



# Traffic Density Mapping Service

## User Guide

Version: 2.0

Date: 22.01.2024



## Document History

Version	Date	Changes	Prepared
1.0	10/10/2019	Initial version of the TDM Service	EMSA
1.1	17.03.2022	Amended draft version. Includes TDMS-2 developments	EMSA
1.1.1.	08.08.2022	Revised version	EMSA
2.0	22.01.2024	Version of TDMS-2 service (Final version)	EMSA

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## List of Abbreviations

Abbreviation	Explanation
AIS	Automatic Identification System
INSPIRE	INfrastructure for SPatial Information is the Directive 2007/2/EC regarding spatial data and supporting the creation of policy relating to the environment.
EMSA	European Maritime Safety Agency
EU	European Union
SAI	Specific area of interests defined by the users
SEG	SSN Ecosystem Graphical Users Interface
SSN	SafeSeaNet
TDM	Traffic Density Map
VTMIS	Vessel Traffic Monitoring Information System

# 1. Purpose of the document

This document is a user guide for the Traffic Density Mapping service. It provides a general description of Traffic Density Maps (TDM) and explains how they can be displayed in the SafeSeaNet Ecosystem's Graphical user interface (SEG).

This document is available on EMSA's website: <https://emsa.europa.eu/ssn-main/documents.html>

## 2. Background

### 2.1 Concept

TDMs are a simple and effective way of displaying vessel movement patterns and contribute to a better understanding of maritime traffic, locations of the main shipping lanes and of ship types navigating on routes.

The method used to generate TDMs is the “**ship routes restoring method**”. This method rebuilds the track of each distinct ship from the recorded positions and counts how many routes are crossing each cell of a grid during a given period of time. This method can be implemented in all regions (coastal and open sea), using all the available ships position data available to EMSA and allows connecting routes even within areas with a low coverage.

TDMs are calculated from historical Terrestrial and Satellite AIS ships position data covering EU coastal areas as well as open sea areas outside the Terrestrial AIS coverage.

The following types of TDMs are available:

- Standard,
- Comparative,
- Vector, and
- Detailed.

#### 2.1.1 Standard TDMs

Standard TDMs are created for each of the following predefined areas:

- Baltic Sea
- North Sea/North Atlantic
- Atlantic
- Mediterranean Sea
- Black Sea
- All Europe (i.e. including all the above areas)

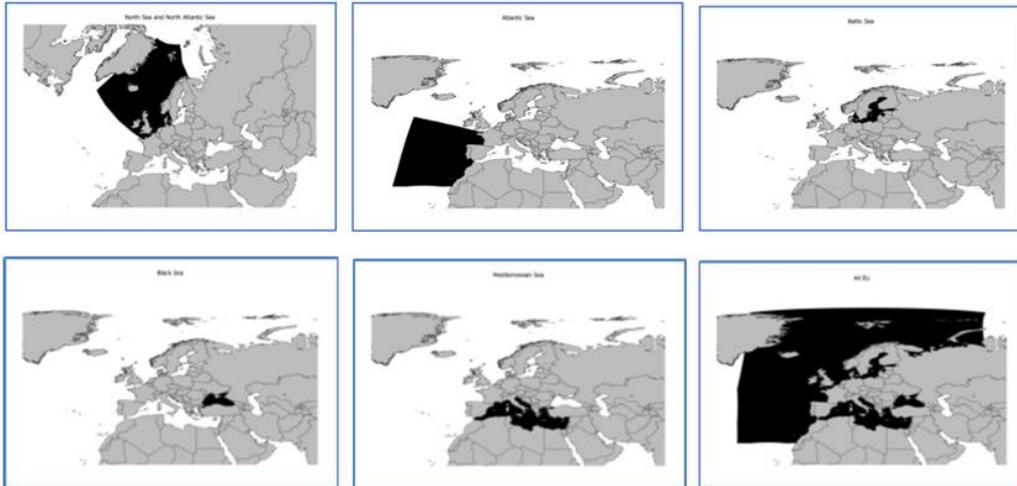


Figure 1: TDMS areas

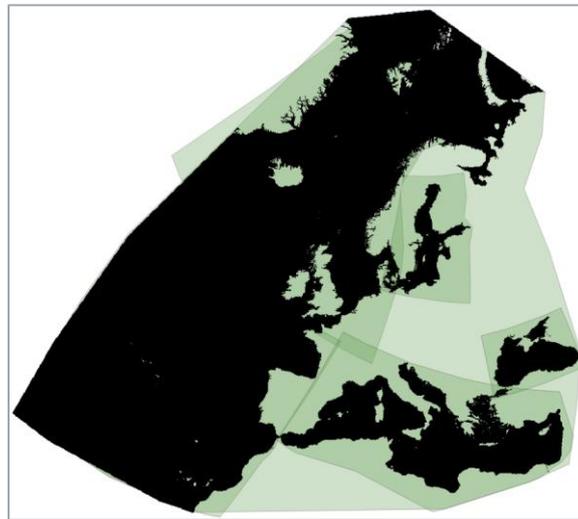


Figure 2: TDMS areas

Standard TDMs are calculated for the following time periods:

- **Month** - presents the data collected during a calendar month, from the first day until the last day of the corresponding month.
- **Season** - presents the data collected during the following periods:
  - Spring (period: March, April, May)
  - Summer (period: June, July, August)
  - Autumn (period: September, October, November)
  - Winter (period: December, January, February)
- **Year** - presents the data collected during a calendar year.

The basic period for the Standard TDM is one month. The monthly maps are combined in order to create seasonal or annual TDMs. All calculations are provided for the preceding period of reference.

Standard TDMs are produced for the following ranges of AIS ship types:

- **Passenger** - AIS type codes 60 to 69,
- **Cargo** - AIS type codes 70 to 79,

- **Tanker** - AIS type codes 80 to 89,
- **Fishing** - AIS type code 30,
- **All other** - includes all ship types not listed above, and
- **All Traffic** - includes all ships monitored.

### 2.1.2 Detailed TDMs

Detailed traffic density maps present the traffic density in the Specific Areas of Interest (SAIs). The reference grids used to build Detailed TDMs have a definition of 200x200 meters. The grid cells are aligned to the cells used for the Standard TDMs.

### 2.1.3 Vector TDMs

Vector TDMs present routes (polylines) of ships within Specific Areas of Interest (SAIs). A Vector TDM is a set of daily ships routes segments contained in a certain time period, i.e. the route of the ship from its entry in the area to its exit is cut into daily segments covering the ship's positions during 24h periods. The ship route is a polyline connecting consecutive ship's positions<sup>1</sup>.

### 2.1.4 Comparative TDMs

Comparative TDMs present the difference between two selected Standard TDMs or Detailed TDMs of the same type, time period category, area but different time periods.

Comparative TDMs are constructed "on-the-fly", on the user's request in SEG. They present the differences in values per cell using colour ranges.

## 2.2 Methodology used to create TDMs

The sections below provide an overview of the methodologies for calculating TDMs. More details are provided in the TDM methodology document which is available on EMSA's website.

### 2.2.1 Standard TDMs

The following steps are used to calculate a Standard TDM:

- a. Divide the selected area in cells,
- b. Aggregate ships positions per grid cell,
- c. Connect ship positions to create polylines, sort the polylines per ships type ranges,
- d. Count grid cell crossings,
- e. Apply a density classification colouring, and
- f. Make the maps available to SEG.

The result is a TDM **per ship type range, per area and per time period**. The steps are presented in Figure 3.

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<sup>1</sup> Reported AIS positions

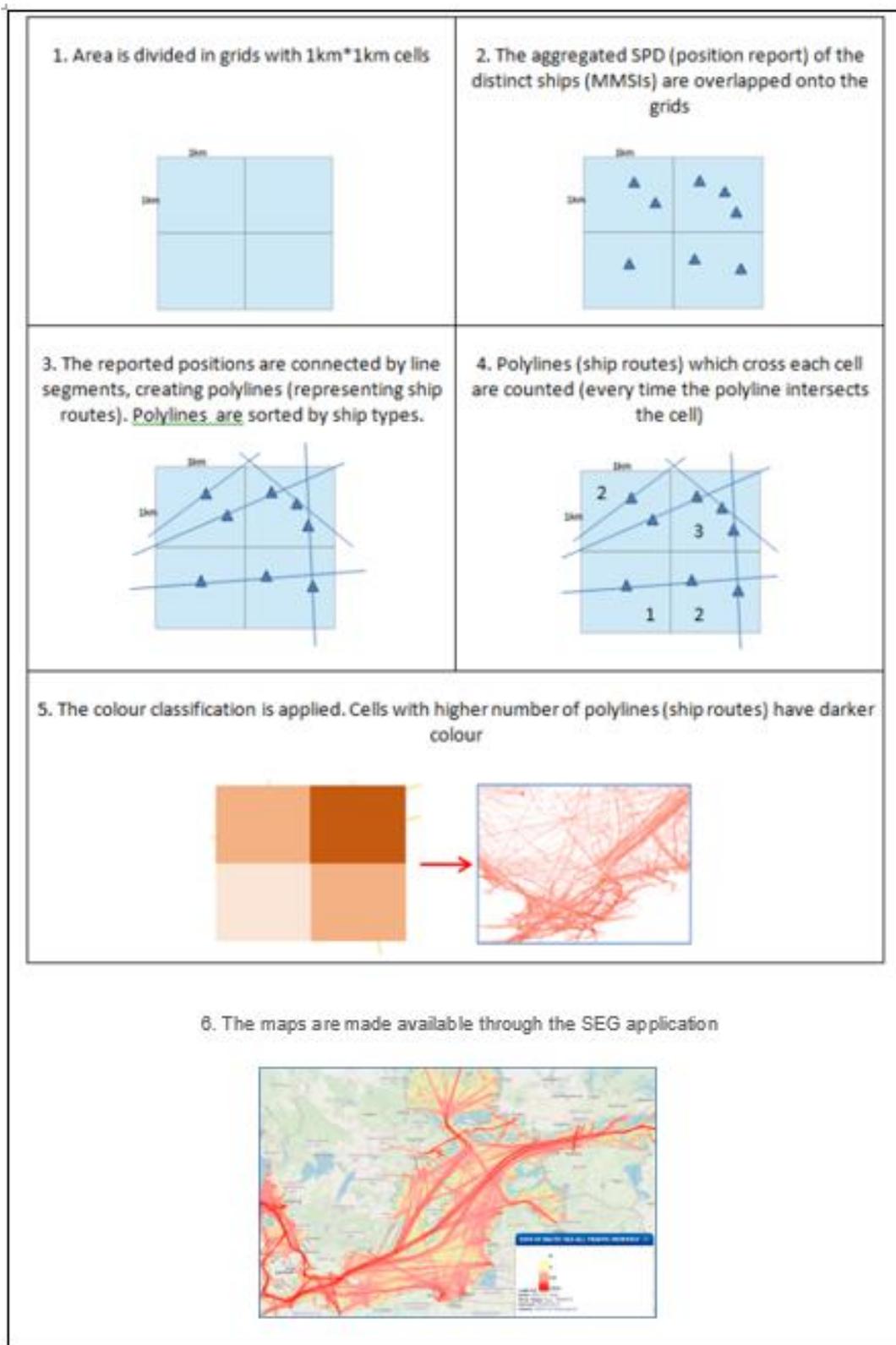


Figure 3: Steps for creating a TDM

### 2.2.2 Detailed TDMs

The general steps for creating a Detailed TDM are the same as for Standard TDMs, but reference grids have a definition of 200x200 meters. Detailed maps are created using the same ships positions data as for Standard TDMs. Filtering and down sampling configurations are identical as well.

Detailed maps are constructed for all time categories (month, spring, summer, autumn, winter, year) and ship types ranges (i.e. Cargo, Tanker, Fishing, Passenger, All Other and All Traffic), but only for the predefined specific areas of interest (SAIs).

### 2.2.3 Vector TDMs

Calculation of Vector TDMs follows the general TDMS methodology with some exceptions. Ship routes calculations follow the same algorithms as for Standard and Detailed TDMs. The same filtering, down sampling and routes reconstruction configurations are applied as well. However, the reconstructed routes undergo an additional processing to calculate ship routes' metadata (speed, duration, length).

Vector TDMs are calculated for specific areas (SAIs) and are provided per month only. Vector TDMs are not generated per individual ship type range, the only proposed ship type range is "All traffic".

#### Routes length

The system calculates the total length of all ship routes in the area. The routes' lengths are measured from the ship's entrance in the area (or the first position) to its exit from the area (or the last position). The route's length is calculated for each route segment. The statistics are calculated by aggregating the data.

#### Average ships speed

The system calculates the average ship speed of all routes. The average speed is also calculated for each route's segment. The statistics are calculated by aggregating the data.

#### Ships routes duration

The system calculates a total duration of all ship routes, measured from ship's entrance in the area (or the first timestamp), until the ship's exit from the area (or the last timestamp). The duration of each route segment is also calculated. The statistics are calculated by aggregating the data.

### 2.2.4 Comparative TDMs

The TDM service requires, as a parameter to create Comparative TDM, the identification of two Standard or Detailed TDMs. Only existing maps (pre-calculated and available) can be selected. The traffic density values in the newer map are compared against the values in older map. The newer (most recent) map is always used as a reference to define differences. Comparative TDMs are calculated on request and are not stored.

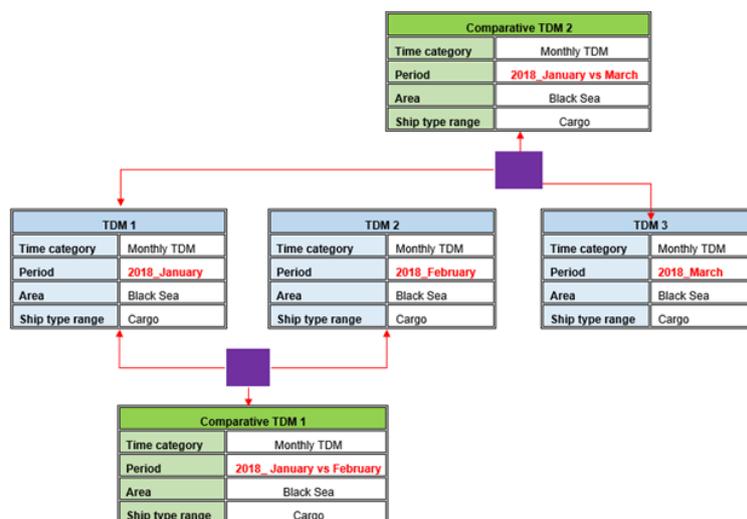


Figure 4: Comparative TDMs calculation

## 2.3 Users

Access to TDMs is restricted to end-users having access to SEG and to operation “IVTMIS”, who have the following user profiles: SSN NCA, Maritime Authority, or Port.

Users with profile Port can only view Standard TDMs and Standard Comparative TDMs (no download is possible).

## 2.4 Use of TDM data products

The TDMs data files are produced by EMSA to support the VTMIS purposes and objectives. The users shall refer to EMSA as the source of information when using the TDM data or promoting the TDM based services, or generating related publications, whatever the purpose.

### 3. How to display TDMs in SEG

TDMs are available to users through the EMSA SEG application. To access the maps, users should complete the following steps:

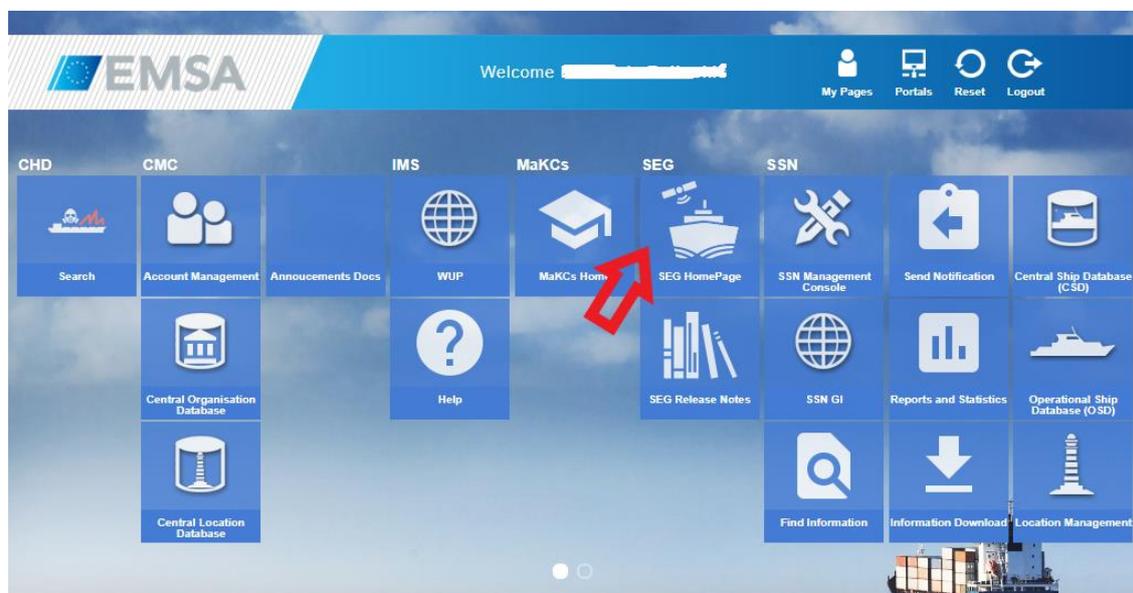
#### 3.1 Access the Maritime Applications Portal

Use your “Username” and “Password” to log in EMSA’s Maritime Applications Portal.



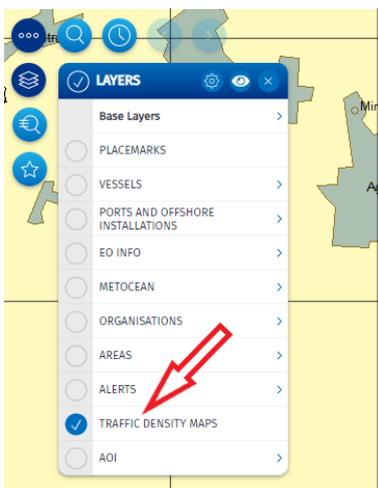
#### 3.2 Open the SEG application

Click on the SEG application icon.

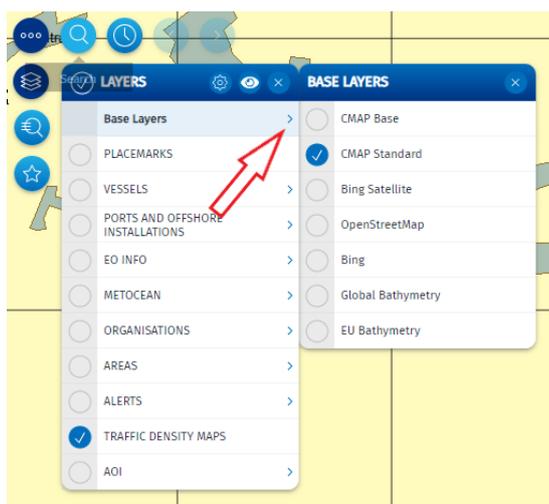


### 3.3 Activate the Traffic Density Maps layer

In the layers panel, select the layer “Traffic Density Maps”



The base layer (background map) can be changed by using the option “**Base layers**”.

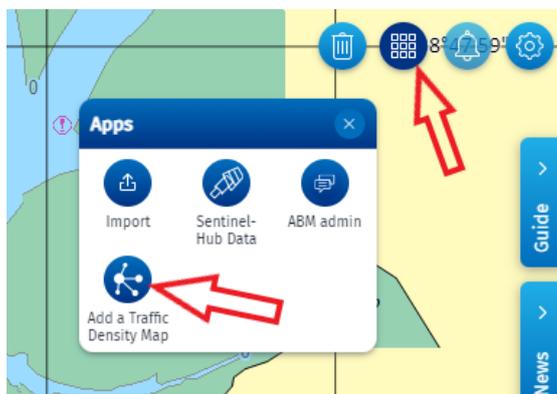


### 3.4 Open the TDM app

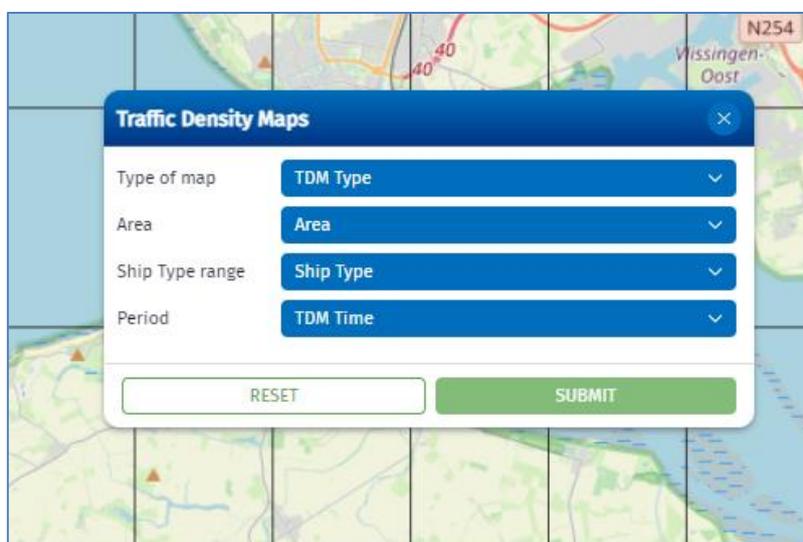
Click on the “Apps” icon to open the “Apps” panel.



Click on the “**Add Traffic Density Map**” icon.



A new panel “**Traffic Density Maps**” will open, allowing to request the TDM to be displayed.



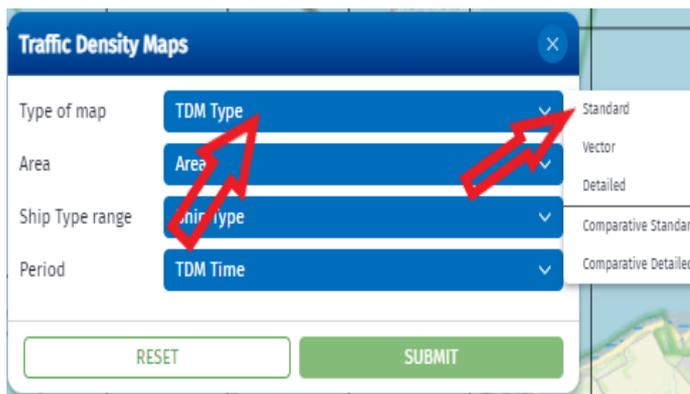
The panel can be moved by grabbing and dropping it to a new location on the screen.

## 3.5 Select the map

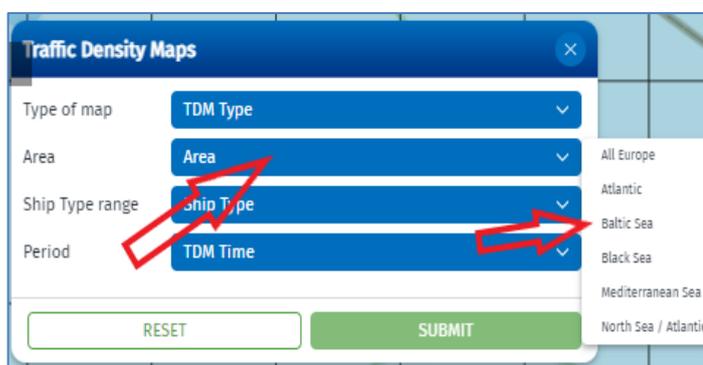
### 3.5.1 Select Standard TDM

To request a Standard TDM, all the criteria must be selected (**Type of map**; **Area**, **Ship Type range** and **Period**) using the drop-down menus.

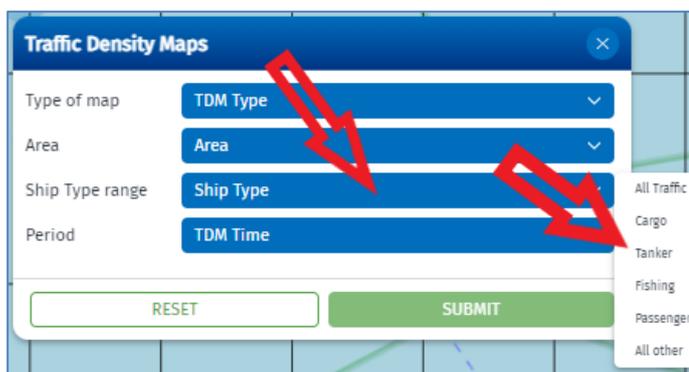
- **Type of map**: Click on the “**TDM Type**” bar and then on a map type (e.g. Standard) in the drop-down menu.



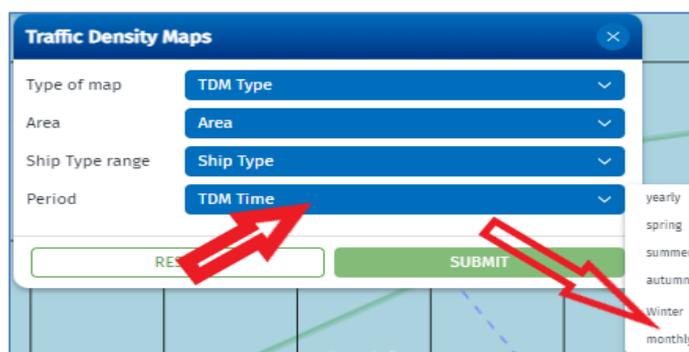
**Area:** Click on the “**Area**” bar and then on the selected area (e.g. Baltic Sea) in the drop-down menu.



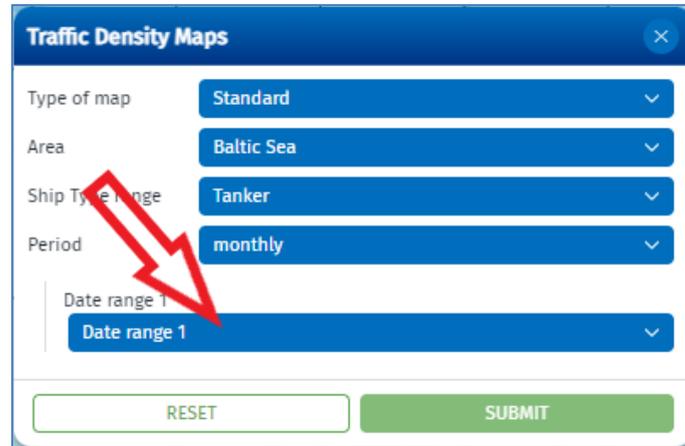
- **Ship type range:** Click on the “**Ship Type**” bar and then on a ship type range (e.g. Tanker) in the drop-down menu.



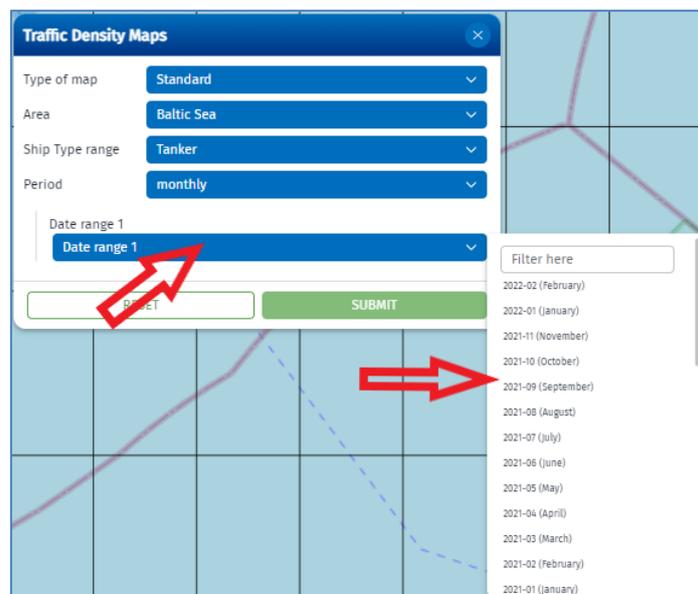
- **Period:** Click on the “**TDM Time**” bar, then click on the time period (e.g. “Monthly”) in the drop-down menu.



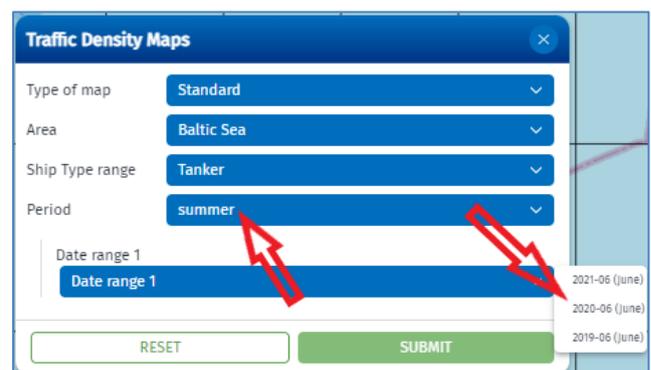
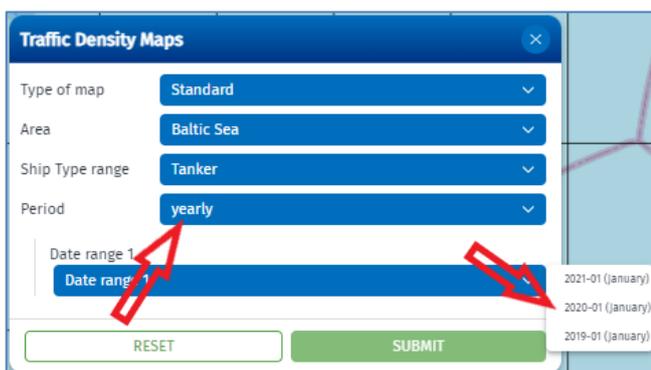
After selecting the period (e.g. monthly TDM), a new selection bar “**Date range-1**” will be enabled, allowing to specify the month, season or year of the map (depending on the selected period).



Click on the “**Date range -1**” bar and then select the month (or e.g. season) from the drop-down menu. The drop-down menu shows all maps available for this category.



**Note:** All maps are sorted by the year and month (e.g. “2019-08(August)”). Dates ranges of seasonal maps are named by the first month in the season, e.g. the name of the map for spring 2019 is “2019-03(March)”. Date ranges of yearly maps are named by the first month in the year, e.g. “2020-01(January)”.

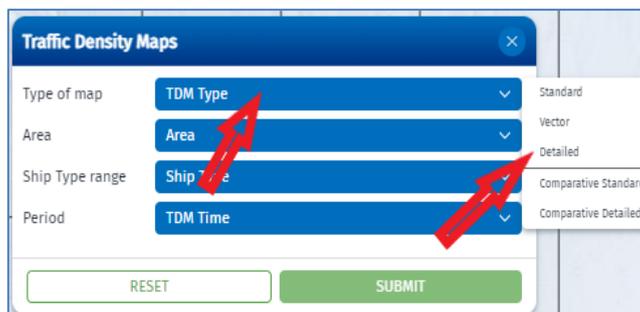


### 3.5.2 Select Detailed TDM

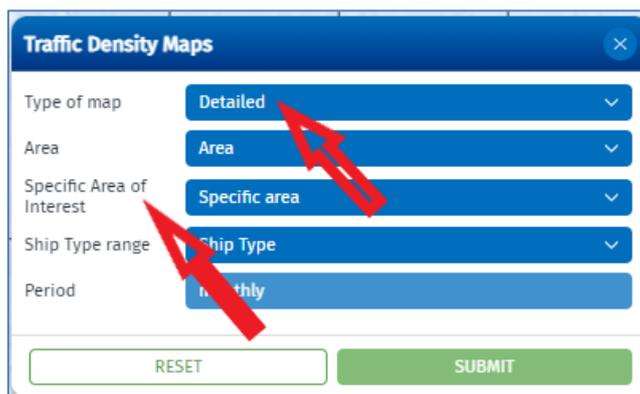
To request a Detailed TDM, all the required criteria must be selected (**Type of map**; **Area**, **Specific Area of Interest**, **Ship Type range** and **Period**) using the drop-down menus.

**Note:** selection bar “**Specific Area of Interest**” will be activated only if the selected type of map is “Detailed”.

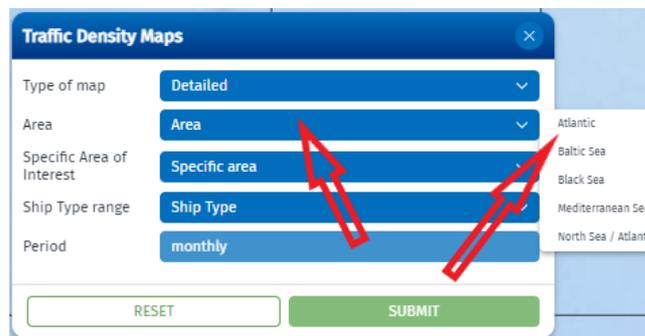
- **Type of map:** Click on the “**TDM Type**” bar and then on a map type (e.g. Detailed) in the drop-down menu.



After selecting the type of map “Detailed”, a new selection bar “**Specific Area of Interest**” will be enabled, allowing to specify the map (depending on the selected area).

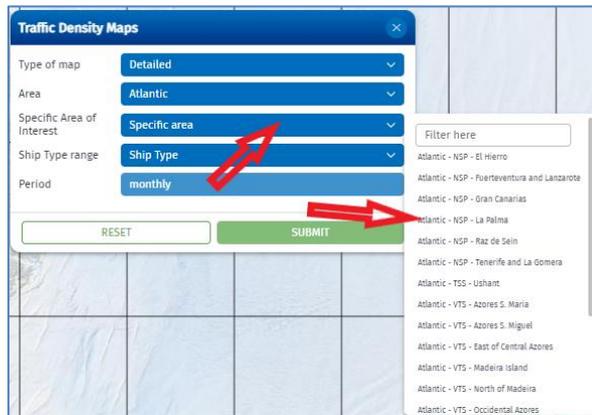


- **Area:** Click on the “**Area**” bar and then on an area (e.g., Atlantic) in the drop-down menu.

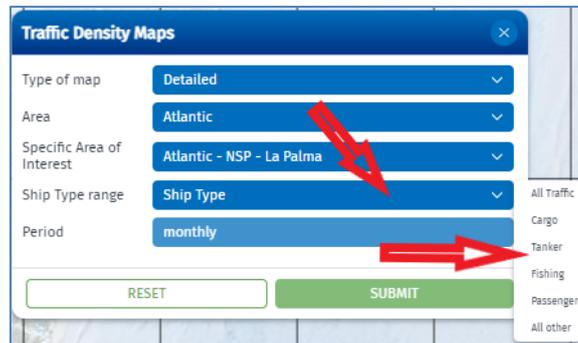


**Note:** for Detailed TDMs, the drop-down menu will not include the area “All Europe”

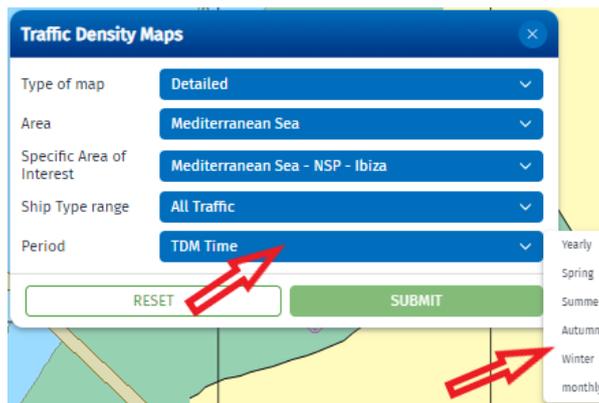
- **Specific Area of Interest:** Click on the “*Specific Area*” bar and then select the SAI (e.g., NSP – La Palma) from the drop-down menu. The drop-down menu shows all SAIs available for this type of map and the selected area.



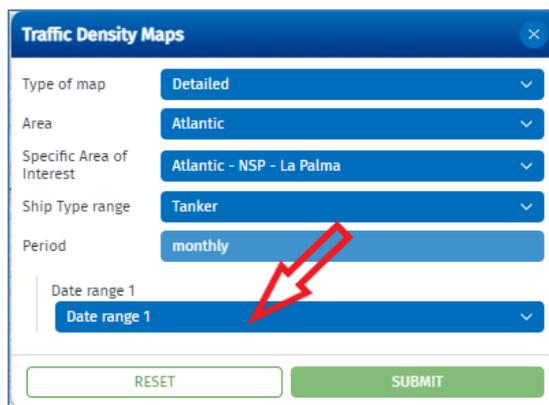
- **Ship type range:** Click on the “*Ship Type*” bar and then on a ship type range (e.g., Tanker) in the drop-down menu.



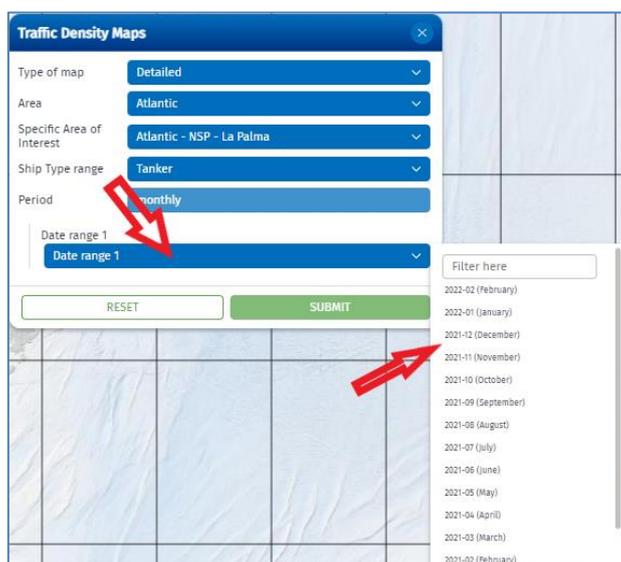
- **Period:** Click on the “*TDM Time*” bar, then click on the time period (e.g., “Monthly”) in the drop-down menu.



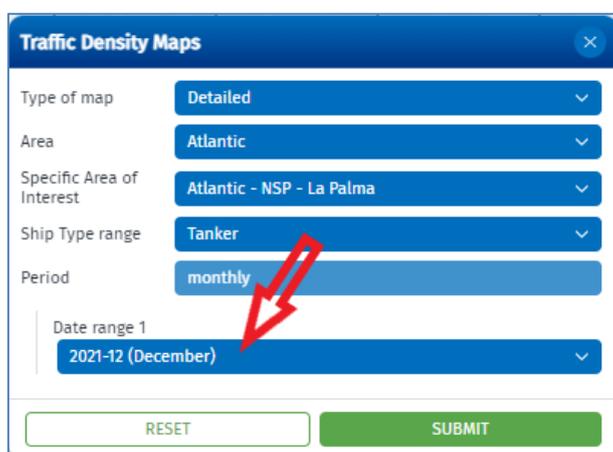
After selecting the period, a new selection bar “Date range-1” will be enabled, allowing to specify the month, season, or year of the map (depending on the selected period) (e.g., “2019-08(August)”).



- **Date range:** Click on the “*Date range*” bar and then select the month (or e.g., season or year) from the drop-down menu. The drop-down menu shows all maps available for this category.



**Note:** Date ranges of seasonal maps are named by the first month in the season, e.g., the name of map for spring 2019 is “2019-03(March)”. Date ranges of yearly maps are named by the first month in the year, e.g., “2020-01(January)”.



### 3.5.3 Select Vector TDM

To request a Vector TDM, all the required criteria must be selected (i.e. **Type of map**; **Area**, **Specific Area of Interest** and **Period**) using the drop-down menus.

**Note:** selection bar “**Specific Area of Interest**” will be activated only if the selected type of map is “Vector”.

**Note:** for Vector TDMs, only the period “Monthly” and the ship types range “All traffic” are available by default.

- **Type of map:** Click on the “**TDM Type**” bar and then on a map type (e.g. Vector) in the drop-down menu.

The screenshot shows the 'Traffic Density Maps' selection interface. The 'Type of map' dropdown menu is open, displaying options: Standard, Vector, Detailed, Comparative Standard, and Comparative Detailed. Red arrows point to the 'Vector' option and the 'TDM Type' bar. Other fields include 'Area' (Area), 'Ship Type range' (All traffic), and 'Period' (TDM Time). There are 'RESET' and 'SUBMIT' buttons at the bottom.

After selecting the type of map “Vector”, a new selection bar “**Specific Area of Interest**” will be enabled, allowing to specify the map (depending on the selected area).

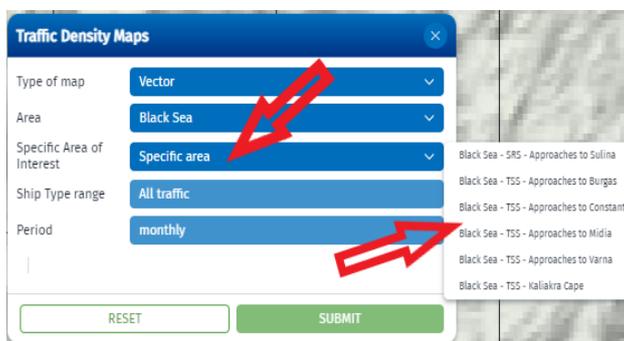
The screenshot shows the 'Traffic Density Maps' selection interface. The 'Type of map' is set to 'Vector'. The 'Specific Area of Interest' dropdown menu is open, displaying options: Atlantic, Baltic Sea, Black Sea, Mediterranean Sea, and North Sea / Atlantic. Red arrows point to the 'Specific area' option and the 'Area' bar. Other fields include 'Area' (Area), 'Ship Type range' (All traffic), and 'Period' (monthly). There are 'RESET' and 'SUBMIT' buttons at the bottom.

- **Area:** Click on the “**Area**” bar and then on an area (e.g. Atlantic) in the drop-down menu.

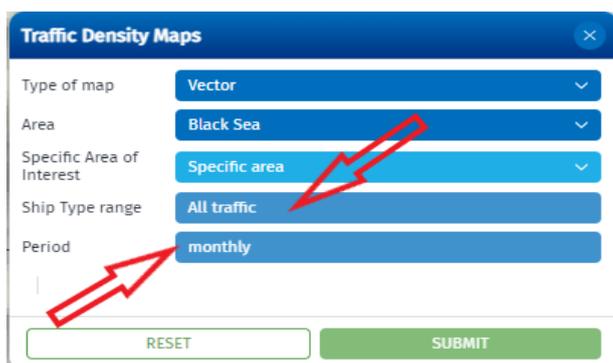
The screenshot shows the 'Traffic Density Maps' selection interface. The 'Area' dropdown menu is open, displaying options: Atlantic, Baltic Sea, Black Sea, Mediterranean Sea, and North Sea / Atlantic. Red arrows point to the 'Atlantic' option and the 'Area' bar. Other fields include 'Type of map' (Vector), 'Specific Area of Interest' (Specific area), 'Ship Type range' (All traffic), and 'Period' (monthly). There are 'RESET' and 'SUBMIT' buttons at the bottom.

**Note:** for Vector TDMs the drop-down menu will not include the area “All Europe”

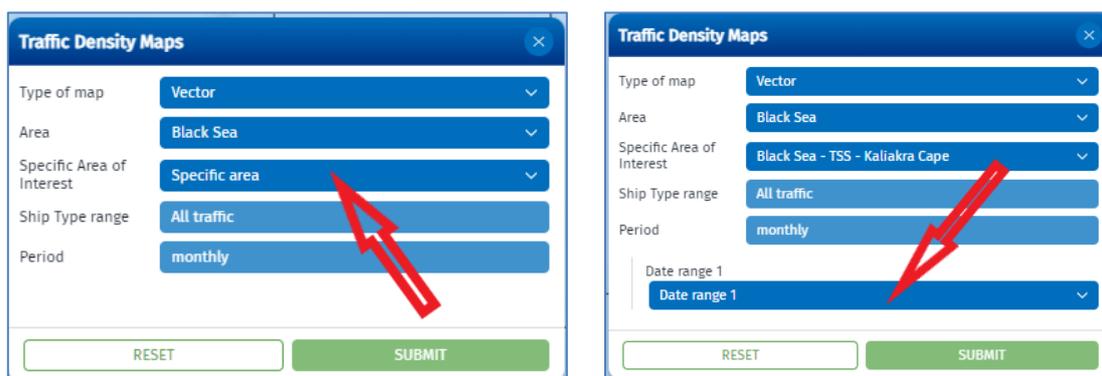
- Specific Area of Interest:** Click on the “*Specific Area*” bar and then select the SAI (e.g. TSS Kaliakra Cape) from the drop-down menu. The drop-down menu shows all SAIs available for this type of map and the selected area.



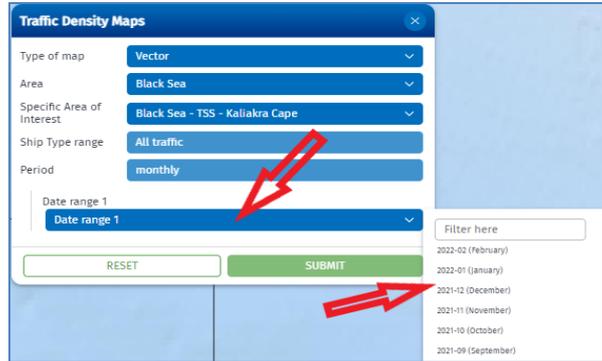
- Ship type range:** for Vector TDMs, the only ship type range “All traffic” is available by default. This value is pre-configured and cannot be changed.
- Period:** for Vector TDMs, the only period “Monthly” is available by default. This value is preconfigured and cannot be changed.



After selecting the “*Specific Area of Interest*”, a new selection bar “*Date range-1*” will be enabled, allowing to specify the month of the map (e.g. “*2019-08(August)*”).



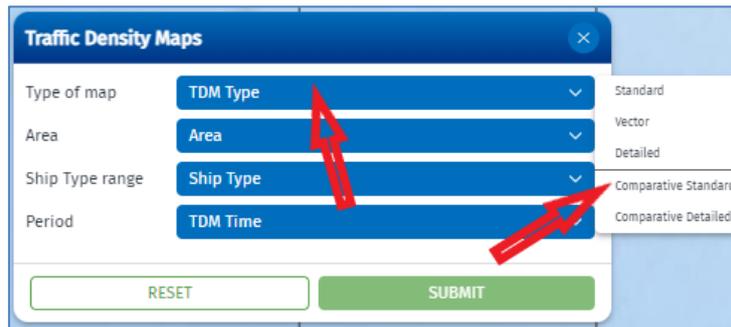
Click on the “**Date range**” bar and then select the month (e.g. 2021-12(December) from the drop-down menu. The drop-down menu shows all maps available for this category.



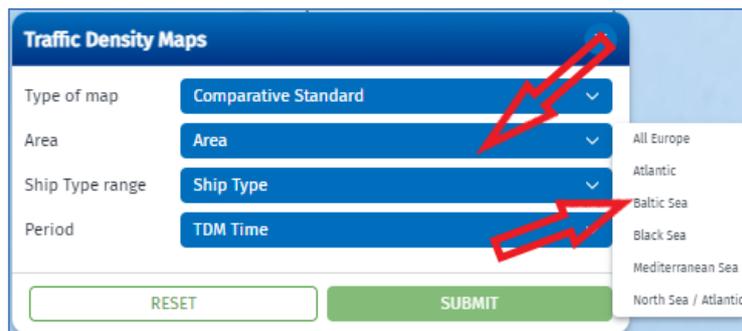
### 3.5.4 Select Comparative Standard TDM

To request a Comparative Standard TDM, all the required criteria must be selected (i.e. **Type of map**; **Area**, **Ship Type range** and **Period**) using the drop-down menus.

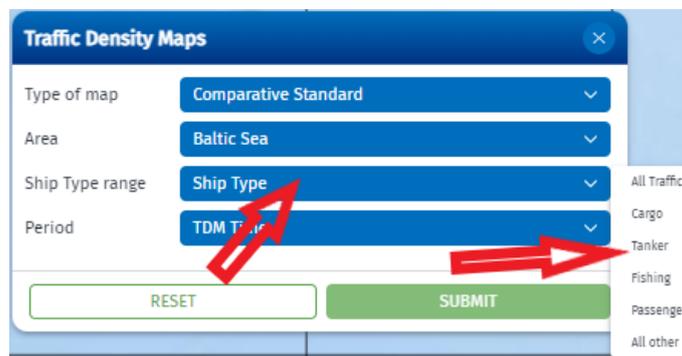
- **Type of map:** Click on the “**TDM Type**” bar and then on a map type (Comparative Standard) in the drop-down menu.



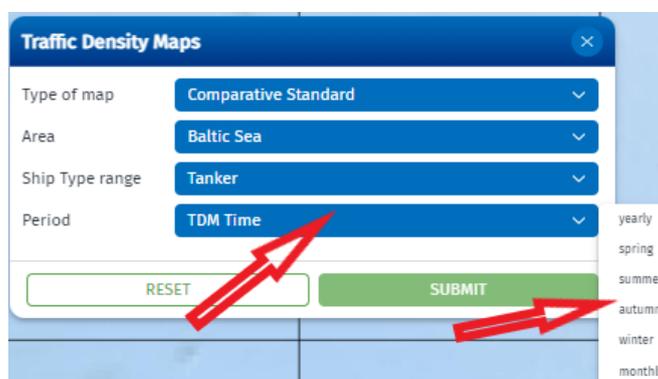
- **Area:** Click on the “**Area**” bar and then on the selected area (e.g. Baltic Sea) in the drop-down menu.



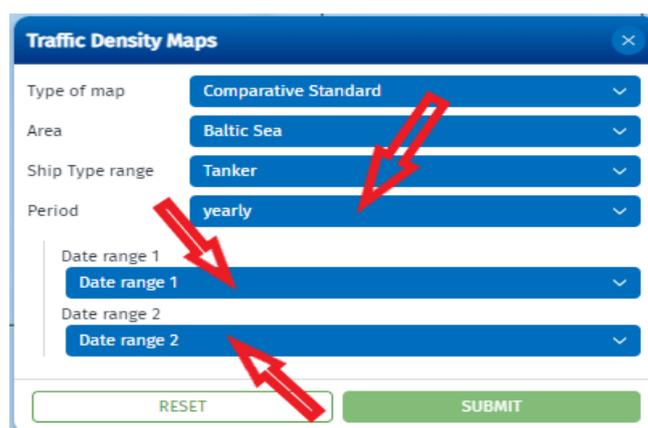
- **Ship type range:** Click on the “*Ship Type*” bar and then on a ship type range (e.g. Tanker) in the drop-down menu.



- **Period:** Click on the “*TDM Time*” bar, then click on the time period (e.g. “Yearly”) in the drop-down menu.



After selecting the period (e.g. yearly), two new selection bars “*Date range-1*” and “*Date range-2*” will be enabled, allowing to specify the time criteria (month, season or year - depending on the selected period) of two corresponding Standard TDMs to be compared ((e.g. “2019-01(January)” and “2020-01(January)”)<sup>2</sup>.



**Note:** Date ranges of seasonal maps are named by the first month in the season, e.g. the name of the map for spring 2019 is “2019-03(March)”. Date ranges of yearly maps are named by the first month in the year, e.g. “2020-01(January)”.

<sup>2</sup> For Date range-1 select the newest of two maps to be compared

- **Date range-1:** Click on the “**Date range-1**” bar and then select from the drop-down menu the month, season or year (depending on the period selected) of the first map. The drop-down menu shows all maps available for this category.

The screenshot shows the 'Traffic Density Maps' form with the following settings: Type of map: Comparative Standard; Area: Baltic Sea; Ship Type range: Tanker; Period: yearly. The 'Date range 1' dropdown is open, showing options for 2021-01 (January), 2020-01 (January), and 2019-01 (January). Red arrows indicate the selection process.

- **Date range-2:** Click on the “**Date range-2**” bar and then select from the drop-down menu the month, season, or year (depending on the period selected) of the second map. The drop-down menu shows all maps available for this category.

The screenshot shows the 'Traffic Density Maps' form with the following settings: Type of map: Comparative Standard; Area: Baltic Sea; Ship Type range: Tanker; Period: yearly. The 'Date range 1' is set to 2021-01 (January). The 'Date range 2' dropdown is open, showing options for 2021-01 (January), 2020-01 (January), and 2019-01 (January). Red arrows indicate the selection process.

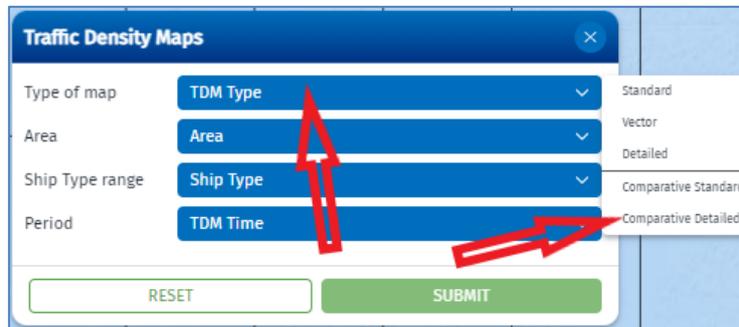
**Note:** the selected both maps should have different date ranges.

The screenshot shows the 'Traffic Density Maps' form with the following settings: Type of map: Comparative Standard; Area: Baltic Sea; Ship Type range: Tanker; Period: yearly. The 'Date range 1' is set to 2021-01 (January) and the 'Date range 2' is set to 2020-01 (January). Red arrows indicate the final selection.

### 3.5.5 Select Comparative Detailed TDM

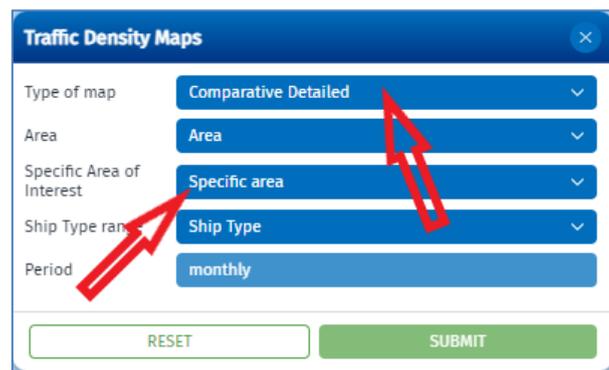
To request a Comparative Detailed TDM, all the required criteria must be selected (**Type of map**, **Area**, **Specific Area of Interest**, **Ship Type range** and **Period**) using the drop-down menus.

- **Type of map:** Click on the “**TDM Type**” bar and then on a map type (Comparative Detailed) in the drop-down menu.

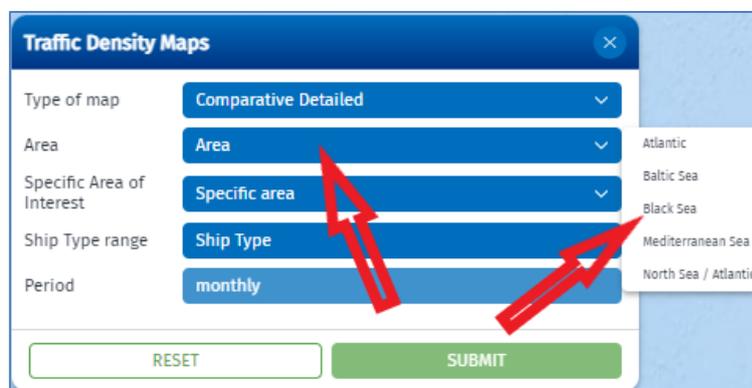


After selecting the type of map “Comparative Detailed TDM”, a new selection bar “**Specific Area of Interest**” will be enabled, allowing to specify the map (depending on the selected area).

**Note:** selection bar “Specific Area of Interest” will be activated only after selecting the type of map “Comparative Detailed TDM”.

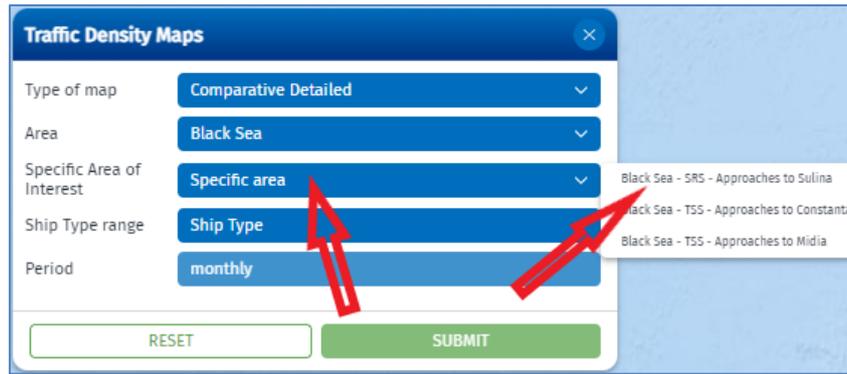


- **Area:** Click on the “**Area**” bar and then on an area (e.g. Black Sea) in the drop-down menu.

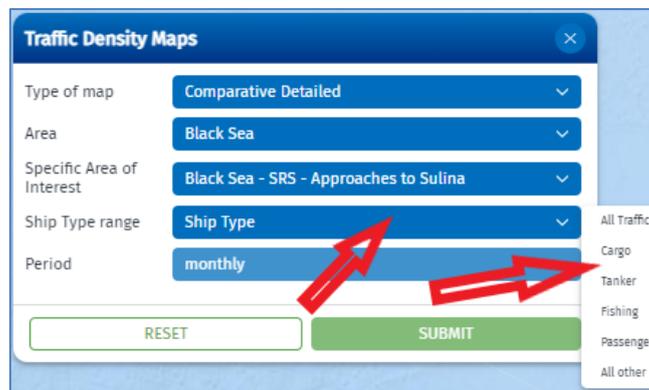


**Note:** for Comparative Detailed TDMs the drop-down menu will not include the area “All Europe”

- **Specific Area of Interest:** Click on the “**Specific Area**” bar and then select the SAI (e.g. TSS Approaches to Sulina) from the drop-down menu. The drop-down menu shows all SAIs available for this type of map and the selected area.



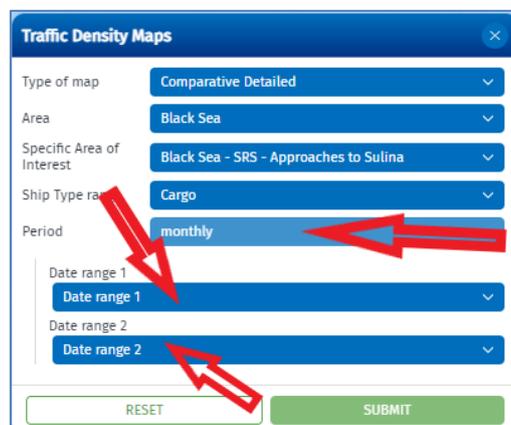
- **Ship type range:** Click on the “*Ship Type*” bar and then on a ship type range (e.g. Cargo) in the drop-down menu.



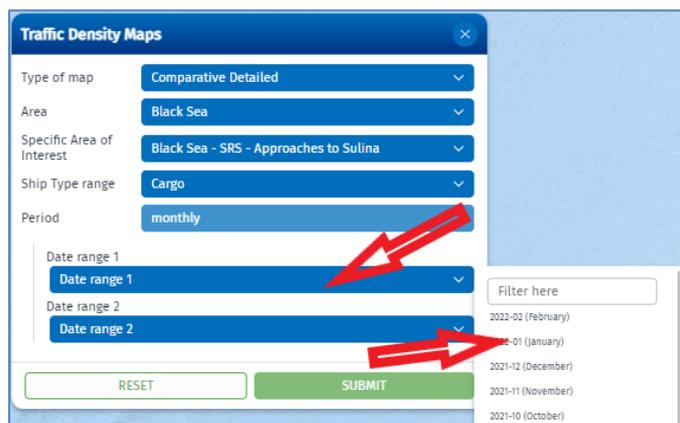
- **Period:** Click on the “*TDM Time*” bar, then click on the time period (e.g. “Monthly”) in the drop-down menu.

After selecting the period, two new selection bars “*Date range-1*” and “*Date range-2*” will be enabled, allowing to specify the time criteria of two corresponding Detailed TDMs to be compared (monthly, seasonal or yearly - depending on the selected period) ((e.g. “2019-02(February)” and “2020-03(March)”)).

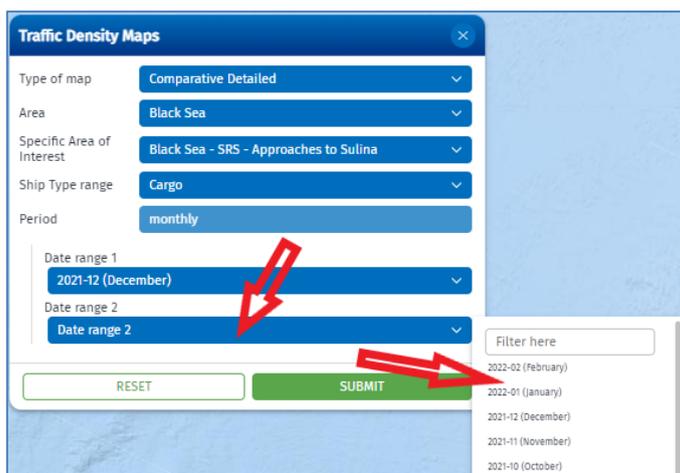
**Note:** *Date ranges of seasonal maps are named by the first month in the season, e.g. the name of the map for spring 2019 is “2019-03(March)”. Date ranges of yearly maps are named by the first month in the year, e.g. “2020-01(January)”.*



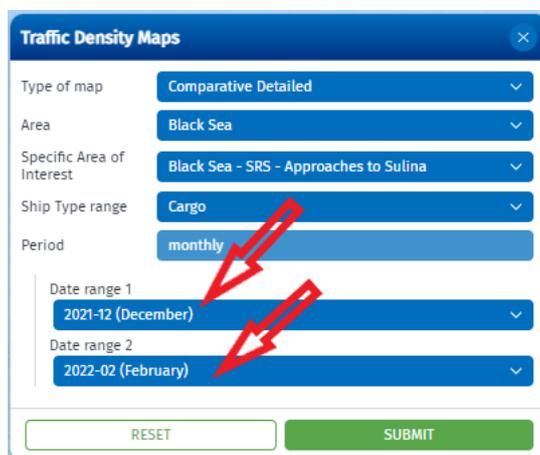
- Date range-1:** Click on the “*Date range-1*” bar and then select the month, seasonal or year (depending on the period selected) of the first map from the drop-down menu. The drop-down menu shows all maps available for this category.



- Date range-2:** Click on the “*Date range-2*” bar and then select the month, season, or year (depending on the period selected) of the second map from the drop-down menu. The drop-down menu shows all maps available for this category.

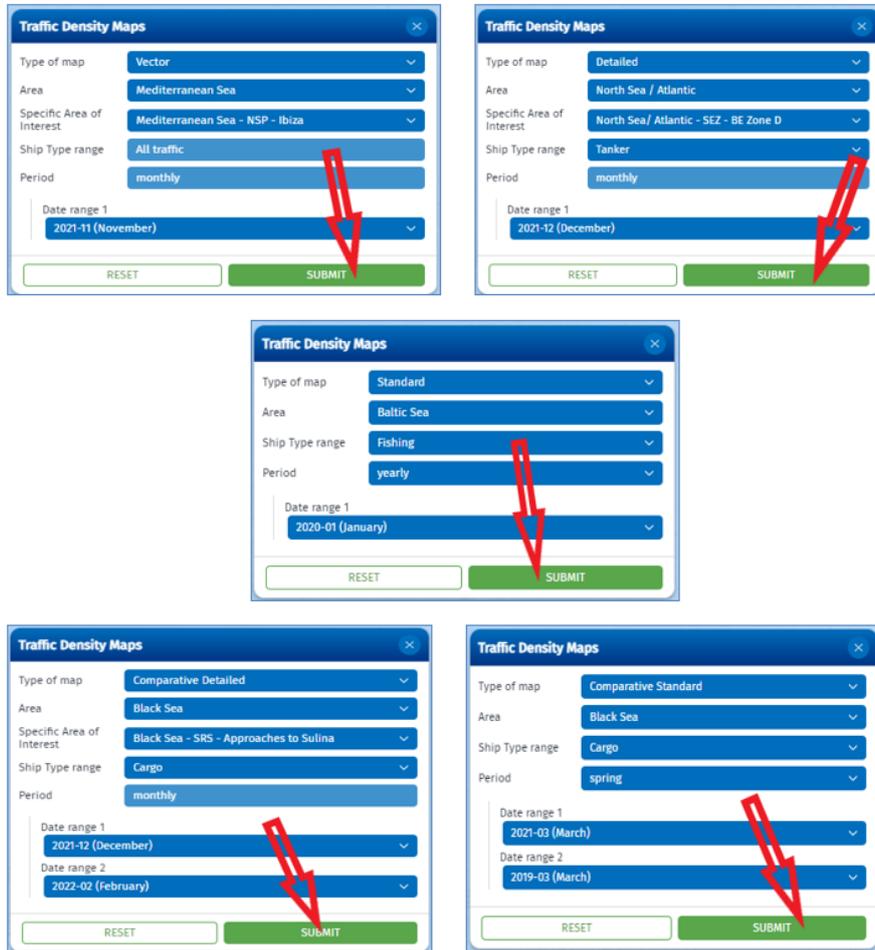


**Note:** the selected both maps should have different date ranges.



### 3.6 Request the selected map

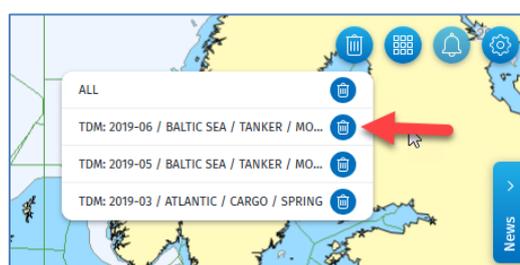
Once all criteria are selected, submit your request by clicking on the “**Submit**” button. To reset your selection, use the “**Reset**” button.



Your requested map will be displayed on the screen. Use SEG functionalities to zoom it to the required level. The TDM will also be added to the list in the bottom-right corner of the page.

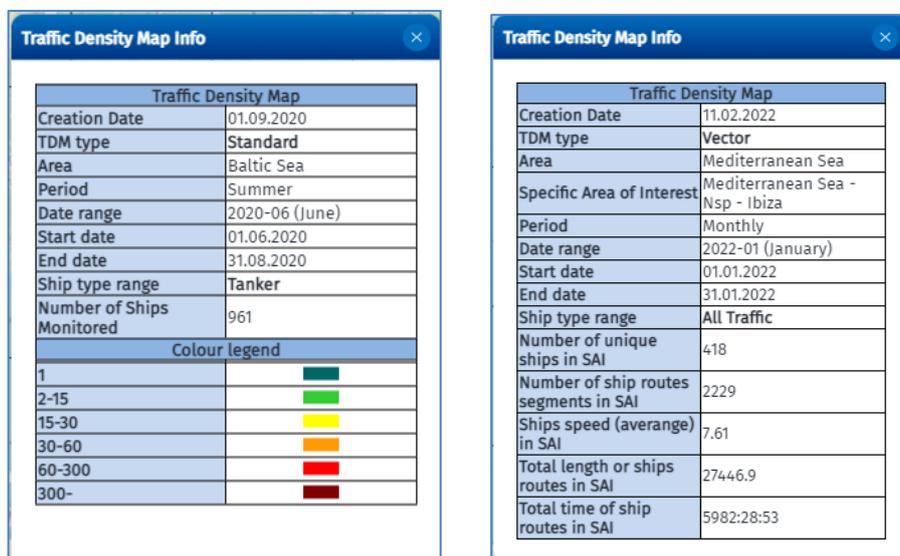
Traffic Density Maps						
Filter applied in all columns						
AREA	SHIP TYPE RANGE	PERIOD	DATES	MAP NAME	DOWNLOAD	
<input type="radio"/>	BALTIC SEA	ALL TRAFFIC	YEARLY	2021-01 (January)	STANDARD	<a href="#">Download</a>
<input type="radio"/>	MEDITERRANEAN SEA	FISHING	YEARLY	2020-01 (January)	STANDARD	<a href="#">Download</a>
<input type="radio"/>	MEDITERRANEAN SEA	TANKER	MONTHLY	2021-11 (November)	DETAILED	<a href="#">Download</a>

TDMs can be removed from the display by using the “trash” icon in the top-right corner of the page. Click on the trash icon and then on the corresponding TDM in the list.



### 3.7 View information and legend of a TDM

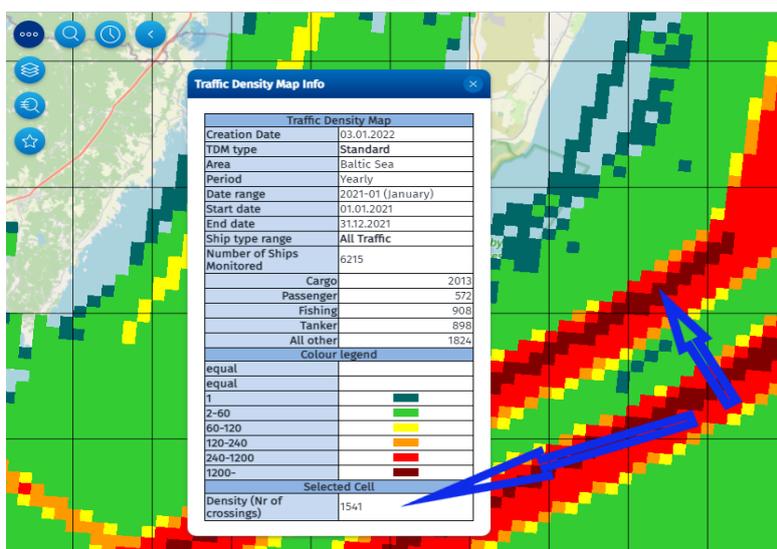
The “Traffic Density Map Info” panel is opened automatically when the TDM is requested and when clicking on TDM area on the screen. The structure and content of the information panel depends on the type of map.



The panel can be moved by grabbing and dropping it to a new location on the screen.

### 3.8 View traffic density values per grid cell

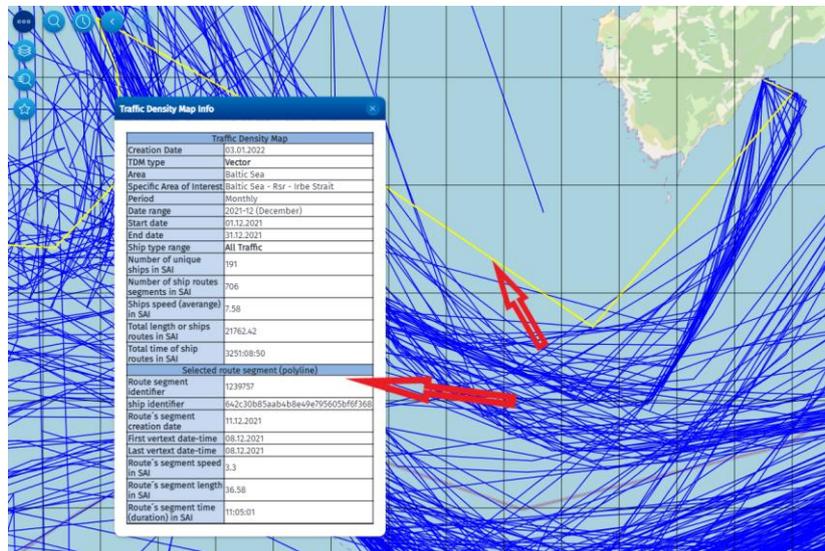
This functionality is available for Standard, Detailed and Comparative TDMs. Click at any (selected) grid cell in a TDM area. The “Selected Cell” section in the “Traffic Density Maps Info” panel will be opened and the value of the selected grid cell (number of crossings) will be presented.



For Comparative maps, the information panel will present the values of the compared cell per each map and the difference.

### 3.9 View ships routes information

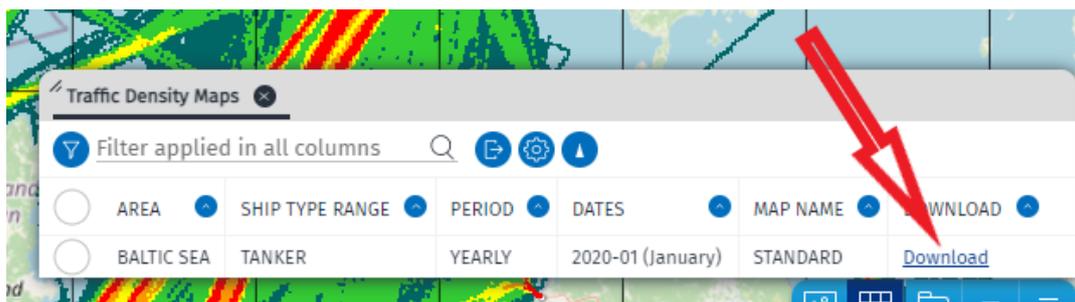
This functionality is available for Vector TDMs. Double click at any (selected) ship route (polyline) in the Vector TDM. The selected ship route's segment will be visualised with a different colour and the "Selected route segment" section in the "Traffic Density Map Info" panel will be opened, providing details of the selected ship route's segment (date, speed, length, duration etc.).



### 3.10 Download TDMs

This functionality is available only for Standard and Detailed TDMs. Once a TDM is requested, a link to download the map will be activated in the TTT panel in the bottom-right corner of the table.

Click on the link to request the selected map (zipped files): a georeferenced image file, a grid data file, and a metadata file. Use system's functionalities to download the map (files).



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