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‘Anthropogenic Intensity’ and ‘Coastality’: Two new Spatial Indicators for Exploring & Monitoring the Coastal Areas, in the framework of Environmental Management

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1. Introduction

The history of human settlement and the international demographic statistics prove that villages and cities of any type and size seek to be concentrated in a narrow ribbon of land, near the shorelines. [Mumford, 1961; UNFPA, 2007; WRI, 2010].
Moreover, because of their affluent resources and historically confirmed attractiveness, coastal areas have been among the most exploited areas all over the world. Therefore, it is not surprising that a cruel conflict takes place between the natural coastal environment (as a long-term supplier of special and unique resources) and the constantly increasing demand for continuous (over)use of coastal resources. At a second level, even stronger conflicts take place among human activities, as they are expressed through the coastal land uses. [Stanners & Bourdeau, 1995; EC, 1999; UNEP, 2001; Benoit & Comeau, 2005; EEA, 2006; Valiela, 2006; Goudie, 2006; UNEP/PAP/RAC, 2009].
Because of the (greater than ever) international concern on sustainable development principles, the coastal issues are already enough highlighted. The related academic literature and institutional concern are enormously expanded. [WCED, 1987; Brachya et al., 1994; Benoit & Comeau, 2005; CIESIN, 2010].
Having the above facts as starting point, this chapter belongs to the integrated coastal area management research field. It aims to trigger off the development of a more comprehensive approach of coastal areas, as the already available coastal information (and related indicators) does not sufficiently satisfy the spatial notion of the coastal areas, especially at local level. The general concept is to prove that the two newly launched indicators, **‘Anthropogenic Intensity’ and ‘Coastality’, are emerging with efficiency the spatial notion of coastal areas, and thus they are able to support the planning-exploring-monitoring process of coastal space**, in the perspective of territorial cohesion and sustainable development.
After a brief review of the international scientific agenda, regarding the coastal issues (in particular from the spatial planning point of view), a critical overview is recorded, concerning the indicators already been in use through the coastal management process. But, the core of the present text is dedicated to the full description of these two new indicators. Additionally, an epigrammatic synopsis of the already completed case studies is

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demonstrated. These case studies have been implemented along the Hellenic coasts, from 2006 to 2009.

The new indicators' effectiveness, their ability to propose a new coastal typology and their potential future improvement will be also discussed. The contribution of this chapter will be considered as positive if the illustrated new indicators achieve to enrich the argument about the (integrated) environmental management and the sustainable development of the coastal space.

2. Coastal space

2.1 Basic coastal ontology

'Coastal areas' consist from the land and sea areas bordering the shoreline. [ENCORA, 2010].

More precisely, according to a rather old but classic definition, a 'coastal zone' contains:

> *"The part of the land affected by its proximity to the sea, and that part of the sea affected by its proximity to the land as the extent to which man's land-based activities have a measurable influence on water chemistry and marine ecology". [Stanners & Bourdeau, 1995, from US Commission on Marine Science, Engineering and Resources, 1969; USC, 1972].*

According to the recent Protocol on Integrated Coastal Zone Management (ICZM) in the Mediterranean, 'coastal zone' means:

> *"The geomorphologic area either side of the seashore in which the interaction between the marine and land parts occurs in the form of complex ecological and resource systems made up of biotic and abiotic components coexisting and interacting with human communities and relevant socio-economic activities". [UNEP/MAP/PAP, 2008].*

The terms: (coastal) area/zone/space have a similar but not completely equal meaning. The 'zone' usually refers to limits (landward and seaward) "parallel" to the shoreline, the 'area' is a more general concept, without restrictions regarding the limits (so, it is proposed for cases where the coastal limits match with the rather random administrative boundaries or the watershed perimeter) and finally the term 'space' is used by spatial planners in order to assist the focusing on the spatial notion. In addition, the French origin term 'littoral' refers to a rather narrow zone between the limits of high and low tides; even if the term 'littoral zone' is used for a more extended coastal area. The term 'coastal environment' is favoured when the focal point is on the natural ecosystems. Throughout a systematic approach, the term 'coastal system' can be used. Finally, the term 'coastal region' is not very common, particularly at local level.

Because of the fuzziness of the coastal area notion, there is a difficulty to reach a single scientific description of this term. Biological, chemical, geomorphologic, oceanographic, legislative and other criteria drive to various definitions, both scientific and operational; the latter are used with the intention of solving specific managerial/administrative coastal problems. Almost all of them (especially these with scientific starting point) accept a double composition of coastal areas, by identifying a land and a marine part. [Clark, 1995; Kiousopoulos, 1999].

Usually, during the planning process a three-dimension approach is chosen, as it is widely accepted that the intensity of the coastal phenomena is gradually changed, with the pick taking place very close to the shoreline. Furthermore, the international literature accepts the existence of coastal phenomena around a (large) lake or river.

In accordance with the previous analysis, it is understandable that a critical point of every coastal project is the location of the coastal areas limits, both landward and seaward. This

geographical coverage specification is very essential landward, "*in order to apply, inter alia, the ecosystem approach and economic and social criteria and to consider the specific needs of islands related to geomorphologic characteristics and to take into account the negative effects of climate change*" [UNEP/MAP/PAP, 2008].

2.2 Current situation

No important how they are defined (and beyond the unavoidable impact of natural processes) coastal areas are arenas of human-environment interactions. Their particular characteristics attract human activities in an increasing rate. As a result, coastal space needs to be controlled by means of policies such as spatial planning, integrated coastal area management, environmental assessment etc. Usually, environmental, economic and social dimensions are recognized; but lately, governance issues are present with an emphatic way. [Brachya et al., 1994; EC, 1999; UNEP, 2001; Heileman, 2006].

Coastal space is under intense pressure due to: uncontrolled urban expansion, tourism development, intensive agricultural production and diversification of fishery activities, energy production, "mobility and commerce–ports, harbours and coastal transport routes" and many other human activities. [Clark, 1995; EC, 1999; Valiela, 2006]. The expected growth, particularly in the tourism sector, increases human pressure on natural, rural and urban coastal environments. [UNEP/PAP/RAC, 2009]. However, there is no adequate information to cope with the real magnitude of human impact on coastal areas. [UNEP, 2001; Creel, 2003; EPA, 2009].

Along the already overdevelopment coasts, like those of the Mediterranean region, the process has been progressing for several decades. It leads almost inevitably to an artificial land cover over the previously natural environment. [Stanners & Bourdeau, 1995; Benoit & Comeau, 2005; Vogiatzakis et al., 2005]. On the other hand, today, the global coastal system faces a rather vague future. Indeed, it is quite certain that climate change and sea level rise will stress coastal resources and afterwards will interact with many social and environmental factors, as population growth, use of resources etc. [EEA, 2006; UNFPA, 2007; NOAA, 2009].

Simultaneously, the massive demand of coastal space increases the number of involved actors. Local population and the businessmen with economic interest in coastal space are at the first level of concern for the coastal affairs. Visitors and tourists compose a second group. Local authorities and numerous ministries of the central government follow, but often find themselves undertaking the same or similar tasks and sometimes, even working against each other due to their own inharmonious and competing objectives. Besides, many public, non public agencies and NGOs are occupied in different coastal issues.

It is remarkable that the majority of the just before mentioned stakeholders are apparently not experienced in coastal planning and management. Moreover, beyond the competing needs of the implicated stakeholders, other parameters as temporality (that drives to "seasonal land uses"), the overlapping of terrestrial and marine features, the regionally diversified natural phenomena etc. make the management of coastal areas quite complicated, a rather fuzzy process.

The policy response fluctuates widely, but during the last 30 years and especially after the Earth Summit held in Rio de Janeiro, 1992, coastal nations are encouraged to develop their own Integrated Coastal Zone Management (ICZM) infrastructures. [UN, 1992; Brachya et al., 1994; UNEP, 2001]. In accordance with the above mandate, many efforts have been done all

over the world, but not all of them can be considered as successful. Besides, no seldom, they deal only with just the marine/ocean part or the land part of a coastal area.
In our days, after a long period of experience, ICZM seems to be a temporally extended process of continuous confronting efforts against social, economic and political interests, which usually protect the existing status quo. Consequently, even if it is yet promoted as the ideal solution, in many cases, ICZM seems to be only a "*part of the rhetoric for sustainable development*". [Sorensen, 2002]. Thus, ICZM is rather an umbrella that includes all the coastal areas planning and management procedures, in general.

3. Coastal indicators

3.1 General overview

The study of coastal areas through indicators is strongly recommended by the international bodies devoted to coastal and environmental issues. It is remarkable that according to the 'Agenda 21' -and especially to the passage of the article 17 ("protection of the oceans, all kinds of seas, including enclosed and semi-enclosed seas, and coastal areas and the protection, rational use and development of their living resources") dedicated to data and information (article 17.8)- the promotion of indicators is very clear [UN, 1992]:

> *"Coastal States, where necessary, should improve their capacity to collect, analyse, assess and use information for sustainable use of resources, including environmental impacts of activities affecting the coastal and marine areas. Information for management purposes should receive priority support in view of the intensity and magnitude of the changes occurring in the coastal and marine areas. To this end, it is necessary to, inter alia:*
> *(a) Develop and maintain databases for assessment and management of coastal areas and all seas and their resources;*
> *(b) Develop socio-economic and environmental indicators;*
> *(c) Conduct regular environmental assessment of the state of the environment of coastal and marine areas;*
> *(d) Prepare and maintain profiles of coastal area resources, activities, uses, habitats and protected areas based on the criteria of sustainable development;*
> *(e) Exchange information and data."*

In parallel, the European Union directives on the assessment of almost every human construction of large scale endorse goals which are equivalent to the previously mentioned information/indicators demand of ICZM. Indeed, the under discussion TIA (Territorial Impact Assessment), the already existed Environmental Impact Assessment (EIA), but even more the Strategic Environmental Assessment (SEA) require on-going information on the earth territory status, coastal areas included. All of them (ICZM and TIA/EIA/SEA) fuel a continuous need of geographic information, especially after the recent more persistent promotion of the spatial cohesion notion, through the 3rd and the 4th reports of European Commission on Economic and Social Cohesion. [EC, 2004; EC, 2007].
As the supply of efficient and effective information is one of the greater needs -if not the greatest one- for successful management of coastal space, the research on indicators -as an analysis tool- is widespread along the academic community and the institutional bodies. [UN, 2001; OECD, 2001; Bossel, 1999; UNEP, 2000; Nebert, 2004; EEA, 2005]. Existing indicators useful for ICZM and in general for the coastal space can be distinguished into several categories, but mainly into the two already reported in the above quotation of the 'Agenda 21': the socio-economic and the environmental category.

Beyond the criterion of specialization, the indicators can be categorized according to the frameworks, in which they belong. The more well-known are: the Pressure-State-Response (PSR) framework (launched and supported by UN and OECD) and the Driving forces – Pressure – State – Impact – Response (DPSIR) framework (launched and supported mainly by EU and the affiliate agencies). [OECD, 2001; Smeets & Weterings, 1999; Heileman, 2006].
Very close to the indicators issues, the ambitious initiative INSPIRE of the European Union aims to solve problems such as the fragmentation of datasets and sources, the lack of harmonization between datasets at different geographical scales, the gaps in information availability etc. [INSPIRE, 2010]. Similar objectives are evident in the analogous international initiative of the GSDI Association. [GSDI, 2010].
Until nowadays, a huge number of indicators (simple or with the form of a complex algorithm) or sets of indicators have been launched, mainly for environmental use. [Smeets & Weterings, 1999; UNEP, 2000; UN, 2001; Barbière, 2003; EEA, 2005; Heileman, 2006]. Some of those indicators are registered in Table 1. The first group refers to a general approach concerning the sustainable development. The second and the third are specialized to ICZM (in Mediterranean and in oceans, accordingly), while the fourth one has been used in a smaller ICZM project (in the Belgian coast).

Percent of Population Living below Poverty Line, Gini Index of Income Inequality, Unemployment Rate, Ratio of Average Female Wage to Male Wage, Nutritional Status of Children, Mortality Rate Under 5 Years Old, Life Expectancy at Birth, Percent of Population with Adequate Sewage Disposal Facilities, Population with Access to Safe Drinking Water, Percent of Population with Access to Primary Health Care Facilities, Immunization Against Infectious Childhood Diseases, Contraceptive Prevalence Rate, Secondary or Primary School Completion Ratio, Adult Literacy Rate, Floor Area per Person, Number of Recorded Crimes per 100,000 Population, Population Growth Rate, Population of Urban Formal and Informal Settlements, Emissions of Greenhouse Gases, Consumption of Ozone Depleting Substances, Ambient Concentration of Air Pollutants in Urban Areas, Arable and Permanent Crop Land Area, Use of Fertilizers, Use of Agricultural Pesticides, Forest Area as a Percent of Land Area, Wood Harvesting Intensity, Land Affected by Desertification, Area of Urban Formal and Informal Settlements, **Coastal Zone Algae Concentration in Coastal Waters**, **Percent of Total Population Living in Coastal Areas**, Annual Catch by Major Species, Annual Withdrawal of Ground and Surface Water as a Percent of Total Available Water, BOD in Water Bodies, Concentration of Faecal Coliform in Freshwater, Area of Selected Key Ecosystems, Protected Area as a % of Total Area, Abundance of Selected Key Species, Economic Performance GDP per Capita, Investment Share in GDP, Balance of Trade in Goods and Services, Debt to GNP Ratio, Total ODA Given or Received as a Percent of GNP, Intensity of Material Use, Annual Energy Consumption per Capita, Share of Consumption of Renewable Energy Resources, Intensity of Energy Use, Generation of Industrial and Municipal Solid Waste, Generation of Hazardous Waste, Generation of Radioactive Waste, Distance Travelled per Capita by Mode of Transport, Strategic Implementation of SD, National Sustainable Development Strategy, Implementation of Ratified Global Agreements, Number of Internet Subscribers per 1000 Inhabitants, Main Telephone Lines per 1000 Inhabitants, Expenditure on Research and Development as a Percent of GDP, Economic and Human Loss Due to Natural Disasters. [UN, 2001].
Population growth, Total fertility rate, Women per hundred men in the labour force, Human poverty index, Employment rate, School enrolment gross ratio, Difference between male and female school enrolment ratios, Production of cultural goods, Share of private and public finances allocated to the professional training, Public expenditure for the conservation and value enhancement of nature, cultural and historical patrimony, Life expectancy at birth, Public expenditure for the conservation and value

enhancement of natural, cultural and historical patrimony, Public expenditure for the conservation and value enhancement of natural, cultural and historical patrimony, Life expectancy at birth, Infant mortality rate, Access to safe drinking water, Annual energy consumption per inhabitant, Number of passenger cars per 100 inhabitants, Main telephone lines per 100 inhabitants, Distribution of food consumption per income decile, Urban population growth rate, Loss of agricultural land due to the urbanisation, Urbanisation rate, Floor area per person, Population change in mountain areas, Existence of program(s) concerning the less favoured rural zones, Exploitation index of forest resources, Forest area, Forest protection rate, **Artificialized coastline / total coastline, Number of tourists per km of coastline, Number of moorings in yachting harbours, Population growth in Mediterranean coastal regions, Population density in coastal regions, Coastline erosion, Protected coastal area, Oil tanker traffic, Global quality of coastal waters, Density of the solid waste disposed in the sea, Coastal waters quality in some main "hot spots"**, Quality of biophysical milieu, Protection of specific ecosystems, Existence of monitoring programs concerning pollutant inputs, **Wastewater treatment rate before sea release for coastal agglomerations over 100 000 inhabitants, Harbour equipment ratio in unballasting facilities**, Distribution of GDP (Agriculture, Industry, Services), Foreign Direct Investment, External debt / GDP, Saving / investment, Public deficit / GDP, Current payments / GDP, Employment distribution (Agriculture, Industry, Services), Use of agricultural pesticides, Use of fertilisers per hectare of agricultural land, Share of irrigated agricultural land, Agriculture water demand per irrigated area, "Arable land" per capita, Rate of food dependence, Annual average of wheat yield, Water use efficiency for irrigation, Value of halieutic catches at constant prices, Number and average power of fishing boats, Fishing production per broad species groups, Production of aquaculture, Public expenditures on fish stocks monitoring, Industrial Releases into water, Intensity of material use, Number of mines and carries rehabilitated after exploitation, Turnover distribution of commerce according to the number of employees, Share of merchant services to the enterprises, Existence of legislations on the hypermarket setting up restriction, Energy intensity, Energy balance, Share of consumption of renewable energy resources, Average annual distance covered per passenger car, Structure of transport by mode, Density of the road network, Share of collective transport, Number of nights per 100 inhabitants, Number of secondary homes over total number of residences, Number of bed-places per 100 inhabitants, Public expenditure on tourism development, Number of international tourists per 100 inhabitants, Share of tourism receipts in the exportations, Currency balance due to tourism activities, Public expenditure on tourism sites conservation, Exploitation index of renewable resources, Non-sustainable water production index, Share of distributed water not conform to quality standards, Water global quality index, Share of collected and treated wastewater by the public sewerage system, Existence of economic tools to recover the water cost in various sector, Drinking water use efficiency, Share of Industrial wastewater treated on site, Ratio of land exploitation, Land use change, "Arable land" change, **Wetland area, Number of turtles cached per year, Share of fishing fleet using barge,** Threatened species, Total expenditure on protected areas management, Generation of municipal solid waste, Generation of hazardous wastes, Imports and exports of hazardous wastes, Generation of industrial solid waste, Area of land contaminated by hazardous wastes, Distribution of municipal wastes, Minimisation of waste production, Cost recovery index of municipal wastes, Destination of household wastes, Collection rate of household wastes, Emissions of greenhouse gasses, Emissions of sulphur oxides, Emissions of nitrogen oxides, Consumption of ozone depleting substances, Frequency of excess over air standard (ozone), Expenditure on air pollution abatement, Share of clean fuels consumption in total motor fuels consumption, Share of agglomerations over 100 000 inhabitants equipped with a air pollution monitoring network, Number of sites with high risk, Economic impact of natural disasters, Burnt area per year, Existence of intervention plans, Number of direct employments linked to the environment, Number of associations involved in environment and/or sustainable development, Number of enterprises engaged in "environment management" processes, Public expenditure on environmental protection as a percent of GDP, Existence of environment national plans and/or sustainable development strategies, Number of Agendas 21 adopted by local authorities, Openness rate of GDP, Net migration rate, Public development assistance coming from abroad.
[UNEP, 2000].

Value of living resources, Value of non-living resources, Non-consumptive uses, Economic value-added, Value of exports, Management & administration costs, Investment by government, Private sector investment, Foreign direct investment, Number employed, Employment payroll value, Same sub-categories as total economic value, **Land-based activities dependent on the marine environment**, **Activities in the ICOM area out to the boundary of the EEZ or the continental shelf**, Non-living resource exploitation, Non-consumptive use, Land use/land cover patterns & composition, Population density, Extent of hard-surface areas, **High-impact fishing gear/practices**, Dumped & dredged material, Population served by wastewater treatment, Volume, no. & type of point-source discharges, Non-point-source nutrient loading, Discharged sediments and nutrients, Litter & debris. [Heileman, 2006].
Degree of unemployment, Employment in the tourist sector, Number of good renovations and restorations, Change in employment in the sectors of fish and agriculture, Fish stocks out of the biological limits, Ratio of business started/bankrupt, Value added per employee, **Efforts concerning integrated coastal zone management**, Pressure on incomes, The population structure, Housing quality, **Bathing water quality**, Domestic waste, Number of pollutions (oil) observed/hour flying time, **Surface of typical seaside habitat**, Surface of the protected green area, Number of accommodation with easy access, Ratio resident/non-resident tourism, Traffic pressure on the road, Economic value of the shipping industry versus emission of toxic dust. [Maelfait et al., 2006].

Table 1. Indicative catalogue of several of the already existent indicators, they could be used in coastal management projects.

3.2 Critical approach

Normally, environmental indicators cover the general needs of coastal projects, but not in an adequate way. The majority of the indicators listed in Table 1 are not designed exclusively for coastal areas. But, what is the more essential is that these indicators do not pay attention on the spatial notion. This means that **the geomorphologic geographic information, that characterizes and gives a unique identity in every coastal area, is not regarded as valuable to be incorporated in the majority of the already proposed indicator**. Therefore, vital spatial information for coastal geomorphology is either missing or ignored, even if the "geomorphologic area" is the core of the coastal zone definition, according to the Protocol on Integrated Coastal Zone Management [UNEP/MAP/PAP, 2008].

The indicators of Table 1 can be classified into international, national, regional and (rarely) local level of approach, regarding the geographical scale of their potential use. The ones related to coastal areas are rather suitable for international, national or regional approach [UNEP, 2000]; at any rate, they are no committed to geomorphologic information. In the literature, there are available indicators respecting spatial concept at local level [Chalkias, 2002], but they limit their interest mainly to the islands.

Finally, because there are not indicators supporting the local approach, a small coastal area can neither be easily explored and monitored nor be compared with another coastal area (of equal size). Simultaneously, there is no indicator to cope with either the human impact on a coastal area, in general, or more specifically, with the bulk of man-made coastal environment (constructions of any kind and size).

Because of the previously proved lack of coastal information/indicators indented to depict:

- the spatial notion,
- the local identity and

- the total human impact,

a continuous effort to improve and to expand the already used system of indicators is needed. In this context, indicators suitable for: i) exploring (with the meaning of analysis) and monitoring the coastal areas, ii) enriching spatial planning, in general, iii) supporting all the involved stakeholders and iv) getting on a successful governance process on a coastal area, should incorporate geomorphologic factors as the following:

1. **Position**, with potential parameters like: location, vicinity, orientation etc.,
2. **Geometry**, with potential parameters like: shape, distance etc.,
3. **Topography**, with potential parameters like: elevation, slope, drainage etc.,
4. **Geology**, with potential parameters like: shore type, beach rocks, dunes, deltas, tectonics etc.

Beyond the previous preconditions and in order to convert reliably (coastal) data into (coastal) information, during the planning/exploring/monitoring process, an indicator (of Pressure or State type, according to the DPSIR framework) should fulfill the following general requirements:

a. be clearly defined,
b. be representative, relevant and reliable,
c. be easy and inexpensive in measuring and
d. be grounded on scientific theory and be applicable into future policies.

Moreover, a new coastal indicator is preferable to: α) be flexible enough, in order to supply the possibility of a future improvement and β) have the ability to support the building of a new coastal typology.

During the last decade, a number of new indicators have been introduced, after team work at the Spatial Analysis Laboratory of Technological Educational Institute of Athens. 'Vicinity' and 'Ideal Shoreline' are some of them, belonging to the first period. More recently, the indicators 'Anthropogenic Intensity' and 'Coastality' have been proposed. [Kioussopoulos, 1997; Kiousopoulos, 1999; Kiousopoulos & Lagkas, 2005; Kiousopoulos, 2008a; Kiousopoulos, 2008b; Kiousopoulos et al., 2008; Kouki et al., 2008].

4. Anthropogenic Intensity

4.1 The concept

Coastal areas attract a big variety of human activities. The last ones, as they are expressed by the (coastal) land uses, impact the natural coastal environment in an unpredictable (and more or less aggravating) degree. Anthropogenic Intensity[1], (AI), aims to answer the question "How intense are the human activities along a coastal area?" and consequently to become a feasible tool to assess all the human activities along a specific coast, at a time. In this context, Anthropogenic Intensity provides information about the amount of human intervention on a studied coastal area, by measuring the man-made "volume" of the building and all the anthropogenic constructions.

Until the beginning of 2010, this indicator has been studied only in relation to the terrestrial part of the coastal areas.

The geographic scale (that affects the size of the studied coastal area) has been chosen to be closer to the local level of (spatial planning) approach. The landward edge of a coastal area

[1]In all the past books, paper and other publications of the author, this indicator was named Anthropogenetic Intensity', but from this text onwards it is renamed 'Anthropogenic Intensity'.

is decided to be at a distance no longer of 10 km from the shoreline, a well-accepted limit in the ICZM projects and the European Union related paradigms of good practice.
The methodology contains, first of all, the recognition of polygons or pixels with single (or one dominant) land use (or land cover) and the same height of connected man-made constructions of any type. Additionally, a full detailed scheme with all the observed land uses should be available, plus a (a priori) quantitative estimation of the impact of each of them on the environment. It is recommended that the previous scheme to be supplemented with the (estimated/supposed) heights of the man-made constructions for each observed land use/cover. These heights values can be used alternatively to the observed real ones.
Common and very suitable sources of data are satellite images, but other sources can be used, as well. Furthermore, this indicator is depended, mainly, on digital data and sources.

4.2 Formula & comments

At a first level of approach, every polygon or pixel with (observed) single land use (or land cover) is represented by its surface, (s). Secondly, the man-made constructions height, (h), on each area-unit (polygon or pixel) is a critical size that is also implicated. Next, weights, (w), for each land use are used to express the real human impact on the coastal space as the result of each observed land use. With these parameters, Anthropogenic Intensity (AI) can be calculated according to the following formula (1), for a coastal area with total surface equal to S.

$$AI = \frac{\sum_{1}^{n} s_i \cdot h_i \cdot w_i}{S} \tag{1}$$

At a more thorough approach, in order to further correlate the man-made impact with the distance from the shoreline (D), this distance (as it is expressed by the integer part of the related value in km) is involved into the formula. The influence of D is minimized gradually, from the shoreline to the landward coastal area limit (here: 10 km from the shoreline). This approach leads to the calculation of the Anthropogenic Intensity, (AI), with the alternative (and more specified) formula (2):

$$AI = \frac{\sum_{1}^{n} s_i \cdot h_i \cdot w_i \cdot \left(1 - 0{,}1 \cdot \operatorname{int} D_i\right)}{S} \tag{2}$$

where: s_i: area of each polygon/pixel with single land use/cover and the same height of man-made constructions,
h_i: the height of man-made constructions, in each polygon/pixel, in meters,
w_i: weights for each land use/cover,
int D: the integer part of the distance (D, in km) from the shoreline, for each polygon/pixel,
S: the total area of all the polygons/pixels (the total coastal area under examination), in the same unit as s_i.

Anthropogenic Intensity, (AI), is expressed in meters and this value depicts the "mean height" of buildings and all other constructions on a coastal area, at a time.
The value AI = 0 m (zero meters) indicates a pure natural coastal environment, without any man-made invasion.

The version (1) is built without the Distance component. It means that there is no importance where exactly (how far away from the shoreline, but inside the studied coastal area) each land use/cover is located. According to this version, all the AI values are positive.
The version (2) is built with the Distance component. It means that there is great significance where exactly (how far away from the shoreline, but inside the studied coastal area) each land use/cover is located. According to this second (full) version of the Anthropogenic Intensity formula, all the AI values are positive inside a coastal zone of 10 km.
The version (2) can be operationally useful, even in the case of a coastal area with 'Width'[2] greater than 10 km, in two ways. Firstly, by an appropriate change of the formula (2), where another suitable constant value is put instead of the constant '1' (that corresponds to 10 Km). Secondly, by using the same formula without change. In this case, the addition of area-units (polygons/pixels) with man-made constructions (in distances greater than 10 km from the shoreline) generates AI' values gradually smaller. That is reasonable as the added man-made constructions are not so close to the sea, so, the (indirect) impact on the studied 10 km coastal area becomes relatively smaller. Only in this last case, the AI' values could be possibly negative.
For coastal zones with 'Width' less than 1 km, the two versions of the AI formula are practically the same.
Anthropogenic Intensity, (AI), reveals the degree of economic activities, the intensity of land uses and the total stress caused by mankind along a delimited coastal area. So, it could be an appropriate tool for exploring and monitoring a coastal area, in the context of environmental management.
But the most important and valuable advantage can be arisen from the differences of values at the same coast at two different times or at different coasts the same time. The size of these differences could be used as an alert to activate already established coastal policy's mechanisms.

4.3 Anthropogenic Intensity's case studies

In order to test the new indicator, numerous case studies have been implemented along the Hellenic coasts, from 2006 to 2007. The following three places of the continental part of Hellas have been selected (see Fig. 1):

1. NAFPAKTOS,
2. KYPARISSIA,
3. PREVEZA.

These places have been decided in order neither to be in the islands (where the coastal phenomena are very strongly dominated by only one land use, tourism) nor to be very populated (because of the special prevailing conditions in the urban areas, which maybe deteriorate the coastal characteristics).
The maximum studied coastal area surface in each region is: 185,4 sq. km (I, NAFPAKTOS), 10,2 sq. km (II, KYPARISSIA) and 137,2 sq. km (III, PREVEZA). Smaller territorial parts have

[2]The indicator 'Width' or 'Depth', (B), of the land part of a coastal area is used to depict how far away from the shoreline the terrestrial part of the examined coastal area exceeds, if the coastal area is supposed to be a zone with single width. A small value of B means that the coastal area has a relatively extensive waterfront and thus there is a high interaction between the marine and the (narrow) land part. A high value of B shows that the examined coastal area exceeds far away from the shoreline, landward, so limited coastal phenomena can be recognised there. [Kiousopoulos, 2008b].

been studied, too, by choosing different 'Width' in the same coastal area. In this way, 19 values of the new indicator have been calculated. (see Table 4).

INDICATOR NAME / SYMBOL	Anthropogenic Intensity / AI
GENERAL OBJECTIVE	The quantitative calculation of human impact on a coastal area, in a given time, via the measurement of the height of all the man-made constructions, in relationship to the distance from the shoreline.
FORMULA	$AI = \frac{\sum_{1}^{n} s_i \cdot h_i \cdot w_i \cdot (1 - 0{,}1 \cdot \text{int} D_i)}{S}$
VALUE RANGE	Relatively small positive real numbers expressed in meters, included zero value. (Negative values are possible only if something like this is designed).
MEASUREMENT FREQUENCY	Every 5 or 10 years, according to source availability.
METHODOLOGY – SOURCES	Polygon/pixel delineation for each land use upon digital maps, orthophotographs etc.
ADDITIONAL NEEDS	Formation of land uses/covers classification scheme. Decision on weight factors per land use/cover. (Estimation of constructions' heights.)
AVAILABILITY OF SOURCES	Relatively high.
APPLICATION SPATIAL LEVEL	Local and only along the terrestrial part, until today.

Table 2. Anthropogenic Intensity in brief.

Fig. 1. Map of Hellas (Greece) with the locations of the three AI case studies (Nafpaktos, Kyparissia and Preveza) and the location of the one Coastality case study (Milies).

The maximum values of 'Ideal Shoreline'[3] for the three studied main coastal area are: 21,0 km, 13,8 km and 19,0 km, accordingly.
Throughout the 19 case studies, three schemes of land use/cover classification have been used. One of them is shown in Table 3 (it is this of type 'A' in Table 4).
The coastal areas of Nafpaktos and Preveza have been studied in two different points of time, each of them, as it is explained by the code in the left column of Table 4.

LAND USES	**HEIGHT, H**	**WEIGHT, W**	**h * w**
ARABLE LAND / PASTURES	1,0	0,5	0,5
FRUIT TREES	3,0	0,5	1,5
FORESTS	10,0	0,0	0,0
INDUSTRIAL AREAS	15,0	5,0	75,0
SMALL INDUSTRIES / WAREHOUSES	8,0	4,0	32,0
MINES / QUARRIES	5,0	5,0	25,0
HIGHWAYS	5,0	5,0	25,0
NATIONAL ROADS	4,0	4,0	16,0
SECONDARY / RURAL ROADS	3,0	3,0	9,0
FOREST ROADS	3,0	2,0	6,0
RAILWAY NETWORK	5,0	2,0	10,0
PORTS	10,0	4,0	40,0
AIRPORTS	10,0	5,0	50,0
ENERGY NETWORKS	15,0	2,0	30,0
MANAGEMENT OF WASTES	3,0	4,0	12,0
BIG CITIES [> 100.000 residents]	25,0	3,0	75,0
CITIES [> 10.000 residents]	15,0	2,5	37,5
TOWNS [> 2.000 residents]	8,0	2,0	16,0
VILLAGES [< 2.000 residents]	5,0	1,5	7,5
UNDER POPULATED (SPRAWLING) AREAS	5,0	1,0	5,0
ISOLATED BUILDINGS	10,0	2,0	20,0
TOURISM DEVELOPMENTS	10,0	2,0	20,0

Table 3. Indicative scheme (type A, see Table 4) of observed land uses, the pre-supposed heights of the related constructions and the chosen weights. [Kiousopoulos, 2008a].

In Fig. 2, the results for Nafpaktos study area in two times (1985 and 2007) are illustrated. For the first case (1985), 5 aerial photos (30cm * 30cm, scale 1:6.000) from the Hellenic Mapping & Cadastral Organization were used. For the year 2007, 5 satellite images from Google Earth were used. In both cases, Anthropogenic Intensity is calculated by using the version (1) of the AI formula.
In Fig. 3, four results in the coastal area of Kyparissia are illustrated, produced by choosing different 'Width' of the examined coastal zone (0,5 km, 1 km, 2 km and 5 km).

[3]The indicator 'Ideal Shoreline' refers to a delimited coastal area and it is defined as the straight distance between the two end points of the related shoreline, in the waterfront. In cases of an island, 'Ideal Shoreline' is equal to the length of a circle's perimeter that has area equal to the area of the island. 'Ideal Shoreline' is a numeric quantity expressed in length units. [Kiousopoulos 2008b].

Fig. 2. The study area and the results of AI case studies in a zone (with Width equal to 2 km), in Nafpaktos, during two different times, 1985 and 2007. (See Table 4, codes: nI/85&nI/07).

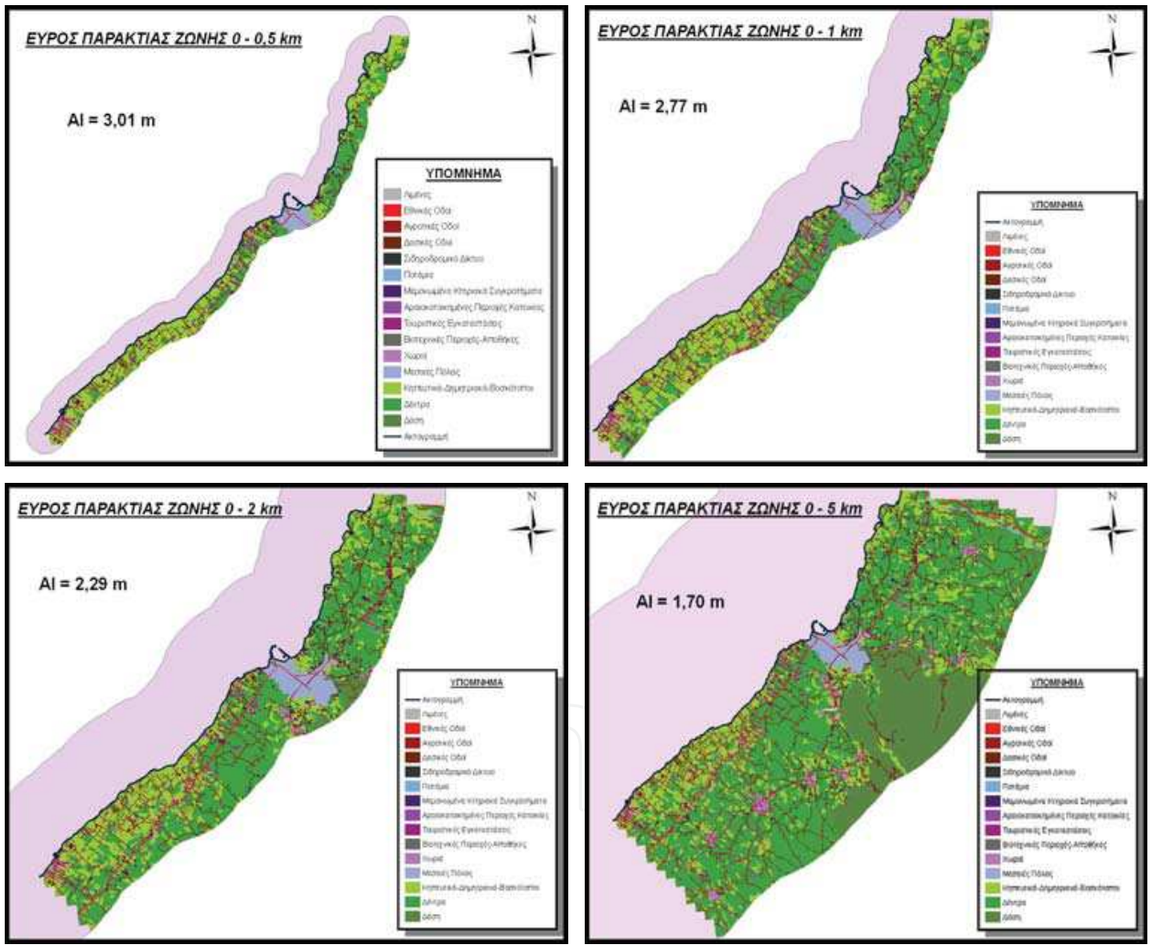

Fig. 3. The area and the results in four cases (with different 'Width') in KYPARISSIA, at the same time, 2007. (See Table 4, codes: kII/07, kVII/07, kVIII/07 & kIX/07).

The results and the related specifications of all the AI' case studies are demonstrated in Table 4. The case studies have been realised with different specifications, in order the formula been tested under dissimilar conditions. So, the results cannot be fully compared, but it is obvious that the new indicator works! E.g. in a very narrow coastal zone near the

shoreline (where the human stress is big), the AI value is big. In a coastal zone with relatively big 'Width' (where the human stress becomes relatively smaller), the AI value is small.

COASTAL AREA, CODE	COASTAL ZONE (LANDWARD) LIMIT (km)	SCHEME OF LAND USES/COVERS	VERSION OF AI' FORMULA	TOTAL SURFACE (km^2)	'IDEAL SHORELINE' LENGTH (km)	AI VALUE (m)
ΝΑΥΠΑΚΤΟΣ, nI/85	0 - 2	A	*(1)*	4,2	5,2	4,10
ΝΑΥΠΑΚΤΟΣ, nI/07	0 - 2	A	*(1)*	4,2	5,2	8,70
ΝΑΥΠΑΚΤΟΣ, nII/07	0 – (12)	B	*(1)*	185,4	21,0	1,41
ΚΥΠΑΡΙΣΣΙΑ, kI/07	0 - 10	B	*(1)*	100,2	13,8	1,66
ΚΥΠΑΡΙΣΣΙΑ, kII/07	0 - 0,5	B	*(1)*	11,4	13,8	3,01
ΚΥΠΑΡΙΣΣΙΑ, kIII/07	0,5 - 1	B	*(1)*	11,2	(13,8)	2,53
ΚΥΠΑΡΙΣΣΙΑ, kIV/07	1 - 2	B	*(1)*	19,1	(13,8)	1,73
ΚΥΠΑΡΙΣΣΙΑ, kV/07	2 - 5	B	*(1)*	50,1	(13,8)	1,21
ΚΥΠΑΡΙΣΣΙΑ, kVI/07	5 – (10)	B	*(1)*	8,5	(13,8)	1,27
ΚΥΠΑΡΙΣΣΙΑ, kVII/07	0 - 1	B	*(1)*	22,5	13,8	2,77
ΚΥΠΑΡΙΣΣΙΑ, kVIII/07	0 - 2	B	*(1)*	41.7	13,8	2,29
ΚΥΠΑΡΙΣΣΙΑ, kIX/07	0 - 5	B	*(1)*	91,8	13,8	1,70
ΚΥΠΑΡΙΣΣΙΑ, kX/07	0 – (10)	B	*(2)*	100,2	13,8	1,16
ΠΡΕΒΕΖΑ, pI/60	0 - 8	Γ	*(1)*	137,2	19,0	1,16
ΠΡΕΒΕΖΑ, pII/60	0 - 2	Γ	*(1)*	40,3	9,1	1,20
ΠΡΕΒΕΖΑ, pI/07	0 - 2	Γ	*(1)*	18,2	9,2	1,93
ΠΡΕΒΕΖΑ, pII/07	0 - 1	Γ	*(1)*	14,2	9,2	2,20
ΠΡΕΒΕΖΑ, pIII/07	1 - 2	Γ	*(1)*	4,0	(9,2)	0,97
ΠΡΕΒΕΖΑ, pIV/07	0 - 2	Γ	*(2)*	18,2	9,2	1,91

Table 4. The specifications and the results of the Anthropogenic Intensity case studies. [Kiousopoulos, 2008a].

5. Coastality

5.1 The concept

Coastality is not a common term. It is very rarely used [Plane, 2005]. The majority of dictionaries and glossaries do not contain the entry 'coastality'. But, according to the more probable etymological explanation, it seems to express the proximity to the sea and maybe the quality of living next to the seashore.

In our research, the term Coastality (C) has been chosen, since 2005, as the name of a new indicator aiming to answer the question "How coastal is a coastal area?". In this way, Coastality intends to identify and to assess the coastal characteristics (of the terrestrial part of a coastal area, at local level) that originate from the "proximity to the sea".

So, first of all, Coastality needs to represent all the important sub-indicators that are able to describe correctly and completely the coastal characteristics, at local level. Beyond this rather qualitative goal, one other rather quantitative must follow, the finest formulation of the related mathematical formula.
Concerning the first very ambitious target, Coastality can reach it by a bidirectional approach that distinguishes the natural from the man-made characteristics of a coastal area. These two directions configure the two components of Coastality, (C), the Natural Coastality, (nC), and the Artificial Coastality, (aC).
The natural-abiotic features, that attract people near the seashore, belong to the Natural Coastality that aims to incorporate the so named supply of a coastal area.
On the other hand, the aim of Artificial Coastality is to incorporate all the expressions of human impact along the same coastal area, i.e. the demand for coastal space, but in a different way than AI indicator does it.
Each of these components can be manipulated in order to give values from '0' (zero) or 0% to '1' (one) or 100%. As a result, Coastality can be the sum of the two components' values and the C value will fluctuate (theoretically) from '0' (zero) to '2' (two).
An alternative idea is to keep the two values separately and in this way, Coastality will be expressed by two numbers, or percentages, the first referring to the Natural Coastality and the second referring to the Artificial Coastality e.g. '0,8 – 0,4' or '80% - 40%'.

5.2 Potential parameters and provisional formula

Until the beginning of 2010, the following approach of Natural Coastality and Artificial Coastality is the background of the ongoing related research (see Fig. 4):
1. **Natural Coastality**. It aims to determine the attractiveness of the natural coastal environment by measuring the following two sub-indicators:

- **Coastal Feeling**. It is generally accepted that the coastal feeling depends mainly on the distance from the shoreline. The altitude, the orientation, the geological forms and of course the landscape are some other significant parameters. Beyond this, other factors as psychology, legislation restrictions, safety etc. can change the Coastal Feeling from place to place and from time to time.
  The meaning of feeling is not very familiar to a regional planner, but according to the more common approaches, 'feeling' is: a) a particular sensitivity, b) the capacity of the soul for an emotional state, c) a particular emotional reaction (an 'atmosphere'), d) the general atmosphere of a place or of a situation, e) the general emotional response produced by a work of art, piece of music, a view at a landscape.
  According to another, more technical definition, feeling is "*the sense by which the mind, through certain nerves of the body, perceives external objects or certain states of the body itself; that one of the five senses which resides in the general nerves of sensation distributed over the body, especially in its surface; the sense of touch; nervous sensibility to external objects*". In this approach we can distinguish some fundamental characteristics as the following: 1) there is an initial cause, the 'external objects or certain states', 2) there is a special situation because of the cause and 3) there is an impact on '*one of the five senses*'.
  On the other hand, the experience of being near the sea incorporates the following fundamental factors:
  a. Cause. The sea, the eternally moving water, the sea-land interaction etc.
  b. Special situation, as the space-infinite views of sea and sky, the calming nature but the storms and high tides, too, watching the ships etc.

c. Impact on one of the five senses. It is obvious that somebody can see, hear, smell, taste and touch the sea depending on parameters such as: a) the distance from the shoreline, b) the inclination of the territorial part of the coastal area, c) the amount of visible sea surface, d) the distance of the visible sea surface; it is close or far away from the land, e) the general annoyance that caused from the non natural, the man-made environment, the number of people being around, near the seashore etc. [Kiousopoulos 2009].

- **Sea Visibility**. It refers to the possibility to see the sea from a place (area-unit) of the terrestrial part of a coastal area. Additionally, this indicator can depend on the possibility to see the shoreline, too. The main methodological issue is to calculate how much (%) of the sea surface or the shoreline length is visible from each area-unit of the terrestrial part. So, it can be expressed as a percentage or, alternatively, with an angle. A small percentage or angle means a small value to the Sea Visibility sub-indicator.

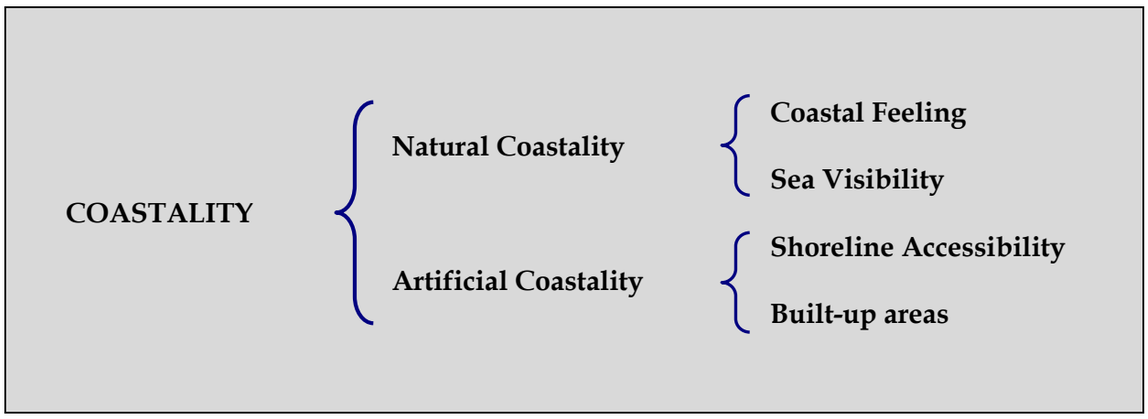

Fig. 4. The structural framework of Coastality.

2. **Artificial Coastality**. The objective is to express the size of the mankind impact on a coastal area, but in a different way from that used in the case of Anthropogenic Intensity indicator. Shoreline Accessibility via all means of transportation and the percentage of Built-up Areas within the terrestrial part of the coastal areas are the two sub-indicators, which will be used to give the Artificial Coastality value.

- **Shoreline accessibility**. It deals with the ability of a coastal area to accept massive flows of people, both from sea and land. It takes into account all means of transportation and all kind of "roads", pathways included. Probably, weights will be given concerning the carrying capacity and the scheduled intensity of itineraries of each means of transportation.
- **Built-up Areas**. It refers to the expansion of build-up areas as it is expressed by the percentage of the terrestrial part of the coastal area that is built-up and also it takes into consideration all kinds of human constructions. Opposite to the Anthropogenic Intensity indicator, this sub-indicator is not connected to the height of constructions, but only to their sprawl, to their spatial expansion.

According to the previous analysis, the formula of Coastality of a coastal area can be configured as following:

$$C = nC + aC = (\alpha \cdot c_f + \beta \cdot V) + (\gamma \cdot s_a + \delta \cdot b_a) \quad (3)$$

where: C, nC, aC: Coastality, natural Coastality, artificial Coastality,
c_f, V: Coastal Feeling, Sea Visibility,
s_a, h_a: Shoreline Accessibility, Build-up Areas,
α, β, γ, δ: coefficients.

Actually, Coastality value of a coastal area is the mean value of the related values of each point (area-unit) of the examined coastal area. Nevertheless, the formula (3) is not totally clarified, as the sub-indicators must be defined precisely and the coefficients must be thoroughly chosen.

INDICATOR NAME / SYMBOL	**Coastality / C**
GENERAL OBJECTIVE	Research on the properties which form the coastal identity. This initial aim is transformed to the aim of separate formulation of Natural Coastality (as an expression of the existing natural abiotic resources) and of Artificial Coastality (as an expression of the human impact on the coastal space).
FORMULA	$C = nC + aC = (\alpha \cdot c_f + \beta \cdot V) + (\gamma \cdot s_a + \delta \cdot b_a)$
VALUE RANGE	0,0 – 1,0 or 0% - 100% for each component.
MEASUREMENT FREQUENCY	Every 5 or 10 years, according to source availability.
METHODOLOGY – SOURCES	Specialized research studies to calculate Natural Coastality. Use of current statistics for the calculation of Artificial Coastality.
ADDITIONAL NEEDS	Full clarification of Natural Coastality and Artificial Coastality. Full definition of the implicated coefficients. Full description of the mathematical formula. Case studies with the Coastality components.
AVAILABILITY OF SOURCES	Not plenty.
APPLICATION SPATIAL LEVEL	Local at the present phase.

Table 5. Coastality in brief.

Coastality is a complex indicator which intends to evaluate coastal areas according to two components, referring both the natural and to the man-made coastal environment.
Still yet (beginning of 2010) the research interest is focused on the Natural Coastality, as it is believed that it is more difficult to be determined and calculated. So, a theoretic approach about 'Coastal Feeling' has been designed [Kiousopoulos, 2009] and a case study related to the Sea Visibility has been developed. [Kiousopoulos & Stathakis, 2009].

5.3 Sea visibility's case study

Visibility can be determined in many ways. In the framework of this case study, the notion of Sea Visibility (V), from the land part to the marine part of a coastal area, incorporates the following two factors, i) visibility to the shoreline (Vc) and ii) visibility to the sea (Vs). The values of both the factors represent the percentage of the shoreline or the sea (belonging to

the examined coastal area), accordingly, that are visible from each terrestrial location (area-unit).

The maximum value is '1' (one) or 100%, for each of the factors. Thus, the maximum value of Sea Visibility indicator is '2' (two). This value will be further transformed (during the Coastality calculation), in order the Natural Coastality value to have maximum value equal to '1' (one).

Also, for the present case study, the (initial) form of the Sea Visibility sub-indicator, for each area-unit is:

$$V = [V_C + V_S] \tag{4}$$

Two parameters have been added in the above formula, to incorporate the more probable reasons that eliminate the visual emotion/pleasure to the sea and the shoreline. The first one is the Distance, (D), from the shoreline to each examined area-unit of the coastal area terrestrial part. The second is the combination of distance and altitude, namely the Inclination, (z), of each examined area-unit. Both of them are incorporated into the formula according to the following rules:

- It is accepted that D is inversely proportional to the Sea Visibility and the produced emotion/pleasure. Indeed, the largest the Distance is, the smaller the Sea Visibility value is. So, the following admissions have been adopted: a) on the shoreline, the indicator V has the biggest value, this of formula (4), and b) in a distance equal to the double of the 'Width' (B) size, the value of the indicator V becomes equal to '0' (zero). Alternatively to this limit, an ad hoc limit (e.g. 10 km) can be used as the edge beyond which Sea Visibility values become equal to '0' (zero).
- The value of (z) is the slope of the ground at each examined area-unit of the coastal area. One more admission is that the contribution of this parameter should be neutral for slopes equal to 10% (z=0.1 or an approximate 5.7° angle). Additionally, as the value of (z) deviates (above or below) from the 10% set, this acts negatively to the Sea Visibility value. In other words, slopes other than the 10% are associated with a negative impact on Sea Visibility possibility, the produced emotion/pleasure and the general coastal attractiveness. The value of V becomes equal to '0' (zero) due to excessive slope (47.7° angle).

Consequently, during this case study, the formula for calculating Sea Visibility of a coastal area is the following:

$$V = \sum_{1}^{n} \frac{\left[V_C + V_S\right] * \left[0{,}5 + \left(B - D\right) / 2B\right] * \left[1 - \left|z - 0{,}1\right|\right]}{n} \tag{5}$$

The municipality of Milies, part of the prefecture of Magnesia, Hellas, is selected to serve as the case study area (Fig. 1). Its area is 63.8 sq. km and its 'Width' equal to 7,1 km. Beyond to be coastal, this municipality is quite inhomogeneous, in terms of geomorphologic characteristics. Altitude, for example, ranges from the sea level to as high as 1500 meters. Simultaneously, a variety of slopes can be observed there.

The case study is based on the construction of suitable cartographic layers in a geographical information system. The work is based on the raster structure as it is more suitable for modelling. Sea Visibility is estimated for each location in the study area. The basic data are the contour lines, at an interval of twenty meters. The source of the contours is topographic

maps, at a scale of 1/50.000. A ten meters resolution Digital Elevation Model (DEM) is created based on the contour lines. A shaded relief is derived from the DEM to facilitate the comprehension of ground topography. The slope at each location (area-unit) is also derived based on the DEM.

Finally, Sea Visibility is estimated for each location within the municipality of Milies, based again on the DEM. Sea Visibility is calculated based on the creation of straight lines that connect each location to each of the points of interest (sea and shoreline). Subsequently, it is determined whether each line crosses the relief or not. In order to differentiate between locations that have a more open view towards more points of the shoreline or of the open sea, the number of visible points is summed. Consequently, it is not only a matter of the shoreline or the sea being visible from a particular location or not. An estimation of the quantity of the Sea Visibility is also calculated. As an upper bound, the distance of 10 km is set. Passed the 10 km limit, it is assumed that visibility is practically '0' (zero). The value set, i.e. 10 km, is subjective but within reasonable bounds, as it is already mentioned (see section 4.1).

Fig. 5. The cartographic output of the Sea Visibility case study (Milies, Hellas, 2009). On the left, the spatial results of Visibility to the shoreline are illustrated. In center, the spatial results of Visibility to the sea are illustrated. On the right, the spatial results of Sea Visibility as the sum of its two factors are illustrated.

	V minimum value	**V maximum value**	**V mean value**	**Standard deviation**
Distance, D (km)	0	9.02	3.76	2.12
Ground slope, z (tanz)	0	1.67	0.36	0.20
Visibility to the shoreline, Vc	0	1	0.19	0.26
Visibility to the sea, Vs	0	1	0.50	0.21
Sea Visibility, V	0	1.1	0.41	0.26

Table 6. The Sea Visibility case study results (Milies, Hellas, 2009).

A synopsis of the results of the case study is shown in Fig. 5 and in Table 6. In general, the introduced sub-indicator (Sea Visibility) has been calculated without significant problems. All needed data for calculating this indicator are widely available. The final value of Sea

Visibility, concerning municipality of Milies, is equal to 0,41. It is a rather small value, as the Sea Visibility values fluctuate between '0' (zero) and '2' (two).
What is more interesting is the actual use of the indicator introduced. If we can successfully summarize the effect of Sea Visibility in a single value, this paves the way for establishing a typology. The coastal areas can then be classified according to this parameter. It is probably more meaningful to imaging that administrative units or other not autonomous coastal areas can be characterized by this value. The way forward would then be to use the typology as a means to study spatial tensions as Sea Visibility is a major factor attracting human activities.

6. Discussion

Coastal areas are considered as a common good that need to be protected. At the same time, the unstopped natural processes and the very lucrative human activities in this interface between the land and the sea have as result an unstopped transformation of the coastal space. Exploring and managing a dynamic area (as a coastal space is) are very difficult and complicate issues.
The two proposed new indicators do not annul the existed ones. Both, Anthropogenic Intensity and Coastality can act in a supportive and a collaborative manner to accomplish a more precise visualisation of the coastal space.

	CRITERIA / REQUIREMENTS (see 3.2)	ANTHROPOGENIC INTENSITY	COASTALITY
o	Spatial notion	* * * *	* * * * *
o	Local identity	* * * * *	* * * * *
o	Related to total human impact	* * * *	* * *
i.	Exploring and monitoring the coastal areas	* * *	* *
ii.	Enriching spatial planning, in general	* * * * *	* * * *
iii.	Supporting all the involved stakeholders	* * * * *	* * *
iv.	Scientifically robust and useful for governance	* * *	* *
1.	Position	* * * *	* * * *
2.	Geometry	* * *	* * * *
3.	Topography	*	* * * *
4.	Geology	--	*
a.	Clearly defined	* * * *	no, still yet
b.	Representative, relevant and reliable	* * *	* * *
c.	Easy and inexpensive in measuring	* * *	*
d.	Grounded on scientific theory & applicable policies	* *	*
α.	Possibility of future improvement	* * * *	* *
β.	Ability to build a new coastal typology	* * * * *	* * *

Table 7. The new indicators assessment, according to the criteria recorded in section 3.2.

Table 7 illustrates, separately for Anthropogenic Intensity and Coastality, the degree of satisfaction for each criterion mentioned in section 3.2. Undoubtedly is a subjective opinion. A scale of 0-5 stars is used.

Anthropogenic Intensity, (AI), fulfils the majority of the criteria. Indeed, it is of pressure type (according to the P-S-R framework) and it incorporates the spatial notion as it is familiar with parameters like distance and surface. It is able to illustrate with accuracy the local identity. It seems to be very functional for planners, authorities and other stakeholders, as it can provide the total human impact on a coastal area, at local level.
AI is clearly defined with a high degree of representatively and reliability. Based on the case studies, AI has been proved quite easy and inexpensive to be measured. Moreover, because of the previously mentioned advantages, Anthropogenic Intensity can support the building of a coastal typology for small coastal areas (local approach) and in this way it can help the reasonable building of a coastal policy.
Coastality, (C), is not yet fully defined, but it is believed that it can be a very interesting new indicator. The till now related research is very encouraging. Indeed, it incorporates the spatial notion, much more than AI does it. In this way it could be functional for planners and stakeholders, in general. Both the Coastality components can be independent and in this way they can contribute separately to a new typology of coastal areas. It is obvious that everything about Coastality sustains upon the future clarification of the related mathematical formula (3).
The formula used to estimate **Sea Visibility** (V) might be improved in the future by incorporating more parameters or by combining the available parameters in a different way. An important finding of related case study is that the proposed method can be easily applied to similar case studies, preferably in a diverse range of relief formations. This would permit to gain a better insight on the actual meaning of the parameters examined on the ground. An auxiliary method could be to estimate V values for several virtual coastal areas that have ideal shapes.
It is noticeable that indicators like Anthropogenic Intensity and Coastality do not exist nowadays. Both of them are able to support the exploring (with the meaning of analysis) and the monitoring process along the coastal areas in the framework of environmental management. In addition, as they are strongly related to the spatial notion, they are able to make certain several coastal phenomena that they are not yet detectable.

7. Conclusion

The management of the coastal space confronts with the continuous need of reliable data.
The two new indicators support the sustainable ICZM with attention to all coastal space aspects, geomorphology included. Both of them could be in a list of more or less 25 indicators suitable for exploring and monitoring the coastal space.
The ability of Anthropogenic Intensity to be useful for spatial planning procedure and coastal environment management, in general, has been proved. This indicator is suitable to estimate with big precision the total human impact of coastal space.
Further research for specifying the Coastality indicator is needed. The usefulness of Artificial Coastality is obvious and rather easy to be recorded. Natural Coastality could be a very worth instrument (e.g. for real estate market), even if it is yet quite complicated to reach its end definition. Indeed, Natural Coastality could become at local level the representative indicator-identity for a coastal area.
The future research concerning these indicators should attempt to reach a broaden knowledge. Above all, Anthropogenic Intensity and Coastality should try to:

- be adjusted to different geographical scales,

- be adjusted in different areas such as: a) islands and b) lake and river regions
- be adjusted in non Hellenic coasts,
- study the incorporation of parameters for floods, tide phenomena etc.,
- support a new integrated coastal typology.

A very ambitious plan is to look for other (alternative) ways, in the field of spatial planning instruments and methodologies (beyond the present indicators), in order to assess the human impact on the same coastal area. In this way, it is possible to compare the AI results with another "reality".

Alternatively, a less ambitious but tangible objective is the comparison of the values of Anthropogenic Intensity and Artificial Coastality for the same coastal area. This comparison can act as an evaluation test for both the new indicators.

Even more interesting could be the comparison (concerning the same coastal area) of the difference between the Anthropogenic Intensity values during two times, with the difference between the Artificial Coastality values during the same two times. The potential "equal" alteration is obviously a proof that the two new indicators are really valuable.

8. Acknowledgements

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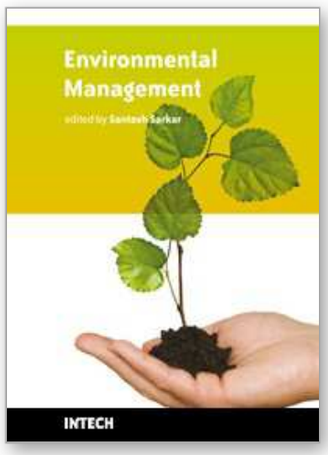

Environmental Management

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There has been a steady increase in anthropogenic pressure over the past few years due to rapid industrialization, urbanization and population growth, causing frequent environmental hazards. Threats of global environmental change, such as climate change and sea level rise, will exacerbate such problems. Therefore, appropriate policies and measures are needed for management to address both local and global trends. The book 'Environmental Management' provides a comprehensive and authoritative account of sustainable environmental management of diverse ecotypes, from tropical to temperate. A variety of regional environmental issues with the respective remedial measures has been precisely illustrated. The book provides an excellent text which offers a versatile and in-depth account of management of wide perspectives, e.g. waste management, lake, coastal and water management, high mountain ecosystem as well as viticulture management. We hope that this publication will be a reference document to serve the needs of researchers of various disciplines, policy makers, planners and administrators as well as stakeholders to formulate strategies for sustainable management of emerging environmental issues.

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