

Chapter 3

Analysis and Future

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3.1 Integrated Analysis in Practice: policy context

Unbalanced and unsustainable use of ecosystems and the goods and services they provide, may significantly compromise essential ecosystem functioning on which we depend and ultimately impact on society and human wellbeing. To counter this, current legislation frameworks for the marine and coastal environment rely on concepts and guiding principles that aim for achieving/maintaining healthy and productive ecosystems. Existing environmental policies regarding water management (e.g. WFD), nature conservation (e.g. HD, BD, Natura 2000) and marine waters (e.g. MSFD) relate human activities to the state of the environment so that impacts can be monitored and appropriate responses can be developed. In the ICZM policies, the IMP and the MSFD, as well as in the proposed directive for ICM-MSP, the ecosystem-based approach (EsA) is cornerstone (see 'concepts'). The EsA also calls for an integrative approach in planning, monitoring and assessment. Specifically, in the European IC(Z)M policy context, one of the objectives is to develop reliable sources of comprehensible information on the human-environment interface to assist in better-informed public decision-making. An integrated science-policy interface, would support the needs of decision makers and managers by making use of scientific expertise, reliable data and existing information systems. At the same time it would support scientists, managers and stakeholders to become better informed of their roles in ICZM processes.

Due to the complexity of the human-environment interface, the **tools and instruments** used for the purposes of **assessment and analysis** must be highly **methodical and structured**. At the same time, they must be flexible to **adapt to the wide diversity of coastal zones** in the EU and around the regional seas bordered by its member states.

To serve this purpose PEGASO developed an approach for an integrated regional assessment IRA. This 'new' resource is an integration of existing data, information sources, tools and approaches that have been made accessible to a wider user group within a contextual framework. The present IRA approach proposes a policy-oriented blueprint for guiding future assessments at the scale of (sub)regional seas, taking into account the scientific research, policy making and socio-economic activities.

The proposed IRA approach for assessment and analysis specifically acknowledges the need to:

- a) **Develop a consistent and basin-wide assessment framework**
- b) **Focus on the land-sea interface and interaction between both**
- c) **Assess the cumulative and synergistic effects of multiple anthropogenic stressors and threats at various spatial scales: from local to basin-wide**

- d) Assess the effects of stressors and threats and their impact on coastal and marine ecosystems and social communities**
- e) Examine the relationships between the environment and socio-economic processes**
- f) Deliver science-based assessments in a periodic and systematic way**

Furthermore, the assessment must be set in a coherent planning and management process aiming to:

- 1) Focus on context-dependent impacts, related measures, and strategies for the management of human activities**
- 2) Stretch beyond the description of status and trends of the environment and human activities, and tackle future outlooks for policy directions including appropriate management and mitigation measures**
- 3) Invest efforts in applied research to unravel cause-effect relationships and identify gaps in knowledge and suggesting future research needs**
- 4) Build on continuous, improved and structured dialogue between science, policy and management at the appropriate scale**

The PEGASO project identified, tested and further developed a number of these instruments and tools that are components of the IRA. By integrating them into an assessment framework, PEGASO aims to address and meet policy needs and contribute to the implementation of the ICZM Protocol. The present proposal must be viewed as a blueprint or guidance for conducting integrated assessments at the scale of regional seas. It aims to demonstrate the value of using the IRA tools both at the local scale with the ten [PEGASO pilot sites](#) (CASES) as well at the scale of the Mediterranean and Black Sea region.

Tools in Support of an Integrated Assessment

The Ecosystem Approach requires monitoring trends and assessing impacts, at the scale of ecologically relevant spatial scales such as regional seas and/or large marine ecosystems. In order to monitor trends and impacts in a consistent and basin-wide approach it is crucial to develop IRAs within a policy framework that is legally adopted throughout the region, such as the ICZM Protocol for the Mediterranean. However, countries bordering the regional seas may or not be part of larger geo-political agreements such as the EU. Countries such as Turkey even need to address regulations under different Regional Sea Conventions, reporting both to the Mediterranean and the Black Sea Conventions. To date, however there is no standardized or coherent approach between ICZM provisions established at the scale of the different regional seas. However, the concepts and principles of ICZM and the EsA (EcAp) provide guidance for building a coherent and consistent framework between regional seas. Next to these agreed concepts and principles, an important degree of coherence between spatial scales and regional seas can be achieved by building IRA on science-based, robust and standardized methods and scientifically validated tools.

Indicators and Indices as key components

Cornerstone in the IRA, are the indicators and indices. In support of the IRA and the ICZM Protocol, PEGASO developed a suite of indicators that could be applied at different scales and both in the Mediterranean and Black Seas. The indicators are deployed as sustainability assessment tools, and as tools to measure the implementation of ICZM policy and programmes. In the process, the following issues are central:

- Taking stock of existing indicator initiatives to measure the progress towards sustainable development in coastal zones, in particular for the Mediterranean and Black Sea Basins;
- Assessing these initiatives against the needs of ICZM and other relevant policy instruments;
- Designing indicators adopting a multi-scale approach, to address the needs at local, national and regional scales.
- Fine-tuning indicators taking into account recommendations from previous experiences
- Using the indicators in a sustainability framework applying a DPSIR framework

The indicators become policy-relevant when applied in **regional and local frameworks** that describe key aspects in the current ecosystem status as well as the associated interactions, processes and impacts. A simplified **Pressure Impact Framework** was applied as approach for informing integrated assessments in coastal and marine environments. The framework is able to detect changes over time and aims at providing an explanation for past causalities, and assessments for the future.

The use of **spatial indicators** further improves the analysis of interactions between uses, pressures, delivery of ecosystem goods and services, and the wellbeing of coastal populations.

Land and Ecosystem Accounting (LEAC) uses indicator and indices to assesses a range of policy-relevant ecosystem properties and functions, such as land cover, habitats and primary production. The information is derived from remote-sensing products and other spatial data, which are processed and analysed in spatial units that are relevant for decision-making (e.g. river catchments, administrative divisions, protected sites). This accounting approach helps to structure multiple sources of spatial data to construct accounts of natural and human-built stocks, flows (changes) and therefore balances.

Cumulative Index Mapping (CIM) builds on indices to map the *cumulative pressures* and *impacts* of human activities on marine ecosystems. The cumulative *pressure* index combines individual *pressure* layers in order to locate where multiple pressures are occurring at the same time with high intensity (Figure 11). This index is independent of ecosystem-related parameters, i.e. pressures are displayed with the same intensity whether they affect sensitive or resilient ecosystems. The cumulative *impact* index represents the modelled impact of pressures over the ecosystem components under study. The displayed impact intensity in a grid cell depends both on the intensity of the pressure(s) and the specific vulnerability of the ecosystem. CIM is based on a methodology designed by Halpern *et al.* (2009) [15] and provides critical information for IC(Z)M and the management of human activities. *Cumulative pressure* and *cumulative impact* indices were calculated over the western Mediterranean however the method is applicable at different scales and can easily be scaled up to the entire regional sea basins. CIM allows comparing impacts of different anthropogenic pressures (e.g. marine litter, riverine input, atmospheric deposition of heavy metals and nutrients) and distinguishing marine-based, land-based and fishery-related impacts.

Spatial data and information (spatial indicators, LEAC and CIM products, maps) are stored and organised in a structured way so that query and access is optimised. A Shared Data Infrastructure SDI is a common technical platform for sharing, storing, querying and accessing this spatial information. Although it is regarded as a technical component of the ICZM Platform, it needs steering by a common vision and strategy by the ‘human’ component of the platform.

Public participation has become a fundamental pillar of environmental processes as described in the Water Framework Directive (2000/60/EC), the 2002 EU Recommendation on ICZM (2002/413/EC), the Marine Strategy Framework Directive (2008/ /EC) and the Mediterranean Protocol on ICZM. The Conference on Environment and Development (Earth Summit) in Rio de Janeiro in 1992, Principle 10 [31] and Agenda 21 [32] both called for increased public participation in environmental decision-making and led to the adoption in Europe of the Aarhus Convention [33]. Participation can be defined as a process where individuals, groups and organisations choose to take an active role in making decisions that affect them [34]. A widely recognized categorisation of participation is the so-called “*Ladder of participation*” [35]. The categorisation shows the different ways in which the organisation responsible for activity (e.g. an authority) can involve participants.

Scenarios use the results of these (spatial) analyses based on indicators and indices as input, so the framework becomes increasingly powerful as it is validated from real data, and parameters are refined to provide more accurate estimates and analysis. The purpose of **scenarios** is to allow decision makers to think through the implications of different assumptions about the ways (socio)ecosystems might respond to different drivers of change [36, 37]. Scenario thinking is intended to help address more complex situations involving a high degree of uncertainty [38].

The framework is further completed by comparing the **cost of environmental degradation** (due to overuse, misuse or mismanagement) to the cost of management responses.

In PEGASO, a core set of indicators was identified to support IC(Z)M across the Mediterranean and Black Sea regions. They cover biophysical issues and socio-economic themes, taking account of threats and impacts to the coastal zone, and assessing the cost of ecosystem degradation at local scales. Indices were also designed around the economics of the Large Marine Ecosystems approach [39]. The work further identifies the data and statistics needed to populate and maintain the indicators, and the outputs were tested iteratively with end-users, across the region and within the 10 PEGASO Collaborative Application Sites (CASES) [40].

The process and integrated approach, consists therefore of an integration of coherent and standardized tools and methods that can be applied at different spatial scales (diagram overview Figure 1).

3.2 Integrated Analysis in Practice

A comprehensive overview of the current state-of-knowledge on the main threats and issues in the Mediterranean and Black Sea is outside the scope and objective of this blueprint. However, by focusing on the objectives ‘**balanced urban development**’ and ‘**preservation of natural capital**’, the different approaches and methods for an IRA are demonstrated in the present document.

The vision of the ICZM Protocol is to achieve a balanced use of the coastal zone, while ensuring sustainable socio-economic development and the conservation of natural capital. In the Mediterranean, urban development and especially urban sprawl is one of the main threats exerted by socio-economic development. The Protocol emphasizes that “*allocation of uses throughout the entire coastal zone should be balanced and unnecessary concentration and urban sprawl should be avoided*”. Therefore, tools and methods to assess progress in moving towards this policy objective, should address the requirements as described above a) to f); see above):

Develop a consistent and basin-wide assessment framework, focusing on the land-sea interface (a-b))

Land and Ecosystem Accounts LEAC were extracted from a purposely developed PEGASO land cover PLC layer (spatial data) to assess policy priorities such as Urban Sprawl and Natural Capital. PLC focuses specifically on the coastal zone in order to allow analysis of land-sea interface. The definition of 'Urban areas' includes two subclasses; densely built-up land, and dispersed developments. Indices to measure progress in achieving these policy objectives were calculated at basin-wide scale so as to allow for a coherent assessment among regions and coastal zones. They cover:

- Standardized different spatial reporting 'coastal accounting' units (1km, 10 km and 50 km land strips)
- Reporting within relevant administrative divisions as reporting units (NUTS3, countries)
- Agreed years of reporting over an agreed time interval (e.g. 2000 and 2011)
- Standardized units for reporting (e.g. % of change over time interval) and agreed indices (e.g. 'Urban Concentration Index')

Ideally, the accounts must be expanded towards the marine realm to include categories in the marine ecosystems. Furthermore, to assess some of the specific policy objectives for the Mediterranean Sea such as the 100m 'setback zone', the analysis must be conducted for land strips of 100 m from the officially established coastline and at the entire basin-wide scale. However, current spatial resolution of the available basin-wide PEGASO land cover layer (250 m grid) is too coarse for assessment of these finer-scale patterns. Both issues are crucial and need urgent attention in order to achieve a full assessment.

Land accounts were calculated for three buffers around the coast at 1km, 10km and 50km distance and 2 different years (example Figure 7, 2011).

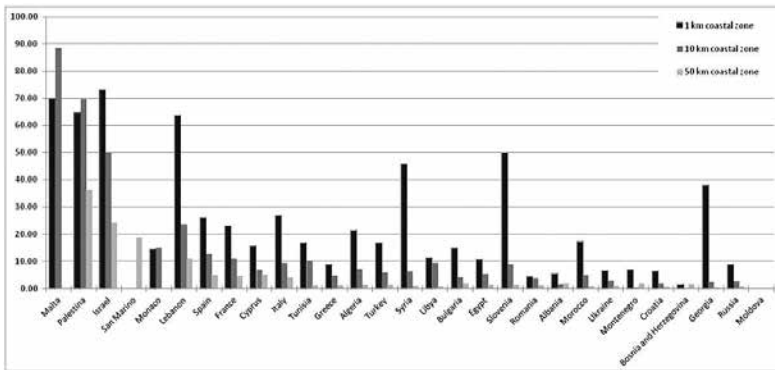


Figure 7. Percentage of urban and artificial land cover in 2011, for 2 coastal zones (1km and 10km land strip) and the inland 50km land strip, in Mediterranean and Black Sea countries

Trends in coastal urbanisation over a 12-year period (2000 to 2011) were assessed in the Mediterranean and Black Sea (Figure 8). Trends expressed as percentages of increase in urbanised land coverage were categorised as: high (>1.5%), intermediate (>0.5% to 1.5%), or low (0.1% to 0.5%). Decreasing percentages of urbanisation were categorised as low (0.1% to 0.5%) or intermediate (>0.5% to 1.5%). The relation between percentage of urban coverage within the first kilometre and the hinterland was used to assess the degree of urban sprawl. The Urban Concentration Index (UCI) is calculated to further distinguish between typologies and spatial patterns of coastal development. The UCI calculates the normalised difference between percentage of urban land on the 10 km and 1 km coastal strips for administrative divisions bordering the Mediterranean or the Black Sea, in 2011. The underlying assumption for the UCI is that regions with a more balanced urban development have higher percentages of urban land cover in the 10 km coastal strip, compared to the 1 km. Coastal areas that tend towards unbalanced development are often associated with long stretches of linear construction patterns along the coast. The index values range between 1 and -1. In regions with a higher proportion of coastal protection, hence an effective policy implementation of the coastal setback, the UCI is a positive value. Regions with less than 5% urban land cover in both of the land strips need to be excluded from the analysis so as to ensure relevance of interpretation.

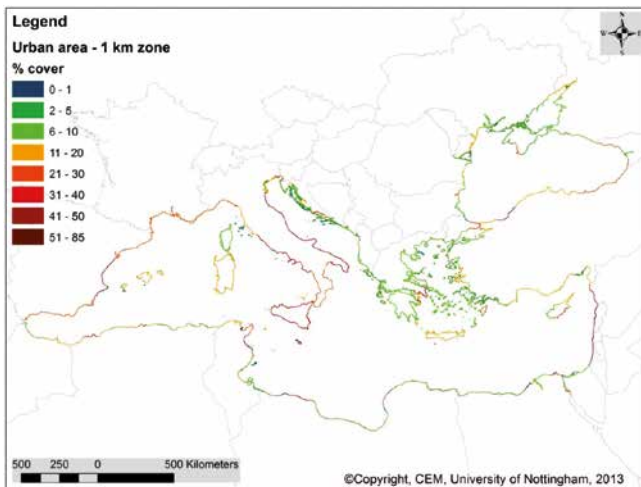


Figure 8. Percentages of urbanised land cover in 2011 in a 1 km coastal strip, reported by administrative divisions as spatial units (source: World Administrative Divisions).

Similarly, **LEAC** gives a broad overview of natural capital at the regional scale; it estimates accounts of natural and semi-natural areas on land, species and habitats of conservation importance, and accounts of protected areas for different protection classifications (Natura2000 and national/local designations). Data on natural and semi-natural land cover types include the PEGASO Land Cover level 1 classifications, such as forests, grasslands,



The highest value (85%) of urbanised coast in 2011 was found in the region of Tarabulus, Libya. The longest stretches of highly urbanised coastal areas (>20% of the reporting unit), extend along most of the north-west Mediterranean coast from Gibraltar to Genoa. Most of the Italian coast has values exceeding 30%, as well as the coastal region of Valencia, Spain. The majority of coastal Croatia, Montenegro, Greece and Aegean Turkey have low values (<10%), with the exception of the metropolitan areas of Athens, Istanbul, Izmir, and the islands of Rhodes and Crete. Data for the first kilometre of the coastline in the Black Sea region shows considerable variation, with higher percentages on the southern and eastern shores, e.g. Turkish and Georgian coasts, and lower values in the north. Considerably high percentages of coastal urban development are found along the entire Near-east Mediterranean coast. The southern Mediterranean has long stretches of less-urbanised coast (<5%), but with contrastingly high percentages around the major urban centres of Damietta, Alexandria, Benghazi, Tripoli and Tunis. The highest value (100%) of urbanised 10 km coastal strip is found in the region of Beirut in Lebanon (Figure 7). Other exceptionally high percentages (>90%) include Port Said in Egypt, Tarabulus in Libya, and Malta. The longest stretches of highly urbanised 10km coastal strips are located on the northwestern and Near-east Mediterranean coasts. Relatively high percentages are found on certain stretches of the Mediterranean coast, including Valencia, Athens, Istanbul, Israel, the Gaza strip, Alexandria, Tripoli and a few other pockets on the southern coast. However, the majority of 10 km coastal strips have values below 10% of urban development.

The index revealed a broad distribution of unbalanced development for the majority of the northwestern and Near-east Mediterranean coast, and the Black Sea coasts of Bulgaria, Turkey and Georgia. This pattern of development is also evident on the southwestern Mediterranean coast. Most of the coasts of Libya and Egypt, besides the Nile delta, appear to be either less developed or developed in a more balanced way. The administrative regions of Attiki and central Macedonia in Greece, and Izmir in Turkey show positive values because they contain rather extensive stretches of non-urbanised coastline, including many of the islands.

shrublands, sparse vegetation and deserts, wetlands and water bodies (i.e. classes 3, 4 and 5). In the PLC Product nomenclature, level 1 is the most general classification level. Stocktakes were assessed for parameters: percent of natural areas; percent of increase or decrease in natural areas over an eleven-year period; and percent of protected areas (Figures 9 & 10).

Stocks of natural area coverage (Figure 9) were categorised as: High (> 60%); Intermediate (30% to 60%); Low (15% to 30%); and critically low (<15%). LEAC allows to identify areas with likelihood of high proportions of preserved natural and semi-natural areas, as well as critically low stocks of natural areas. These basin-wide data then need to be confirmed by local-level studies focused on e.g. the maintenance of habitats and provision of basic ecosystem services. The approach allows identifying patterns of coastal development. Furthermore, the PLC on urban development and natural capital can be compared and subjected to an integrated analysis.

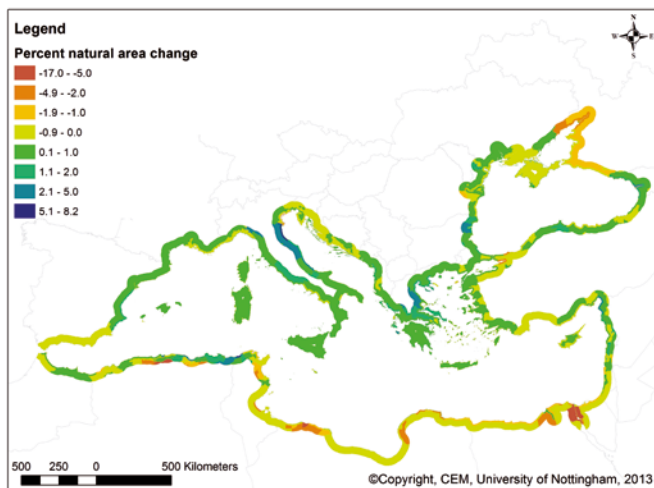


Figure 9. Map of temporal change of natural area coverage from PEGASO (between 2000 and 2011), expressed as a per cent of total unit area of the coastal accounting units.

The percent of natural area coverage shows a decreasing trend in natural and semi-natural areas for the Russian and Egyptian coasts from 2000 to 2011. Conversely, there is a general trend of increased natural land in the coastal strip of the northern Mediterranean, except Andalucía, and a decrease in the south, except Algeria. The results suggest that, due to the designation of NATURA sites on the EU coast, there is an increase of natural areas, however this is mostly situated in the hinterland. Regarding the Black Sea, there is an intermediate increase of natural areas in Bulgaria, a low increase in Georgia and a low decrease in Ukraine. Caution is required with further interpretation of these trends, given that parameters need to be independently validated.

Accounts of protected areas were constructed using the world database of protected areas as a source (Figure 10). Results are shown for coastal zones divided into three buffers, and for coastal accounting units. The accounts show higher percentages closer to the coast in parts of Spain, France and Italy; and lower in others, including Cyprus, Israel and Slovenia. The northern countries, especially EU-member States, have relatively high proportions of protected coastal areas whereas certain countries from the southern Mediterranean do not appear to have similar protection measures. However, these results could be due to the inability to collect data for these countries from the global source used for this assessment.

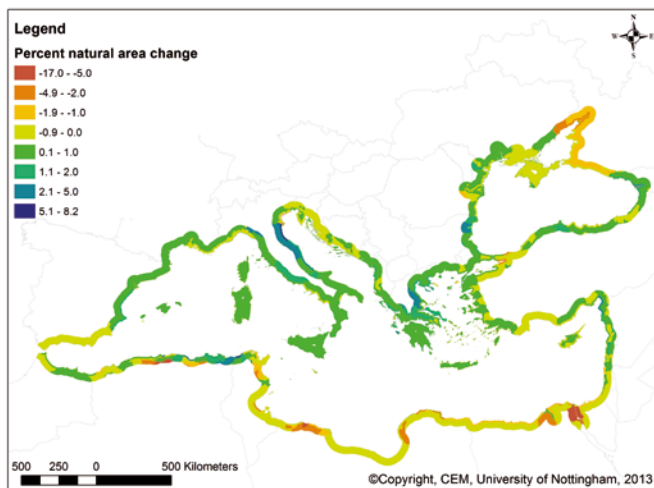


Figure 10. Percentage of areas protected.
Source: World database of protected areas.

Using Indicators in the assessment framework: from the local to the basin-wide scale

Although different indicators may be used in planning and management at the local scale, coherence and standardization at different scales offers a number of strengths and opportunities. A regional assessment based on a coherent set of standardized indicators and indices allows to:

- **Monitor trends and progress in moving towards the priority policy objectives**
- **Identify areas of special concern, based on comparable methods and standards**
- **Support the setting of priorities for strategic action within the region.**

However, the causalities that explain the observed trends may be very different in origin, depending on the processes that take place in a particular area. Applying indicators at the local level provides additional information:

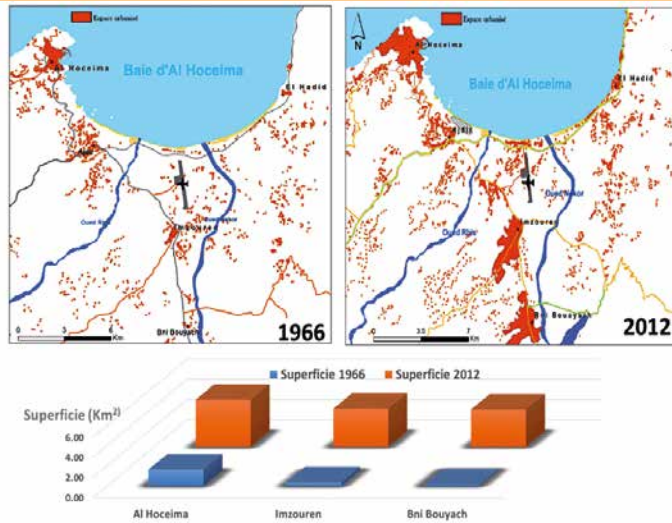
- **Cause-effect relationships are often complex and easier to disentangle at a local scale**
- **Cause-effect relationships that explain the observed trends can provide crucial insights for the development of effective policy instruments and targeted management actions in other regions or at the regional scale**
- **Local high-quality data can support validation of data used in broad basin-wide assessments**



The Al Hoceima CASE is located in the central part of the Mediterranean coast of Morocco. Major issues are urban sprawl, resource degradation, coastal risks and erosion. The coast is extensively developed and experienced a coastal real-estate boom including residential construction on fore dunes or on vulnerable cliffs, combined with a high population density (5,310 inhabitants/Km² in Al Hoceima city). A major issue is the achievement of balanced development while protecting biodiversity and managing coastal risks.

Three indicators calculated:

- Coastal urbanisation (km²)
- Coastal population density (inhabitants/km²)
- Coastal erosion rate (m/year)



Coastal urbanisation between 1966 and 2012

Box 2.

Coastal urbanisation: erosion and risks in the Al Hoceima CASE [41]

In the context of the PEGASO project, coherence was achieved for indicator calculations both at the local and basin-wide scale. Developing methodological indicator factsheets is a first step in standardizing and harmonizing a common representation of the supporting data. Specific guidelines for spatial data harmonization are a next step in order to combine spatial data from different areas in a coherent way, e.g. within a distributed network of geonodes in the SDI (see also above).

At the local scale, CASES calculated a number of indicators from the PEGASO core set, e.g. on urban development and population density. The Al Hoceima PEGASO CASE (Morocco) illustrates the integrated assessment based on indicators of 'natural capital' and 'urban development', as calculated in one of the CASES. Furthermore, the calculated indicators for changes in urban land use and population density in Al Hoceima are related to driving forces (erosion and risks) and to impacts (natural capital), using PEGASO indicators within the assessment framework (Box 2). This constitutes an example of how a standardized approach (indicator calculation) allows comparison at the basin-wide scale while taking into account of local specificity (causal relationship of pressures and impact).

Assess the cumulative and synergistic effects of multiple anthropogenic stressors and threats and their impact on coastal and marine ecosystems and social communities at various spatial scales b) c) d).

Cumulative Index Mapping allows identifying and mapping *Pressures* and *Impacts* in a systemic way at different spatial scales (from basin-wide to local) and disaggregated by spatial reporting unit. By selecting drivers that are most relevant for the coastal and marine regions, it focuses the analysis on the land-sea interaction. The method allows separating between marine-based, land-based and fishery related pressures and impacts (figure 11) and assessing the influences of individual pressures in relation to the total intensity of combined pressures.

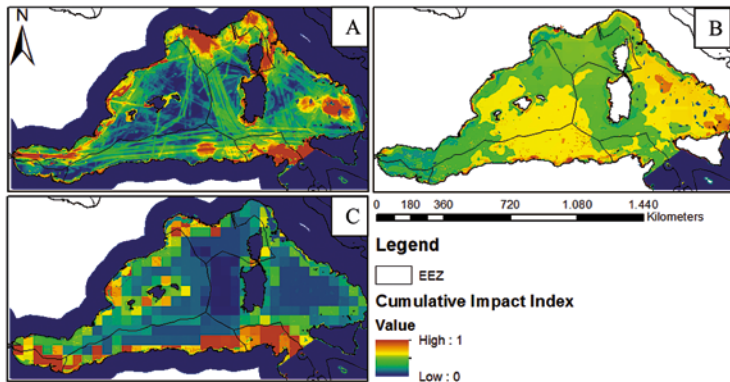


Figure 11. Cumulative Impact Index disaggregated into marine-based impacts (A), land-based impacts (B) and fishery-related impacts (C) in the western Mediterranean Sea. Climate-change-related stressors are excluded from the analysis. Source: Morrisseau, 2013 (PEGASO Project)

Marine-based impacts are related to important harbours and associated traffic (Figure 11A). Areas of intense land-based impacts were located north of Algeria and in the Tyrrhenian Sea (Figure 11B), mainly resulting from marine debris accumulation. Areas of high fishery-related impacts follow the continental shelf contours and are mainly located off the North African coast and in the Gulf of Lion, off southern France (Figure 11C).

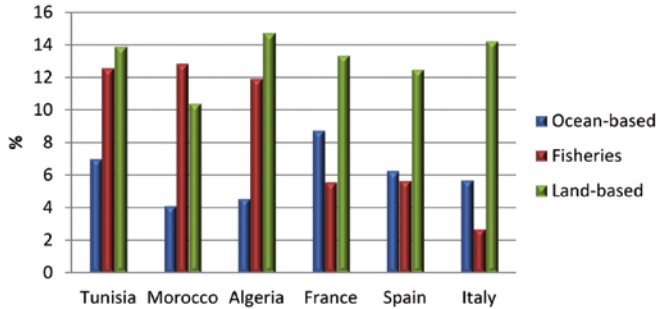


Figure 12. Influence of pressures on the first 20 km in the of western Mediterranean Sea littoral, disaggregated by country and land-based, marine-based, and fishery-related pressures. The results suggest higher proportions of land-based pressures in France, Spain and Italy, which could be explained by the higher urbanisation and coastal population densities in these countries.

Assess the relationships between the environment and socio-economic processes

Traditional economic assessments do not fully account for the role of the environment in the measurement of economic activity. Besides capital used to produce goods and services, there are additional values of natural capital to be accounted for. Ecosystems are degraded by over-use, and ecosystem services need to operate at sustainable levels in order to continue supporting economic welfare and social wellbeing. Although there are considerable costs associated with remediating and/or preventing ecosystem degradation; in the lack of remediation and preventative measures, ecosystem capital is depreciated, leading to an ecological debt [42]. This situation can result in biased, inaccurate statistics on economic growth and development, hiding critical concerns about rapid economic growth. Short-term benefits achieved through depletion of natural capital are temporary strategies that create no basis for sustainable development.

When considering the effects of urban development on the environment and social wellbeing, a multitude of closely related potential impacts must be considered. Similarly, the environmental and socio-economic sectors that are affected are also integrally linked. For example, ecologically fragile habitats that are most susceptible to degradation are often the very areas that are attractive to tourists and developers, leading to increased pressures on the ecosystem and reducing its potential for recovery. This is well illustrated by one of the PEGASO CASES, the Aegean Islands. Tourism, the dominant activity on these islands, relies on attractiveness of the area mainly based on natural capital (Figure 13 A-B). However, at the same time tourism causes a shift in populations between islands in the archipelago due

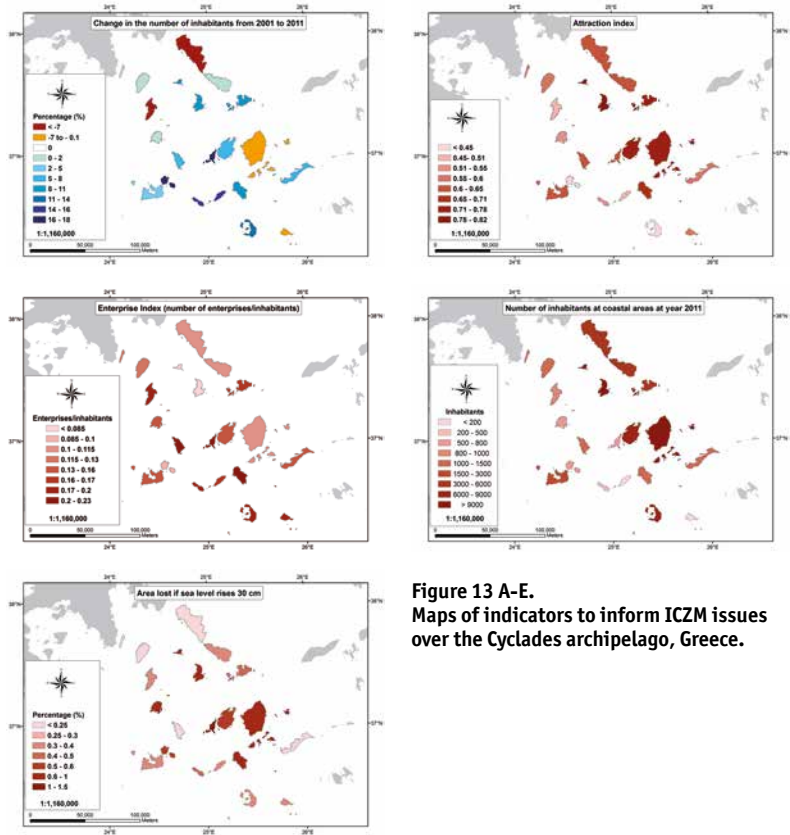


Figure 13 A-E.
Maps of indicators to inform ICZM issues over the Cyclades archipelago, Greece.

to employment opportunities, driving coastal development, and contributing to threats from over natural-capitalisation (Figure 13 C-D). Consequentially, this increases the percentage of the population at risk from climate-change-related pressures, such as sea-level rise (Figure 13E).

This dual character of “balanced use” can be classified into main categories and interactions mapped by identifying pressures-impacts indices. Furthermore, factors that are driving coastal development can be ascertained by monitoring previous feedback responses. Impacts can be considered in terms of changes to the state of ecosystems or human wellbeing. This process can be informed through a web of relationships among uses and the environment, taking the form of a causal chain or diagram of influence. The diagram can receive input from different analytical tools (indicators, LEAC, CIM, participation, and scenarios). The scale of the assessment requires working at an ecosystem level. The Cyclades case again demonstrates how a basin-wide approach based on agreed and standardized tools, can be set in a analytical framework using causal relationships for processes that are relevant at the local level.

A Cost-Based Approach for Assessing Natural-Capital Depreciation

Ecosystem degradation results in losses to the value of natural capital. Degradation can result from overuse, misuse or mismanagement of marine ecosystems and resources. PEGASO designed a framework to assess such degradation costs, but at a regional scale there is no existing database that allows for such an approach. Few marine and coastal analyses focus on economic activities that are dependent on both fisheries and shipping –related issues (normally an analysis focuses on one or the other). In most cases analyses are designed for measuring impacts from land-based activities. This illustrates the gap between maritime policies as expressed at national and international levels, and the spatial scale of monitoring programmes and reporting. Nevertheless, an alternative was to work at the level of the administrative unit of the coastal zones, and refine the spatial scale for work done in the CASES. Degradation costs were then assessed at a local scale over the Bouches-du-Rhône CASE regarding water quality issues, and addressed at a regional scale for the French territorial units of the ‘façades maritimes’ (Box 5 and 6).

Compared to other approaches (monetary valuation), the cost approach produces minimum, but realistic values of degradation. The residual impacts (e.g. cost of remaining pollution) can be documented quantitatively and/or qualitatively through multi-criteria analysis or monetary reference value if available. Residual impact costs are assessed against a baseline of no degradation. This socio-economic approach is useful to decision-makers for the market-derived information produced.

Indices to Assess Natural Capital and Use of Coastal Zones

A typology of Mediterranean and Black Sea nations was developed from multivariate analyses using a series of composite indices: socio-economic development (education, health, income, new businesses and population), marine industry activities (fisheries, aquaculture, tourism, ship building, shipping and oil) and environmental threats (threatened species, natural resource depletion and environmental protection index). This typology can be used to compare coastal zones in a basin-wide context.



Costs of ecosystem degradation over the French 'façades maritimes' (North/Channel, Atlantic/Biscay and Mediterranean)

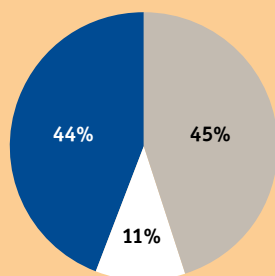
- i) Maintenance costs for French marine ecosystems in 2010:
 - The total amount of maintenance costs is over **2 billion Euros per year**.
 - The most significant proportion of these costs (1.25 billion €) is spent on **avoidance measures against microbiological contamination**, mostly in the form of wastewater treatment (99%) for reaching sanitary standards.
 - As a corollary of this result, the maintenance costs are the highest where urban density on the coast is the highest in the Mediterranean sub-region.
 - Other important degradation thematic are **chemical pollution** (347 M€), **loss of biodiversity** (148 M€) and the **degradation of fishery resources** (133 M€).
 - The majority of chemical pollution costs are also generated from avoidance measures (81%).
 - Loss of biodiversity mostly generates costs from monitoring and information (52%) which indicates a persistent lack of data in this field, while efficient positive actions (28%) may be difficult to implement.
 - Fishery resource degradation mostly generates prevention costs (67%) in the form of management measures (enforcement and control for sustainable fishing, and also monitoring and information costs (27%).
- ii) International comparisons with member States applying a similar approach:
 - **At a very large scale, the results obtained by the Netherlands, France and Spain follow similar patterns, but there are some inconsistencies:**
 - **In the Netherlands, total expenditure amounts to 1.58 billion Euros a year, split into land-based costs (1.45 billion) and marine-based costs (0.132 billion) [43]. French estimates are fairly close to this, but for a coastline seven times longer in France than in the Netherlands.**
 - **In Spain, total expenditures for the maintenance of marine natural capital was about 1.53 billion Euros in 2010, divided into seven issue areas or thematic (Ministerio de medio ambiente y medio rural y marino, 2011), where the cost of wastewater treatment accounts for only 38% (73% FR, 90% NL).**

Box 3.
Ecosystem degradation - A cost-based approach.

- These comparisons highlight the need for consistent and standardised costs-assessment methods, in contrast to conventional monetary economic valuations which have evolved over decades and are more stable from a technical point-of-view. Ecosystem accounting can easily be improved if common criteria are adopted to define expenditures and to standardise use of referentials.

Costs associated with biodiversity losses in the French western Mediterranean

Reduced marine biodiversity is a multifaceted issue as it is related to many different pressures and focuses on impacts which are not taken into account by the other degradation topics.



French Western Mediterranean:
Total = 57,000,000 €

Monitoring and Information Cost

Positive Actions / Prevention Costs

Remediation Costs



Water quality is a major issue for the Bouches-du-Rhône because of its importance for coastal tourism and nautical activities. Main causes of non-compliance of bathing water are structural deficiencies in sewage systems, occasional failures, and non-point-source discharges. Agricultural and urban areas have a direct impact on the sanitation quality of bathing and shellfish waters. The impacts of microbial pathogens organisms (MPO) on human health result from the practice of leisure activities (swimming, nautical sports) in contaminated water, or consumption of contaminated shellfish from aquaculture activities, or professional and recreational fishing. Presence of MPO can cause loss of amenities for recreational activities as well as economic losses to tourism, aquaculture and fisheries.

Degradation costs associated to Microbial Pathogens Organisms	
1. Monitoring and information measures	
Monitoring networks of the microbiological quality of shellfish waters	7,608 €
Bathing water monitoring network	159,273 €
Nautical activities monitoring network	17,784 €
Research projects, surveys, sanitary classification	Not available (minor costs)
Total 1	184,665 €
2. Prevention and avoidance measures	
Collective sewage system	154,875,500 €
Non collective sewage system	724,055 €
Liquid manure control (< 1 km from shoreline)	Not available (minor costs)
Total 2	155,599,555 €
3. Mitigation and remediation measures	
Total costs of shellfish purification in B-areas	70,200 €
DEGRADATION COSTS	155,854,420 €
4. Residual impacts	
Percentage of beaches with insufficient quality (C or D)	1.7%
Percentage of recreational sites with insufficient quality (C or D)	6.9%
Number of beach closures per year (days)	92
Number of temporary bathing interdiction (days)	19
Percentage of shellfish farming zones in C or D	0%
Number of shellfish farming zone closures (days)	0
Number of human diseases due to contaminated shellfish products	Not available (very few number)

The sum of degradation costs totals over 150 million € (2010), with prevention representing the majority of costs (99.8% of quantifiable costs).

Box 4.

Cost of water quality degradation in the Bouches-du-Rhône, France CASE.

Deliver science-based assessments in a periodic and systematic way: communication tools to disseminate assessment outputs.

Appropriate and effective dissemination of the outputs of assessments is crucial to achieve either a support to existing or future ICZM policies, and to achieve a change in behaviour of key actors (see also participatory approach). Scientific support, which is one of the components of ICZM assumes participation of various specialists and utilization of various data depending on a specific task. In the Bay of Sevastopol (Ukraine), several research institutions carry out monitoring programs for the state of the marine environment of the Sevastopol Bay. The Marine Hydrophysical Institute (MHI) and Institute of Biology of the Southern Seas of the National academy of sciences (IBSS) set up a standalone version of the GIS-type system for the Sevastopol Bay. The system incorporates general information for the Bay (meteorological, physical, biogeochemical, ecological properties, and supplementary materials, catalogue and repository of documents and scientific publications) and provides information on data available for specific chemical, physical, ecological parameters and pollutants for individual months and years. Yet, the most valuable part of this atlas is the set of pre-processed maps that can be displayed and compared or printed for further analysis. The tool is basically an extended set of regular numerical grids for all considered properties that can be arranged as needed (scale of maps, color scheme, isolines and their format) and combined with other layers of information (municipal and industrial buildings, sources of pollutants and their properties, etc. Though this tool is powerful for environmental assessment, it also provides basic scientific information, and serves as a basis for calculation of indexes for a wider public of professionals and end-users. It allows provide an integrated regional assessment, to monitor spatial and temporal variations in the state of coastal environment, to trace negative and positive trends due to changes in anthropogenic pressures or/and climate changes. The Bay of Sevastopol has been chosen as one of the sites for practical application and the demonstration of a dissemination tool, to assess local conditions and to provide practically useful end-products for the purpose of ICZM implementation.