Projet cofinancé par le Fonds Européen de Développement Régional (FEDER)
Project cofinanced by the European Regional Development Fund (ERDF)

MED MARITIME INTEGRATED PROJECTS
Med-IAMER

Adriatic Ionian ecoregion (AIE)

Maritime Transport

Definition

Maritime transport relates to the transportation of goods and/or passengers by sea by a person for commercial purposes, either in return for payment (i.e. for hire and reward) or on an organization's own account as part of its wider economic activity. Goods transportation refers to the volume of containerized, dry bulk, liquid bulk and roll on-roll off (Ro-Ro) type of cargo handled by ports and vessels (cargos, tankers, etc.) while passenger traffic refers to the number of national, international and cruise passenger volumes transported through ports by ferry, cruise or other type of vessel.

Regional context

The Adriatic Ionian ecoregion (AIE) constitutes an important maritime transport node due to its position on the east-west and north-south European axes (including motorway of the sea of south-east Europe) connecting the region to the eastern Mediterranean and the Levantine Sea. The region's ports benefit from their proximity to a large market that extends from the Balkan Peninsula to central Europe but compete with the ports of northern Europe and their distance from the Suez-Gibraltar sea route.

Depending on the type of cargo transportation, ports' dynamics are quite different in the region. Container market of the AIE is dominated by the northern ports and mainly by the ports of North Adriatic Ports Association (NAPA). Additionally, Southern ports are dominating the market of Roll On-Roll Off (Ro-Ro) transport. Finally, in the market of dry and liquid bulk transportation the ports that are presenting the greatest activity are located both in the southern and the northern parts of Adriatic-Ionian Sea.

Driver	Maritime transport
Relevant contribution (%) to total GVA	26,56
Relevant contribution (%) to total employment	11,69
Intensity of environmental pressure (%)	17,89
Total %	18,71

Maritime transport is the second highest driver of ecosystem change in terms of priority for the AIE

Port	Pax/Call	Shipping Lines
Bari	3537	5
Venice	3314	20
Katakolon	2488	16
Messina	2199	11
Trieste	2195	3
Corfu	1551	21
Kefallinia	1357	7
Dubrovnik	1348	23
Ravenna	1311	6
Koper	1212	11
Zakynthos	1004	3
Split	840	16
Kotor	821	19
Zadar	501	6
Sibenik	298	3

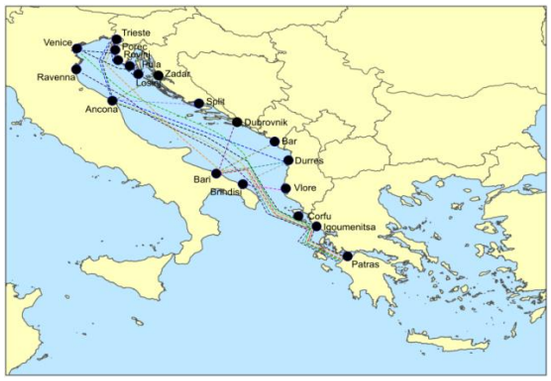
Shipping companies and size of ships calling at Adriatic Ionian ports (2014)

The region has a high share of cruise traffic, as it attracts over 21% of tourist passengers calls of the total passengers' calls at European ports. It is amongst the most active European regions in international passengers' traffic as 11% of all ship passengers travel from Adriatic-Ionian ports (Medcruise, 2014). In terms of merchandise transportation, the region is mostly specialized in dry bulk transport, since the relative volume against total European handling volumes is around 8%. The lowest performance is observed in the container handling sector as the percentage of the Adriatic-Ionian ports to the total European volumes just exceeds 2%. This lack of competitiveness is mostly caused by the dominance of North European ports both in terms of infrastructure and hinterland connections' quality.

Despite the relative lack of adequate infrastructure, cruise passenger flows are showing a steady increase in the last decade, a tendency that is expected to grow in the future (EC, 2014), and many ports are more and more accommodating ships with high carrying capacities. Additionally, port authorities are strengthening their networks among shipping lines and thus, tend to attract significant traffic. The table below presents the average carrying capacity of ships and the number of cruise lines calling at each port. Bari and Venice (Italy) are the two ports that accommodate cruise ships with average capacity exceeding 3000 passengers. Additionally, concerning the connectivity of each port, Dubrovnik (Croatia), Corfu (Greece) and Venice (Italy) have established an extended lines' network as the lines calling at the ports exceed 20. In terms of annual traffic of cruise passengers, Venice (Italy) is the dominant port of the Adriatic-Ionian region (1.8 million pax), followed by Dubrovnik (Croatia) port with about 1.1 million pax.

AIE is well served by shipping companies and the main international lines concern the connection of the Balkan coastline to the Italian ports. The following map shows the strong established connections between ports of the Balkan Peninsula such as Patras, Igoumenitsa, Durres and Bar, and Italian ports of Bari, Brindisi, Ancona and Venezia (Synthesis Project, 2012). Connections are more intensive during the summer period because of the high tourist demand. Nevertheless, many lines remain also active during the winter period, especially in the routes between Greece and Italy. The busiest ports, in terms of passenger traffic, are those of Messina, Reggio di Calabria which are linked to Italian ports of the West coast. Additionally, in the Adriatic Sea Ancona, Patras, Igoumenitsa, Bari and Durres present the highest figures. These ports are well connected with a significant number of destinations and are called by

more than 30 ships per week whose average capacity exceeds 1k passengers. High levels of connectivity are also observed in the ports of Brindisi, Split and Venice. Nevertheless, most lines of Split and Venice are characterized by seasonality and are not operating during the winter period.



Roll on/Roll off PAX Connections in the Adriatic-Ionian Region (2014)

Related Pressures

The intensive maritime transport activity observed in the Adriatic-Ionian region implies ships and port emissions, risks of accidents, acute pollution events, underwater noise, and the introduction of alien species through ballast water discharges (EC, 2012). Furthermore, the increase in demand calls for increasing infrastructural facilities in the region.

Soil sealing

The increase in the capacities of local infrastructures results in negative impacts on the environment. The construction and expansion of present infrastructures is increasing the soil sealing extent and contributes to physical alteration of coasts. Furthermore, material discharge derived from ports dredging is a significant contributor to smothering (ISPRA, 2012).

Underwater noise

Underwater noise has become a ubiquitous form of marine pollution and is a growing concern in the Mediterranean Sea due to the increasing maritime activity, with ship propulsion noise accounting for more than 90% of the acoustic energy that humans put into the sea. This pressure affects communication of marine mammals and certain fish species, especially in areas of heavy maritime traffic and along developed coasts.

There are three categories of impacts of underwater anthropogenic noise on cetaceans: Behavioral (i.e. changes in surfacing or diving), acoustic (i.e. changes in type or timing of vocalizations as well as masking acoustic signal) and physiological (i.e. hearing loss, mortality) (UNEP/MAP, 2012). Marine mammals are particularly affected by underwater noise as they rely heavily on sound to communicate, to coordinate their movements, to navigate, to exploit and investigate the environment, to find prey and to avoid obstacles, predators, and other hazards. Noise pollution can cause marine mammals to abandon their habitat and/or alter their behavior by directly disturbing them or by masking their acoustic signals over large areas (Abdulla & Linden 2008). Nevertheless, there is also increasing concern regarding the impact of such noise on fish, other vertebrates such as aquatic and diving birds, and marine invertebrates.

Maritime traffic is an important source of anthropogenic noise especially in the Ligurian Sea. The high volume of shipping in the Mediterranean Sea results in high background noise levels that do not allow for silent areas or refuge.

Mapping of areas affected by underwater noise due to marine transport is complex as it depends on specific information that is not always available including vessel size, motor type, routes and motorways and the frequency of ambient noise levels they produce. Nevertheless, the pollution map shown below gives an approximation of the areas with highest intensity of maritime transport and, hence, the potential relative pressure of underwater noise.

Contamination by hazardous substances

Petroleum Hydrocarbon (oil), Polycyclic Aromatic Hydrocarbons and oily residue discharges from ships represent a significant threat to marine and coastal ecosystems. These discharges may occur during normal activities (such as tank washing, loading/ discharging, bunkering, dry docking operations) (UNEP/ MAP, 2012) or may be accidental or illegal. Illegal discharges of oil from ships are often limited in size and scattered in specific areas but their sum is greater than that of oil spills and they may create a chronic impact of oil in specific regions. Accidental oil spills have historically been of crude oil rather than refined products but recently this trend has reversed. Such spills have both immediate and longer term impacts including contamination of farmed fish or shellfish for human consumption. Most of the oil spills are often located along the major East – West maritime traffic lane and along the Sicilian channel as well as on the Ionian stretch between Sicily and the Peloponnese. Considerable oil spills are also present along the Ionian waters off western Greece which most likely arise from the considerable maritime traffic leading into and away from the Adriatic (Metis, 2014; UNEP/ MAP, 2012). It is estimated that, at a Mediterranean level, the most important share (80%) of hydrocarbon pollution derives from routine shipping operations such as tanker washing or ballasting, while accidental spills account for 10% of this share (SHAPE, 2013).

A brief assessment of the overall accident exposure in the Adriatic Sea has recently been undertaken by Det norske Veritas who concluded that the Adriatic Sea has the highest accident frequency, more than five times higher than the world average (Thana and Patuzi, 2013). Regarding the number of ship accidents in the Adriatic Sea over the past 15 years, a total of 174 accidents have occurred. This increases the pressure of pollution, where 257 oil spills from ships in 1999; 263 in 2000; 184 in 2001; 244 in 2002 were detected in the Adriatic Sea (D. Vidas).

The main impacts of PAHs include effects on the functional traits of marine species at the genetic, cellular, biochemical and physiological levels. Genetic damage may result in chromosomal aberrations, impacts on embryonic stages and long-term effects such as carcinogenic and mutagenic growth in vertebrates.

Carriage of chemicals is also a common threat from maritime transport mainly through accidental incidents. TBT (Tributyltin) is considered the most toxic substance that is intentionally introduced into marine environments. It affects non target biota, especially in areas with high vessel density and restricted water circulations. Highest concentrations of TBT are found in sediments from harbors, marinas and shipping channels because TBT is broken down only very slowly in sediments with low oxygen content. Its use in large vessels is currently the major source of input to the sea. Marine invertebrates are very sensitive to TBT, effects include morphological changes, growth inhibition, suppressed immunity, reduced reproductive potential and changes in population structure while another known effect is the development of male sexual characters in female prosobranch gastropods as collected in areas of Venice (Italy) and Rovinj (Croatia). Besides the impact of gastropods, TBT and its degradation products accumulate in tissues of marine organisms and move up the food chain. Within the Mediterranean Sea, very high concentrations were found in top predators including the bottlenose dolphin, bluefin tuna and blue shark collected off Italy (ICES, 2003; UNEP/ MAP, 2012).

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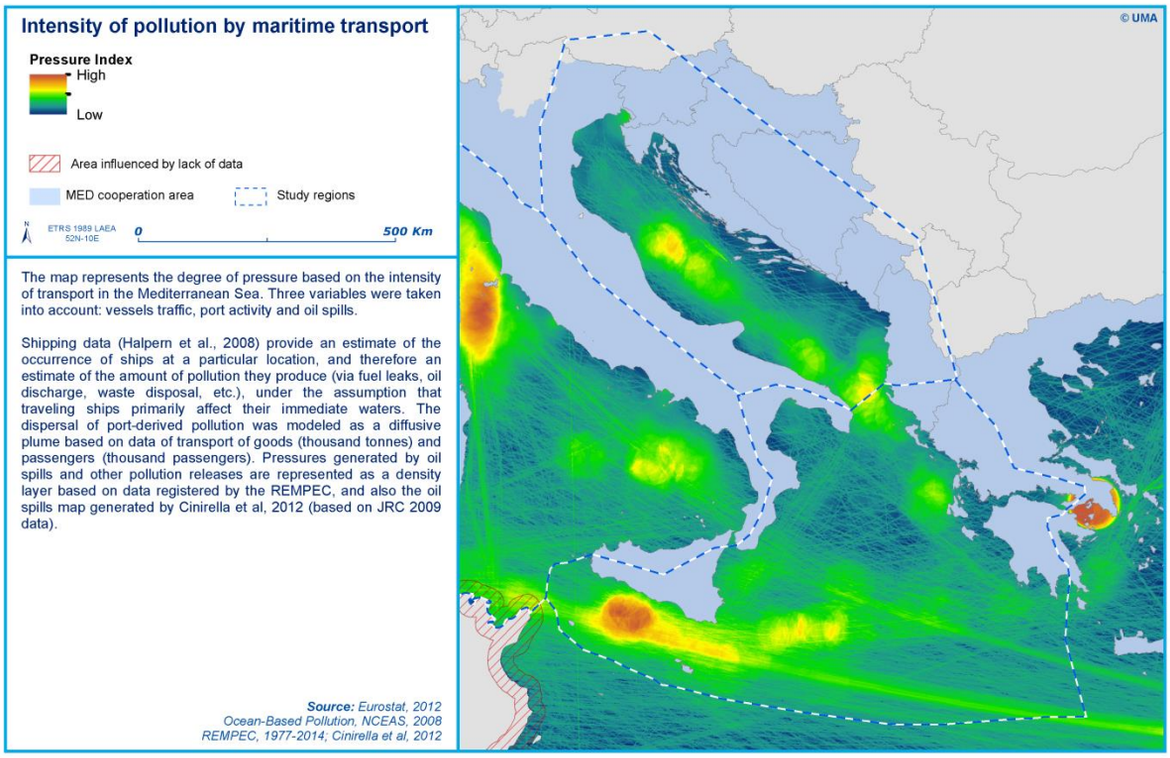


Highlighted features

The map represents the estimated intensity of pollution in terms of hazardous substances and underwater noise resulting from maritime transport, based on shipping tracks and port influence. The relatively low pressure index for the Adriatic contrasts with the high density of shipping tracks in the Southern Ionian Sea, leading to high potential pressure from pollution. Mainly the most important ports (Venice, Dubrovnik, Koper-Trieste) have major influence on marine pollution in the region.

Data/Indicator used

The indicators developed are based on four variables: vessels traffic, port activity, underwater noise and oil spills. The indicator shows the potential intensity of pressure originated from these pollution sources in terms of hazardous substances and underwater noise resulting from maritime transport, based on shipping tracks and port influence. Shipping data used (Halpern et al., 2008) provide an estimate of the occurrence of ships at a particular location, and therefore an estimate of the amount of pollution they produce (via fuel leaks, oil discharge, waste disposal, etc.), under the assumption that traveling ships primarily affect their immediate waters. The dispersal of port-derived pollution was modeled as a diffusive plume based on Eurostat data of transport of goods (thousand tons) and passengers (thousand passengers). Pressure generated by oil spills is represented as a density layer based on data registered by the Mandate of the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC) for the period 1977-2011, and also the oil spills map generated by Cinirella et al. 2012 (based on JRC 2009 data).

Gaps

The data used for the development of the indicator do not cover ports in North African and Middle Eastern countries. However, ports in Turkey are covered by Eurostat. Data for Albania and Montenegro were extracted from different sources and included in the calculation of the indicator (UNECE, 2014; ECOPORT8, 2012; MEDCRUISE, 2014).

Limits of methodology

The potential pollution generated from ships is based on a global model calculated with Vessel Monitoring System data, so it has its inherent uncertainty. In this analysis, no distinction is made between cruisers, ferries and commercial good ships. Hence a more regionalized modeling approach may improve the information. Eurostat data used are not actual port pollution data but an estimate based on maritime traffic. Port and oil spills pollution does not consider ocean currents and dispersion of pollution produced by them. For the noise underwater pollution, the indicator does not differentiate the distribution of biodiversity in these areas due to lack of data and therefore, it provides the potential impact of underwater noise pollution in the ecoregions.

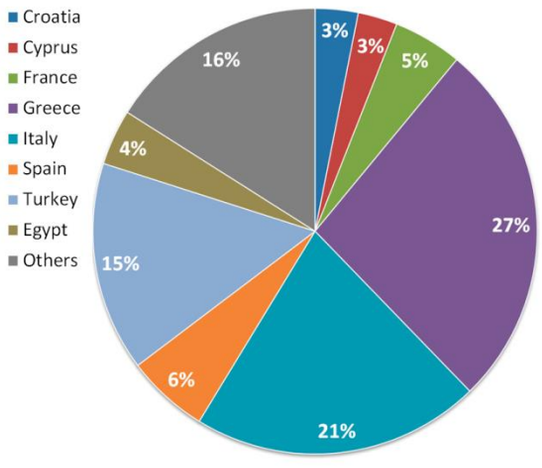
Introduction of alien species (AS) from maritime transport

The introduction of harmful aquatic organisms and pathogens through ships' ballast waters and sediments is of increasing concern in the Adriatic Sea. The quantity of ballast water released in the Adriatic ports of Italy, Croatia and Slovenia estimated for the year 2003 was approximately 8 mil tons, of which around 80% was discharged in Italian Adriatic ports, while the remaining volume was shared between the Slovenian port of Koper and all the Croatian ports. However, most of ballast water arrives from locations in the Mediterranean (58%) and due to inter-Adriatic traffic (34%) while only 8% of ballast water volume released is currently originating from ports located outside the Mediterranean Sea (UNEP/MAP – Plan Bleu, 2009). With expected changes in import and export flows, and especially if a major new oil export route is introduced from a deep – sea port in the Adriatic, these proportions could change considerably. According to specific studies on invasive AS along Italian coasts based on data collected during years 1945-2009, 51 invasive AS were identified in the northern Adriatic, 9 in central, 32 in southern Adriatic and 42 in northern Ionian with major impacts in Venice and Taranto. Available data show that vessels contribute significantly (54%) to invasive alien species occurrence in Italian seas (SHAPE, 2013).

Highlighted features

The pie chart shows the pressure by alien species (AS) represented as the % of AS introduced through transport in the coastal areas of the Mediterranean Sea. These percentages are based on the coastal account of AS according to the 10 km grid of the EASIN Database (JRC,

% Alien species introduced through transport in the Mediterranean coast



2014). Greece, Italy and Turkey present the highest invasion levels, being a 63% of the total in the Mediterranean coasts.

The map on alien species illustrates the distribution and the number of AS (introduced through transport) in a grid cell of 10 km. It shows that the intensity of species introduction in the Adriatic and Ionian is through maritime transport concentrated along the coasts, indicating the high impact of ships' ballast waters close to ports. Within the Mediterranean, the countries with the most AS are located in the Eastern Mediterranean. The Suez Canal constitutes a major introduction route for species from the Red Sea, both 'naturally' and via maritime transport. However, the figures reported on the distribution map of AS should be considered with great caution since the information depends on the scientific investigation efforts within the countries.

Within the AIE, the Northern Adriatic seems to host high number of AS due to its semi-closed nature, the number of ports, and the high frequency of shipping lines in the region. Around the island of Sicily, the high number of AS is related to the major shipping lines passing by the region, the major ports and the high level of ballast water discharged in the region.

Data/Indicator used

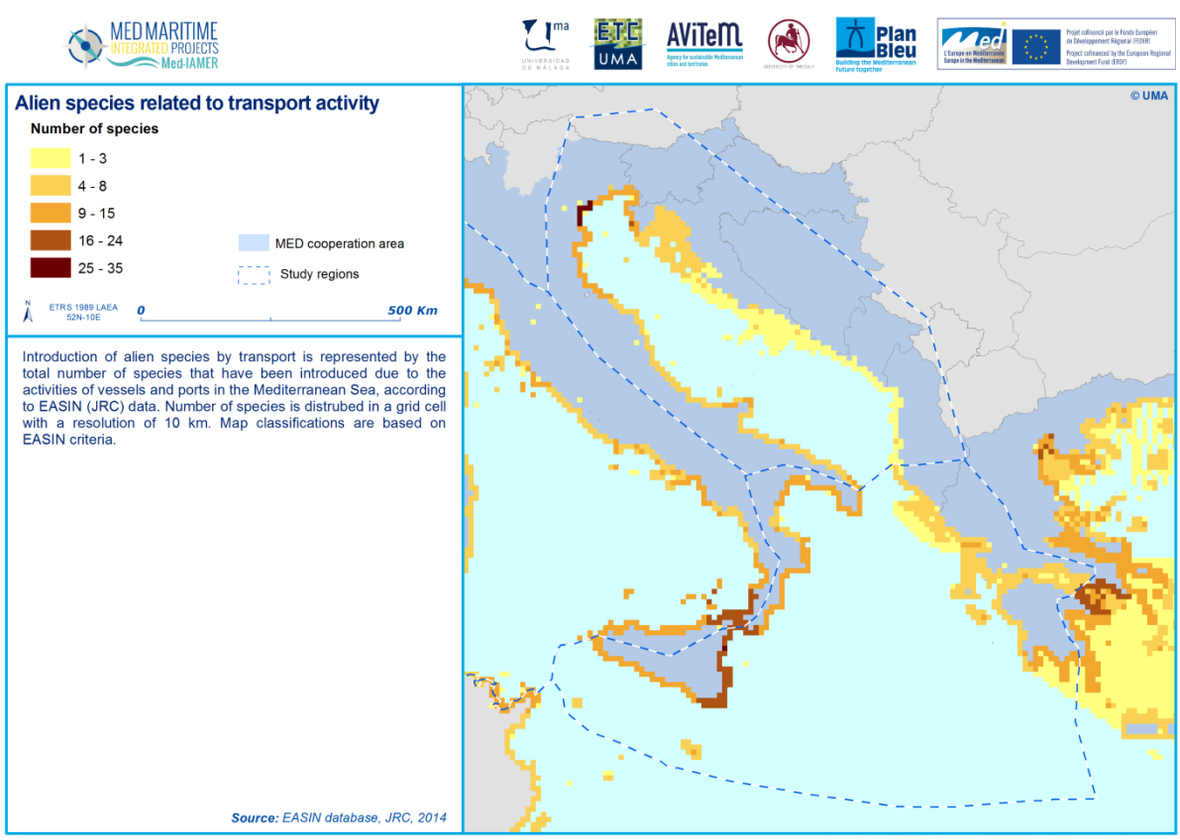
The indicator presents the total number of alien species introduced due to transport activities in the Mediterranean Sea. Species count was made by the European Alien Species Information Network (EASIN), an initiative of the Joint Research Centre of the European Commission that aggregates data from different data providers (see Katsanevakis et al. 2014 for more details).

Gaps

N/A

Limits of methodology

Model-based approach with uncertainty, as it is based on species databases and peer-reviewed literatures. The indicator does not reflect the state of invasion and the extent of the harmful effects of alien

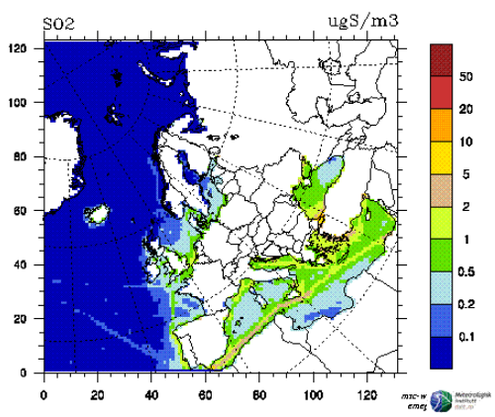


species as it does not differentiate the degree of harm caused by specific species but rather counts the number of alien species per area (density).

Air pollution

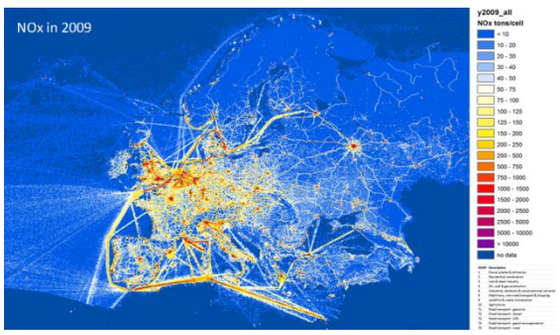
Shipping emissions of pollutants are currently increasing and will most likely continue to do so in the future due to the increase of global-scale trade. Ship emissions have the potential to contribute to air quality degradation in coastal areas, in addition to contributing to global air pollution. Around 15% of global anthropogenic NOx and 5–8% of global SOx emissions are attributable to oceangoing ships. The contribution of maritime transport to the total emissions of pollutants in Europe (SO_2, NOx, PM, etc.) can be very significant (Viana et al., 2014), with 1–7% of ambient air PM10 levels, 1–14% of PM2.5, and at least 11% of PM1. Contributions from shipping to ambient NO_2 levels range between 7 and 24%.

The European Monitoring and Evaluation Programme (EMEP) is a scientifically based and policy driven programme under the Convention on Long-range Transboundary Air Pollution (CLRTAP) for international co-operation to solve transboundary air pollution problems. It provides modelled data of air concentration and deposition of main pollutants specifically related to ships.



EMEP Map of ship related SO_2 concentration.

TNO-MACC-II emission data provides records on atmospheric composition for recent years, data for monitoring present conditions and forecasts for a few days ahead. It combines state-of-the-art atmospheric modelling with Earth observation data to provide information services covering European air quality, global atmospheric composition, and emissions and surface fluxes. Along with the study of pollution at coastal level (air samples, ships emissions, etc.), it could be an effective tool for monitoring the air pollution related to maritime transport.



Map of TNO-MACC-II anthropogenic emissions of NOx for the European domain.

Both data sources detailed here provide valuable information for monitoring of air pollution related to maritime transport.

List of proposed indicators

The following table lists the indicators developed and mapped within Med-IAMER on the pressures and impacts of maritime transport on coastal (land) and marine environments. **All maps identified by the indicator ID, can be found at the project's web page:**

http://www.medmaritimeprojects.eu/section/med-iamer-redirect/outputs

ID	Indicator description
TP01	Marine exposure due to port activity: goods transport
TP02	Marine exposure due to port activity: passenger transport
TP03	Marine exposure due to port activity: ferry transport
TP04	Marine exposure due to port activity: cruise transport
TP05	Intensity of pollution by maritime transport
TP06	Intensity of maritime traffic
TP07	Alien species related to transport activity
TP08	Alerts and accidents between 2008 and 2014
ML02	Marine litter by transport influence

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