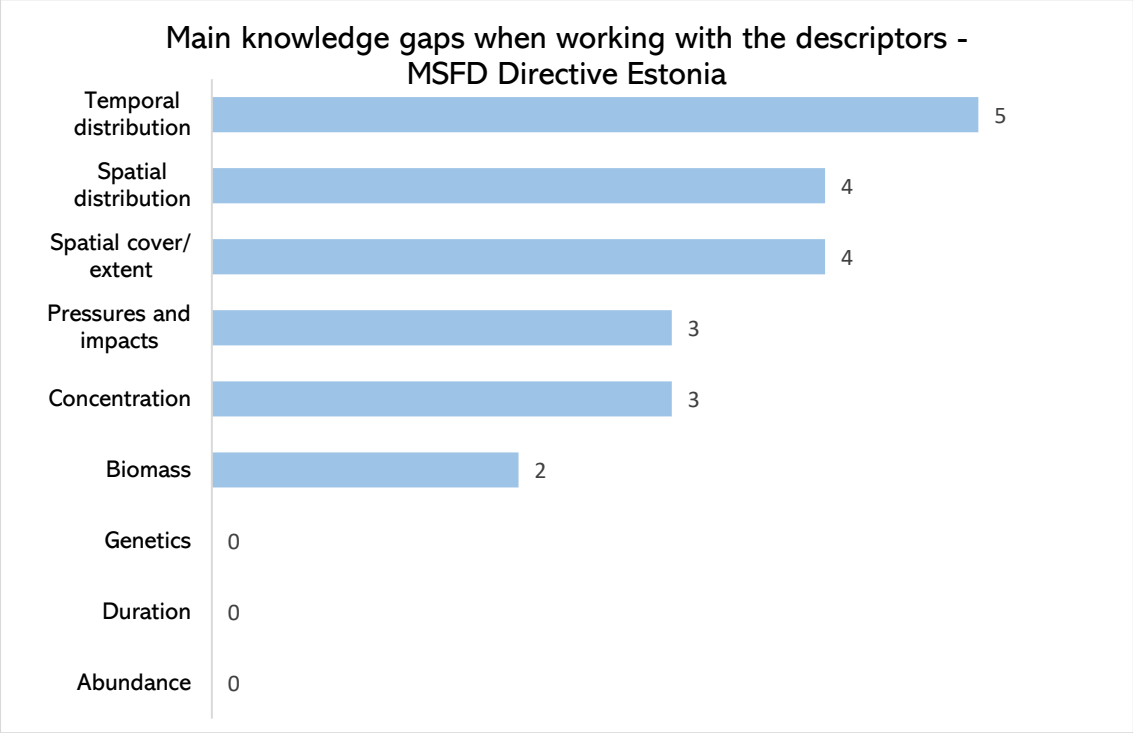

Figure 7-6. Stakeholder's main gaps encountered when working with data related to the descriptors in MSFD implementation in Estonia

As there were relatively few sectors covered for Estonia, further division for specific sectors included Ports and harbours, Species conservation and protected areas, Energy sector, Coastal protection, Submarine cable and pipe routs.

In Ports and harbours and Energy sector the Complexity of the data, Data format, Unsuitable resolution and Lack of tools was brought out as main problems. In Species conservation and protected areas were present all noted problems except Heterogeneous sources, Lack of tools and Data reliability. In Coastal protection the Incomplete temporal distribution was brought out as the main problem. In Submarine cable and pipe routs sector were present all noted problems except Data reliability, Heterogeneous sources and Lack of tools to manipulate data.

Needs regarding temporal extent of the data

Majority of interest laid in long-term historical data series (Figure 7-7).

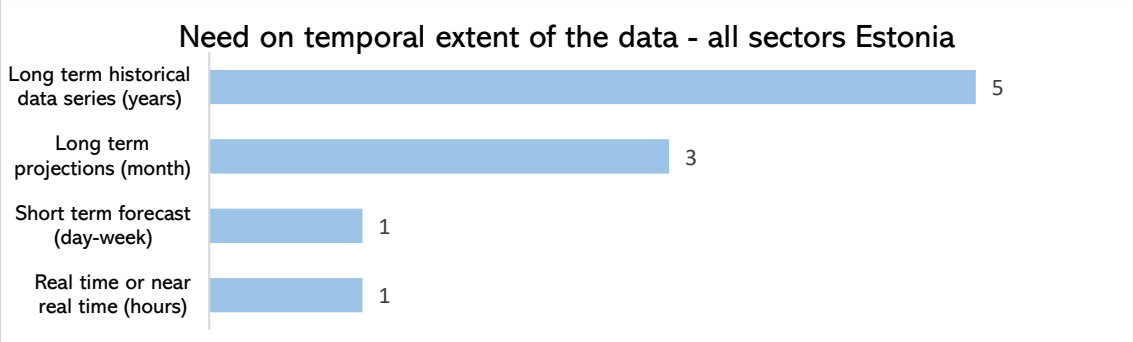

Figure 7-7. Stakeholder's interests for the temporal extent of the data in Estonia

Needs regarding spatial resolution of the data of the data

In terms of the spatial resolution of data, when analysed marine sectors in Estonia (Figure 7-8), stakeholders expressed a clearly higher need for medium (5-30 m) resolutions. Next there was a similar need for the high resolution (1-5 m) and low resolution (≥250m-1 km), and also the need for very high and reduced resolution data was present.

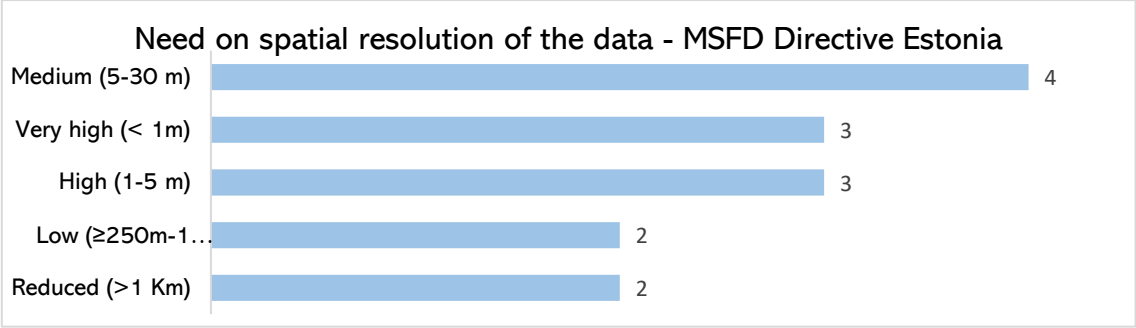

Figure 7-8. Stakeholder's needs on spatial resolution of the data in the implementation process of EU Directives in Estonia

7.4 Copernicus needs in the implementation process of MSFD in Estonia

The following analysis focuses on the main challenges encountered by stakeholders involved in the implementation process of MSFD in Estonia regarding usage of the Copernicus products. The survey analyses, on the one hand, the difficulties and needs in terms of Copernicus tool usage and data access. On the other hand, it examines space solutions and data analysis tools used to work with Copernicus data.

Within the questions collected in the general information section, stakeholders were asked what type of Copernicus user they considered themselves to be. Estonian stakeholders all stated them to be "End users".

Regarding **stakeholder's awareness of the Copernicus program** (Figure 7-9), majority were aware of the Copernicus data.

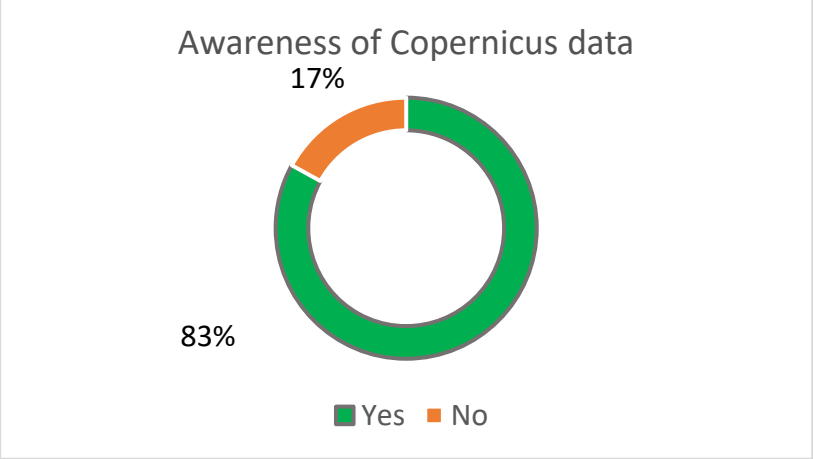

Figure 7-9. Stakeholders' awareness of the Copernicus program in Estonia across marine sectors

For the stakeholders that mentioned being aware of the program it was further questioned their **usage of Copernicus Data**. All end-users replied that they are using Copernicus data.

For the stakeholders that **declared using Copernicus data**, the periodicity of usage and type of data used were further inquired (Figure 7-10). 80% of users, who are using Copernicus data in Estonia, stated they are using Copernicus data yearly, and 20% in every week, mostly modelled products were used. The level of the users is either intermediate or basic (Figure 7-11).

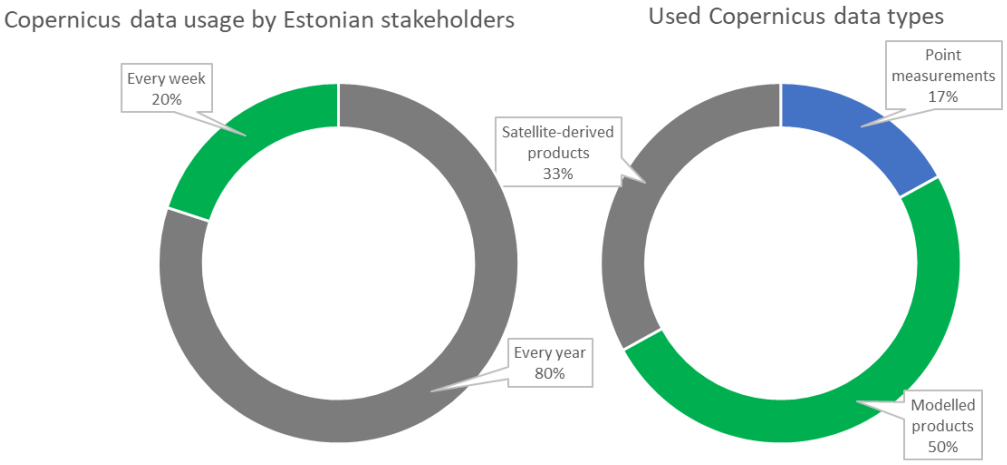

Figure 7-10. Stakeholders' that declared using Copernicus data in Estonia: periodicity of usage and used data types.

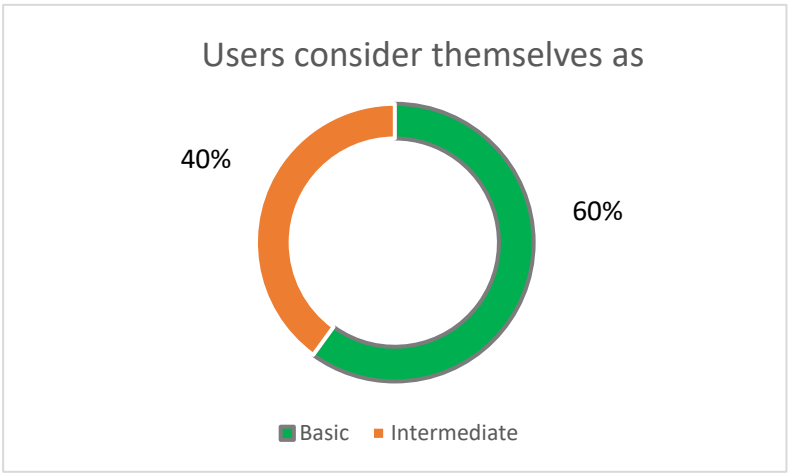

Figure 7-11. Stakeholders' that declared using Copernicus data in Estonia: level of competence

For the stakeholders that **declared using Copernicus data**, one open-ended question (Q.30ii) was asked to get further information to know what was stakeholders' purpose for using Copernicus data. In summary, Spanish stakeholders highlighted the importance of

Detailed summary to the question Q30ii is reported in the Annex IV.

7.5 Copernicus needs in the implementation process of EU Directives in Estonia

The following analysis focuses on the main challenges encountered by stakeholders involved in the implementation process of the two EU Directives in Estonia regarding usage of Copernicus products. The survey analyses, on the one hand, the difficulties and needs in terms of Copernicus tool usage and data access. On the other hand, it examines space solutions and data analysis tools used to work with Copernicus data.

7.5.1 Data analysis and visualisation tools

Regarding needs related to the tools for data transformations for the implementation process in Estonia, stakeholders were asked about most-used data tools for Copernicus data analysis and visualisation.

Estonian stakeholders are often using mapping software (Figure 7-12), some are using programming languages and image processing software. One stakeholder noted that he is not using any of this, and it is difficult to even start from somewhere.

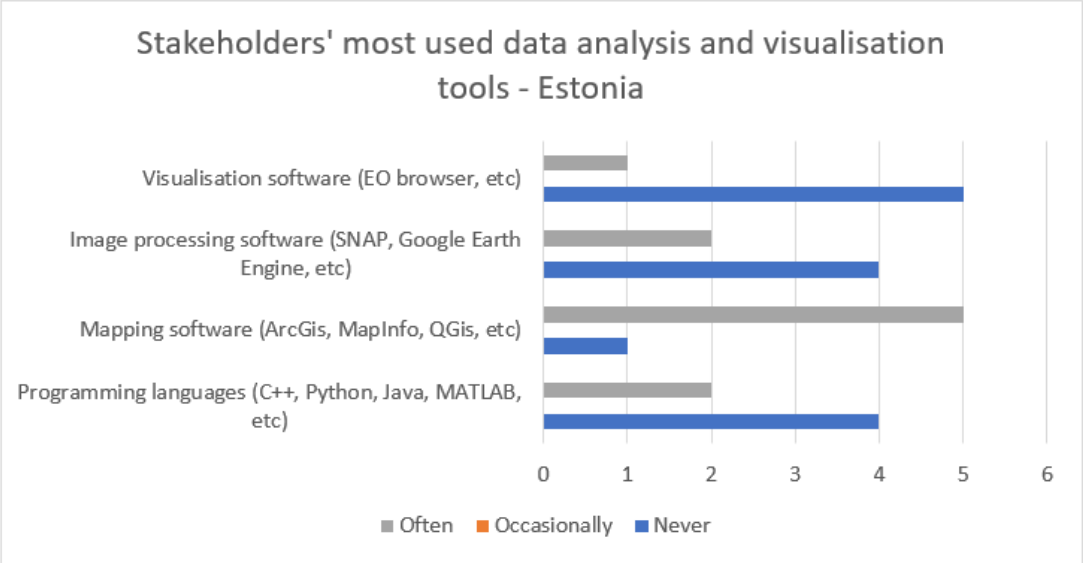

Figure 7-12. Stakeholder's usage of data analysing and visualization tools in Estonia

7.5.2 Space solutions relevant to the maritime domain

One open-ended question (Q.33) was asked to get further information on stakeholders' relevant space solutions for the maritime domain. In summary, Estonian stakeholders highlighted the importance of data fusion and data continuity together with specialized solutions i.e., for eutrophication.

Detailed summary to the question Q33 is reported in the Annex IV.

7.5.3 Suggestions for Copernicus improvement

Another open-ended question (Q.30vi) was asked to get further information on how users think that Copernicus data can be improved. In summary, Estonian stakeholders' suggestions focus on easier access to images and cloud-processing of the data.

Detailed summary to the question Q30 is reported in the Annex IV.

8. Conclusions for Task 2

All stakeholders, who were filling the questionnaire, were interested in Copernicus services.

In Estonia, Copernicus data is used in the frames of MSFD, users are mostly in basic or intermediate level.

Majority of the users were interested in long-term time series.

Most common challenges were associated with Incomplete Temporal and Spatial distribution together with the Data Format issues.

As spatial and temporal extent were the most noted gaps in current datasets, inclusion of Copernicus data may relieve both gaps for at least for some parameters.

TASK 3: IDENTIFICATION ON HOW TO USE COPERNICUS DATA IN THE IMPLEMENTATION OF EU MARINE DIRECTIVES

Requirements of the Marine Directives and the data gaps detected will be contrasted with the benefits and opportunities offered by Copernicus data services. This will be performed in 3 phases:

- 1st phase (September 2023): first insight with the collaboration of public authorities (from all the participant countries), stakeholders and the private sector (aquaculture companies, renewable energy entities).
- 2nd phase: include conclusions from working groups meetings organised in Actions 2021-2-42 and 2021-2-47.
- 3rd phase: compile results from the 2 previous phases.

Eutrophication was stated as the primary interest of several stakeholders, relevant to assess in both, MSFD and WFD reporting. Remote sensing allows to acquire additional information for characterizing eutrophication direct indicators Chl a and transparency, and also to give additional indication about algal blooms. In Estonia, Chl a and transparency are already monitored regularly by Estonian Marine Institute of Tartu University (i.e., Kutser, 2021), but specific assessment of blooms is currently under the development. Thus, the following activity in frames of the Task 3 will focus to spring bloom characterization in Estonian coastal areas during 2023.

REFERENCES

115B. Helsinki Commission. 148 pp. http://www.helcom.fi/Lists/Publications/BSEP115B.pdf

2014/89/EL https://eur-lex.europa.eu/legal-content/ET/TXT/PDF/?uri=CELEX:32014L0089&from=EN; (ELT L 257, 28.08.2014, lk 135–145), visited 07.03.2023.

Andersen, J.H., K.J. Hammer, C. Murray 2021. Comparison of multi-metric indicator-based tools for assessment of the environmental status in Europe's seas. ETC/ICM Report 1/2022: European Topic Centre on Inland, Coastal and Marine Waters, 50 pp.

Balti keskkonnafoorum 2011. Protokoll. 6 lk. https://bef.ee/wp-content/uploads/2015/10/Protokoll_170111.doc

BSA update 2021. https://helcom.fi/baltic-sea-action-plan/2021-update-process/ visited 07.03.23.

BSAP 2021. Baltic Sea Action Plan. 2021 update. Baltic Marine Environment Protection Commission 31 pg. https://helcom.fi/wp-content/uploads/2021/10/Baltic-Sea-Action-Plan-2021-update.pdf

Capon, S. J., Stewart-Koster, B. & Bunn, S. E., 2021. Future of Freshwater Ecosystems in a 1.5°C Warmer World. Frontiers in Environmental Science 9, 784642. DOI: 10.3389/fenvs.2021.784642

Chorus, I., J. Fastner & M. Welker, 2021. Cyanobacteria and Cyanotoxins in a Changing Environment: Concepts, Controversies, Challenges. *Water 13:* 2463. https://doi.org/10.3390/w13182463

COMMISSION DECISION (EU) 2017/848 https://eur-lex.europa.eu/legal-content/En/TXT/PDF/?uri=CELEX:32017D0848&from=EN

Commission Directive (EL) 2017/845. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017L0845&from=EN

Dodds, W. K, W. W. Bouska, J. L. Eitzmann, T. J. Pilger, K. L. Pitts, A. J. Riley, J. T. Schloesser, T. J. Thornbrugh & J. Darren, 2009. Eutrophication of U.S. Freshwaters: Analysis of Potential Economic Damages. Environmental Science and Technology 43:12–19.

Eesti mereala planeering. Mõjude hindamise aruanne. 2021. 239 pg. https://www.fin.ee/media/4733/download

FAO 2018 The State of World Fisheries and Aquaculture 2018. Meeting the sustainable development goals. Rome. http://www.fao.org/3/i9540en/I9540EN.pdf

FAO 2022. The State of World Fisheries and Aquaculture 2022. Towards Blue Transformation. Rome, FAO. **https://www.fao.org/3/cc0461en/cc0461en.pdf**

HELCOM 2009. Eutrophication in the Baltic Sea. An integrated thematic assessment of eutrophication

HELCOM 2010. Ecosystem Health of the Baltic Sea. HELCOM Initial Holistic Assessment 2003-2007. Edited by J.H. Andersen, S. Korpinen, M. Laamanen & U. Wolpers. Baltic Sea Environmental Proceedings 122. Helsinki Commission. 63 pp.

HELCOM 2013. HELCOM core indicators: Final report of the HELCOM CORESET project. Balt. Sea Environ. Proc. No. 136

HELCOM 2017. The integrated assessment of eutrophication - supplementary report to the first version of the 'State of the Baltic Sea' report 2017. Available at: http://stateofthebalticsea.helcom.fi/about-helcom-and-the-assessment/downloads-and-data/

in the Baltic Sea region. Ed. by J.H. Andersen & M. Laamanen. Baltic Sea Environmental Proceedings No.

Kaldma, A. Mereprügi plaan 23 pg. https://envir.ee/ringmajandus/jaatmed/riigi-jaatmekava#riigi-jaatmekava-koo

Kangro, K., Rahn, I.-A., Jaanus, A., Alikas, K., 2023. EL merestrateegia raamdirektiivi (2008/56/EÜ) kohase kriteeriumi D5C3 hindamisindikaatorite edasiarendamine Eesti mereala seisundihinnangute täpsustamiseks. Lõpparuanne 01.03.2023. TÜ Tartu observatoorium, 123 pg.

Keskkonnaministeerium 2022. Eesti merestrateegia meetmekava 2022-2027 Keskkonnamõju strateegilise hindamise (KSH) program (21.04.2022). Läbiviija OÜ Alkranel 66 pg.

Keskkonnaseire kaardilugu 2023 https://storymaps.arcgis.com/stories/2fc7f74485ca45858dabd933ffc6443e, visited 08.03.23

Kutser, T. 2021. Riikliku keskkonnaseire rannikumere kaugseire alaprogramm. 2021 aasta. Lõpparuanne. 40 pg. In Estonian. https://kese.envir.ee/kese/downloadReportFile.action?fileUid=26135164&monitoringWorkUid=23605977, accessed 30.09.2023

Lips, U. 2016 Eesti merestrateegia meetmekava. Eelnõu konsolideeritud tekst. 90 lk. Tallinn (https://www.fin.ee/en/state-local-governments-spatial-planning/spatial-planning/maritime-spatial-planning)

Martin, G. & Torn, K. 2018. EL merestrateegia raamdirektiivi (2008/56/EÜ) kohane merekeskkonna seisundihinnang teemadel bioloogiline mitmekesisus, toiduvõrgud ning merepõhja ja veesamba kooslused (D1, D4 ja D6). Tallinn. Keskkonnainvesteeringute keskus. 84 pg.

Martin, G. 2022. Mereseire 2022-2023, raamleping nr 4-3/22/3 Vahearuanne 2022. aasta II etapp. 3 pg.

Martin, G. 2023. Natura mereelupaikade uuring. Leping: 4-1/22/105. Tartu Ülikooli Eesti Mereinstituut. 36 pg.

Merealade valitud ökosüsteemiteenuste alusmaterjalid (tellija KAUR), OU Hobikoda, 2019 Merekeskkonna ressursside kasutamisest saadava majandusliku kasu mudel 2017. Mereala kasutamisest saadava majandusliku tulu, kulu ja kasu mudel, hindamaks merealal praegu toimuvat majandustegevust), Poliitikauuringute Keskus Praxis.

Mereseire allprogramm (2009) Lisa 5.1-5.5

Mereseire allprogramm (2019). Lisa 5. Riikliku keskkonnaseire programmi mereseire allprogramm. Keskkonnaagentuur 39 pg.

MSFD 2008. DIRECTIVE 2008/56/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
https://helcom.fi/wp-content/uploads/2019/10/CELEX_32008L0056_EN_TXT.pdf

Nõmmela, K., Tartu Ülikool RAKE; Kotta, J., OÜ Hobikoda; Piirimäe, K., OÜ Roheline Rada 2019. Merekeskkonna ressursside kasutamisest saadava majandusliku kasu mudeli täiendamine ökosüsteemiteenustega; Tellija Rajandusministeerium, (https://www.rahandusministeerium.ee/et/system/files_force/document_files/mudeli_taiendamine_okosusteemiteenustega_aruanne.pdf)

Nurmik, M. 2019. Merestrateegia meetmekava rakendamise vahearuannet tutvustavad slaidid. https://envir.ee/media/299/download

REKK 2020 https://energy.ec.europa.eu/system/files/2020-03/ee_final_necp_main_ee_0.pdf

RT 2020. RT I, 21.04.2020, 61 https://www.riigiteataja.ee/akt/121042020061#para3, visited 07.03.2023

RT III, 17.05.2022, 2. Üleriigilise planeeringu Eesti mereala ja sellega piirneva rannikuala, samuti majandusvööndi teemaplaneeringu kehtestamine. https://www.riigiteataja.ee/akt/317052022002, visited 07.03.2023

Seletuskiri Eesti mereala seire ja andmekogumise programmi 2021-2026 juurde 51 pg. https://envir.ee/media/293/download

Selgrootute ja vetikate kasvatamiseks sobivate alade väljaselgitamine, 2016. TÜ Eesti Mereinstituut

Szymczycha, B., A. Zaborska, J. Bełdowski, K. Kuliński, A. Beszczyńska-Möller, M. Kędra & J. Pempkowiak (2019): Chapter 4 – The Baltic Sea. Pages 85–111 in C. Sheppard, editor. World Seas: an Environmental Evaluation (Second Edition). Academic Press.

WHO, 2022. State of the world's drinking water: an urgent call to action to accelerate progress on ensuring safe drinking water for all. Geneva: World Health Organization, UNICEF, World Bank. 114 pg.

Woodward, G., Perkins, D. M., Brown, L. E. 2010. Climate change and freshwater ecosystems: impacts across multiple levels of organization. Philos. Trans. R. Soc. Lond. B. Biol. Sci. 365(1549): 2093-2106. https://10.1098/rstb.2010.0055.

ANNEXES

Annex I: Documents describing sectoral development and the fundamentals of politics in Estonia

- River basin management plans. Programme of measures (2015-2021, 2022-2027). Eastern Estonian water district. Western Estonian water district. Koiva water district. (https://envir.ee/veemajanduskavad-2022-2027#veemajanduskavade-do)
- European Maritime and Fisheries Fund – Operational Programme for Estonia 2014-2020; 2022-2027.
  https://oceans-and-fisheries.ec.europa.eu/system/files/2022-12/emfaf-programme-estonia-summary_en.pdf
- Internal security development plan 2015-2020, 2020-2030 and its programme of measures.
  https://www.siseministeerium.ee/stak2030
- National waste management plan 2014-2020 and its implementation plan 2014-2017. Plan for 2022-2028 is currently under development
  https://envir.ee/ringmajandus/jaatmed/riigi-jaatmekava#riigi-jaatmekava-koo
- Plan for marine waste
  https://envir.ee/media/5682/download
- Environmental protection development plan until 2020 and its measures. Environmental development plan up to 2030 is currently under development
- Environmental protection and management plan 2023-2026 (draft version)
  https://www.fin.ee/media/7863/download
- Transportation and movement: development plan 2023-2035
  https://mkm.ee/media/6865/download
- Policy of maritime transportation
  https://mkm.ee/media/6886/download
- Marine economy strategy 2022-2035 -a white paper
  https://mkm.ee/media/8055/download
- Joint program of fisheries 2021-2024 (draft version)
  https://www.fin.ee/media/1362/download
- Estonian Tourism development plan 2014-2020
  https://www.riigiteataja.ee/aktilisa/3191/1201/3015/lisa.pdf.
- Development plan for forestry (2021-2030 under compilation)
  Version from 19.01.23 https://envir.ee/media/9018/download

- Estonian environmental strategy up to year 2030
  https://www.riigiteataja.ee/aktilisa/0000/1279/3848/12793882.pdf
- Estonian national energy and climate plan until 2030
  https://www.mkm.ee/media/118/download
- Development plan for the adaption to the climate change until the year 2030
  https://envir.ee/media/928/download
- Estonian rural development plan (2007-2013, 2014-2020, 2021-2030 under compilation)
  https://www.agri.ee/media/673/download
- Estonian regional development action plan
  https://www.fin.ee/media/7012/download
- Development plan for Estonian Culture (2021-2030)
  https://www.kul.ee/media/3567/download
- Estonian sustainable development strategy "Sustainable Estonia 2021"
  https://www.riigiteataja.ee/akt/940717
- Strategy "Estonia 2035"
  https://valitsus.ee/media/4022/download
- Action plan for "Estonia 2035"
  https://valitsus.ee/media/4771/download
- Transportation and movement development plan 2021-2035
  https://valitsus.ee/media/4253/download
- Estonian fisheries strategy 2021-2024
  https://www.fin.ee/media/1362/download
- The development plan for Nature Protection until the year 2020 (environmental strategy until 2030 is under compilation)
  https://envir.ee/media/50/download

Annex II: Survey questions

Survey on the use of Copernicus data for the Marine sector

The marine sector faces several challenges regarding management and sustainability. It is becoming evident that the challenges linked to marine data and information availability will become even more important during the implementation of certain policies and strategies. Users from different marine sectors can use Copernicus data to extract information to determine the environmental status of coastal waters, to support sustainable development or growth in certain maritime areas and activities.

Under this context, the Framework Partnership Agreement on Copernicus User Uptake (FPCUP) aims at a better integration of Copernicus data in the European regulatory framework by increasing the number of users and applications derived from Copernicus through 3 different actions:

- Action A2021-2-33 pursues "to promote the use of Copernicus data in the implementation of the EU Marine Spatial Planning Directive (Directive 2014/89/EU; MSP) and EU Marine Strategy Framework Directive (Directive 2008/56/EC; MSFD),
- Action A2021-2-42 pursues "to promote the use of Copernicus data across the maritime sector, focusing on Ports and Harbours, Aquaculture and Fisheries",
- Action A2021-2-47 pursues "to define the roadmap to guide the future evolution of Copernicus products to fulfil the needs of users in coastal areas".

The aim of this survey is to identify the current needs and gaps of the stakeholders to better understand the current usage of Copernicus data across different sectors:

- implementation of the two Directives (Action 33),
- marine sector, focusing on Ports and Harbours, Aquaculture and Fisheries (Action 42),
- national coastal users (Action 47).

By participating in this survey, you will have the opportunity to join future Copernicus training events that will be organised in the scope of the FPCUP project.

For this survey, please consider the following definitions and policies:

"Copernicus program" is the Earth Observation program of the European Union.

"Copernicus satellite data" are the data from Sentinel satellite missions (Sentinel 1, 2, 3, 5P and 6), as well as data from satellite missions of other space agencies and commercial providers, called Contributing Missions.

"Copernicus service products" are the products provided by the 6 Copernicus Services (Land, Marine, Atmosphere, Climate Change, Emergency, Security), that use satellite and in situ data as inputs.
"EU Marine Strategy Framework Directive (Directive 2008/56/EC)". This Directive establishes a framework within which Member States shall take the necessary measures to achieve or maintain good environmental status in the marine environment.

"Commission Decision (EU) 2017/848" laying down criteria and methodological standards on good environmental status of marine waters and specifications and standardised methods for monitoring and assessment.

"EU Marine Spatial Planning Directive (Directive 2014/89/EU)". This Directive establishes a framework for maritime spatial planning aimed at promoting the sustainable growth of maritime economies, the sustainable development of marine areas and the sustainable use of marine resources.

"Water Framework Directive (Directive 2000/60/EC)". This Directive requires EU Member States to achieve good status in all bodies of surface water and groundwater by 2027.

"Habitats Directive (Directive 92/43/EEC)". This Directive ensures the conservation of a wide range of rare, threatened or endemic animal and plant species.

ANNEXES

Survey
(*in bold below was for internal reading*)

1. General information
    a. Entity
    b. Department
    c. Contact name:
    d. Email:
    e. Job position:
    f. City:
    g. Country:
    h. Type of Entity
        i. Academia
        ii. Research
        iii. Public administration
        iv. Another public entity
        v. Private sector
        vi. Non-Governmental Organization (NGO)
        vii. Other (please specify)
    i. What is your area of activity? (***Multiple choices allowed***)
        i. Inland
        ii. Coastal
        iii. Marine
    j. In terms of Copernicus Data, do you consider yourself a:
        i. End-user
        ii. Service provider
2. Which of these marine sectors are you related with? (***Multiple choices allowed***)
    a. Ports and harbours
    b. Aquaculture (shell farming)
    c. Aquaculture (fish farming)
    d. Fisheries
    e. Species conservation and protected areas
    f. Maritime transport routes and traffic flows
    g. Energy sector (hydrocarbons and renewable energies)
    h. Coastal protection
    i. Raw material extraction
    j. Tourism and recreational activities
    k. Other

3. (***If chosen "Ports and harbours" in Q2***) For the "Ports and harbours" sector, which services are of higher interest to you? (Rank by order of interest, with 1 being the highest interest) **(bold means it is a common option between marine sectors)**
    a. Maritime climate (e.g., for Operational and maintenance activities)
    b. Ship detection (e.g., monitoring vessel activity)
    c. Pollution and environmental monitoring (e.g., oil spills, water quality, air quality)
    d. Effects of climate change (e.g., sea-level rise, extreme events)
    e. Infrastructure monitoring (e.g., containers, piers)
    f. Navigation and dredging operations (e.g., bathymetric mapping, sediment dynamics)
    g. Others (specify)

4. (***If chosen "Aquaculture (shell farming)" in Q2***) For the" Aquaculture" sector, which services are of higher interest to you? (Rank by order of interest, with 1 being the highest interest)
    a. Oceanographic data: waves, tides (e.g., for Operational and maintenance activities)
    b. Ship detection (e.g., monitoring illegal activity)
    c. Pollution and environmental monitoring (e.g., oil spills, microbiological contamination, chemical contamination, biotoxins)
    d. Effects of climate change (e.g., extreme events, marine heatwaves)

e. **Marine water quality data (e.g., anoxic events, acidification, chlorophyll concentration, jellyfish presence)**
f. Infrastructure monitoring (e.g., cages)
g. Selection of suitable site locations and species (e.g., temperature, salinity, etc)
h. Others (specify)

5. **(If chosen "Aquaculture (fish farming)" in Q2**) For the" Aquaculture" sector, which services are of higher interest to you? (Rank by order of interest, with 1 being the highest interest)
   a. Oceanographic data: waves, tides (e.g., for Operational and maintenance activities)
   b. Marine water quality data: anoxic events, acidification, chlorophyll concentration, jellyfish presence
   c. Ship detection (e.g., monitoring illegal activity)
   d. Pollution and environmental monitoring (e.g., oil spills, microbiological contamination, chemical contamination, biotoxins)
   e. Effects of climate change (e.g., extreme events, marine heatwaves)
   f. Infrastructure monitoring (e.g., cages)
   g. Selection of suitable site locations and species (e.g., water temperature, salinity, etc)
   h. Others (specify)

6. (***If chosen "Fisheries" in Q2***) For the "Fisheries" sector, which services are of higher interest to you? (Rank by order of interest, with 1 being the highest interest)
   a. Maritime climate (e.g., for Operational and maintenance activities)
   b. Ship detection (e.g., monitoring illegal activity)
   c. Pollution and environmental monitoring (e.g., oil spills, water quality)
   d. Effects of climate change (e.g., extreme events, marine heatwaves)
   e. Fishing area characterizations (e.g., areas of higher productivity)
   f. Fisheries certification
   g. Map of sea use (e.g., presence of conflicting human activities)
   h. Others (specify)

7. (***If chosen "Species conservation and protected areas" in Q2***) For the "Species conservation and protected areas" sector, which services are of higher interest to you? (Rank by order of interest, with 1 being the highest interest)
   a. Pressures (e.g., pollution, spills, maritime activities…etc.)
   b. Environmental monitoring (e.g., water quality, ecological status)
   c. Effects of climate change (e.g., sea-level rise, extreme events)
   d. Habitat distribution area and trends
   e. Species distribution area and trends
   f. Map of sea use (e.g., presence of conflicting human activities)
   g. Others (specify)

8. (***If chosen "Maritime transport routes and traffic flows" in Q2***) For the "Maritime transport routes and traffic flows" sector, which services are of higher interest to you? (Rank by order of interest, with 1 being the highest interest)
   a. Maritime climate (e.g., for Operational and maintenance activities)
   b. Ship detection (e.g., monitoring vessel activity and flows)
   c. Pollution and environmental monitoring (e.g., oil spills, water quality)
   d. Effects of climate change (e.g., new routes, extreme events)
   e. Weather services
   f. Navigation (e.g., Bathymetry, Sediment dynamics monitoring, etc.)
   g. Others (specify)

9. (***If chosen "Energy sector" in Q2***) For the "Energy sector" sector, which services are of higher interest to you? (Rank by order of interest, with 1 being the highest interest)
   a. Maritime climate (e.g., for Operational and maintenance activities)
   b. Ship detection (e.g., monitoring vessel activity)

c. Environmental monitoring (e.g., oil spills, water quality)
d. Effects of climate change (e.g., sea-level rise, extreme events)
e. Selection of suitable renewable energy locations (wind, waves, currents)
f. Bottom geologic maps
g. Energy production surveying
h. Map of sea use (e.g., presence of conflicting human activities)
i. Others (specify)

10. (***If chosen "Coastal protection" in Q2***) For the "Coastal protection" sector, which services are of higher interest to you? (Rank by order of interest, with 1 being the highest interest)
    a. Maritime climate (e.g., winds, waves and current forecasts)
    b. Pollution and environmental monitoring (e.g., eutrophication, water quality)
    c. Effects of climate change (e.g., sea-level rise, extreme events)
    d. Monitoring and prevention of coastal erosion
    e. Bathymetry and sedimentation
    f. Coastline detection
    g. Characterisation of emerged coastal areas (e.g., sediment dimension, inland extension of the beach, presence of dunes)
    h. Others (specify)

11. (***If chosen "Raw material extraction" in Q2***) For the "Raw material extraction" sector, which services are of higher interest to you? (Rank by order of interest, with 1 being the highest interest)
    a. Maritime climate (e.g., for Operational and maintenance activities)
    b. Ship detection (e.g., monitoring vessel activity)
    c. Pollution and environmental monitoring (e.g., oil spills, water quality)
    d. Effects of climate change (e.g., sea-level rise, extreme events)
    e. Map of sea use (e.g., presence of conflicting human activities)
    f. Others (specify)

12. (***If chosen "Tourism and recreational activities" in Q2***) For the "Tourism and recreational activities" sector, which services are of higher interest to you? (Rank by order of interest, with 1 being the highest interest)
    a. Maritime climate (e.g., for weather)
    b. **Effects of climate change (e.g., sea-level rise, extreme events)**
    c. Water quality (e.g., preserving human health in bathing waters)
    d. Identification of pressures (e.g., land use, presence of urban wastewaters or industrial waters discharges)
    e. Landscape quality (e.g., absence of infrastructures, presence of nature-based solutions)
    f. Others (specify)

13. (***If chosen "Other" in Q2***) For "Other" sectors, select one of the lists below and describe which services are of higher interest to you.
    a. Military
    b. Exploration, exploitation, and extraction
    c. Scientific research
    d. Underwater cultural heritage
    e. Submarine cable and pipeline routes

Concerning the sectors mentioned above, we will analyse the challenges you have encountered when searching/working for data related with them.

14. Within the framework of your current activities, what problems do you encounter when working with the data available to you? (***Multiple choices allowed***)
    a. Complexity of the data
    b. Data format
    c. Data reliability
    d. Heterogeneous data collection methodologies
    e. Heterogeneous sources

f. Inaccessible data or unavailability of data
g. Incomplete Temporal distribution
h. Incomplete Spatial distribution
i. Unsuitable resolution
j. Lack of tools to manipulate the data.
k. Other, please specify.

15. Within the framework of your current activities, what temporal extent of the data would you need? (***Multiple choices allowed***)
    a. Real time or near real time (h)
    b. Short term forecast (day-week)
    c. Long term projections (month)
    d. Long term historical data series (years)

16. Within the framework of your current activities, what spatial resolution of the data would you need? (***Multiple choices allowed***)
    a. Reduced (>1Km)
    b. Low (>= 250 m-1Km)
    c. Medium (5-30 m)
    d. High (1-5 m)
    e. Very high (< 1 m)
17. Have you participated in the implementation of these Directives in your Country? (***Multiple choices allowed***)
    a. EU Marine Strategy Framework Directive (Directive 2008/56/EC; MSFD)
    b. EU Marine Spatial Planning Directive (Directive 2014/89/EU; MSP)

18. (***If yes in Q17.b***)
    a. In what period? (***Multiple choices allowed***)
        i. 2012-2018
        ii. 2018-2024
    b. In what phase of MSP? (***Multiple choices allowed***)
        i. Establishment of management objectives
        ii. Diagnosis of the current situation
        iii. Land-sea interactions
        iv. Maritime spatial plans
19. In what period? (***Multiple choices allowed***)
    a. 2012-2018
    b. 2018-2024

20. In what phase of MSFD? (***Multiple choices allowed***)
    a. initial assessment
    b. determination of good environmental status
    c. establishment of environmental targets and associated indicators
    d. monitoring programme
    e. programme of measures

21. What Marine Region do you belong to?
    a. Baltic Sea
    b. North-east Atlantic Ocean
    c. Mediterranean Sea
    d. Black Sea

22. What subdivisions (if exist) of the Marine region do you belong to? (***Each country please specify yours***)
    a. North-Atlantic
    b. Sud-Atlantic
    c. …
    d. …

e. …

23. Following the classification in COMMISSION DECISION (EU) 2017/848, which of the following descriptors and Criteria elements are you related with? (***Multiple choices allowed***)
    1. Biodiversity
        - Species groups (specify which):
            - birds,
            - mammals,
            - reptiles,
            - fish
            - cephalopods
        - Pelagic habitats (specify which)
        - Benthic habitats (specify which)
        - Ecosystems, including food webs (specify which)
    2. non-indigenous species
    3. Commercial fish species
    4. Food webs
        - Ecosystems, including food webs (specify which)
    5. Eutrophication
    6. Sea floor
        - Benthic habitats (specify which)
    7. Hydrographical conditions
    8. Contaminants and effects
    9. Contaminants in seafood
    10. Marine litter
    11. Introduction of energy (including underwater noise)

Concerning the descriptors/criteria mentioned above, we will analyse the challenges you have encountered when searching/working for data related with them.

24. What are the main knowledge gaps descriptors you encountered when working with the descriptor/criteria specified above? (***Multiple choices allowed***)
    a. Abundance
    b. Biomass
    c. Concentration
    d. Duration
    e. Genetics
    f. Pressures and impacts
    g. Spatial cover/ extent
    h. Spatial distribution
    i. Temporal distribution
    j. Other, please specify.

25. Within the framework of your current activities, what problems do you encounter when working with the data available to you? (***Multiple choices allowed***)
    a. Complexity of the data
    b. Data format
    c. Data reliability
    d. Heterogeneous data collection methodologies
    e. Heterogeneous sources
    f. Inaccessible data or unavailability of data
    g. Incomplete Temporal distribution
    h. Incomplete Spatial distribution
    i. Unsuitable resolution
    j. Lack of tools to manipulate the data.
    k. Other, please specify.

26. Within the framework of your current activities, what temporal extent of the data would you need? (***Multiple choices allowed***)
    a. Real time or near real time (h)
    b. Short term forecast (day-week)
    c. Long term projections (month)
    d. Long term historical data series (years)

27. Within the framework of your current activities, what spatial resolution of the data would you need? (***Multiple choices allowed***)
    a. Reduced (>1 Km)
    b. Low (>= 250 m - 1 Km)
    c. Medium (5-30 m)
    d. High (1-5 m)
    e. Very high (< 1 m)

28. Have you ever heard before about the Copernicus program?
    a. Yes
    b. No

29. (***If yes in Q28***) Are you familiar with the different definitions of "Copernicus Satellite Data" and "Copernicus Service Products".
    a. Yes
    b. No

30. (***If yes in Q28 go to a; If no in Q28 go to b***) Do you use data from Copernicus?
    a. If Yes
        i. How often?
            1. every week
            2. every month
            3. every year
        ii. For what purpose (i.e., use case)? (Please specify)
        iii. What kind of Copernicus data do you use?
            1. In situ data
            2. Satellite-derived products
            3. Modelled-derived products.
        iv. Do you consider yourself as a basic, intermediate, or advanced Copernicus data user?
            1. Basic
            2. Intermediate
            3. Advance
        v. What is your level of satisfaction with Copernicus? (Set from 1(low) to 5 (very high))
            1. 1
            2. 2
            3. 3
            4. 4
            5. 5
        vi. How can Copernicus data be improved (e.g., new products, different spatial/temporal resolutions, improved access)? (Please specify)

    b. If No, why?
        i. I do not have enough knowledge or skills to use them.
        ii. I do not have enough staff or time to do it.
        iii. Not relevant for me
        iv. Other

31. Within the framework of your current activities, do you use most: (***multiple choices allowed***)
    a. Programming languages (C++, Python, Java, MATLAB, etc)

b. Mapping software (ArcGIS, MapInfo, Qis, etc)
c. Image processing software (SNAP, Google Earth Engine, etc)
d. Visualisation software (EO browser, etc)
e. I do not use any.

32. Besides Copernicus data, what kind of data or services would you need? (Please specify)
33. From your entity's perspective, which space solutions (e.g., products, providers) are relevant to the maritime domain, that you are familiar with/have you heard of? (Please specify)
34. Would you be interested to attend a workshop presenting the different tools and services offered by Copernicus?

a. Yes
b. No

Annex III: Survey stakeholders for Estonia

University of Tartu
Estonian Marine Institute of UT
AS Sillamäe Port
Estonian Ministry of Environment
Estonian Environmental Agency

Annex IV: open-ended questions summary replies

Purposes for using Copernicus data (Q.30ii)

- Research
- If I need information about larger areas. The most I use for giving an overview of the environmental status of the Baltic Sea or to track changes in some specific parameters
- As I do not have in situ data, then just to get an overview
- Directly I do not use, but I look at different trends in time

Suggestions for Copernicus improvement (Q.30vi)

- Easier access
- Easier search modules - now even the place to start is difficult to find
- Better resolution and services, which have high overlap with real data
- It is hard to suggest something, when not an every-day user, but to develop specific services for the Baltic Sea area, centralized service for assessment of D5 criteria for all member states

Space solutions relevant to the maritime domain (Q.33)

- Different GIS solutions
- Cloud-based tool for analyses. Even more important in the future, when data volume increases even more
- GIS-information of human activities, and under-water objects
- Data fusion techniques to filling gaps due to clouds for optical sensor