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Application of ICZM tool's: Experience from the French PEGASO study site

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Abstract

The Integrated Coastal Zone Management (ICZM) protocol sets a common framework for ICZM for all countries in the Mediterranean basin, yet a wide variety of approaches and techniques are implemented. This study presents the approach implemented from a pilot site in the People for Ecosystem-based Governance in Assessing Sustainable development of Ocean and coast (PEGASO) project; building on existing capacities to develop a common novel approach to support integrated coastal zone management in the south of France (Bouches du Rhone Department). Using a participatory approach, local stakeholders were interviewed to identify potential tools to facilitate ICZM in the Department. The in-depth interviews highlighted a multitude of conflicting land uses (urbanization, farming, natural areas, etc.) resulting from a prolongation of sectorial management put in place during the 1960. In response, the project implemented a Land and Ecosystem Accounting technique (LEAC). This tool aimed to identify how conflicting land use issues have evolved over the years and the consequences that this has on the site. Ecosystem accounts recorded the state of natural resources and ecosystem components in terms of quality (e.g. land-cover); quantity (e.g. volume of biomass, area of certain land-cover, number of species etc.) and changes in quality and quantity in time and space. The first results were presented to the stakeholders in the form of maps during a participative workshop, opening discussion for possible improvements. This pilot test demonstrates the importance of implicating local stakeholders in the development process in order to provide tools that have a better acceptance rate and can be sustained after the projects are completed.

Introduction.

Context.

Coastal ecosystems are amongst the most productive and valuable but also the most threatened ecosystems on Earth (MEA, 2005). This is especially true for the Mediterranean Sea's coastal areas which historically have been one of the most densely populated regions on Earth (Airoldi and Beck, 2007). The population density, along with 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 parts (Coll et al., 2010; Lotze et al., 2006). Since the 1992 Rio Declaration on Environment and Development, the concept of "Integrated management" strategies has gained importance. One outcome of this movement is the ratification of the Integrated Coastal Zone Management Mediterranean (ICZM) protocol for the Mediterranean Sea in 2011, calling for better management within an ecosystem based framework at international, national, and local scales.

The ICZM protocol has the objective of facilitating the sustainable development of coastal zones by ensuring that the environment and landscapes are taken into account in harmony with economic, social and cultural development (UNEP-MAP 2008). This can be achieved through increasing the coherence between public and private initiatives and between decisions by the public authorities, at the national, regional and local levels, which affect the use of the coastal zone (United Nations Environmental Programme, Mediterranean Action Programme, and Priorities Action Programme 2012).

The PEGASO Project.

The People for Ecosystem-based Governance in Assessing Sustainable development of Ocean and coast (PEGASO) project was developed 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. PEGASO seeks to do this by constructing an ICZM governance platform as a bridge between scientist and end-user communities. An ICZM tool kit and pilot sites have fed into this platform to create hands-on ICZM application and experimentation.

One pilot site was established in southern France and covers the coastal zone of the Bouches du Rhone Department. The objective of this paper is to present the results of some of the ICZM tools applied to the study area. Here we will focus on the territory diagnosis using a participatory approach and environmental accounting. The novelty of the participatory process in scientific research aims to provide useful tools for stakeholders that are sustainable after the life of an individual project (Young et al. 2013).

Territorial Diagnosis.

The coastal zone of the Bouches-du-Rhone Department (located within the Provence-Alpes-Cote d'Azur Region) presents, in an area of modest size, the major geographic characteristics that can be found along the French Mediterranean coast. Table 1 presents a

subdivision of the site into several units, defined on the basis of homogeneous geographical features and of their uses.

Table 1: Geographical units of the Bouches du Rhone CASE.

| Units | Coastline delimitation | Geographical characteristics | Uses and management orientations |
|-------------|--|--|--|
| Camargue | Rhône river delta | Delta and coastline. Lagoons, marches, beaches, urban areas, rural habitats, agriculture. | Natural protected areas, urban areas, rural habitats, agriculture, salt marshes, livestock and tourism |
| Gulf of Fos | Mouth of the Grand Rhône-Cape Couronne | Terrestrial side: dry Crau and lagoons, industrial and port zones and suburbs ; Marine side: the Gulf waters and harbour channel. | West terminals of the port of Marseille, industrial and port activities, steel industry, oil refineries, gas terminals, incinerator, container logistic facilities, industrial wastes in the air and water, natural protected areas, urban areas, beach tourism, mussel farming, fishing, dredged material discharge and sunk area |
| Cote Bleue | Cape Couronne-Tunnel of Rove | Narrow coastal band and cliffs and small bays. | Small urban areas, small ports, Natura 2000 zone, marine protected areas, tourism, water sports. |
| Marseille | Tunnel of Rove-Cape Croisette | Urban and port zone and small rivers; Marseille gulf, Islands, beaches and marinas. | East terminals of the port of Marseille, vast and very densely populated urban area, tourism, marinas, deep and short sea shipping, and cruises. |
| | Cape Croisette-Cape Cacao | Narrow coastal band including cliffs and small bays; marine area including Islands. | One National Park (land and marine), terrestrial and aquatic sports. |

The territory diagnosis was composed of two distinct and complementary tasks: a multidisciplinary evaluation (morpho-ecological and socio-economic indicators) of the main environmental issues and an institutional analysis using a participatory approach that reflected the diversity of local actors and their actions in the management of the coastal zone. These linked tasks allowed for the clarification of the evolution of the territory and existing issues in order to give the most relevant responses to the environmental degradation due to human activities.

The multidisciplinary evaluation of the morpho-ecological and socio-economic assessments of environmental issues identified the "pressures/impacts" and "threats" of the coastal zone and attempted to identify the best responses to these issues.

Participatory Approach

The institutional analysis developed a non-exhaustive inventory of agents active in the field of coastal zone management, to maintain, restore and/or improve the marine and coastal ecosystem quality and reduce use conflicts. The objective of this approach was to understand the current management system and collect the point of view of key agents on its functioning (Besancenot, 2008). The semi structured interviews aimed to:

- Identify institutional knowledge, i.e. status and missions that they are given and on which they build their legitimacy as a territorial agent;
- Collect points of view on the main environmental problems in the intervention area;
- Identify specific objectives of environmental management policies that they lead in the coastal zone (management tools, financial and human means, etc.);

- And define institutional deadlock points, i.e. pressures met by these agents that prevent them from fully achieving their objectives (problems of management measure acceptability, means and knowledge necessary to make their mission, etc.).

We selected at least 1 -2 stakeholders from each geographical sector ranging from site managers to local decision makers. A total of 10 stakeholders were interviewed over a 4 month period between January and April 2012 and the interviews lasted between two to four hours. The interviews were critical for determining which PEGASO tools could be the most interesting for the local stakeholders and which tools could have an added value to the current work already implemented in the coastal zone. The majority of the participants highlighted the need for additional tools that focused on social-economic data. As a result, the Land Ecosystem Accounts (LEAC) tool was prioritized for this pilot site.

Environmental accounting methodology.

LEAC is a generic tool useful for environmental assessments and monitoring. In particular it can provide spatial indicators for regional assessment of the status and degradation of natural capital due to the over-use of natural resources. LEAC also provides multi-scale (hierarchical) outputs, to facilitate the assessment of processes that manifest on different levels e.g. continental, country, region and local level.

Essentially the ecosystem accounts aim to register properties or the state of natural resources and ecosystem components in terms of quality (for example type of land-cover); quantity (volume of biomass, area of certain land-cover, number of species,...) and change in quality and quantity in time and space. The quantity and quality features are basically termed and accounted as physical “stocks”, while the change features are accounted as “flows”. Land cover stock is the area of certain land cover type within a unit of measurement, be it administrative region, river catchment, a country, etc. In this study case, a stock was defined by the natural capital calculated using CORINE Land Cover (CLC) maps. The stock derived from CLC maps were represented in three hierarchical levels on European scales; level three being the most detailed containing 44 classes. In this study, flows were defined by the land cover change rates.

Spatial scale of work and time scale.

Ivanov et al. (2012) LEAC application protocol was used for this study case. Accordingly a grid of 1km² (cell area) was used in order to input data and calculate stocks and flows. This grid approach allowed for data from different times and/or geometries to be combined with continuous (such as CLC) and/or discrete data (e.g. species distribution). In other words, complex spatial, statistical, qualitative and quantitative inputs provided comparable, meaningful outputs.

Time scales of work were calculated using three CLC mapping periods: 1990, 2000 and 2006. These data were used to determine the natural capital (stocks) for each period, and the land cover change maps were also used to calculate changes in terms of land use conversion and the lost/gain of natural capital between two time steps.

Aggregation into classes of interest.

Once the land cover data was extracted from the CLC maps for each unit, habitats were aggregated to obtain different classes of interest based on the land use type that they cover (Table 2).

Table 2: LEAC classes of interest (Bouches du Rhone pilot study)

| Classes of land cover of interest | CLC classes |
|-----------------------------------|-------------|
| Urban areas | 11, 14 |
| Agricultural land | 2 |
| Natural or semi-natural land | 3, 4, 5 |
| Transport infrastructures | 122, 124 |
| Industries, mines, dumps | 121, 13 |
| Ports | 123 |

The conversion rates were calculated for each class of interest as it is shown in the Table 3. Indicators were then identified using the type of conversion from Table 3 and changes were detected between two dates every 1km² cell. The unit, in order of priority, was:

- The surface having experienced such a conversion (ha or km²)
- % of change as compared to the land cover class of interest

Table 3: LEAC indicators for the Bouches du Rhone pilot study

| Type of conversion | From | To |
|--|---------|----------|
| Conversion of agricultural land to urban area | 2 | 11, 14 |
| Conversion of natural or semi-natural land to urban area | 3, 4, 5 | 11, 14 |
| Conversion of natural or semi-natural land to agricultural land | 3, 4, 5 | 2 |
| Conversion of agricultural land to industrial area | 2 | 121, 13 |
| Conversion of natural or semi-natural land to industrial area | 3, 4, 5 | 121, 13 |
| Conversion of agricultural land to transport infrastructure | 2 | 122, 124 |
| Conversion of natural or semi-natural land to transport infrastructure | 3, 4, 5 | 122, 124 |
| Conversion of agricultural land to ports | 2 | 123 |
| Conversion of natural or semi-natural land to ports | 3, 4, 5 | 123 |

Results.

Territorial Diagnosis results.

Segmentation and specialization.

The pilot site was subdivided into four geographic units. Each unit has distinct dominant characteristics: natural, urban, tourist or industrial. The management problems are different for each unit:

- Camargue: the problems focus on the state of wetlands and their sensitivity to urban and agricultural pressures, sea level rise, coastal zone erosion and flood risks;
- Cote Bleue and the Calanques National Park: the problems are principally marine, linked to fisheries management, aquatic sports, water quality, and biodiversity conservation;
- Gulf of Fos and Marseilles: the problems are both terrestrial and marine, with urban clusters and industrial and port activities.

Despite global guidelines provided by framework documents published by the Provence Alpes Côte d'Azur Region and the Bouches du Rhone department, the management

tools are not continuous along the coastal zones. Each unit continues to be managed individually without much contact and interaction with the neighbouring units. The segmentation follows the specialization and geographic particularities of each unit. This strategy aims to protect the sensible zones and to monitor heavy industry and tourism areas while permitting their development at the cost of environmental risks (Le Gentil et al., Unpublished document).

Interactions between units and common uses.

The abovementioned segmentation was qualified as interactions between units also exist, given common uses and management options:

- Common coastal uses: coastal fisheries in the three mile zone, beach and aquatic sport.
- Marseilles: the two sub-units are linked through boating and aquatic sports and terrestrial leisure and Calanques visitor flows;
- The development of marinas in a given unit may increase the number of visits in neighbour units (e.g. Marseilles vs. the Calanques and the Cote Bleue).
- Marseilles and the Gulf of Fos: the East and West terminals of the port. Meanwhile, they increasingly differ in terms of traffic categories with passenger and small containerships traffic being processed on the East terminals, and liquid bulk (oil, oil products and LNG) and large containerships traffic on the West terminals.
- Coastal zone management projects are conducted in partnership by the Provence Alpes Côte d'Azur Region and Bouches du Rhone department authorities and the Water Agency, e.g. for the Camargue and the Cote Bleue.
- Finally, interactions also exist between units and zones external to the pilot study area. This was expected as the pilot study limits follow administrative borders and not geographic limits.

Common management issues.

The segmentation of the pilot study area also identified the existence of management issues common to different units. It was important to identify these common issues in the backdrop of the implementation of the Marine Strategy Framework Directive on the Mediterranean coastal zone:

- Coastal and marine natural zones are becoming increasingly fragile: wetlands in Camargue (exposed to impacts from irrigation); or marine flora and fauna of the Cote Bleue, sensitive to tourism and visits
- Population growth impacts: very high density in the Marseilles and Gulf of Fos. Low in the Camargue but growing.
- The development of farming was contrasted in the different units over the recent years. The activity remains steady in the Camargue, with a need for protecting natural zones against farming irrigation and effluent impacts. Elsewhere in the pilot study area, many farming zones are exposed to the pressure from urban expansion.
- Traffic and access issues: access, transport facility and traffic intensiveness issues exist in the different units of the pilot study for several reasons:
 - Urban expansion in coastal communes.
 - Fragile, tourist attractive and protected zones (Calanques, Cote Bleue, Camargue) require some control over tourist visits, which largely depends on the regulation of terrestrial access.

- Access to the sea is space consuming as shown by the harbour zone of Fos, marinas, beaches, urban promenades and wharves, private corporate estates such as salt marshes in the Camargue. It will probably be increasingly space consuming as coastal tourism is likely to intensify.
- Uncertainty: owing to the lack of detailed knowledge on the environment impacts of certain uses, coastal zone management strategies are lead to develop under uncertainty. That is the case for shipping and fishing port zones, marinas, beaches, industrial zones such as Fos, the outfall of Cortiou in the Calanques for the discharge of waste water from Marseilles. Many environment impact indicators exist and can be followed by managers; but the difficulty is to share those indicators with the other managers in order to have a common use of them and a common understanding of impacts.
- Finally, the numerous management schemes and the segmentation of management into Communes, the Department, the Region, the State, Europe, natural parks, corporate and harbour authorities does not seem to be in itself a major impediment to an efficient and integrated coastal zone management. The latter rather seems to depend on managers to adopt a concerted approach, sharing indicators and on users adhesion to management projects.

LEAC results.

For the Bouches du Rhone study site, the units for calculating the LEAC indicators were defined by the administrative limits of the coastal communes from Marseille to the Saintes-Maries-de-la-Mer (Figure 1). Those administrative units as described in the territorial diagnostic were then included into 4 geographic supra-units (see Table 1).

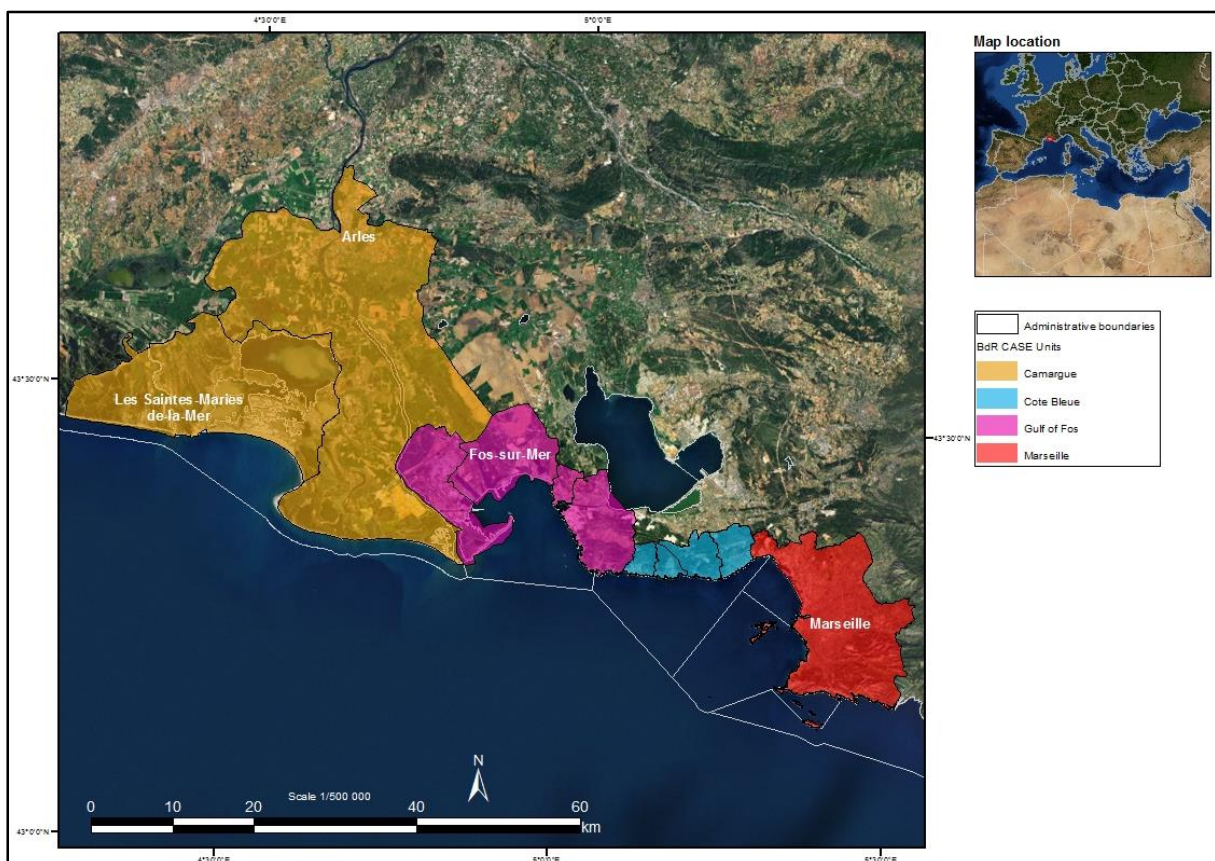


Figure 1: Geographical units for the Bouches du Rhone CASE including all coastal communes.

The classes of interest were aggregated for each of three periods analyzed (e.g. in the Figure 2 for 2000). This permitted the estimation of natural capital stocks available, and the determination of the evolution of stocks over time (Table 4).

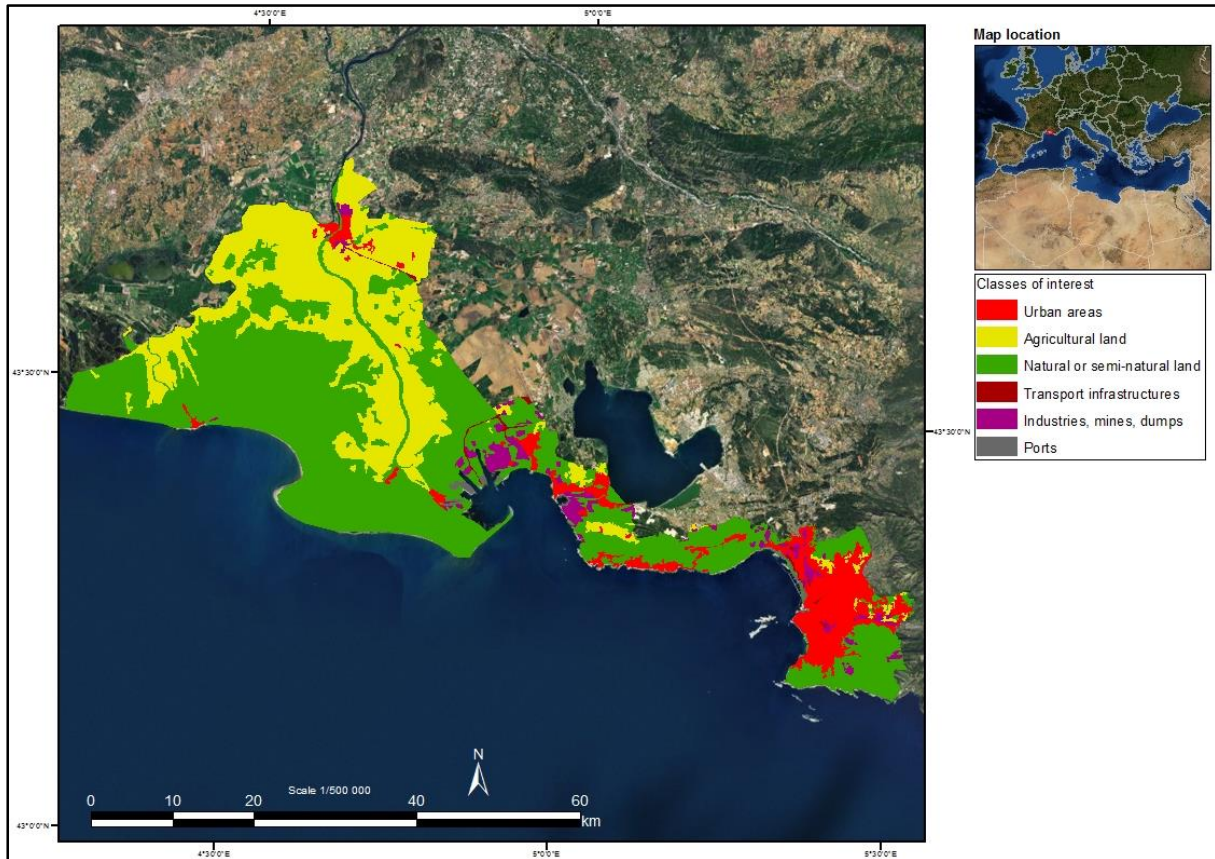


Figure 2: Example of aggregation of the CLC habitats into classes of interest (derived from CLC 2000 data).

Table 4: Classes of interest changes over time for the entire pilot study area.

| Class of interest | 1990 | | 2000 | | 2006 | |
|------------------------------|-----------|-------|-----------|-------|-----------|-------|
| | Area (ha) | % | Area (ha) | % | Area (ha) | % |
| Urban areas | 15225 | 8.78 | 15828 | 9.13 | 15978 | 9.21 |
| Agricultural land | 50082 | 28.88 | 49621 | 28.61 | 49481 | 28.53 |
| Natural or semi-natural land | 101363 | 58.45 | 96755 | 55.79 | 96691 | 55.75 |
| Transport infrastructures | 715 | 0.41 | 743 | 0.43 | 743 | 0.43 |
| Industries, mines, dumps | 5155 | 2.97 | 5174 | 2.98 | 5228 | 3.01 |
| Ports | 885 | 0.51 | 802 | 0.46 | 802 | 0.46 |

Globally for all units in the pilot study, there were no significant changes in terms of land use between 1990 and 2006. However, given the results presented in Table 4, there was a loss of natural capital (from 58.45% to 55.75%) for the entire surface area. This loss is probably due to a sharp increase of the artificialization of the territory during the same analysed period in some coastal zones. Urbanized areas increased from 8.78% to 9.21% and industrial areas increased from 2.97% to 3.01%. Changes were also seen through the conversion of natural habitats into agricultural areas. It is important to note that although the surface areas remain relatively stable in terms of used surface, it does not necessarily mean that there has been no evolution as natural habitats might be compensated by losses in

urbanization for example. Further analysis took into account the different types of changes previously defined (LEAC indicators).

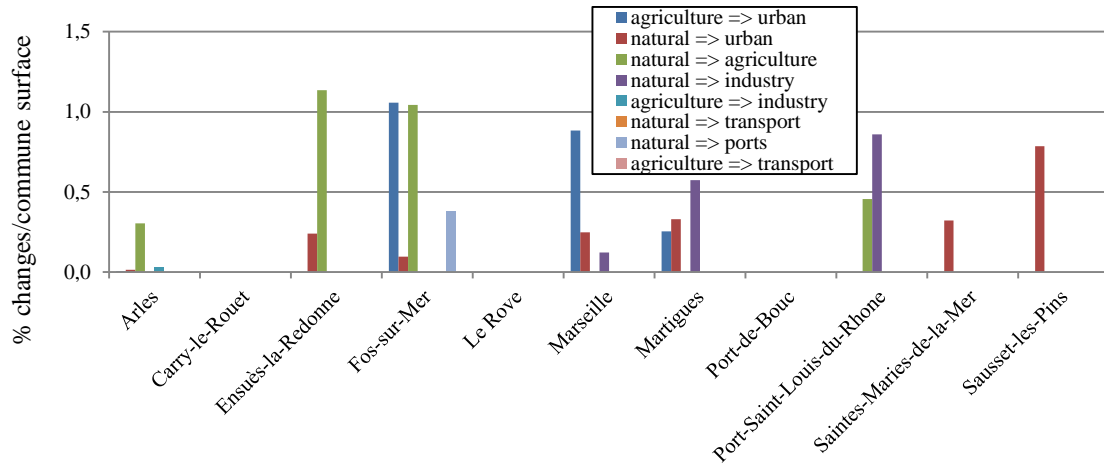


Figure 3: LEAC indicators corresponding to different land use changes between 1990 and 2006.

Taking into account the different municipalities constituting the pilot study area (see Figure 3), the most important conversion rates were those of natural habitats to agricultural and built areas (urban, industry and ports), as well as agricultural areas converted into built lands (urban and/or industrial).

Moreover, with this analysis, it was possible to identify some trends in economic policies of each administrative units of the Bouches du Rhone pilot site. For example, the communities with the highest rate of industrialization in terms of land cover, are those of Martigues and Port-Saint-Louis-du-Rhône, which both are in the geographic unit of the Gulf of Fos. However, the municipalities where urban sprawl was the highest during the 16 years analysed, were Fos-sur-Mer, Marseille and Sausset-les-Pins (located respectively in units of the Gulf of Fos, Marseille and the Cote Bleue). These urban expansions may be due to strong demographic growth, which itself could result from an economic attractiveness of these regions between 1990 and 2006 (industrial and port activities, agriculture and tourism). Finally, with the LEAC tool, it was possible to localize the changes through maps (Figure 4).

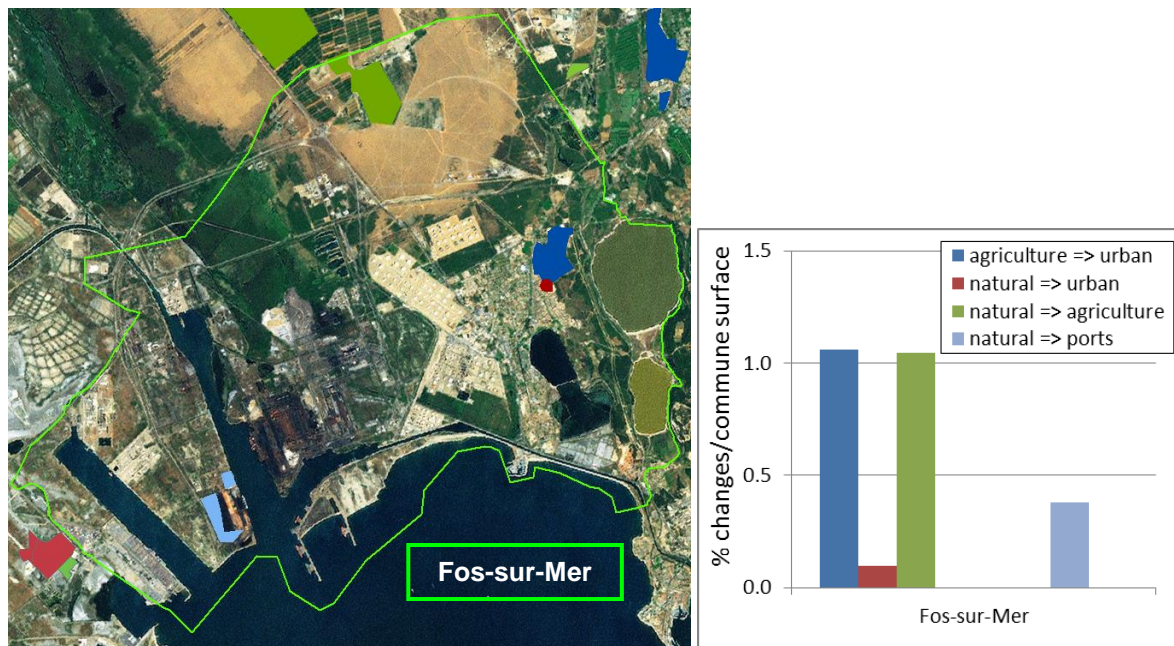


Figure 4: Land use and land cover change map in the municipality of Fos-sur-Mer between 1990 and 2006.

Conclusion.

Given the participants' interest in the PEGASO tools, a final restitution was presented in a participative workshop to validate the results and to determine potential further uses. The participants validated the territorial diagnostic and were very motivated by the preliminary LEAC results. The participants highlighted their interest in the LEAC tool and particularly appreciated the visual attractiveness of the maps. During the workshop it was mentioned that the maps allowed the stakeholders to visualise the evolution of the sites overtime and the interactions between the different units. Various suggestions were offered by the participants to improve the LEAC tool. In order to keep the tool as user-friendly as possible, the only feasible recommendation was to add the protected area boundaries to the maps. The completed tool is now being transferred to the local Water Agency who will be responsible for updated the classes every five years (with the available CLC data). Using a participative approach for the territorial diagnostic and LEAC ensured an open dialogue between scientist and local stakeholders. This dialogue proved successful in creating tools that will be useful to the management of the coastal region after the end of the PEGASO project.

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Keywords.

France, Integrated Coastal Zone Management, Land and Ecosystem Accounting, Participatory Methodologies, PEGASO Project