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Pegaso Project
People for Ecosystem based
Funded by the European Union
under FP7 – ENV.2009.2.2.1.4
Integrated Coastal Zone Management

Specific Programme FP7
Collaborative Projects
Large scale integrating Project

Grant agreement nº: 244170

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Master 2 AIEL.
Année 2010-2011

Sous la direction de Françoise Breton.

North Adriatic Sea Marine Protected Areas, assessment of current situation, potential pressures and synergies in an ICZM context.

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UAB

La Rochelle Université

SEVENTH FRAMEWORK PROGRAMME

Remerciement, agradeciemientos, thanks

Muchas gracias a todo el equipo de la UAB que me a bien ayudado, a mi Jefa, los pros del GIS y LEAC, la pro del management de proyecto y de la enerjia y a Rosa por toda su ayuda. Merci aussi beaucoup à Laurent pour sa grande aide dans cette grande salle de classe. Notably a big thank for Megan who finish beautifully to polish this work.

Gracie mille al Italian team especially a Marco, Fabrizzia for the good moments and for the help to run after the escaping data…Merci a Ann Katrien y Maria del Mar pour l'aide de construction.

Merci à la dame aux 6sous y la maintenant panamaien et aussi à tous les gens à la Rochelle, ça à vraiment été un bon bout d'année.

Merci a mon Oncle et Tante tourdumondiste avec qui cette année à commencée et ce termine.

Merci à mes parents pour les tomates du potager sans lesquelles je n'aurais pas tenu le coup.

Y muchas gracias a la Coccinelle quien lo ha hecho todo posible.

Je tiens également à remercier la bourse Erasmus stage qui m'a permis de faire ce stage à Barcelone et l'université de la Rochelle et le master 2 en général dont certains cours on vraiment été très bon.

Summary

Résumé

Les aires marines protégées sont un des outils clés pour protéger les écosystèmes marins et de plus en plus utilisées comme moyen de gestion de la pêche. Cependant, gérées en isolation de programmes plus larges de gestion de la côte et de la mer, elles sont comme des îlots de protection menacées par la pollution et entourées de zones où la destruction des habitats ou la surpêche est permise. L'identification des caractéristiques de ces aires (institutionnelles, taille, connectivité, etc) dans le contexte des pressions qu'elles subissent et de leur provenance permet la mise en lumière d'éléments clés pour mieux les intégrer dans des programmes tels que la gestion intégrée des zones côtière (GIZC).

Le projet PEGASO (People for Ecosystem-based Governance in Assessing Sustainable development of Ocean and coast) a pour but d'aider les pays de la Méditerranée et de la Mer Noire à mettre en place le protocole de gestion intégrée de la zone côtière issu de la convention de Barcelone. Le présent travail s'inscrit dans ce cadre en répondant de plus à une demande de la commission de l'Adriatique pour appréhender l'intégration des aires marines protégées dans le cadre d'une stratégie transfrontalière de gestion.

La mer Adriatique est une mer semi fermée où l'important développement côtier notamment dans le Nord a participé à une forte dégradation de l'écosystème marin. Les aires marines protégées y sont généralement de taille réduite, proche de la côte et donc d'autant plus influencées par des pressions majoritairement issues de l'artificialisation et de l'urbanisation des côtes ainsi que de l'agriculture intensive, du développement de la mariculture et du trafique maritime. Le manque de plan et de structure de gestion adéquatement financé dans la plupart de ces aires a été identifié comme une barrière majeure à leur intégration dans les processus de GIZC. Cependant l'impulsion du protocole GIZC et l'élaboration de stratégies nationales dans chaque pays représente une opportunité unique pour la construction et l'intégration d'un réseau d'aires marines protégées dans un programme transfrontalier de gestion de l'environnement côtier et marin.

Introduction

There is a growing evidence and we are getting more conscious that human well being depend heavily on ecosystem services and that we are degrading them (MEA, 2005).

Coastal marine ecosystems are among the most productive and valuable ecosystem of the world (MEA, 2005; Costanza et al, 1997). They produce disproportionately more services related to human well being than any other ecosystems and host most of the marine biodiversity (90% of known plant species and 75% of fish species between 0 and 50m deep (Bazairi et al, 2010)).

As a cause and consequence this connection between land and sea has historically been a place of concentration of both people and biodiversity.

Indeed costal zones occupy less than 15% of the earth land surface but they accommodate a growing population, currently more than 40% of the world population (MEA, 2005) and up to 75% expected in 2025 (EEA, 1999a).

This is especially true for the coast of Mediterranean Sea which has been one of the most densely populated regions on Earth since a long time (Airoldi and Beck, 2007).

This population, the associated activities and infrastructures have led to growing pressure on terrestrial and marine coastal ecosystems which have resulted in a considerable loss of biodiversity and habitats especially in the more industrialized Northwestern part (Coll et all, 2010).

A relatively recent awareness has lead to new national, the international policies (WFD, MSFD) aiming to reduce or reverse this loss by developing a more integrated framework for management based on the preservation of ecosystem services.

A lot of progress has been made in the Mediterranean Sea by the launch of Integrated Coastal Zone Management (ICZM see glossary) Protocol in January 2008 in the framework of Barcelona Convention. However it has been pointed out that ICZM strategies are generally terrestrial oriented and pay more attention to effect of sea on the coast (erosion, sea level rise) than the contrary.

Despite that, Marine Protected Areas (MPAs) are highly advocated tools for the conservation of marine habitats and species, management of sea uses and their number is continuously increasing (Mora et al, 2006) but they are rarely included in larger ocean and coast oriented strategies.

The importance of MPAs is increasing as we become aware of the need for protecting key marine habitats in order to ensure the life cycle of threatened species and also a better efficiency for fishery management.

However, even though local efficiency of MPAs have been demonstrated in some cases in the Mediterranean sea (Planes et al, 2006), a lot of them fail to achieve or have no management goals (Kelleher, 1995; Abdulla et al, 2008).

Agardy et al, 2011 attribute this failure to (a) a mismatch of MPA scale, (b) inappropriate planning or management process, (c) degradation of the unprotected surrounding ecosystem, (d) MPAs that do more harm than good due to displacement and unintended consequences of management (example of fishing), (e) illusion of protection.

Moreover, Mediterranean MPAs are generally coastal and small (Abdulla et al, 2008), (Pelagos sanctuary excluded) and therefore heavily affected by human activities that lie outside their boundaries, ranging from marine transportation and fishing to land-based sources of marine pollution, e.g., agriculture, urban runoff, and industry (Halpern et al, 2009 ; Cicin-Sain, 2005).

Mediterranean MPAs illustrate well the problem of scale in addressing threats because they are sharing regional and global problems (strong human pressure, higher proportion of common species, loss of biodiversity) together with very diverse local situations (Harmelin et al 2000).

Therefore it appears essential to link and integrate MPAs into a larger and broader spatial development strategy like Integrated Coastal Zone Management (ICZM) which should strongly interact with MPAs both to achieve the ecosystem conservation goals and to act as umbrellas of protection dealing with the pressures surrounding MPAs, with a full land/sea interface perspective.

As a conclusion for Cho et al, 2005 ***The greatest challenges to MPA and ICM programs in the next 10 years are: improved linkages between the two, fostering of community participation in management, broadening of the scope of ICM to watersheds and ocean governance (see glossary), and sustainable financing for both programs.***

Context

This report will focus on the link between MPAs and ICZM in a way that is in line with the framework of the European FP7 PEGASO project (People for Ecosystem Based

Governance in Assessing Sustainable Development of Ocean and Coast) regrouping 25 partners in both the Mediterranean and Black Seas.

The aim of PEGASO is to build on existing capacities and develop common novel approaches to support integrated policies for the coastal, marine and maritime realms of the Mediterranean and Black Sea Basins in ways that are consistent with and relevant to the implementation of the ICZM Protocol for the Mediterranean..

The aim will be achieved by accomplishing five key objectives:

1) To construct an ICZM governance platform, consistent with the aims of article 14 of the ICZM Protocol for the Mediterranean, to support the development of integrated policies for the coastal, marine and maritime realms of the Mediterranean and Black Sea basins.

2) To make an integrated regional assessment for the Mediterranean and Black Sea coastal and maritime areas.

3) To refine and further develop efficient and easy to use tools for making sustainability assessments in the coastal zone.

4) To test and validate the assessment tools at regional and local scales to understand both global and cumulative local trends and how they interact in specific coastal and marine regions.

5) To establish and strengthen mechanisms for networking and capacity development so as to promote knowledge transfer and the continued use of the project outputs.

The present work enters into the fourth objective of PEGASO which is based on the experience gained from work in 10 Mediterranean and Black Sea sites called “Collaborative Applications SitES” (CASES).

The goal is therefore to test existing assessment tools or creating some new instruments looking at a specific PEGASO CASE, at different scales (global, regional and local) in a land/catchment/sea perspective, focusing on MPAs in order to better understand the MPAs role into the ICZM assessment.

This approach should help to understand the synergies between the different interfaces involving land and sea, and to collect relevant data for management of marine coastal areas and their neighboring territories, including these data into the PEGASO SDI.

Objectives

- Select a relevant area among the CASES of PEGASO to explore the relations between MPAs and ICZM.
- Assess as much as possible the current situation (distribution, surface, zoning, management) of MPAs.
- Assess and compare relevant pressures which could affect these MPAs (land based and ocean based)
- Describe opportunities for liaison between MPAs and ICZM processes and address gaps and needs (governance, scientific knowledge, etc.).

Scientific Strategy

Area of study

It has been chosen to work in the North Adriatic because it is relevant from both a governance and a socio-ecological point of view.

- The Adriatic Sea Commission would like to collaborate with PEGASO. This will give an opportunity to make the results useful to the countries by responding to a necessity for regional governance and agreed decisions making, especially for cross boundary issues (Italy-Slovenia-Croatia),
- The North Adriatic Sea is particularly relevant for addressing marine biodiversity loss in relation to coastal development (see results).
- The area is one of the best studied areas in the Mediterranean basin, which means existence (not necessarily availability) of data.

Selection of data and indicators

Data and outputs have to be coherent with PEGASO framework and relevant to address MPA's situation. They have to be relevant with the threats faced by Mediterranean marine biodiversity inside MPAs. This framework allows the building of spatially explicit indicators that will be operational and easy to use in order to understand what happens in the Adriatic

Sea between MPAs and ICZM. It will further facilitate comparisons across the region in a standardized and transparent way.

In order to assess MPA situation, an important bibliographic work as been done to select:

- Criteria to identify Marine protected Areas.
- The relevant information to be identified for characterizing MPAs.
- The main relevant pressures coming from outside their boundaries both from land/catchments and sea, as well as human drivers of these threats.

As many authors use pressures, threats, drivers with the same meaning, we decided to use the Driver-Pressure-State-Impact and Responses, the DPSIR framework which comes from the EEA work and is the most recognized methodology, if not the only one, to construct our indicators.

Following the PEGASO framework, we ideally use indicators to address current state and evolution of pressures on protected areas. Indicators are quantitative/qualitative statements or measured /observed parameters than can be used to describe existing situation and measure changes or trends over time. They generally permit to simplify complex phenomena enhancing communication of information to policy makers or other interested parties.

Indicators used in the present work have been selected from a list of 51 indicators produced by the Plan Bleu in the framework of PEGASO. They have been selected for their relevance for both MPAs and ICZM and their applicability with available data.

Some of them are based on the LEAC (Land and Ecosystem Accounting) methodology developed by (ETC-SIA/UAB, the EEA and UNOTT).

The work has been regularly presented during PEGASO's meeting and other events in order to communicate the first results, therefore they have been validated by relevant PEGASO end-users and adopted.

Availability of data and governance

Data at an international scale are very difficult to obtain, even for MPAs, due to agreements needed for sharing data between countries. Therefore, the presentation of this work in conjunction with PEGASO End Users has lead to an exchange with stakeholder permitting for us to understand better their needs and for them to understand our goal and therefore the potential usefulness of sharing data. These exchanges have led us to work directly with the

Adriatic Commission following their needs and therefore ensuring the applicability and usefulness of the results. In October these results will be presented at the meeting of the Adriatic Commission.

Materials and methods

Once the area of work identified, the next methodological issues has been defined:

a- Criteria to identify MPAs

b. Relevant elements to assess MPA situation

c. Relation between MPAs and areas of particular importance (lagoons, estuaries)

d. Identifying and mapping of pressures and threats

e. Assessing links between MPAs and ICZM

a. Criteria to identify MPAs

There are currently several definitions of marine protected areas (MPAs) with some important differences. An international definition of a protected area, including MPAs, is provided by the World Conservation Union (IUCN) (WCPA 2008): "A clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values."
The definition of the Convention of Biological Biodiversity (2003) is "Any defined area within or adjacent to the marine environment, together with its overlying waters and associated flora, fauna, and historical and cultural features, which has been reserved by legislation or other effective means, including custom, with the effect that its marine and/or coastal biodiversity enjoys a higher level of protection than its surroundings".

The number of different definition, legislation, categories of protection and sometimes the cumulated protected status makes it difficult to determine the exact number of MPAs especially in a cross-national perspective.
Therefore we decided to use the three criteria defined by Abdulla et al, 2008 for Mediterranean MPAs:
The MPA area has a legal basis under its country's law, regulation of the uses at sea but do not have obligatorily a designated management authority. We also follow the definition of IUCN: "a protected area is commonly called a MPA when the total area of sea it encompasses

exceeds the area of land within its boundaries, or the marine part of a large protected area is sufficient in size to be classified as a MPA in its own right."

Those criteria have lead us to include BPAs (Biological Protection Areas) in the study.
The biological resources protection areas are specific to Italy. They were introduced in 1965 by Law 963/1965 to preserve and increase the productivity of the halieutic resources, not only with prohibitions but with a different management framework. According to the law, they do not require any form of active management, local population involvement and the development of policies aimed at promoting sustainable tourism (Camuffo et al, 2010).
Therefore in a perspective a better understanding of protected areas (synergies, pressures) of the north Adriatic Sea, BPAs are an important feature to be studied.

Under the chosen criteria, coastal protected areas with a marine part (lagoons, estuaries) are not considered as MPAs. However they are very important for life cycle of some species (nursery, marine birds). Therefore they have not been taken into account in the stock take of MPAs but their relation with MPAs has been studied.

In summary, we consider in this study, features of protection (natural reserve, regional park, natural monument and so one) are: mainly marine, with a legal basis under its country law, a regulation of uses but not necessarily management authority.

b. MPA assessment

In order to characterize North Adriatic MPAs, four main points have been looked at:

- Number of MPAs
- Surface of each one, the total surface and spatial distribution of all the N. Adriatic MPAs
- Zoning of each MPA and the associated IUCN category of protection (buffer zone, No take zone)
- Management plan and authority

Information relative to MPAs management, categories of protection, relevant authorities have been gathered from MedPan database (network of managers of marine protected areas in the

Mediterranean, www.medpan.org/) which is the most complete in the Mediterranean Sea. MPAs managers have been contacted; currently we obtained data for Slovenian MPAs and are in the process to obtain data from Miramare MPA. Information relative to spatial extent of MPAs have been gathered from WDPA World Database on Protected Areas website (www.protectedplanet.net) and completed/checked by the data kindly provided by the Adriblu project (Adri.blu, interreg IIIa Norte Adriatico, www.altoadriatico.com). Adri.blu is the result of collaboration between the Italian regions of Emilia Romagna, Friuli Venezia Giulia and Veneto, together with Slovenia, the Istrian region and Primorsko Goranska (Croatia) aiming to promote a sustainable development of the fishery sector in respect of the associated environmental, economic and social sectors in the northern Adriatic Sea.

Spatial extents of BPAs have been drawn using official coordinates gathered from the website: http://www.reteambiente.it/cerca/?cerca=zona+di+tutela+biologica.

BPAs regulations have been gathered from the website: http://www.ambientediritto.it/Legislazione/aree%20protette/2009/dm_22gen2009.htm.

Spatial information has been analyzed and mapped using geographical information System (GIS) software (Arcgis 9.3).

c. Relation between MPAs and areas of particular importance (estuaries, lagoons)

Estuaries and lagoons are generally important nursery for number of demersal or pelagic species. They are also an important area for marine bird fauna who also obtain protection from MPAs. Therefore potential interactions between those areas and MPAs are important information to characterize North Adriatic Sea MPAs.

The mapping of Lagoons and their connections with the sea has been done as a personal work through the utilization of Corine Land Cover 2006 and Google Earth. Further characteristics of wetlands (Spawning ground, importance for marine bird species, threats) have been checked using RAMSAR database (http://ramsar.wetlands.org).

Spatial analysis has been done using GIS software Arcgis 9.3.

d. Identifying and mapping of pressures and threats

One of the main objectives of this study is to obtain a spatial representation of potential pressures affecting MPAs, identifying strategic linkages outside the MPA to be able to identify negative externalities.

Selection of pressures

Pressures have been selected after a review of existing literature concerning general threats in the Mediterranean Sea, especially the North Adriatic marine ecosystems and specific literature about threats affecting MPA from outside their boundaries.

We obtained a list of threats and anthropogenic drivers from where have been selected whom which are relevant for both ICZM and MPAs.

Representation

Spatial indicators have been used when possible. However, their calculation requires harmonized data in time (same moment at different time), spatially (definition) and between countries. When such harmonized data was unavailable to produce spatial indicators we have used statistics directly from the mapping of activities when sectoral information was available (e.g. aquaculture and others).

Generally it has been extremely difficult to obtain validated and actualized data such as observed density of maritime traffic, submarine cables, bottom trawling, dredging, sand extraction etc because: or they simply don't exist, or they are extremely expensive, scattered, not public and not freely accessible even if collected with public money.

Even if some data exist at the scale of a MPA or one country they generally could not be used because of the lack of harmonization or because of language issues.

Finally it has been possible to calculate three indicators which are: The proportion of artificial coast, the proportion of agricultural land farmed intensively by nuts2 (region) and the "artificial surface temperature" which are explained and presented in the next section.

Data Gathering and mapping

An important part of the work has been to search for existing and relevant database for this report and for further PEGASO research. The process of mapping and the main databases used are exposed below.

- Spatial indicators of proportion of agricultural land farmed intensively and "artificial surface temperature" (influence) have been calculated using LEAC database based on Corine Land Cover (CLC) 1990, 2000 and 2006. LEAC methodology has been developed by applying a spatial grid (1km*1km) covering the entire European

territory to 100m CLC raster. This gridded information allows comparisons between sites, regions, or other geographical and administrative units (EEA, 2006c).

The artificial surface temperature express the influence of artificial CLC classes through indexed values that allow the visualization of the pressures on a given area of interest (e.g. MPAs, Natura 2000 etc).

Calculation of "artificial surface temperature" has been done applying the algorithm CORILIS with a radius of 5km to CLC 2006 grid. The CORILIS methodology has been developed in France jointly by the Hypercarte Research Group, INSEE and IFEN (see Grasland et al. 2000). These tools use the gridded structure of the account data to measure the potential or influence of a given land cover type in the area around the place where it is found, using a weighting distance function. A Gaussian type statistical function (called BiWeight) is used to weight (w) this information according to the distance from the considered point in kilometres. The approach is based on the assumption that the influence of a given land parcel on its surroundings declines with increasing distance from it. In order to have a spatial representation of Urban influence on the coast, we used the following CLC classes: **Continuous urban fabric, discontinuous urban fabric, industrial or commercial units, roads and rail network and associated land, port areas, airports, mineral extraction sites, dumps sites, construction sites, Green urban areas, sport and leisure facilities.**

CLC or LEAC database are very advantageous because they are harmonized across countries and time, allowing comparisons and analysis of temporal trends. Moreover they are very easily accessible.

- Spatial indicator of artificial coast and erosion trends has been taken directly from the results of the European project Eurosion (EEA2005, www.eurosion.org). The design approach of Eurosion is an update of the 1990 CORINE Coastal Erosion (CCEr) methodology in which 3 criteria were used: **Morpho-sedimentology** (rocky coasts, beaches, muddy coasts, etc, **Evolutionary trends** (erosion, aggradation, stability) and presence or not of **Coastal defence works**. Shape data were directly accessible. The advantage of those data is that they have been checked and harmonized for European countries (Croatia excluded).

- In order to show principal coastal cities in the North Adriatic sea, population by cities has been collected from the Center for International Earth Science Information Network (CIESIN), Global Rural-Urban Mapping Project (GRUMP), 2005.(http://sedac.ciesin.columbia.edu/legacy?url=http://sedac.ciesin.columbia.edu/wdc/index.jsp). This database has already been used by UNEP MAP Plan Bleu and therefore validated in the entire Mediterranean region. Data are available and harmonized for the entire study area.

- For those cities, presence or absence of waste water treatement plant and degree of treatement has been gathered from MedPol report (UNEP/MAP/MED POL/WHO, 2004). This information has been aggregated to city name in ArcGIS to have a representation of the degree of treatment per city.

- Mariculture is recognized as one the growing pressure on marine environment. In order to show in which place it can exert a pressure on MPAs we tried to map Mariculture farms. These files (shape) have been kindly provided by Adri.blu project, 2007. They cover all the North Adriatic sea but have not been gathered with the same technique (official data for Italian region and Google earth pro for Slovenia and Croatia) (Rossin et al, 2007)

- Maritime traffic constitutes an important risk in term of pollution (chemical, noise) and collision especially for marine mammals. International ports with liquid terminals constitute a risk in term of pollution and can be a source of invasive species (water ballast). Therefore an effort has been done to gather spatial information on observed maritime traffic density. This information exists but only some of it has been possible to obtain. Therefore main ferry routes as been mapped as from European Atlas of the Sea (http://ec.europa.eu/maritimeaffairs/atlas/index_en.htm), 2011.
  Ports localization has been gathered from World Port Index edition 2011 published by National Geospatial-Intelligence Agency:
  (http://msi.nga.mil/NGAPortal/MSI.portal?_nfpb=true&_pageLabel=msi_portal_page_62&pubCode=0015)
  Those data have been completed by traffic information obtained from the Bureau of Statistics of Italia, Slovenia Croatia and ports websites.

Finally we arrived to a comprehensive vision of North Adriatic land based and ocean based pressures. However this demarche has been extremely time consuming. The scarcity and difficulty to gather those data is considered a barrier for any cross border cooperation and large scale project.

d. Assessing links between ICZM and MPAs

In order to assess a common vision, possible synergies and gaps between MPAs management and ICZM, we have determined the following for each country:

- The current progression of ICZM process and initiatives.
- The relevant administration for ICZM.
- The relevant administration and management body for each MPA.

Information relative to ICZM process, initiatives and relevant administration has been gathered in 2 ways:

- Consultation of the database of the European commission DG environment (national report of each country and DG environment report) and UNEP/MAP website:
  DG environment:
  (http://ec.europa.eu/environment/iczm/evaluation/iczm_national_reporting.htm)
  (http://ec.europa.eu/environment/iczm/ia_studies.htm)
  UNEPMAP:
  (http://www.unepmap.org/index.php?module=content2&catid=001001001)

- Gathering information from End Users of PEGASO and governance process.

Information regarding administrations and Management bodies relevant to the MPAs has been gathered using the MedPan database, internet query and PEGASO Italian partners for BPAs.

Results

Study area

The Adriatic Sea is a semi enclosed sea linked to the Mediterranean Sea through the 70 km large Strait of Otranto. It has been recognised as one of the sub areas of the Mediterranean Sea in the EU Marine Strategy Framework directive and as an ecoregion by Splading et al in 2007. However, strong differences can be observed from the North to the South and from the West to the East. The Adriatic Sea can be subdivided in three parts; the Northern, Central and South Adriatic Sea. The North Adriatic Sea and coastline are subdivided among three nations: Italia, Croatia and Slovenia, the last having a coastline of 47km. This area represents the largest continental platform of the Mediterranean Sea (Figure 1) and is therefore a relatively shallow ecosystem with an average depth of 35m (Ott, 1992).

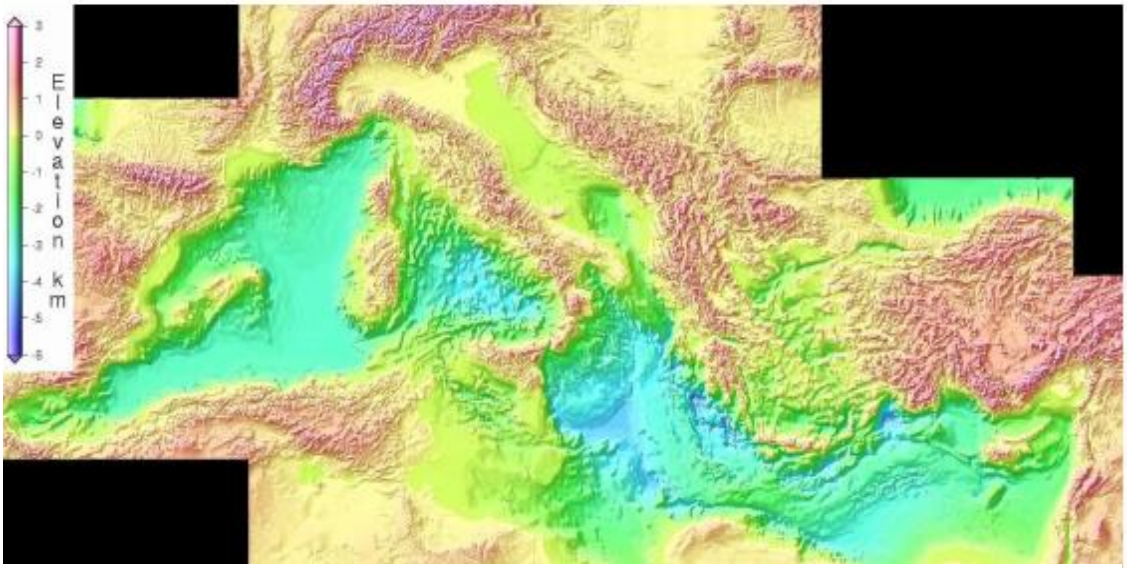


Figure 1: Sea floor topography of the mediterranean sea. Source: Smith and Sandwell 1997

This small volume of water is characterised by a strong terrestrial influence principally coming from the Po River. Indeed it collects one third of the freshwater input of the all Mediterranean Sea and 80 percent of the pollutants entering the Adriatic Sea (Tagliapietra, 2005).

Consequently the biological productivity of this area is one of the highest (Figure 2) of the generally oligotrophic Mediterranean Sea (Ott, 1992) often provoking eutrophication and sea bottom anoxic events. Water circulation is Cyclonic. Therefore the region at the south of the Po River is the most influenced by the river plum.

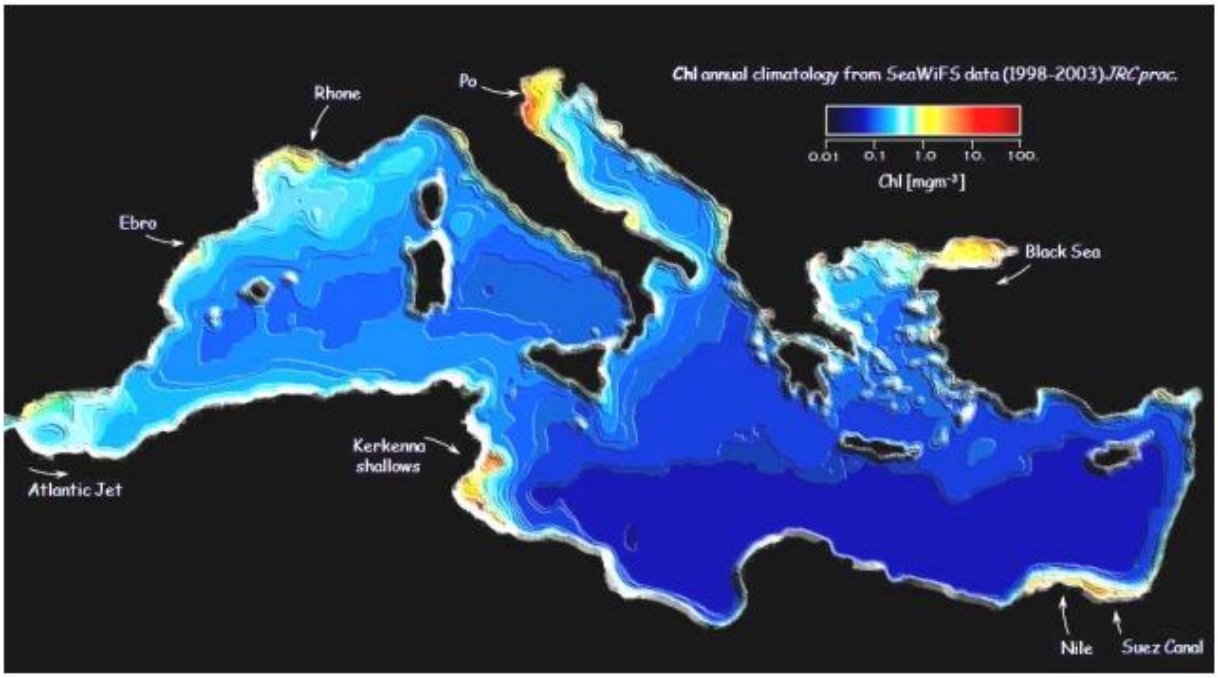


Figure 2: Source: Chlorophyll climatological annual mean. Source: SeaWIfs data, 1998-2003, courtesy of V. Barale, JRC).

The western side is characterised by sandy, relatively homogeneous coasts with the presence of wetlands all along. In contrast, the eastern part is a rocky coast, with many small islands, submerged reefs and many channels.

It has to be stressed that North Adriatic Sea is the area with the biggest tide amplitude in the Mediterranean sea. This specificity makes this area very sensitive to climate change especially in the western sandy part where additional phenomena of subsidence have been registered.

Biodiversity

A high diversity of marine habitats and associated species is concentrated in this small area. It is notably known to host marine mammals such as the bottlenose dolphin mostly in the Croatian part, and has the highest concentration of loggerhead turtles (Casale et al, 2010). It is also host to diverse and abundant marine bird fauna (Carboneras & Requena 2010). The shallow water of the north Adriatic also provide an important spawning ground for small pelagic fishes like anchovy and also for numerous demersal species like red and stripped mullet, musky octopus, common squid and cuttlefish and many others (Turk and Odoriko, 2010).

Existing large framework and structures for biodiversity conservation.

Countries boarding the North Adriatic Sea are all contracting parties of the Convention of Biological Diversity (CBD) and of the Barcelona convention concerning special protected areas (SPA) and biodiversity (BIO) in the Mediterranean Sea.

A regional center called Regional Activity Centre for Specially Protected Areas (RAC/SPA) has been established in Tunis in 1985 by decision of the Contracting Parties to the Barcelona Convention. This center has the responsibility for assessing the situation of natural heritage and assisting the Mediterranean countries to implement the Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean (SPA/BD Protocol), which came into force in 1999.

The CBD has defined the target of "*By 2012, a global network of comprehensive, representative and effectively managed national and regional protected area system is to be established in the marine area*". This global network must cover 10% of coastal and marine areas. This target has been postponed to 2012/2020 at the tenth Convention of the parties in Nagoya in 2010 due to the still underrepresentation of marine ecosystems under protection.

Thus the Contracting Parties of the Barcelona Convention invited the RAC/SPA to elaborate a programme of work aimed at supporting the Mediterranean countries to achieve this new target. As a result the "Regional Working Programme for the Coastal and Marine Protected Areas in the Mediterranean Sea including the High Seas" has been adopted in November 2009. Following the CBD approach, the Working Programme recommends the adoption of a hierarchical planning approach, which begins at the large scale and focuses in on ever-smaller scales consisting in three steps (Notarbartolo and Agardy, 2009) :

- Identification of large scale ecological units.
- Identification of priority conservation areas, or Ecologically or Biologically significant Areas (EBSAs), inside each ecological unit (these areas do not correspond to what would become MPAs but would be focal areas for establishment of MPA network).
- Identification of sites inside EBSA to develop ecological networks of MPAs.

This demarche has lead to define a large part of the North Adriatic Sea as an ESBA and is therefore suitable for the establishment of a MPA network following the criteria of CBD.

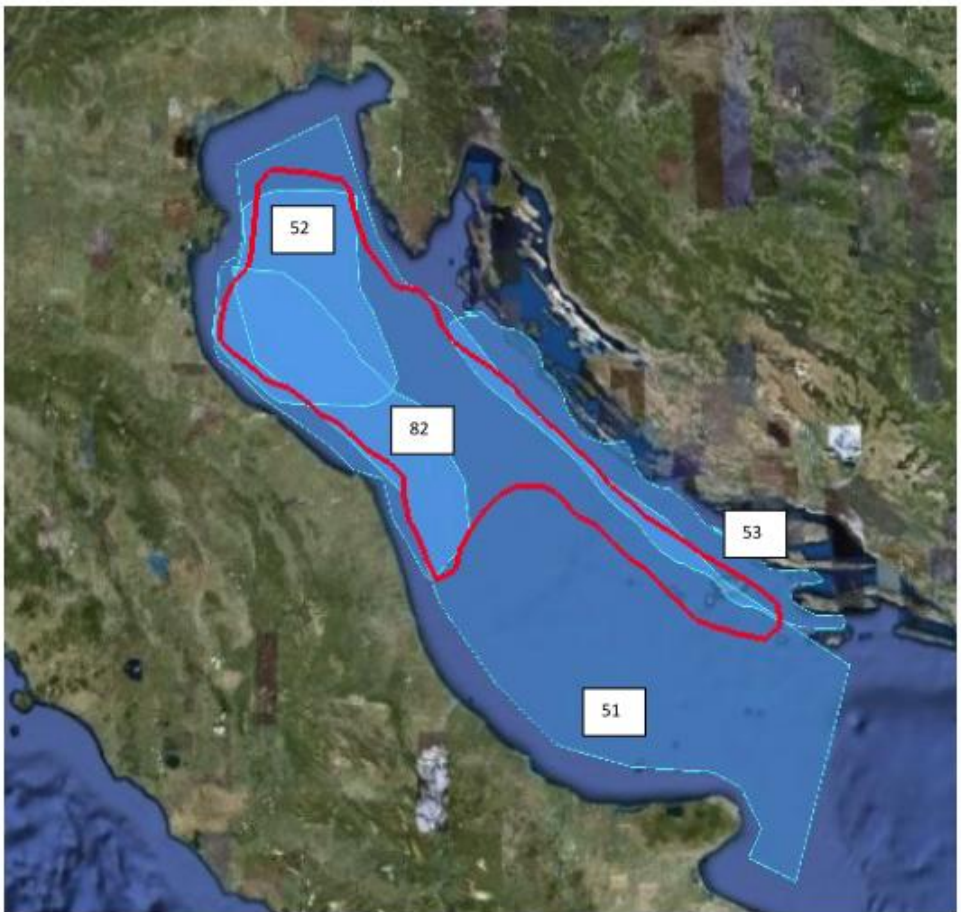


Figure 3: Northern Adriatic Sea. In Red: ESBA; 51: Loggerhead turtle feeding habitat (P. Casale); 52: Squalus acanthias, Prionace glauca nursery area (F. Serena); 53: Scyliorhinus canicula nursery area (F. Serena); 82: Important suitable habitat for small pelagic(sardines and/or anchovies). Source: Notarbartolo and Agardy, 2009

Marine and coastal protected areas in the North Adriatic Sea - State of art.

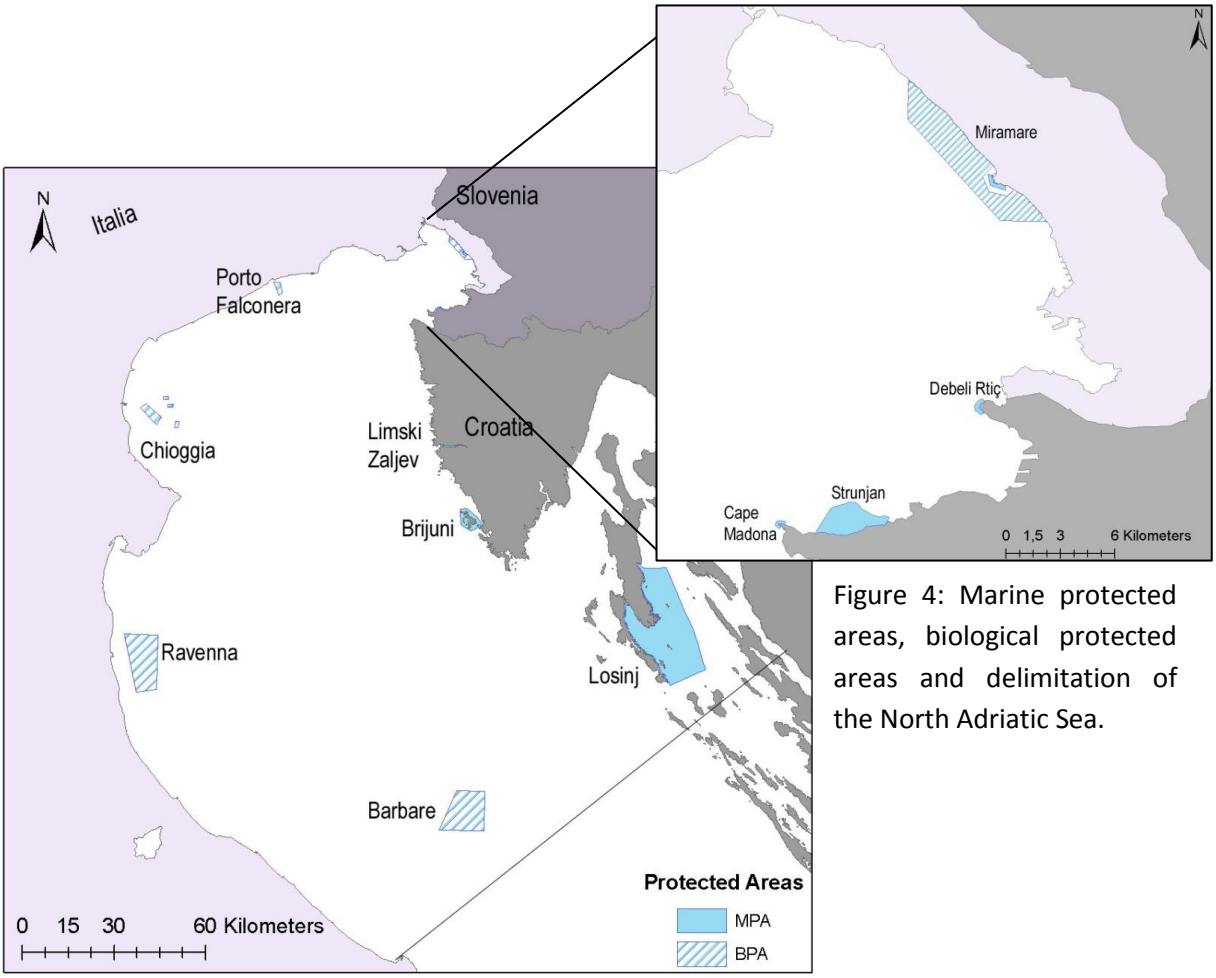


Figure 4: Marine protected areas, biological protected areas and delimitation of the North Adriatic Sea.

MPAs are all situated on the East coast of the North Adriatic, the biggest area of protection being Losinj MPAs which is in progress of implementation.

There is no MPA in the Western Italian coast which is covered uniquely by BPAs. All of the protected area are coastal apart from the BPA of Barbare which is the unique protected area situated in open sea.

Taking into account all the kinds of protection, **3%** of the North Adriatic sea is protected or regulated. This number falls to 1,8% considering just MPAs and 0,4% without Losinj.

The size of protected areas vary from 0, 13 km^2 for Cape Madona to 526 km^2 for Losinj with 6 areas inferior to 10km^2 and 6 superior.

Italy

Protected area	Legal Status	International Recognition	Management Body	Management plan	Creation	Category of protection IUCN
Miramare (1,2 km^2)	Nature reserve	SPAMI (Special Area of Mediterranean Importance), Biosphere Reserve	WWF Italia ONLUS	Yes	1987	IV
Miramare (14 km^2)	BPA	Data not available	Data not available	Data not available	2004	Professional fishing regulated
Raven (160 km^2)	BPA	Data not available	Data not available	Data not available	2004	Professional fishing regulated
Chioggia (24 km^2)	BPA	Data not available	NGO "Tegnue di Chioggia"	Data not available	2002	Prohibition of all kind of fishing activities
Porto Falconera (6 km^2)	BPA	Data not available	Gruppo Sommozzatori Caorle	Unclear	2006	Prohibition of all kind of fishing activities
Barbare (160 km^2)	BPA	Data not available	Data not available	Data not available	2004	Professional fishing regulated

Slovenia

Protected area (name and surface)	Legal Status	International Recognition	Management Body	Management plan (Turk and Vidmar, com pers)	Creation	Category of protection IUCN
Debeli rtic (0,24km^2)	Natural Monument, Specially Protected Area	Natura 2000	Institute of the Republic of Slovenia for Nature Conservation , Regional Unit Piran	No	1991	III
Strunjan (o,9 km^2)	Natural park	Natura 2000	Institute of the Republic of Slovenia for Nature Conservation , Regional Unit Piran	In progress	1990	V
Cape Madona (0,13km^2)	None	Data not available	Institute of the Republic of Slovenia for Nature Conservation , Regional Unit Piran"	Yes	1990	III

Croatia

Protected area	Legal Status	International Recognition	Management Body	Management plan	Creation	Category of protection IUCN
Limski Zaljev ($4km^2$)	Special Marine Reserve	Data not available	Public institution for Natural Protection in Istria County (Natura Histrica)	Data not available	1979	Ia
Brijuni ($26km^2$)	National Park	Data not available	"Brijuni National Park" Public Institution	Data not available	1983	II
Losinj ($526km^2$)	Special Marine Reserve	Data not available	Blue world institute	In progress	2006 (Implementation in progress)	Unknown

Table 1: MPAs and BPAs characteristics for respectively Italy, Slovenia, Croatia. (MPAs are in Grey). Based on MedPan, 2008, official acts of BPAs creation and diverse web sources.

Another important aspect for the characterization of MPAs is the presence and surface of No Take Zone inside (see glossary). This information was not available for Croatian MPAs. For other ones, it varies from 0 (BPA: Miramare, Ravenna, Barbare ; MPA: Debeli Rtiç, Cape Madona) to 100% (BPA: Chioggia, Porto Falconera).

Median surface of NTZ per protected area is 27% considering every protected features, 11% considering only MPAs.

Status of protection

As we can see in Table 1, the legal status of protected areas varies from nature reserve, special marine reserve, to natural monument or Natural Park. Protected areas can include a terrestrial part like Strunjan or Brijuni and belong to nearly all the different category of protection following the IUCN criteria from I (Protected area managed mainly for science or wilderness protection (Strict Nature Reserve/Wilderness Area) to V (Protected area managed mainly for landscape/seascape conservation and recreation (Protected Landscape/Seascape).

All the MPAs apart from Losinj have been created before 1992, the oldest being the special marine reserve of Limski Zaljev. BPAs have all been created after 2002.

Management plan and Goal

Among twelve MPAs, only one has an official management plan (Miramare) which is in the way to be obtained at this date. Therefore we have no information about general objectives.

According to the manager of Slovenian MPAs, Robert Turk, Debeli Rtiç and Cape Madona have no management activities whereas a public institute with sole purpose to manage the Strunjan park has been created in 2008 with a management plan in progress.

In Croatia the Losinj marine reserve has been established with the main goal to protect bottlenose dolphin. Management plan is in progress (Council of Europe, 2010).

There is no information about management plans for BPAs but they have a general goal of fishery management.

For the other ones, we found no data indicating the presence of a management plan or management activities.

Management Body

All the MPAs have an attributed management body, nevertheless the existence of a real structure of management with appropriated funding has been very difficult to assess.

We can affirm that the following MPAs have an effective management structure:

- Italy: Miramare
- Slovenia: Strunjan
- Croatia: Brijuni and Losinj

The existence of a management body is not obligatory for BPAs, nevertheless in the BPAs of Chioggia and Porto Falconera, the dive clubs at the origin of the creation of those areas are doing dissemination and some management activities.

Relation between MPAs and areas of particular importance

Coastal lagoons and estuaries are concentrated in the Western and Northern part of the north Adriatic Sea. MPAs or BPAs closest to point of connection between these areas and sea are Ravenna, Chioggia, Porto Falconera, Strunjan and Cape Madona.

For these areas the mean distance between them is 7,8km with a minimum of 670m for Porto Falconera and a maximum of 11km for Chioggia (centroid).

The majority of wetlands are classified as Natura 2000 or Ramsar, sometimes the two at the same time and some of them like the Delta of Po River (regional park) have other regional, national or international status of protection.

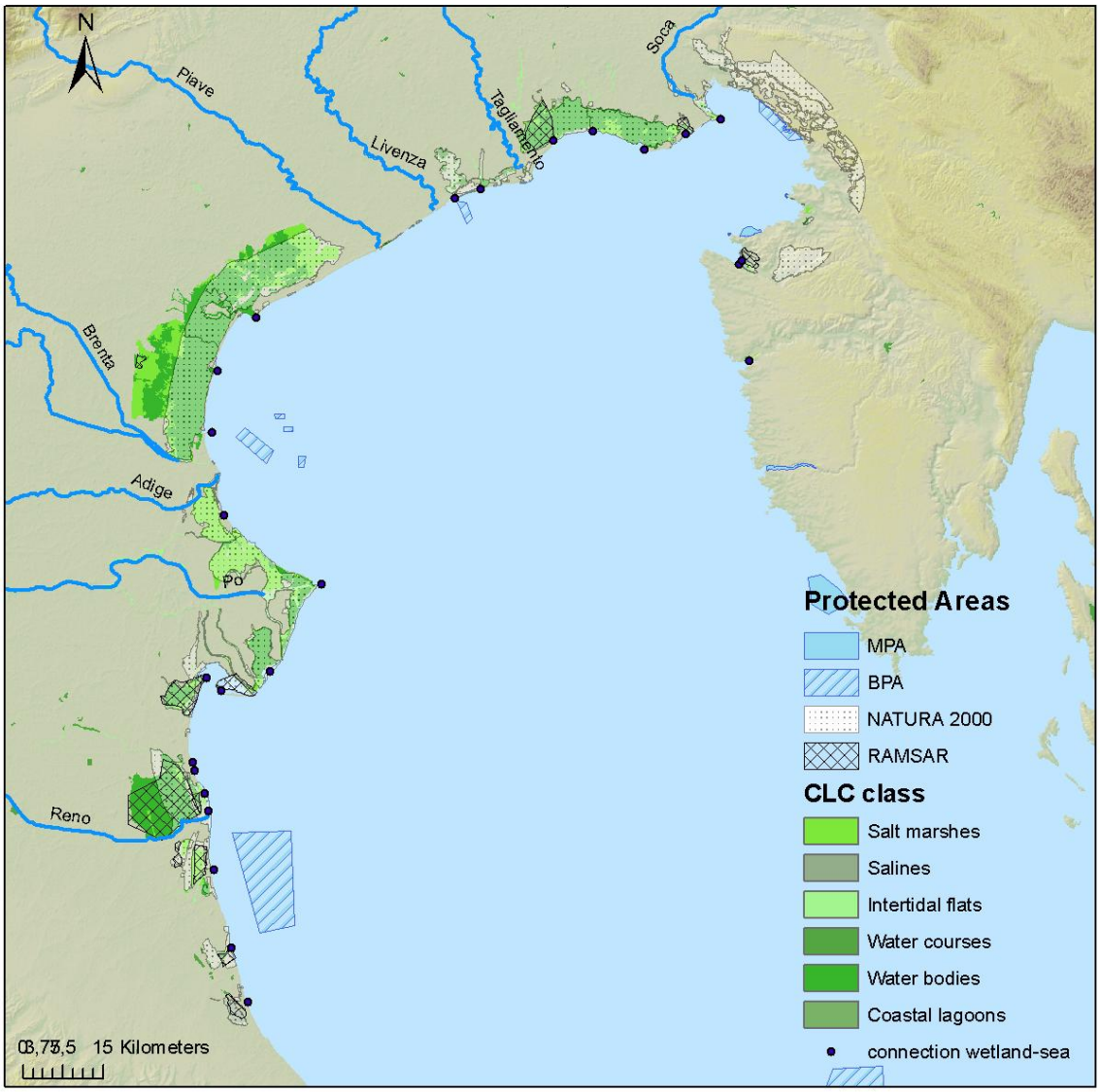


Figure 5: MPAs, BPAS, Ramsar and Natura 2000 in the 10 first kilometers of the North Adriatic Sea coast. Wetlands have been mapped aggregating the CLC classes showed on the map for the Year 2006 and Natura 2000 areas have been obtain from EEA website as on 22 march 2011.

Pressures potentially affecting MPAs

Threats on marine ecosystem and related human activities

One of the goals of the present work is to represent the localization, extent and trend of human activities related to ICZM that could exert a pressure on marine ecosystems and MPAs of the North Adriatic Sea.

Marta Coll et al, 2010, defined **habitat loss and degradation** as the most widespread on important pressures in term of biodiversity loss in Mediterranean sea following by **fishing**, **Pollution, Eutrophication, Introduction of Alien species and Climate Change**.

Therefore, starting from the most important pressures from an ecological point, a bibliographic work has been done to find the most important drivers at the scale of coastal development. Results are shown in Table 2.

Threat	Associated human activities	ICZM related
Habitat loss and degradation	• Coastal engineering (Martin et al, 2005) • Demersal destructive fishing (Thresh and Dayton, 2002) • Aquaculture (CIESM, 2007) • Urbanisation (Mangialago et al, 2007)	**Coastal engineering** **Urbanisation**
Fishing impact	• Fishing	**Sewage and Urban runoff**
Pollution	• Sewage and Urban runoff (EEA, 2006) • Industry (EEA, 2006) • Aquaculture (CIESM, 2007) • Maritime transport (EEA, 2006)	**Aquaculture** **Heavy Industry**
Eutrophication	• Intensive agriculture (Pirrone et al, 2005) • Sewage (Pirrone et al, 2005) • Industry (Pirrone et al, 2005)	**Maritime transport**

	• Aquaculture (CIESM, 2007)	**Intensive agriculture**
Introduction of Alien species	• Maritime traffic (EEA, 2006) • Aquaculture (EEA, 2006)	
Climate Change	• Anthropogenic increase of CO2	

Table 2: Main threats on Mediterranean marine ecosystems, associated human activities and coastal development patterns.

Finally seven human activities or related coastal development have been selected for their potential to originate or enhance the most important pressures on marine ecosystems and MPAs. Thus they have been mapped (directly or calculating indicator) to allow a global vision of their spatial pattern and trends in the North Adriatic Sea and the potential risk their represent for MPAs.

Heavy Industries (point source pollution) have not been mapped due to the impossibility to find spatially explicit data.

It is important to remind that these maps aim to give a spatial representation of general coastal pattern and trends of the potentially most impacting activities for MPAs.

Real pressure and impact of these activities need a lot of information and are also still subject to debate and therefore will be discuss after.

1) Land-based pressures

a) Artificialisation of the coast

According to Figure 5, the Western and Northern coast of the North Adriatic are the most artificialised. The percentage of articificial structure length relative to the total length of the coast is: 45% for Emilia Romagna region, 40% for Fruili Venezia, 34% for Veneto coast and 17% of the Slovenian coast. There was no data available for the Croation coast. The Croatian coast being the same nature of the Slovenian coast (rocky coast-less erosion), it is probable to be less artificialised.

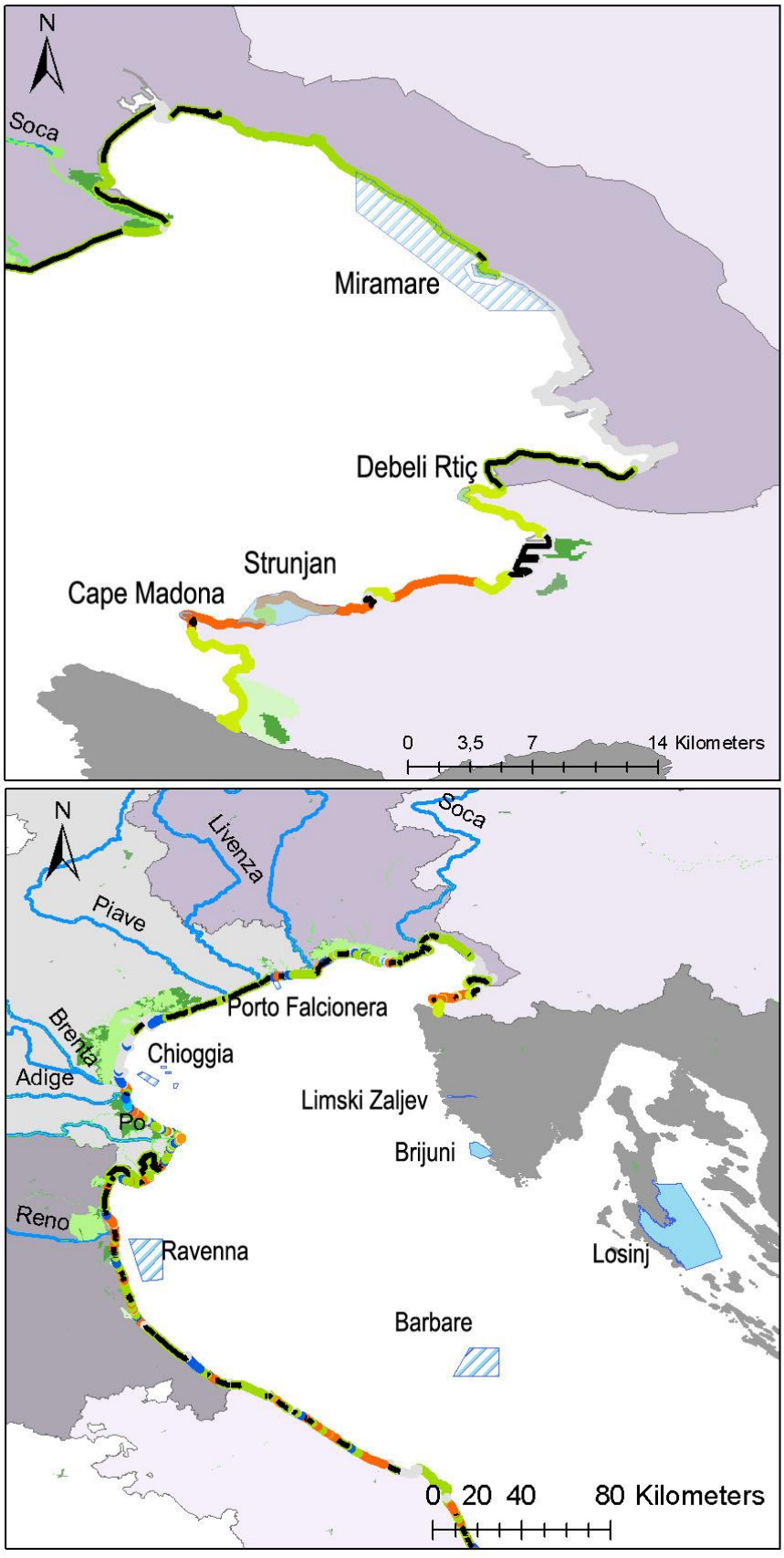
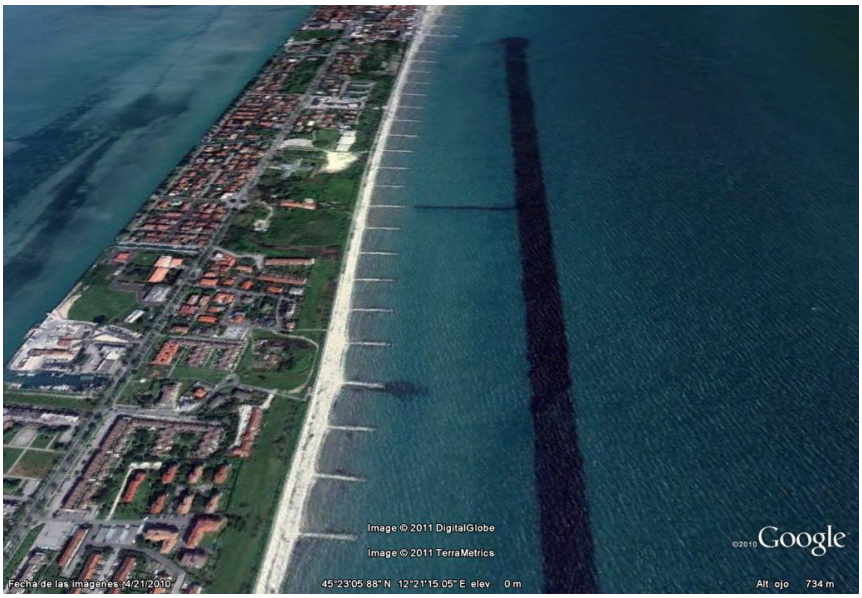


Figure 5: Artificialised area and evolutionary trends, main rivers and wetlands of the north Adriatic Coast (Croatia Excluded). Artificial coast being: Artificial shoreline or shoreline with longitudinal protection works (walls, dikes, quays, rockystrands), without sandy strands, coastal embankments for construction purposes (e.g. earthworks), harbour areas. Mapped using Eurosion data 2005.

Figure 6: Picture of the coast in front of the Venice lagoon, Italy. From Google earth, 2003.



Large patterns of 10km long continuous longitudinal protection work can be observed at the south of Emilia Romagna and East of Veneto. The most preserved areas are the Po Delta river coast, the wetland between Tagliamento and Soca rivers and the south East coast of the golf of Trieste and the Slovenian coast. Looking especially at the situation near protected areas, the coast in front of Ravenna and Porto Falconera is discontinuously artificialised with some preserved areas. Regarding Miramare and Slovenian MPAs, artificial feature (in general marinas) can be seen directly nearby or at less than 1km. Chioggia and Barbare are too far from the coast to say anything. After verification in Google Earth, areas in pale grey (In the legend: not in nomenclature) at the North of Miramare or in the exterior of Venice lagoon appeared to be highly artificialised (Figure 6).

Temporal trend

Coastal engineering constitutes a response to erosion phenomenon, flooding or development of artificial infrastructures like ports or marinas. Looking at the evolutionary trends on the Figure 5, we can see that erosion is confirmed in front of Ravenna and Porto Falconera. Almost all the Slovenian coast including Strunjan and Cape Madona MPAs is experiencing erosion. In the very near future considering the cumulative effect of sea level rise (particularly important in the North Adriatic area) and subsidence experienced in some region (Emilia Romagna and Veneto), a development of coastal engineering is expected.

b) Coastal population and urbanization

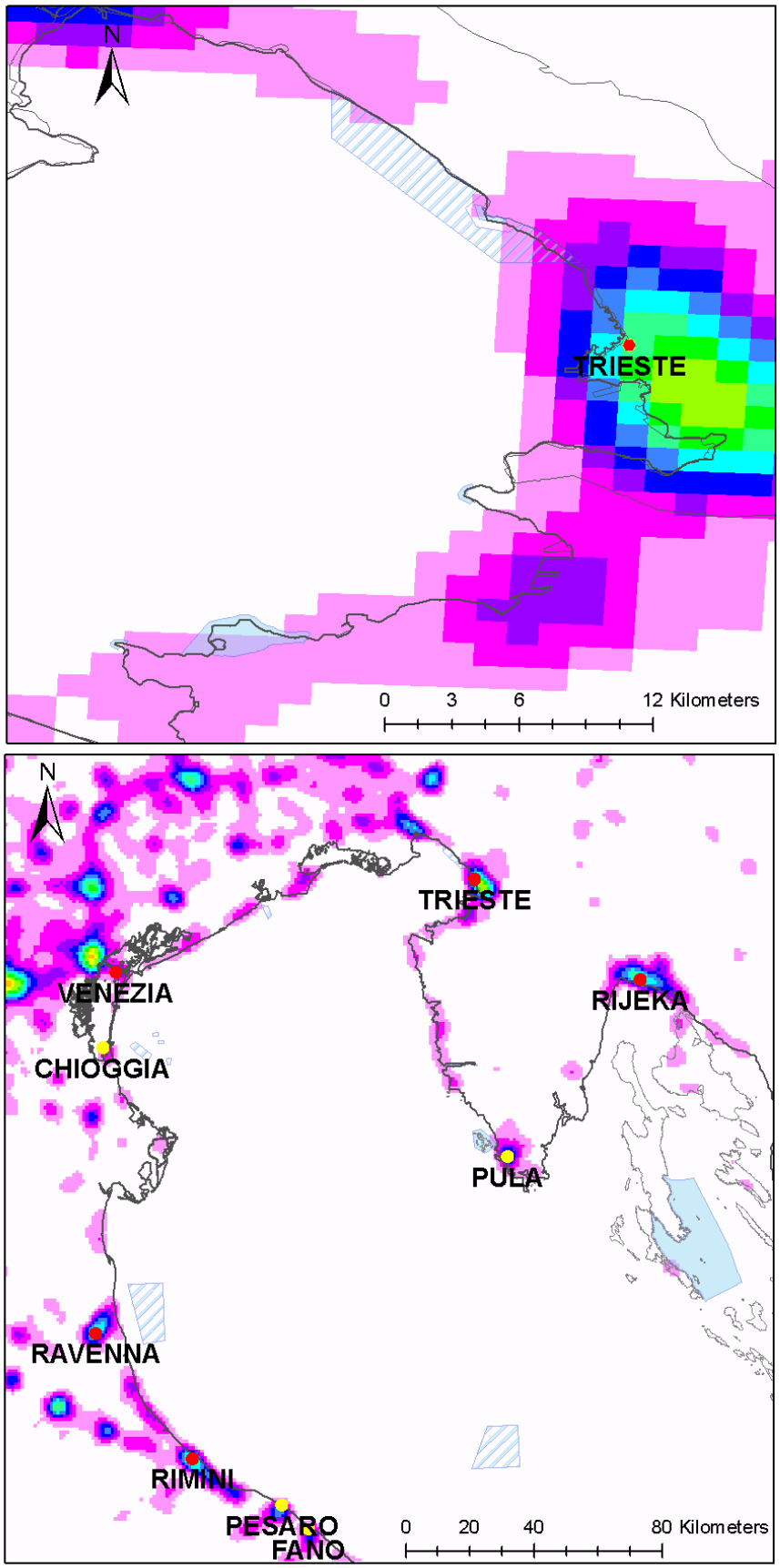


Figure 7: Maps of "urban temperature" constructed using the CORILIS methodology which has been used to calculate the density of artificial surfaces recorded on CLC 2006, within a 5 km radius of each point. Cities of more than 50000 and 100000 have been then added. Population data from CIESN, 2004

There are two different kind of information addressed in the Figure 7; first, the biggest urban centers in term of population, second, the urban influence (or temperature) in term of artificial surface. There are 9 cities of more than 50000 habitants in the North Adriatic coast which correspond to the maximal urban temperature. However, even out of this big center we can see a general relatively high urban temperature concentrated on the coast.

Eight of the 12 protected areas are situated at less than 13km of a city of more than 50000 habitants with a minimum of 4km for the BPA of Miramare. The others i.e. Porto Falconera, Barbare, Losinj and Limski Zaljev are respectively at 49, 45, 47 and 30km.

All the coastal protected areas (in contact with the coast) even far away from big cities are directly under the influence relatively high urban temperature. This fact is particularly marked for Slovenian MPAs.

Trends:

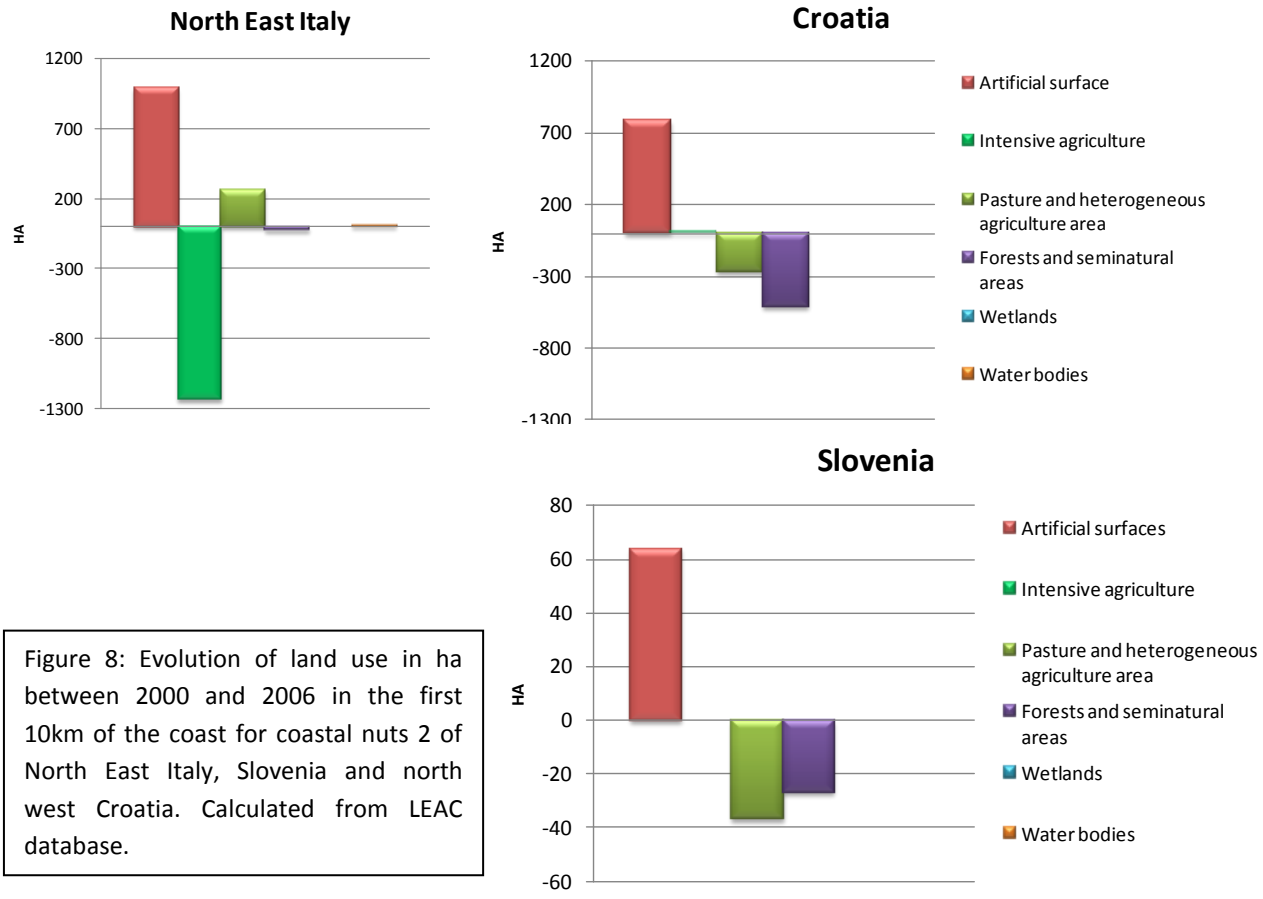


Figure 8: Evolution of land use in ha between 2000 and 2006 in the first 10km of the coast for coastal nuts 2 of North East Italy, Slovenia and north west Croatia. Calculated from LEAC database.

In the three countries, artificial surface in the first 10km of the coast have increased between 2000 and 2006. The augmentation in Slovenia (64ha) is small in relation to Croatia (787ha) or Italy (992ha) but important relatively to the length of Slovenian coast (47km). This increase is

accompanied in Slovenia and Croatia by a decrease of forests and pasture areas. In the Italian coast, artificial surface sprawls mostly on intensive agricultures areas. No data was available for evolution of population or city per city. Despite that, population of Italia, Slovenia and Croatia is stabilized with a growth rate of respectively 0, 55%, 0,15%, -0,23% between 2000 and 2006 (Blue plan, 2009) but with a marked phenomenon of littoralisation (people going to the coastal cities) making urban population increasing on the coast.

Wastewater treatment

In coastal cities municipal wastewaters are discharged directly into the immediate coastal zone, either untreated or subjected to different treatment procedures, through outfall structures of variable length.

In 2004, all the urbanizations of more than 50.000 habitants were equipped with wastewater treatment plants. The degree of treatment for each city is visible in the figure 9. Generally 33% of cities have a primary treatment, 22% a secondary and 45% a tertiary.

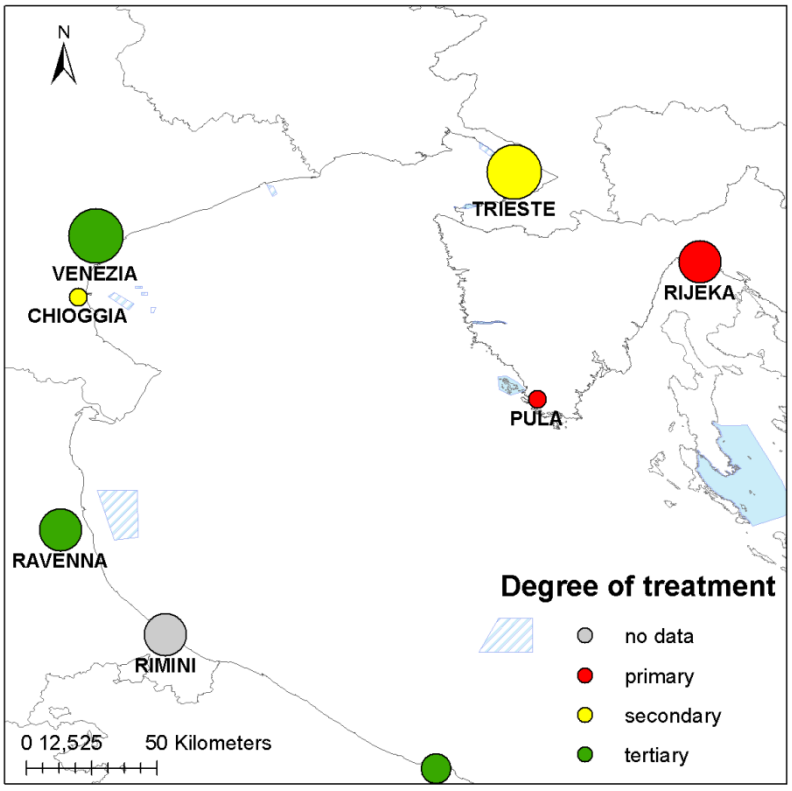


Figure 9: Degree of treatment and relative population for cities of more than 50000 in the North Adriatic.

Agriculture

As we can see on the Figure 10, there is a clear spatial pattern of intensive agriculture in the Western Adriatic, especially in the Po catchment whereas the proportion of intensive agriculture is less than 10% in Slovenia and Croatia. The proportion in Italian regions is more precisely 66% in Marche, Emilia Romagna and Fruili-Venezia region and 73%, 85% respectively in Veneto and Lombardia region.

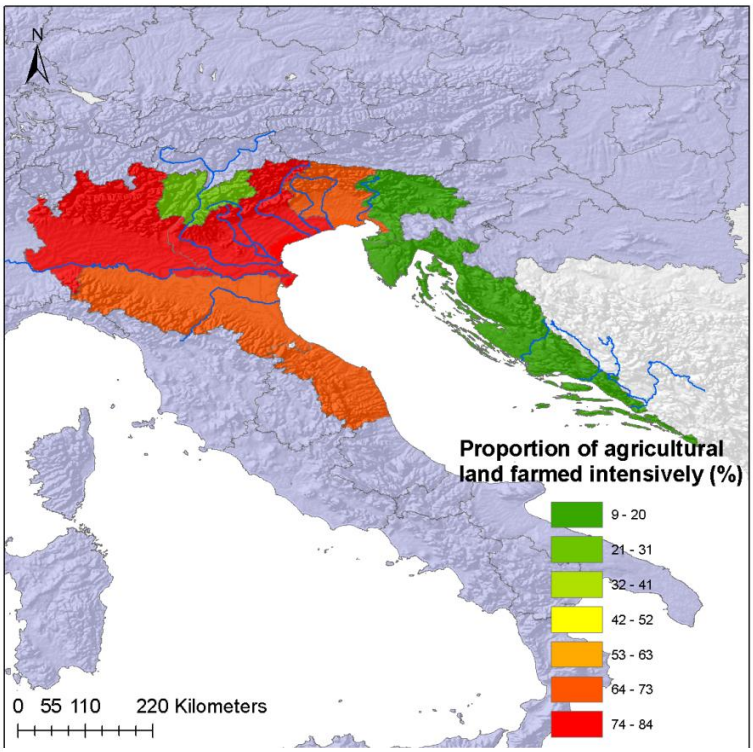


Figure 10: proportion of agricultural land farmed intensively in 2006 in the regions boarding north Adriatic Sea and in the Po plain. Based on Leac database

Trends

The proportion of agricultural land farmed intensively is stable between 2000 and 2006. The unique significant trend is a decrease of 3,6% in Trento region.

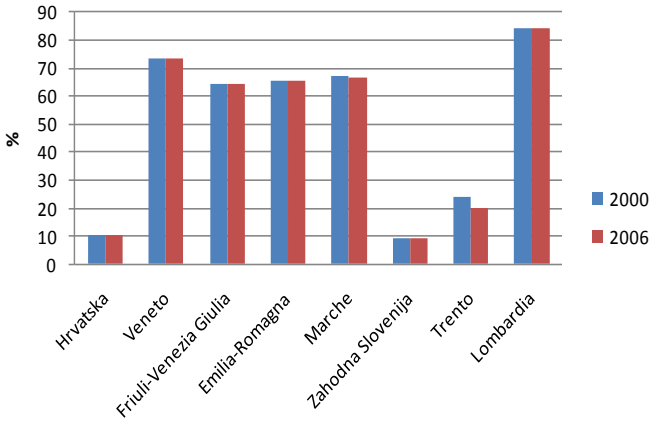


Figure 11: Evolution of the proportion of agricultural land farmed intensively between 2000 and 2006 in in the regions boarding North Adriatic Sea and in the Po plain. Based on Leac database

2) Ocean based pressure

Aquaculture

Figure 12 shows the principal areas of production of mussels and fish as described by Adriblu in 2007. It's important to take into account that all the areas have not been assessed with the same precision (Slovenian and Croatian farms have been assessed solely with Google Earth pro and no official data).

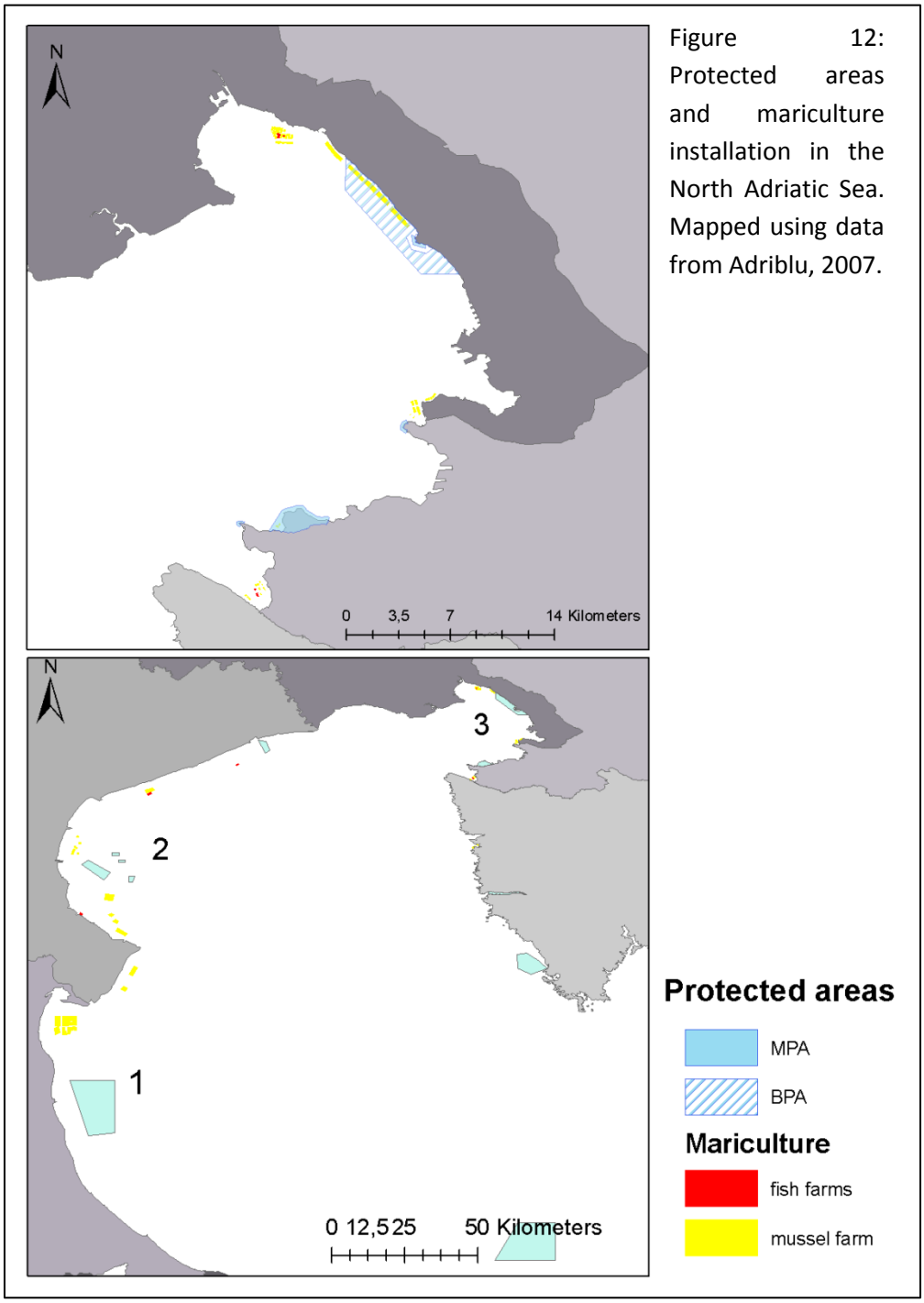


Figure 12: Protected areas and mariculture installation in the North Adriatic Sea. Mapped using data from Adriblu, 2007.

It appears that mariculture infrastructures are mostly developed at the south (1) and north (2) of the Po delta, and in the gulf of Trieste (3). In this last area mussel farms occur at less than 500m away from the MPA of Debeli Rtiç and Miramare and are present inside the BPA of Miramare. Considering the area 1, 2, 3 the mean distance between mariculture installations and protected areas is 6km. This distance has not been estimated for Croatia due to the lack of data. We can see in Table 3 that the areas with the biggest mussel production are Emilia Romagna and Veneto, Slovenia, Croatia and Friuli Venezia having a relatively small production.

Country/nuts2	Mussel porduction in 2005 (tonnes)
Croatia	3000
Slovenia	201
Veneto	70377
Friuli-Venezia	4298
Emilia-Romagna	34.192

Table 3: Mussels production for the Italian region, Slovenia and Croatia in 2005. (from Adriblu)

Trends

Aquaculture industry is generally increasing in all the Adriatic countries (FAO, 2005). Looking at the Figure 13 we can see that total production has been multiplied by 4 between 1990 and 2000 in Slovenia and by three in Croatia between 1997 and 2002. In Slovenia the production of mussel is privileged while the production of marine fish decreases in 2005. In Croatia the production of marine fish and notably blue fin tuna is highest and increasing faster than the other ones.

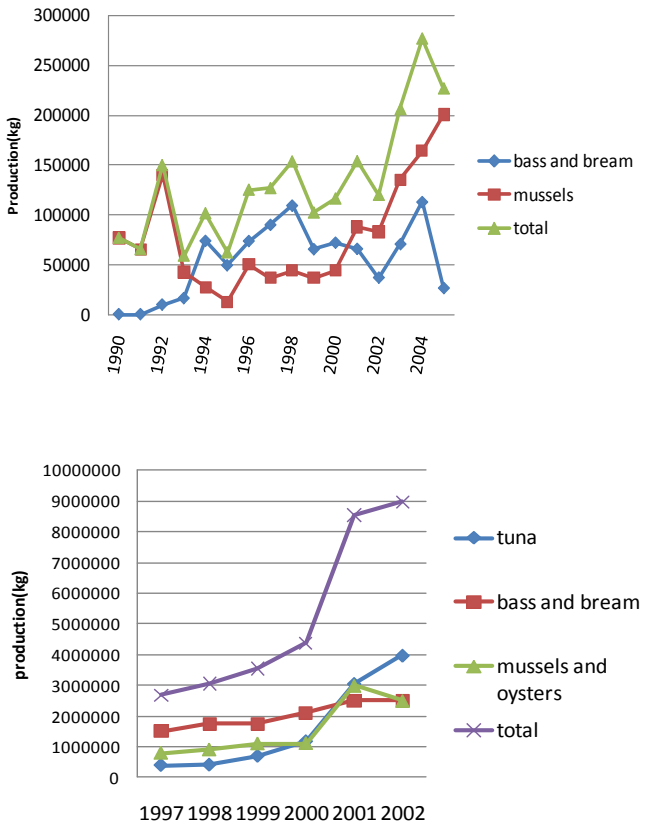


Figure 13: Aquaculture production in Slovenia (1990-2005) and Croatia (1997/2002).(Statistical office of the republic of Slovenia and FAO)

Maritime traffic and ports

Trieste is the biggest port of the north Adriatic Sea in term of traffic followed by Venice, Ravenna, Koper, Rijeka and Chioggia. All these ports apart from Chioggia and Koper have terminal for liquid cargo (essential crude oil and oil products).

Only maritime routes for ferries are represented. An important route for container and liquid traffic pass by Ravenna. Protected areas are in average 29km away from principal ports of the North Adriatic. 7 of the 12 protected areas are at less than 13km from on of the ports represented.

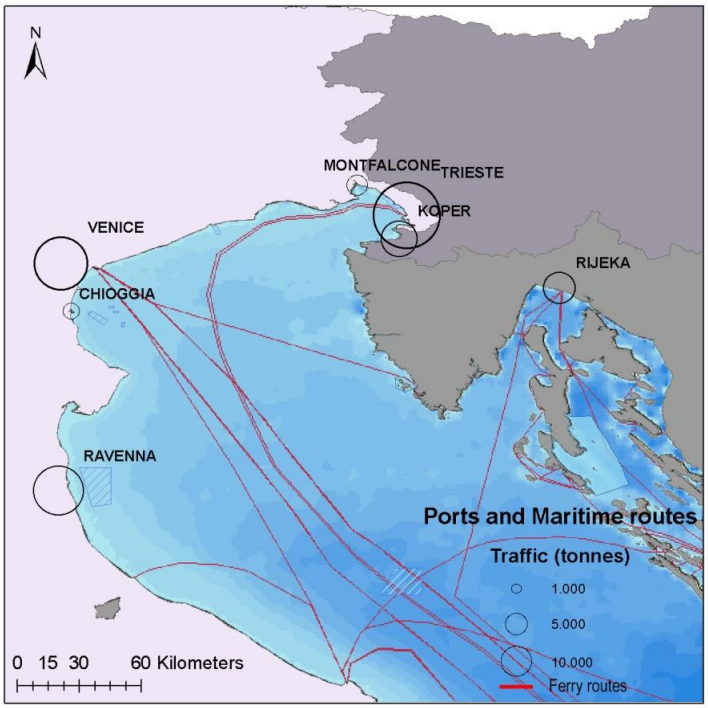


Figure 14: Main ferry routes and industrial ports of the North Adriatic Sea. (Ferry routes: European Atlas of the sea ; Ports: World Port Index 2011)

Trends

In the Mediterranean Sea the capacity of traffic has risen by 58% between 1997 and 2006 due to the increasing flow of energy products in particular (oil, liquefied natural gas) and for the container traffic (Plan Bleu, 2009).

The Adriatic countries believe that maritime transport will increase in the future. Existing routes will be used more intensively, new routes will be introduced (EU comission study, 2011) notably through the european project motorways of the sea.

3) ICZM and Cross boundaries issues in the North Adriatic Countries

a) State of ICZM application

Italy

Italy has signed the ICZM protocol but not yet ratified it. A national strategy is under development but there is not a specific National Policy regarding ICZM. However Italy follows a decentralised pattern and regions had the opportunity to develop their own strategy. In our area of study, Emilia Romagna has developed an ICZM regional strategy (2005) and Marche region is at an advanced stage.

A Coastal Area Management Program (CAMP) is now ongoing in Emilia Romagna.

There is not a specific institution for ICZM implementation.

At national level the relevant administration for MPAs and ICZM is the same: **Ministry of the Environment, land and Sea** while the relevant administration for BPAs is the **Ministry of Agriculture and Forestry.**

<u>Scientific Relevant agencies for coastal planning and MPAs:</u>

ARPA: Agenzia Regionale per la Prevenzione e Protezione Ambientale.

ISPRA: Istituto Superiore per la Protezione e la Ricerca Ambientale.

CNR-ISMAR is an institute of marine sciences.

Universitary

NGOS

Slovenia

Slovenia has signed and ratified the protocol. There is no ICZM national Strategy but an equivalent is under development. Taking into consideration the short coastal length of the country, ICZM issues are incorporated into the Regional Development Strategy for South Primorska firstly developed in 2002 and then revised in 2007.

A CAMP (see annex II) has been running from 2004 to 2006 which has permitted to define the main development guidelines for the region in the period 2007-2013 and took explicitly into account Slovenian MPAs.

Moreover CAMP process established a broad platform and experience of participation between Slovenian Stakeholders.

At national level the relevant administration for MPAs and ICZM is the same: **Ministry of Environment and Spatial Planning.**

Scientific Relevant agencies for coastal planning and MPAs:

Institute of the Republic of Slovenia for Nature Conservation

Marine Biology Station

Universtairy Research group

NGOs

Croatia

Croatia has signed the protocol and is in the way to ratified it. The preparation of a national Strategy has been announced in 2011. ICZM issues are treated mainly at a national level. A specific administration called Office for the Sea and Coasts exists but with very limited power.

At national level the relevant administration is the **Ministry of Culture for MPAs** and the **Ministry of Environmental Protection, Physical Planning and Construction** for ICZM**.** However there is a good exchange of information between the different ministries that we could experienced in a meeting on ICZM in Zagreb in the frame of PEGASO.

Scientific Relevant agencies for coastal planning and MPAs:

Priority Actions Programme Regional Activity Centre (PAP/RAC)

Institute for Oceanography and Fisheries

Centre for Marine Research

Agency for the protection of the environment (AZO)

NGOs

Country	ICZM protocol (as at 13/05/2011)		Equivalent ICZM strategy	Major ICZM projects
	signature	Ratification		
Italy	yes	No	Under development	Coastal Area Management Programme (CAMP) ongoing Plan coast (2006-2008)
Slovenia	yes	01.12.09	Under development	Coastal Area Management Programme (CAMP) 2004-2006 Plancoast (2006-2008)
Croatia	yes	In process	Announced	Plancoast (2006-2008)

Table 4: State of the ICZM protocol implementation and main ICZM project in the three countries boarding North Adriatic Sea.

b) Existing framework for cross border collaboration in the North Adriatic Sea

- **The Trilateral Commission for the protection of the Adriatic**

The Trilateral Commission for the protection of the Adriatic includes Italy, Croatia and Slovenia and recently Montenegro has become a member of the initiative. A Strategy for the North Adriatic is announced.

- **Adriatic-Ionian Initiative**

The Adriatic-Ionian Initiative links the coastal countries of the two seas (Adriatic and Ionian) for the purpose of cooperation in the development and safety of the whole area. Its objectives are achieved by cooperation in different fields: tourism, transport, maritime affairs, culture, education as well as environmental protection and sustainable development. Countries involved are Albania, Bosnia and Herzegovina, Croatia, Greece, Italy, Montenegro, Serbia and Slovenia.

Discussion

The target of the CBD for contracting countries as redefined during the 10th COP in Nagoya is *"By 2020, at least 17 per cent of terrestrial and inland water areas, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes."*

Two main points are addressed in this target, the problem of the intrinsic global surface protected and the proper characteristics or effectiveness of each MPA (protecting important area, effective management, representativity and connectivity integration between broader landscape and seascape).

Therefore considering in one hand this target, and in another hand the need to integrate MPAs into ICZM framework, the following four axes will be discussed:

a) How far we are from CBD target in term of surface.

b) In the current situation, are North Adriatic protected areas (MPAs and BPAs) able to preserve ecosystems given their characteristics (size of the MPA, zoning, localization, management)

c) Strategic linkages outside the protected areas to mitigate negative externalities that threatened these areas.

d) How the ICZM and MPAs are currently interacting and what are the needs and added value of improving this interaction.

e) Finally, following the CBD objective what are the strength and future needs of North Adriatic protected areas to constitute a network.

a) 10% by 2012-2020

Taking into account all kind of protected areas, we estimated that 3% of the north Adriatic Sea is currently protected and 0, 4% taking into account uniquely MPAs without Losinj. This situation is relatively similar to the situation Mediterranean Sea which is protected at 4% including Pelagos Sanctuary (87,500 km²) and at 0.4% without it. So we are still far from achieving the 2020 target of CBD. Moreover the current average surface of no take zone per protected areas (when information available) is 27% taking into account BPA and 11% considering uniquely MPAs. Yet, according to (Garcia-Charton et al, 2008) MPA should be scaled to maximize the size of the no-take area relative to buffer zones to enhance the effect of protection. Therefore this situation could be improved a lot without creating more MPAs just redefining NTZ area.

Moreover the surface reported corresponds just to a surface drawn in a map. It doesn't tell us how well the ecosystem is actually preserved inside the reserve.

b) Scale, connectivity and localization

Marine protected areas are increasingly recognized as a very powerful tool to struggle over-exploitation of marine resource and degradation of marine habitats. They constitute always an opportunity for biodiversity conservation and awareness-raising of local populations. However some key features can improve the effectiveness greatly as well as enhance their reconnaissance and acceptance by local stakeholders.

Considering MPAs for fishery management tool (enhancement of yields, reducing pressure on overexploited species…) or for conservation goal, they should be large enough to be:

- Self sustaining at least in case of species with low dispersal distance for which connection with other MPAs is less probable.

- Maximize the time that marine animals spent inside the boundaries of the reserve (daily and during their life cycle) to maximize protection. Therefore they should integrate key habitats this animals use as feeding or nursery grounds.

The need of planning and monitoring

The presence of a management plan with clear objectives and resources to accomplish and monitor it has been recognized as one of the most important point for the effectiveness of a protected area. These management activities should include as a minimum: education and outreach, surveillance and monitoring, enforcement, performance monitoring and evaluation, and adaptive design of MPA boundaries and regulations as information increases and/or environmental conditions change (adaptive management) (Agardy et al, 2011). Among North Adriatic protected areas, Miramare is the unique area to have an implemented plan. Losinj and Strunjan park are preparing one whereas we didn't find any data showing the presence of management plan for other Croatian MPAs and BPAs.

MPAs of Miramare, recently Strunjan and Losinj seemed to be the unique in having appropriate monitoring with scientific activities. Even if there is a public structure for the national park of Brijuni and Limski Zaljev, we have no information relative to management activities. The situation of BPAs is less satisfying from this point of view. According to the law they have no obligation to be managed. Even if local NGOs are voluntarily doing this work, they have generally no institutional reconnaissance and appropriate funding and capacity to enforce and monitor BPAs.

Management and monitoring is the base to be able to address problems and effectiveness of protection. Therefore there is an important need to develop and implement these features in the North Adriatic Sea MPAs.

The situation of BPAs has to be clarified relatively to the status of the management body and the resource to finance it.

Ensuring self replenishment

Protected areas should be large enough to ensure that larval production and recruitment inside the reserve is sufficient to maintain the population protected.

North Adriatic Sea MPAs have an average surface of 5.8 km^2 without taking into account Losinj (526km2). MPAs of Miramare, Strunjan, Debeli Rtiç and cape Madona are respectively 1,2 ; 0,9; 0,24 and 0,13km^2.

BPAs are generally larger (average 72,8km^2) with a minimum of 6km^2.

Larval dispersal and fish movement depend highly between species but also between local oceanographic conditions. Shanks et al, (2003) and Kinland and Gaines, (2003), report larval dispersal from less than 10 m to more than 1000km depending on species and genera. Therefore there is no standardized "good size" of MPAs, this size depends specifically on the species the protected area aim to protect and local patterns of dispersion (currents) have to be studied. However considering a precaution principle, protected areas should be large enough to ensure self replenishment at least for species with low dispersal potential. In this case, Shanks et al, (2003) advise a diameter of 4 to 6km.

Thereby, MPAs of Miramare, Strunjan, Debeli Rtiç and cape Madona have potentially a low ability to self replenish in case of low dispersal species.

Protecting marine animals

Marine protected areas should also be large enough to maximize the time that marine animals pass inside the reserve to avoid fishing of this species permitting an increase of the size of individuals and of ponds. As for larval dispersal, movement of fish depend highly from species and therefore from the protection objective of the reserve. Given that the unique reserve to have a management plan in our knowledge is Miramare and that we still don't have it, it is not possible to say anything. However protection against fishing is not just a problem of scale but also of zoning. The current average surface of no take zone per protected areas (when information available) is 27% taking into account BPA and 11% considering uniquely MPAs. Yet, according to (Garcia-Charton et al, 2008), Mediterranean MPAs should be scaled to maximize the size of the no-take area relative to buffer zones to enhanced effect of protection. Therefore given the actual percentage of NTZ per protected area, this situation could be improved if necessary by, redefining zoning of protected areas. Finally the socio-economic aspect needs also to be considered: yet if areas have to be large enough to protect a population of adequate size, they need also to be small enough to be able to supplement production effectively in surrounded fished population and so not result in a conflicting situation with fishermen.

Protecting key habitats

The term habitat is used here as defined by Airoldi and Beck, 2007: Predominant features that create structural complexity in the environment such as plants (e.g., seagrass meadows, kelp forests), animals (oyster reefs) or other geological features (e.g., rocky reefs, mudflats).

As stated before protected areas should maximize the time marine animals they aim to protect pass iniside. Therefore considering key habitat they use (nursery or foraging ground) is essential. Indeed Agardy et al, 2011, addressing shortcomings of MPAs takes the example of a reserve designated in Gulf of California to protect the endangered mammal Vaquita (Phocoena sinus) threatened by intense gillnet fishing in its core habitat. The reserve left 40% of the core habitat of Vaquita outside his boundaries and failed to protect this mammal which has continued to decline.

Therefore the designation of reserve should focus on some key habitats for their importance for species and generally for protecting the habitat itself (E.g.,Posidonia Oceanica).

All the MPAs of our study area apart from Losinj have been designated before 1991 when science on MPAs was at the beginning. According to Camuffo et al, 2010 in the design and implementation of Italian marine protected areas, greater attention has been paid to those coastal and marine areas characterized by outstanding landscape values. The situation is quite similar for the MPA of Debeli Rtiç which has been established for its exceptional natural features in term of geology and geomorphology but not for biodiversity conservation (Vimar and Turk, pers com). Contrarily BPAS of Chioggia and Porto Falconera have been established more recently (2002 and 2006) at the demand of dive clubs to protect the submarine rocky substrate "*Tegnue"* characterized by an extraordinary rich benthonic biocenosis (Camuffo et al, 2010). The situation is the same for Ravenna BPA but for protecting a submarine relic of a gas platform showing a high biodiversity. Similarly importance of habitats for bottlenose dolphins has been considered for the establishment of Losinj (Holcer et al, 2006). There was no information for other protected areas. According (Vidmar and Turk, pers com), even at the scale of Slovenian Sea, some Key habitats are (Posidonia Oceanica) are not protected. More than that, the CBD asks for **representative** network of MPA. Representativity, meaning that the network should include the full range of ecosystems, including the biotic and habitat diversity present in the ESBA defined to implement the network (Figure 3). Therefore cross-border collaboration will be full necessary to reach this objective.

Connectivity

According to Planes et al, (2008), marine reserves can be successful in protecting biodiversity only if they are self-sustaining or connected to other MPA via dispersal.

Connectivity means that adults, larvaes or propagules produced inside a reserve are able to reach another one and help replenish it by colonization or settlement supporting local process of recruitment.

Failure to ensure connectivity could lead to a genetic isolation and loss of genetic diversity leading to lower capacity to adapt to change and if there is not sufficient self recruitment to a diminution of the population inside the reserve.

In the North Adriatic Sea, the minimum average distance between both MPAs and BPAs is 53km. As stated before, the dispersal distance varies highly among species. Therefore we stress again the need for protected areas to have management plan with clear objectives for protection.

Moreover research on connectivity is much more developed on coral ecosystems and there is not so much knowledge on temperate ecosystems and therefore there is a need for developing knowledge on this subject.

Despite that, connectivity studies focus on connectivity among MPAs but not with others important features, such as areas like lagoons and estuary which are known to be privileged nursery or breeding areas. Nevertheless, we didn't find any study of connectivity between those features in temperate climate. These areas are also critical for marine bird fauna which can use both them and marine protected areas. In the North Adriatic Sea, minimum mean distance between MPAs and BPAs of Ravenna, Chioggia, Porto Falconera, Strunjan and Cape Madona and coastal lagoons and estuaries is 7,8km. Given the dispersal distance reported before there is a potential link by dispersal besides of the clear link for marine bird fauna. Thereby there is a clear need of science to investigate potential linkage between lagoons, estuaries and those areas.

Summary

North Adriatic protected areas are characterized by a general lack of management plan effectively implemented and monitored.

Consequently it is currently difficult to say anything about the adequate size, connectivity, or habitat protection of North Adriatic Sea protected area. However some weakness, strengths and need for the future can be addressed.

- The proportion of No Take Zone per protected area is small (27%) comparatively at the recommendations of last studies.
- Most of the MPAs are not taking into account the protection of key habitats in their primary conception but BPAs generally do.
- There is an urgent need to develop management plan and implement, enforce and monitor them with adapted resource.
- There is a need for developing knowledge concerning: the mapping of marine habitats in the North Adriatic Sea and inside each protected area, investigate connectivity potential for protected species and spatial pattern of fish movement.
- Harmonized, accessible and easy to use information accessible in a common database for MPA manager of each country.
- Cross border collaboration to define a representative network and ensure connectivity.

c) Relating pressures to potential impacts on protected areas

Protected areas in the sea aim to protect species and habitat against degradation resulting from human activities. Yet according to the Table 2, most of the human activities impacting marine ecosystems come from sources outside the protected areas and do not respect boundaries. One of the goals of this work was to identify and represent of these activities and the trends that are relevant both for ICZM and MPAs stakeholders.

Yet one of the difficulties emerging when dealing with ICZM and MPAs at the same time is that the two are generally dealing with the same issues but not at the same level or scale. ICZM is generally dealing with pressure addressing broad pattern of coastal development whereas protected areas are often dealing with local impact on a given ecosystem.

Therefore, it is important to link each pressures coming from coastal pattern development to specific and quantitative impact (good or bad) they can have to a specific ecosystem. By this way coastal management could be thought of in a more integrative approach with a clear vision of the impact it could have on marine ecosystems and enhancing benefit for both ICZM and MPAs.

This could be possible in a perfect world where science would have focus and monitor the long term effects of coastal development on the different coastal ecosystems.

Unfortunately this is not the case and our knowledge of the quantified impact of human activities on a given habitat or ecosystems is surprisingly very scarce. This is explained in part

because contrary to the terrestrial environment, we have a very scarce knowledge of submarine habitats and have a very sporadic, irregular, and very limited spatially vision of their evolution.

Nevertheless some authors have given a first evaluation of stressors impact (quantitative and/or qualitative approach) on different marine habitats specifically on the Mediterranean Sea (Claudet and Frashetti, 2010) or at a global scale (Halpern et al, 2007).

These publications have been used and completed by others to give an evaluation of the potential impact that the coastal activities we describe could have on the protected areas of the North Adriatic Sea.

Coastal engineering (defense work)

Coastal Defense Works (CDW) have an impact by direct destruction of habitats where they are built. After their construction they induce a change in sedimentation and water circulation. According to Martin et al, 2005, longitudinal CDW:

- Can increase the habitat level of diversity changing the uniform sandy habitat to a mosaic of new habitats and favor aggregation of fishes.
- Can cause extensive areas of stagnation and possible anoxic conditions landward if badly and extensively deployed especially in areas with rivers input (accumulation of fine sediment).

The same author shows that the effect (sedimentation change) of a CDW at the south of Ravenna BPA is felt until the shore of the BPA.

Bacchiocchi and Airoldi, 2003 show that in coastal areas dominated by soft-bottoms, CDWs can have a strong effect in the structure of fish community by attracting species typical of rocky shores but with a low richness of species. They state that the massive introduction of defense structures during the last 30 years along the Emilia Romagna shores may thus have considerably changed the abundance and distribution of some species within this region. The possible role of these structures to support fixation of alien species (Green Algae) has been documented by Bulleri and Airoldi in 2005.

In the North Adriatic Sea extensive CDWs are present mostly in the Western and North Western part which is also the sandiest with most river inputs and increase therefore the risk of eutrophication landward. However perception of risk depends of the goals of each protected areas. For BPAs which aim to increase fisheries yields, the effect of CDW can be comparable seaward to artificial reef of and therefore could be seen as an advantage.

Contrarily, considering a goal of biodiversity conservation, CDWs represent a risk for changing ecosystem and facilitating implantation of alien species

Moreover the North Western Italian Coast counts the presence of numerous lagoons and wetlands. Therefore extensive longitudinal CDW can weaken the linkage between lagoons and wetlands and protected areas, inducing fragmentation of the habitat.

Stating that the effect is relatively local, areas of Ravenna and Porto Falconera seemed to be potentially the most affected. Moreover, given the erosion trends, coastal defense are going to be develop in this areas. Slovenian coast is also at risk of erosion, therefore being rockiest influence of these structures is not known.

Needs for response:

- **A refined comprehension of the effect in term of invasive species and habitat fragmentation especially between lagoons and BPAs.**
- **BPAs goals, if defined should be strongly integrated when designing the implantation of these structures.**

Urbanization

Applying the ecological, trophic and bacteriological quality index CARLIT, TRIX and IQB in coastal MPAs along a moderate urban gradient from a big city to a low urbanized area, Mangialajo et al, (2007), showed that the urbanization of the coastline, water characteristics and ecological quality are strongly correlated for rocky intertidal habitats. An important negative effect on phanerogams notably *Posidonia oceanica* has been noticed by Fraschetti et al, (2011). Contrarily, urbanization seems to have a limited effect on vagil invertebrate of sandy habitats (Claudet et al, 2010).

Majority of North Adriatic Sea MPAs (8 of 12) are situated at less than 13km of a city of more than 50000 habitants and sometime very close (Slovenian MPAs, Miramare, Brijuni, Ravenna).

Nutrients discharge which cause eutrophication are reduced uniquely after tertiary treatment. Therefore areas close to Trieste and Pula are very concerned by waste water discharge. Moreover big urbanizations are generally associated with important industry. Therefore these areas are likely to be concerned by industrial wastewater besides urban runoff.

Beyond that, North Adriatic Coastal zone economy is largely tourism oriented. We showed that urbanization is widespread in the entire coast, with important urban diffusion trends (litoralisation). These small cities generally more than double their population in touristic

season with inappropriate capacity for water treatment, therefore increasing the risk of eutrophication in summer. This could become a big concern given the trends of tourism which is expected to double by 2025 (plan bleu, 2009).

Needs for response:

- **Better comprehension of the effects of urbanization and the different kind of coastal marine habitats.**
- **Improvement of treatment capacity**
- **Reduction of mass tourism infrastructures and development of new form of tourism (Urban and Sectoral Action plans).**
- **Reduction of litoralisation phenomena (policies, national plan).**
- **Strong collaboration of MPAs managers in the planning of urbanization.**

Intensive Agriculture

Coastal zones are the final receptor of the river water where all the pollutants drained by the river in its catchment are discharged. The Po River is the primary source of freshwater and nutrients entering the Northern Adriatic Sea (Degobbis and Gilmartin, 1990). According to Pirrone et al, 2005, 51% of the nitrogen load in the Po River comes from intensive agriculture and livestock. Thus large phenomenon of eutrophication occurring in the North Adriatic Sea is strongly linked with the kind of agriculture practiced in the Po catchment even if coastal agriculture can lead to local eutrophication problems. Several strong hypoxic and anoxic events are recorded since 1970 notably near the Po delta and in the gulf of Trieste. Those events have lead to high mortality of benthic animals from which some communities have still not recovered totally (Lipej et al, 2006). Figure 15 shows the oxyrisk

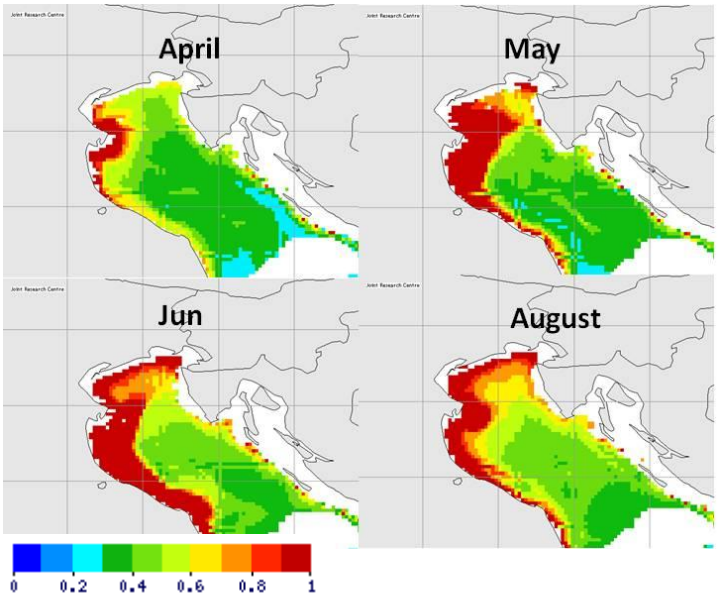


Figure 15 : Oxygen Depletion Risk index (Oxyrisk) in the North Adriatic for the year 2008. From Environmental Marine Information System. European commission

index calculated for the North Adriatic. We can see that nearly all coastal Italian and Slovenian protected area are potentially affected by oxygen depletion. However intensive agriculture practice is almost concentrated in Italian region. Even if there is no major visible change in agriculture practice, the situation is improving (less anoxic events).

In the framework of the Water Framework Directive, states have been asked to determine areas with pristine conditions. Protected areas could be useful but maybe not the existing one.

Needs:

- **Reduction of nutrients load in rivers especially in the Po**
- **Changes in agricultural patterns (policies, Action plans for alternative agriculture)**
- **Collaboration between ICZM and European Water Framework Directive**

Aquaculture

According to Claudet and Frashetti, 2010, fish farms have a negative impact on sandy, rocky and phanerogams. Grego et al, 2009 reports a direct impact under the fish cage with a drastic reduction (50-70%) of species diversity in the bay of Piran. However he shows that the effects on fauna are no longer observed in the 20-100m from the fish cage. Contrarily Martin and Forte, 2003, also in the bay of Piran show that negative effect can be felt up to 300m from the cages. Mussels farms seem to be modified also benthic environment but in a lesser extent.

Fish farms are also associated with a series of threats like introduction of invasive species, introduction of alien parasites and pathogens and spread of pathogens which extent is unknown. There is no documented direct impact of mariculture on MPAs actually but this activity is developing a lot in the three countries notably front of the depletion of marine resource and is already impacting the ecosystems around protected areas.

Needs for response:

- **Better understanding of potential risk for ecosystem (pollutant, invasive species, comportment of wild fish feeding on cage, antibiotics…)**
- **Horizontal collaboration between MPA managers, scientific and fish farms stakeholders to address priorities and suitable areas for development.**
- **Strong policies for implementation of new farms**
- **Collaboration between ICZM and Maritime spatial planning**

Maritime traffic and ports

The main pressures currently known on maritime traffic are:

- Ship strike on cetaceans and sea turtles (IUCN, 2009)
- Underwater noise.
- Introduction of invasive alien species mainly by hull fouling and discharge of ballast water.
- Accidental oil/chemicals and operational oil discharges

Ports constitute an artificialisation per se on the littoral but are also generally the receptacle for water ballast and show generally high hydrocarbon pollution (EEA, 2006). Moreover the implantation of ports and the capacity (liquid terminals, size) they have largely determines maritime routes and traffic density.

As for big cities, the majority of North Adriatic Sea protected areas are close to important ports with liquid terminal. Therefore there is an intrinsic important risk for pollution but also from underwater noise coming from the intensive frequentation. The effect of underwater noise is not positive, but they can reduce the effective range of communication signals and therefore the signaling efficiency between individual fish and marine mammals (IUCN, 2008). Maritime traffic has been recognized as an important factor of mortality for the endangered loggerhead marine turtles (IUCN, 2008) which come to the north Adriatic for foraging (Casale et al, 2010).

Maritime traffic and ports are in expansion in the Adriatic and therefore consequence can be important if some problematic as ballast water, operational oil discharge, regulation of underwater noise, collision are not addressed efficiently.

Needs for responses:

- **Improve comprehension of the effect of underwater noise on fishes and marine mammals and the level of noise inside each reserve.**
- **Improvement of the regulation and enforcement of operational oil discharge.**
- **Improvement of infrastructures for water ballast management.**
- **Management of maritime traffic routes or speed for collision mitigation**
- **Horizontal collaboration with ports authorities to address priorities and suitable sites for development**
- **Collaboration between ICZM and Marine Strategy framework Directive implementation (MSFD)**

Summary

North Adriatic Sea protected areas are threatened by local risk of pollution coming from: big cities and coastal urbanization with insufficient wastewater treatment capacity, ports, maritime traffic and mariculture development. At the same time they are threatened by large scale pressures i.e. global phenomena of eutrophication and oxygen depletion of the North Adriatic coming from pollutant loaded by Po River.

Moreover the construction of extensive and poorly designed CDWs in the North Western coast could have increased local phenomena of eutrophication at the same time it has modified the whole ecosystem. Besides, CDWs could facilitate the implantation of invasive alien species increasingly brought to North Adriatic Sea by the development of mariculture and international maritime traffic.

It is actually extremely difficult to estimate the effect of these pressures on each ecosystem mainly because the sea is a highly diffusive milieu and therefore these pressures interact strongly in a cumulative way. Valuable information is given by the trends which show a clear increase of: Urbanization, mariculture and maritime traffic whereas agriculture seems to be stagnant. In a socio-economic perspective the development of tourism, especially sea oriented tourism could lead in deep modification of the (for the moment) preserved coast and must be taken into account carefully. Indeed the number of marine tourism is expected to double in Croatia for 2020. This construction, in addition to related activities, represents a very important pressure in the next future.

Finally in this context of a growing pressure from climate change, it would be extremely useful to make a global assessment of state and impact on the North Adriatic Sea MPAs to have a global picture now and be able to understand better future evolution.

d) Integrate MPAs and ICZM in a cross border scale

The protocol on integrated coastal zone management in the Mediterranean has been adopted in Madrid in 2008 and entered into force in March 2011. It state that: “In conformity with the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean and its Protocols, the Parties shall establish a common framework for the integrated management of the Mediterranean coastal zone and shall take the necessary measures to strengthen regional co-operation for this purpose.”

The protocol has already entered into force since March 2011.

All of the countries of the North Adriatic have signed this protocol and have or will ratify it. Its adoption will create new energy to improve and implement ICZM. Moreover no countries have yet national strategies but have in general a relative strong experience in ICZM skills (PEGASO will support the countries to build this ICZM strategy and therefore introducing synergies with MPAs and others protection figures). They also have strong scientific institution capable to deal with land and sea conservation problems.

Therefore the impulsion of the protocol and the existing situation in each country represent an opportunity to create strong links between ICZM strategies and MPAs supporting at the same time the Maritime policies, and the European directive on marine ecosystems (MSFD) and water quality (WFD).

Nevertheless the first thing to be able to participate in ICZM process is to exist and then to have the capacity the address problems and needs. Therefore MPAs need managers adequately qualified and a management structure with clearly define management goals within the entire coastal and marine realm. Collaboration efficiency will be highly increased if an adequate monitoring of MPA exist allowing managers to know the MPAs health and identifying and responding to the pressures which are damaging them. A clear scientific understanding of the linkages between land and sea, allowing impact forecasting would also help a better collaboration.

Therefore one of the first actions recommended to integrate MPAs into a larger framework is to give them the resource to do it. From this point of view, the status of BPAs which revealed to be essential from an ecological point of view should be rapidly clarified (Management body, funding, goal).

With this base MPA managers should be represented in ICZM institutions and process that deal with issues that affect them. This could be easiest in Italy and Slovenia where national relevant administration for MPAS and ICZM are the same. At the same time MPA planning and management should be done ensuring their coherence with coastal management and socio economic development. This framework should ensure that MPA benefit fully and are beneficiating to ICZM process.

As we saw, from an ecological point of view, cross national collaboration is a prerequisite for addressing representativeness of protected areas. There is already a good experience of collaboration between North Adriatic countries with the presence of recognised institutions.

Therefore national ICZM Strategies should be completed by a cross regional framework integrating MPA network in the broader coastal and marine area.

General conclusion

Protected areas alienated from a wider programme of coastal resource management exist as "islands of protection" surrounded by uncontrolled areas of threat pollution where pollution, habitat destruction and over fishing may exist.

In the framework of PEGASO and the building of a Strategy for the North Adriatic Sea, this work has tried to give a first overview of existing marine (and coastal) protected areas in the Adriatic Sea in a context of broad coastal and ocean management.

Protected areas of the North Adriatic Sea have been characterized as much as possible allowing us to understand better the current ability they have to protect effectively marine ecosystems and the science we need to reach this objective.

These characteristics have been integrated in the larger context of the coastal development allowing us to understand strategic linkages between negative externalities of coastal development and MPAs and possible responses.

Finally we identified opportunities and needs for integration between MPAs and ICZM in a cross boundary perspective.

The goal is not to focus ICZM on the protection of MPAs. On the contrary, ICZM should act as an umbrella preventing the degradation of the whole coastal ecosystem including MPA because it is clear that they are not sufficient to do that.

However ICZM is strongly based on participation and therefore influenced by the opinion of stakeholders.

Therefore integrating MPAs into a broad ICZM context should allow the reflections on coastal development to integrate the opinion of somebody aware of the current impact and pressures that can be brought by it. Moreover this integration could allow MPAs and ICZM to fully beneficiate each other and then gain in credibility.

There is currently a strong commitment of authorities in the North Adriatic countries to produce a strategy for the whole sea and coast integrating the Europeans directives MSFD and WFD and addressing conservation through a cross border network of MPAs. Therefore a lot of work is still to be done but with great opportunity to better the situation of this threatened region with a very valuable biodiversity.

Bibliography

ADRIATIC SYNTHESIS REPORT 2007: State of art of coastal and marine planning in the Adriatic Region. sustainable projects Berlin, contracted by PAP/RAC Croatia. Online under www.plancoast.eu

Abdulla A., Gomei M., Maison E., Piante C. 2008b. Status of marine protected areas in the M editerranean Sea. IUCN, Malaga and WWF, France. 152 p.

Agardy,T., di Sciara, G. N., Christie, P. 2011."Mind the gap: Addressing the shortcomings of marine protected areas through large scale marine spatial planning," Marine Policy, Elsevier, vol. 35(2), pages 226-232, March.

Agardy, T. & Alder, J. 2005. Coastal systems. In Millennium Ecosystem Assessment: Strengthening Capacity to Manage Ecosystems Sustainably for Human Well Being, Volume 1, Conditions and Terms. R. Hassan et al. (eds). Washington, D.C.: Island Press, 513–549.

Ameer Abdulla, PhD, Olof Linden, PhD (editors). 2008. Maritime traffic effects on biodiversity in the Mediterranean Sea: Review of impacts, priority areas and mitigation measures. Malaga, Spain: IUCN Centre for Mediterranean Cooperation. 184 pp.

Bacchiocchi, F. & Airoldi, L. 2003. Distribution and dynamics of epibiota on hard structures for coastal protection. Estuarine Coastal and Shelf Science 56, 1157–1166.

Bazairi, H., Ben Haj, S., Boero, F., Cebrian, D., De Juan, S., Limam, A., Lleonart, J., Torchia, G., and Rais, C., UNEP-MAP RAC/SPA 2010. The Mediterranean Sea Biodiversity: state of the ecosystems, pressures, impacts and future priorities. Ed. RAC/SPA, Tunis; 100 pages.

Bulleri, F. & Airoldi, L. 2005. Artificial marine structures facilitate the spread of a non-indigenous green alga, Codium fragile ssp. tomentosoides, in the north Adriatic Sea. Journal of Applied Ecology 42, 1063–1072.

Camuffo M., Soriani S., Zanetto G., 2011 "The evolution of marine protected areas (MPAs): the North Adriatic case", Management of Environmental Quality: An International Journal, Vol. 22 Iss: 1, pp.59 – 71

Carboneras C., Requena S. 2010. GIS mapping of seabird distribution a pan-Mediterranean p erspective. Poster presented to the 39the Congress of the CIESM, Venice, May 2010.

Casale P., Affronte M., Insacco G., Freggi D., Vallini C., Pino d'Astore P., Basso R., Paolillo G., Abbate G., Argano R. 2010. Sea turtle strandings reveal high anthropogenic mortality in It alian waters. Aquatic Conservation: Marine and Freshwater Ecosystems DOI: 10.1002/aqc.1133

Cicin-Sain, B. and Belfiore, S. 2005, "Linking marine protected areas to integrated coastal and ocean management: a review of theory and practice", Ocean and Coastal Management, Vol. 48, pp. 847-68.

CIESM, 2007. Impact of mariculture on coastal ecosystems. CIESM worshop monographs n°32
Monaco www.ciesm.org/online/monographs/lisboa07.pdf

Claudet J, Fraschetti F 2010. Human-driven impacts on marine habitats: A regional meta-analysis in the Mediterranean Sea. *Biological Conservation* 143(9): 2195-220

Coll M, Piroddi C, Steenbeek J, Kaschner K, Ben Rais Lasram F, et al. 2010 The Biodiversity of the Mediterranean Sea: Estimates, Patterns, and Threats. PLoS ONE 5(8): e11842. doi:10.1371/journal.pone.0011842

Costanza, R. d'Arge, R. de Groot, S. Farber, M. Grasso, B. Hannon, S.Naeem, K. Limburg, J. Paruelo, R.V. O'Neill, R. Raskin, P. Sutton and M. van den Belt. 1997. The value of the world's ecosystem services and natural capital, *Nature* **387**, pp. 253–260.

Degobbis, D., Gilmartin, M., 1990. Nitrogen, phosphorus and biogenic silicon budgets for the northern Adriatic Sea. Oceanologica Acta 13 (1), 31 – 45.

EEA. 1999c. State and Pressures of the Marine and Coastal Mediterranean Environment. Environmental Issues Series 5. Luxembourg: OPOCE. Online. Available HTTP: http://reports.eea.europa.eu/ENVSERIES05/en/envissue05.pdf (accessed 4 August 2006).

EEA. 2006a. The Changing Faces of Europe's Coastal Areas. EEA Report No 6/2006.
http://reports.eea.europa.eu/eea_report_2006_6/en/eea_report_6_2006.pdf
(accessed 7 August 2006).

EEA. 2006b. Priority Issues in the Mediterranean Environment. EEA Report No 4/2006.
http://reports.eea.europa.eu/eea_report_2006_4/en/medsea_4_2006.pdf
(accessed 7 August 2006).

EEA, 2006c. Land accounts for Europe 1990–2000: Towards integrated land and ecosystem accounts, EEA Report No 11/2006.
http://reports.eea.europa.eu/eea_report_2006_11/en.

EU commission study, 2011. "The potential of Maritime Spatial Planning in the Mediterranean Sea" Case study report: The Adriatic Sea.

Fraschetti S, Guarnieri G, Bevilacqua S, Terlizzi A, Claudet J, Russo GF, Boero F 2011. Conservation of Mediterranean habitats and biodiversity countdown: What information do we really need?. *Aquatic Conservation: Marine and Freshwater Ecosystems* 21(3): 299-306

García-Charton J-A, Pérez-Ruzafa Á, Marcos C, Claudet J, Badalamenti F, Benedetti-Cecchi L, Falcón JM, Milazzo M, Schembri PJ, Stobart B, Vandeperre F, Brito A, Chemello R, Dimech M, Domenici P, Guala I, Le Diréach L, Maggi E, Planes S. 2008. Effectiveness of European Atlanto- Mediterranean MPAs: do they accomplish the expected effects on populations, communities and ecosystems? *Journal for Nature Conservation* 16(4): 193-221.

Grego, M., M. De Troch, J. Forte & A. Malej. 2009. Main meiofauna taxa as an indicator for assessing the spatial and seasonal impact of fish farming. Marine Pollution Bulletin 58(8):1178-1186.

Halpern, B.S., Selkoe, K.A., Micheli, F., Kappel, C.V., 2007. Evaluating and ranking the vulnerability of global marine ecosystems to anthropogenic threats. Conservation Biology 21, 1301–1315.

Halpern, B. S., Ebert, C. M., Kappel, C. V., Madin, E. M., Micheli, F., Perry, M., Selkoe, K. A. and Walbridge, S. 2009, Global priority areas for incorporating land–sea connections in marine conservation. Conservation Letters, 2: 189–196.

Harmelin J.G. 2000. Mediterranean marine protected areas: some prominent traits and promising trends Environmental Conservation 27: 104-105

Holcer, D., Fortuna, C., Mackelworth, P. 2006. The Losinj Dolphin Reserve: two decades of work for a conservation success story? FINS 3(1):22-27.

IUCN 2009. Risks from maritime traffi c to biodiversity in the Mediterranean Sea: Identifi cation of issues and possible responses. Malaga, Spain: IUCN Centre for Mediterranean Cooperation.

Kinlan, B. P. and S. D. Gaines 2003. Propagule Dispersal in Marine and Terrestrial Environments: A Community Perspective. Ecology 84(8): 14.

Lipej, L., Turk, R., Makovec, T. 2006.Endangered species and habitats types in the Slovenian Sea. Zavod RS zavarstvo narave, Ljubljana, 264 pp.

Malačič, V. & J. Forte, 2003: Distribution of the food surplus and faecal particles on the seabed below a fish farm in the Bay of Piran. Annales Series historia naturalis (1) suppl., 3-8.

Mangialajo L, Ruggieri N, Asnaghi V, Chiantore M, Povero P, Cattaneo-Vietti R. 2007. Ecological status in the Ligurian Sea: the effect of coastline urbanisation and the importance of proper reference sites. Mar Pollut Bull. 2007;55(1-6):30-41.

Martin, D., Bertasi, F., Colangelo, M.A., de Vries, M., Frost, M., Hawkins, S.J., Macpherson, E., Moschella P.S., Satta, M.P., Thompson, R.C. & Ceccherelli, V.U. 2005. Ecological impact of coastal defence structures on sediments and mobile infauna: evaluating and forecasting consequences of unavoidable modifications of native habitats. Coastal Engineering 52, 1027–1051.

Mora C., Andréfouët S., Costello M.J., Kranenburg C., Rollo A., Veron J., Gaston K.J., Myers R.A. (2006) Coral Reefs and the Global Network of Marine Protected Areas. Science 312: 1750-1751

Notarbartolo di Sciara G., Agardy T. 2009. Identification of potential SPAMIs in Mediterrane an Areas Beyond National Jurisdiction. Contract N° 01/2008_RAC/SPA, High Seas. 70 p.

Ott, J., 1992. The Adriatic benthos: problems and perspectives. In: Colombo, G., Ferrari, I., Ceccherelli, V.U., Rossi, R. (Eds.). Marine Eutrophication and Population Dynamics. 25th European Marine Biology Symposium. Ed. Olsen and Olsen, Fredensborg: 367 – 378.

Pirrone, N., Trombino,G., Cinnirella S., A. Algieri, G. Bendoricchio, L. Palmeri. The Driver-Pressure-State-Impact-Response (DPSIR) approach for integrated catchment-coastal zone management: preliminary application to the Po catchment-Adriatic Sea coastal zone system. Reg Environ Change (2005) 5: 111–137.

Planes S., García-Charton J.A., Pérez-Ruzafa A. (Coord.), 2006. Ecological effects of Atlanto-Mediterranean Marine Protected Areas in the European Union. EMPAFISH Project, Booklet nº 1. 158 pp.

Rossin P., Bettoso N., Mattassi G. & Scaringella S. 2007. The GIS (geographical information system) of the Northern Adriatic Sea: an essential tool for sustainable fishing. CoastGis.

Shanks, A. L., B. A. Grantham and M. H. Carr 2003. Propagule Dispersal Distance and the Size and Spacing of Marine Reserves. Ecological Applications 13(1; Supplement): 10.

Smith W., Sandwell D. 1997. Measured and estimated seafloor topography. World Data Cen ter for Geophysics & Marine Geology, Boulder, Colrado. Available from http://ibis.grdl.noaa .gov.

Tagliapietra, D. 2005, "Le caratteristiche dell'Alto Adriatico", pp. 24-32, Proceedings of the 1st Congress Diving and Environment (Subacquea and Ambiente): le tegnue di Chioggia, Chioggia 17-18/09/2005.

Thrush, S.F. & Dayton, P.K. 2002. Disturbance to marine benthic habitats by trawling and dredging: implications for marine biodiversity. Annual Reviews of Ecology and Systematics 33, 449–473.

Turk R, Odorico R. 2009. Marine protected areas in the Northern Adriatic. Varstvo Narave 22:33–45.

UNEP/MAP/MED POL/WHO 2004: Municipal wastewater treatment plants in Mediterranean coastal cities (II). MAP Technical Report Series No. 157. UNEP/MAP, Athens

UNEP/MAP-Plan Bleu: State of the Environment and Development in the Mediterranean, UNEP/MAP-Plan Bleu, Athens, 2009.

Internet bibliography

Adri. Blu intereg project (www.altoadriatico.com)

BPAs coordinates
http://www.reteambiente.it/cerca/?cerca=zona+di+tutela+biologica.

BPAs regulation
http://www.ambientediritto.it/Legislazione/aree%20protette/2009/dm_22gen2009.htm.

DG environment:
(http://ec.europa.eu/environment/iczm/evaluation/iczm_national_reporting.htm)
(http://ec.europa.eu/environment/iczm/ia_studies.htm)

European Atlas of the Sea (http://ec.europa.eu/maritimeaffairs/atlas/index_en.htm)

Global Rural-Urban Mapping Project (GRUMP)
http://sedac.ciesin.columbia.edu/legacy?url=http://sedac.ciesin.columbia.edu/wdc/index.jsp

MedPAn (network of managers of marine protected areas in the Mediterranean)
www.medpan.org

Glossary:

Governance: Governance is the process through which diverse elements in a society wield power and authority and, thereby, influence and enact policies and decisions concerning public life and economic and social development. Governance is carried out by the state, as well as the private sector and civil society. (Cicin-Sain and Belfiore, 2005)

ICZM: The European Commission defines ICZM as "a dynamic, multidisciplinary and iterative process to promote sustainable management of coastal zones. It covers the full cycle of information collection, planning (in its broadest sense), decision making, management and monitoring of implementation. ICZM uses the informed participation and cooperation of all stakeholders to assess the societal goals in a given coastal area, and to take actions towards meeting these objectives.

No take zone: No-take areas, either as zones within MPAs or as entire MPAs, are important tools for biodiversity conservation and fisheries management. No-take areas (sometimes called marine reserves in the literature) are marine areas that are closed to all forms of extraction including fishing.
http://wiomsa.org/mpatoolkit/Themesheets/I1_No_take_areas.pdf