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)

Marine Aquaculture

Definition

Marine aquaculture refers to the culturing of species that live in the ocean. It implies some form of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc. Farming also implies individual or corporate ownership of the stock being cultivated (*FAO definition*). In Med-IAMER, we consider marine aquaculture that takes place in the ocean (that is, in cages, on the seafloor, or suspended in the water column).

Regional context

Even though fisheries have traditionally been an important sector in the countries around the Adriatic and Ionian Seas, along with the shrinking of fishing resources as a result of over-fishing and unfavourable ecological conditions, its share in the national economies is constantly dropping. The new trend in the AIE focuses on increasing aquaculture production, especially in Croatia and Slovenia, increasing environmental pressure in the region (PAP/RAC, 2007). In the eastern side of the AIE, marine aquaculture focuses on intensive farming and mussel culture, whereas in the western side, Italy is increasing its production of marine species, namely mollusks and finfish. Greece ranks first in production among European Union and Mediterranean countries of Commercial aquaculture finfish species and the sector ranks second in exports of "food-beverages" (FAO, 2014). The growth in aquaculture production is mainly due to the mastering of seed production techniques for European seabass and gilthead seabream and to the application of new farming technologies. In the last decades, the development of intensive offshore aquaculture including the production of mussels has increased drastically in the region (ADRIPLAN, 2014).

Highlighted features

The map illustrates the distribution of aquaculture fish farms (Trujillo et al., 2012, and EMODnet Human Activities, 2014) and the total aquaculture production per country (tons) in the Mediterranean Sea for year 2012 (FAO, 2012). The concentration of fish farms along the Croatian and

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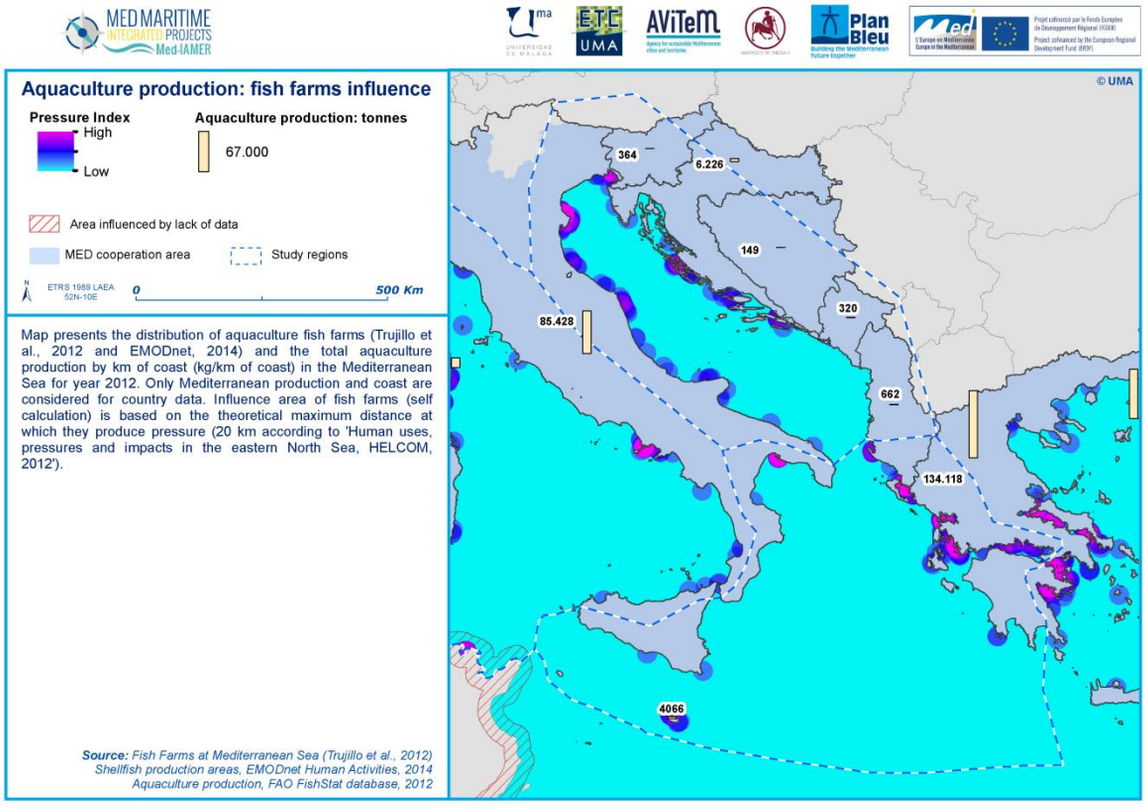

Western coast of Greece is clearly visible (though the Croatian production is relatively low). The pressure exerted by the concentration of fish farms hence affects the specific coastal strips in the NE Adriatic and Ionian Sea.

Data/Indicator used

Locations of fish farms are taken from Trujillo et al. (2012) and EMODnet Human Activities Portal (2014). Country data of aquaculture production are based on FAO FishStat database (2012).

The "fish farm influence" pressure indicator shows the influence area of fish farms. The calculation is based on the location of fish farms applying a theoretical maximum distance at which they produce pressure. In Med-IAMER, a distance of 20 km around each farm location is calculated as highly impacted as used by HELCOM in assessing impacts of aquaculture in the North Sea (Andersen, J.H. & Stock, A., 2013).

Gaps

The aquaculture production estimates by Trujillo (2012) are relatively close to the reported production from aquaculture (FAO). Nevertheless, the methods required several assumptions due to the lack of photographs and/or resolution, and might have underestimated production.

The location of fish farms of Trujillo is based on Google Earth digitalization. Temporal changes or small fish farms may have been overlooked.

As an improvement of these databases, the production estimates are to be validated by local ground data and local experts and stakeholders.

Limits of methodology

The methodology used to calculate the influence of fish farms was elaborated originally for the North Sea. Therefore, a validation of the results and an adaptation to the Mediterranean Sea is a recommendation for improvement in order to regional characteristics.

Related Pressures

Aquaculture creates significant pressures on the Adriatic-Ionian environment through the:

Discharge of organic matter and nutrients

Discharge of organic matter and nutrients (N, P) through fecal material and uneaten food causes specifically adverse effects (creation of hypoxic conditions and eutrophication) in areas with poor circulation, especially on seabed. However, reports (UNEP/MAP, 2012) on eutrophication show that although total discharges are not comparable to other sectors such as municipal sewage or agriculture, they can lead to localized impacts on the marine environment mainly for countries with largest aquaculture development such as Italy, Greece and Croatia. Hypoxic and eutrophicated hot spots can be identified (UNEP/MAP, 2012) at the north – west of the Adriatic – Ionian Sea. No local impacts deriving from these activities in the area seem to be registered according to studies on culture sites offshore carried out in 2001 by ISMAR-CNR in Ancona. These studies did not show the presence of significant quantity of organic waste on the bottom, probably due to strong sea currents. Nevertheless, more evident effects on the environment could instead be observed when farms are situated in closed areas, such as the Gulf of Trieste, or even more in lagoons (FAO) (SHAPE, 2013). Generally, trophic loads are 2-3 magnitude order lower than those derived from atmospheric pollution or from other anthropic inputs (fertilizers, detergent). Consequently, at the Mediterranean level, aquaculture has a low effect on ecosystems but it can generate a relevant impact at a local scale, with local estimated increases of 73% for nitrogen and 99% for phosphorous (SHAPE, 2013). The Dalmatian coast in Croatia seem to show some local effects from discharges related to tuna farms activities in the region. In 2001, nine areas used for tuna farming were recorded, especially in the sheltered bays of some islands (Drvenik, Braè, and other in Zadar area), with a yearly average production of 4,000 t (SHAPE, 2013), which presented dangers to underwater ecosystems.

Nevertheless, an update of studies on culture sites offshore to measure the level of impact of more recent aquaculture activities is crucial to have more updated data to draw better conclusions.

Release of chemicals

These chemicals include medicines (antibiotics and biocides) used in fish farms.

Introduction (intentional or unintentional) of alien species

An estimated 10% of non-indigenous species present in the Mediterranean is attributed to aquaculture, especially in northern Adriatic with 31-50 new species detected (UNEP/MAP, 2012; UNEP/MAP – Plan bleu, 2009). Available data show that aquaculture (19%) is considered one of the main causes for alien species occurrence in Italian seas (SHAPE, 2013). Regarding the impact of some of these species on the environment, for the invertebrates the most clear-cut examples are two bivalves introduced for farming purposes, having developed large natural populations: the Pacific oyster, *Crassostrea gigas*; the Manila clam, *Ruditapes philippinarum*. These species have respectively prevailed over native oysters (*Ostrea edulis*) and clams (the grooved carpet shells *Tapes decussatus)* in the lagoons of the northern Adriatic Sea. These two species are also

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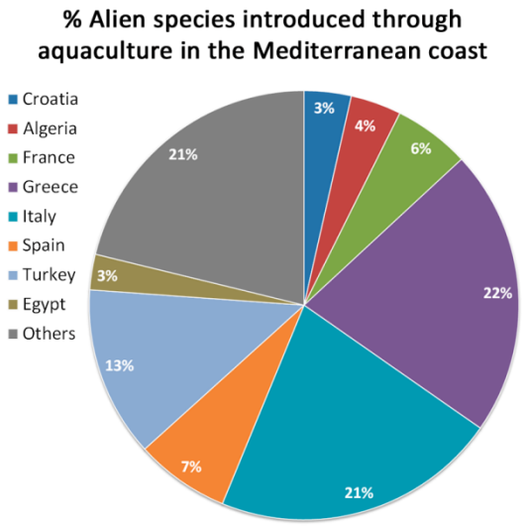
known as powerful vectors for unintentional introductions of other non-target species, concealed in the packaging material and among imported seed clumps, or dwelling as epibionts on the shells. In The Hellenic Ionian sea, 60 alien species were recorded, belonging mainly to zoobenthos (24 species) and phytobenthos (18 species) (Metis, 2014). Also, common species imported from other sea areas but bringing together either disease organisms or small larval forms of invertebrates have serious consequences on native organisms by competing for food or space (i.e. *Thalassoma pavo* and caulerpa *spp.* vs *posidonia spp.*, respectively).

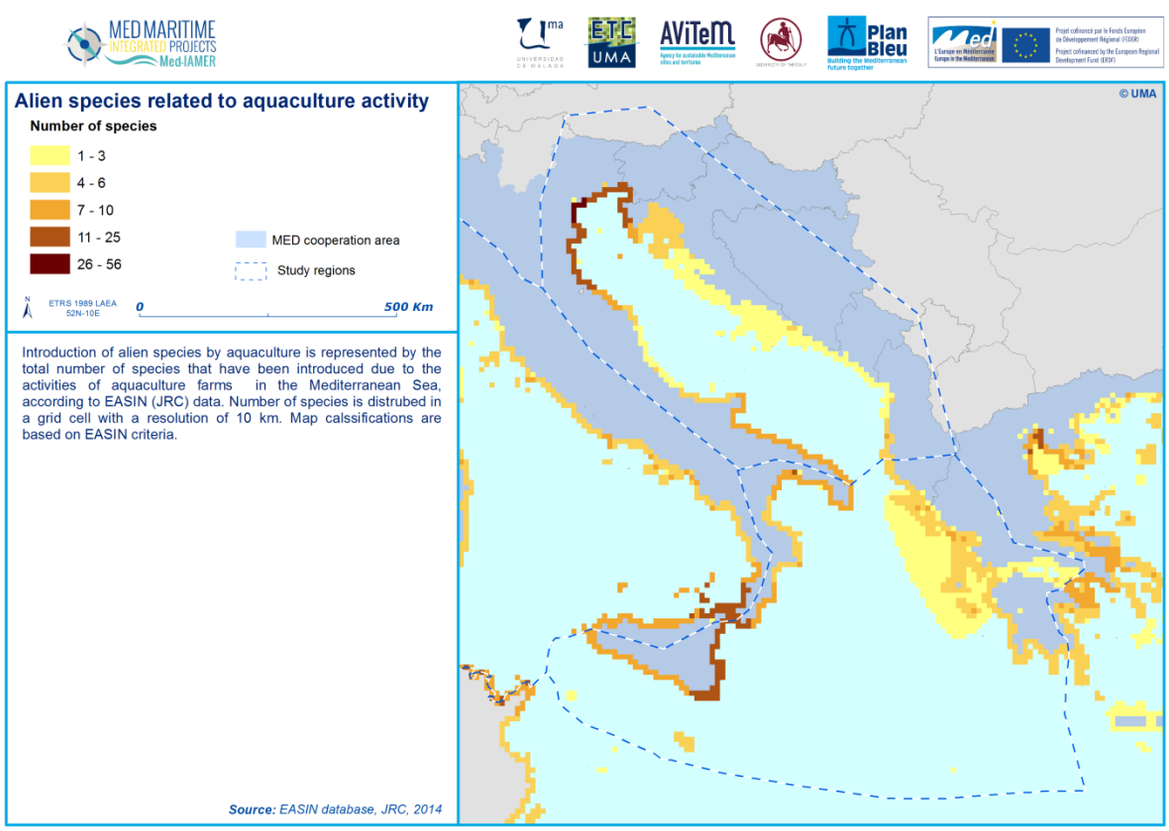
Highlighted features

The pie chart shows the pressure by alien species (AS) represented as the % of AS introduced from aquaculture practices 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, 2014).



Greece, Italy and Turkey present the highest invasion levels, being a 56% of the total in the Mediterranean Sea.

The map on alien species illustrates the number and distribution of AS introduced by aquaculture activities in a grid cell of 10km resolution. It shows that the occurrence of AS is limited to waters close to the coasts, with the exception of the Western Greek Coast. The Northern Western Adriatic coasts as well as those of



Sicily and Western Greece are mainly affected by high numbers of alien species. In addition, the distribution of the highest numbers of alien species seems to be influenced by geographical characteristics where it is clear that closed and less exposed sea regions tend to have higher number of AS, namely the gulf of Lion, the gulf of Trieste and the Strait of Messina. 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.

Data/Indicator used

The indicator presents the total number of alien species (AS) from aquaculture 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 low degree of uncertainty, as 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. It does not consider the pressure caused by specific species but rather counts the number of alien species per area (density).

List of proposed indicators

The following table lists the indicators developed and mapped within Med IAMER on the pressures and impacts of aquaculture 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
FI02	Aquaculture production: fish farms influence
FI05	Aquaculture production: production by km of coast
FI08	Aquaculture production: production per capita, main species
FI09	Alien species related to aquaculture activity

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