Journal of Mediterranean Ecology **vol. 10, 2009: 5-11**

Methods for the sustainability evaluation of coastal zone

Fabiano M.*, Marin V. *, Paoli C. *, Vassallo P. *

** Department for the study of territory and its resources.*
Corso Europa 26, 16132 Genova, Italy, fabianom@unige.it

Key words: Mediterranean coast, Emergy, Ecological footprint, WG-ID indicators, ICZM, DEDUCE

Abstract

Coastal zone sustainability is a key issue frequently expressed in vague terms. In this paper, we describe the state of the art of methods commonly applied for the evaluation of coastal zone sustainability at European level and we suggest innovative techniques adopting a whole system approach. Sustainability is in fact here defined as an emergent property, thus requiring a whole system view to be addressed and interpreted.

Introduction

A unique and shared definition of coastal zone does not exist and it has been defined in a number of different ways. The most employed approach is to consider the coastal zone as a transition area that includes portions of land and sea of different sizes, in relation with the natural environment taken into consideration and on the specific need of the management actions foreseen. European community recognized coastal zone as the resulting environment from the coexistence of two margins: coastal land defined as the terrestrial edge of continents, and coastal waters defined as the littoral section of shelf seas. Together they constitute a whole, which needs a specific methodological approach and dedicated management methods (EEA, 2006a).

It is well known that the coastal zone is one of the areas which hosts among the highest environmental diversity, both in terms of physical, geomorphologic and biological features. Furthermore, some of the most productive natural ecosystems are located in this thin strip area between land and sea. However, this precious and unique natural heritage is nowadays heavily threatened both by natural hazards and human pressures. In fact, more than a half of the world population lives in the area comprised within 200 kilometres of the coastline, which constitutes approximately just the 20% of the total earth's land area (Belfiore, 2003). Moreover, in many countries, coastal population growth rates are higher respect to the inland (Sorensen, 2002). Consequently, coastal areas are subjected to a wide and diverse range of human impact generated by the numerous activities which depend directly and indirectly on them. Urbanisation and related wastewaters management problems, industrialization and related emissions of chemical pollutant, fishing activities and aquaculture development, tourism and the consequent increasing of pressures on coastal resources are just some of the main stresses induced by men on coastal ecosystems. The picture results more complex considering that coastal areas often also suffer from the effects of activities carried out in inland areas far away from the coastline.

As a result, coastal zones can be considered the areas in which demographic, economic and environmental pressures reach their maximum levels (Henocque and Denis, 2001).

The close interdependency between human activities and environmental resources is the main reason why conventional management policies failed addressing complex issues specific of coastal areas (Chua, 1993). This awareness brought the international community to give up specific approaches for a whole system perspective (PAP/RAC, 2003). Sustainable development of coasts and oceans should be based on the principles of integrated management of all activities occurring in or effecting coasts and oceans (UNESCO, 2006). The most commonly applied response to this need is the Integrated Coastal Zone Management (ICZM) process. It provides the theoretical key to this issue by promoting an integrated approach that involves all relevant stakeholders and takes a long-term view of coastal zones. Common goals of sustainable coastal and ocean development, pursued by ICZM, have been defined as follows: i) Sustainable development of coastal and marine areas; ii) Reducing vulnerability of coastal areas and their inhabitants to natural hazards; iii) Sustainable well-being of coastal ecosystems; iv) Sustainable quality of life in coastal communities; and v) Improvement of governance processes (Cicin-Sain and Knecht 1998). The role of ICZM as a key paradigm for the sustainable development of coastal zones is no longer to be questioned (Billé, 2007). ICZM attempts to balance the needs of development with protection of the very resources that sustain coastal economy.

Since 1972, the United Nations Conference on human environment (Stockholm) highlighted the need to design and implement environmental protection strategies while promoting equitable economic development. The ideas formulated in 1972 laid the bases for many subsequent gathering, particularly in the first half of the 1990s, on the subject of Integrated Coastal Zone Management. The 1992 Earth Summit of Rio de Janeiro recognised in its Agenda 21 the need for environmental action for oceans and coastlines (Chapter 17), and committed coastal nations to the sustainable development of their coastal areas and implementation of integrated coastal zone management.

The preparatory materials to Agenda 21, particularly the Report from the World Commission on Environment and Development assumed sustainable development as the contextual and integrated pursuit of: 1) ecological integrity; 2) economic efficiency; and 3) social intra- and inter-generational equity (WCED, 1987).

This is one of the many definitions of sustainability that have been proposed in the last three decades (e.g. Glavič and Lukman, 2007; Daly, 1991; Hediger, 1999; Hediger, 2000; Bartelmus, 2003; Bartelmus, 2007). Most of the definitions deal with the multi-sectoral aspect of the sustainability concept and with the need of integration among different approaches (mainly the economic, environmental and social ones). The great variety of definitions, together with the background opacity of the concept itself (Bartelmus, 2003) make sustainability hard to quantify, often incomplete and generally not very convincing. While integration is unanimously reckoned as a primary task, the proposed approaches for sustainability evaluation are mainly focused on specific sectors of interest or based on the determination of indicators sets that are hardly intelligible and thus rarely useful.

Nonetheless, since integration reveals itself as the key concept of sustainability, in our mind a new approach to this issue must be embraced. Sustainability, arising from the mutual interaction of different components is a property of complex human systems that can't be apperceived when the analyzed system is dismantled in its components and the analysis is focused to each sub-system rather than to its wholeness. It is thus possible to consider sustainability as an emergent property of complex systems. Emergent properties can be thought of as unexpected behaviours that stem from interaction between the components of a system and the surrounding environment (Craige, 2001; Müller and Nielsen, 2008).

Sustainability is thus a property of complex systems that can't be approached with a reductionist approach while it can be detected (and understood) through a whole system approach able to identify properties arising from the interaction among sub-systems.

Moreover, when the sustainability issue is tackled, it can't be neglected that sustainable development is a goal focused on a long time scale. This means that a system is a sustainable only when it is able to maintain itself (healthy and integer) on the long run.

How these definitions match with the ICZM one?

The inclusion of ICZM in the Conference on Environment and Development at Rio highlighted the strict relation of this topic with the objective of the sustainable development (Cicin-Sain, 1993). In fact, even if the ICZM approach has been developed with the aim of protecting the functionality of the coastal natural ecosystems, it is not limited to the definition of environmental policies but intends also to improve the economical and social condition of coastal zones (European Commission, 2001). The link between integrated coastal management and the sustainable development was again highlighted in 2002 in the World Summit on Sustainable Development (WSSD) of Johannesburg, when a special attention was given to the need of protecting and managing natural resources as a base for the social and economic development, whit the specific recommendation of "Promote integrated, multidisciplinary and multi-sectoral coastal and ocean management at the national level, and encourage and assist coastal States in developing ocean policies and mechanisms on integrated coastal management" (Cicin-Sain, 2002).

An innovative tool which was used in CAMP (Coastal Area Management Programme) Malta is the "Systemic Sustainability Analysis". It consisted of seminars developed by the members of the different teams allowing them to explore, describe, and assess, in the past, present and future, the level of sustainability of an agreed system, with the help of indicators. It provided a holistic approach, which can be applied locally and has a dynamic character as it takes into account the relations between indicators describing the elements of the system and their interactions (UNEP/MAP/PAP, 2001; PAP/RAC, 2002).

Sustainability of coastal zones in Europe

Many of Europe's coastal zones face problems of deterioration of their environmental, socio-economic and cultural resources. Since 1996, the European Commission has been working to identify and promote measures to remedy this deterioration and to improve the overall sustainability in our coastal zones. Particularly, from 1996 to 1999, the European Commission operated a Demonstration Programme on ICZM designed around a series of 35 demonstration projects and 6 thematic studies, with the aim of providing technical information about sustainable coastal zone management and leading to a consensus regarding the measures necessary to stimulate ICZM within Europe (EC, 1997). The European Commission has proposed and adopted the following definition for ICZM: "a continuous, proactive and adaptive process with the general aim of implementing sustainable development in coastal zones and maintaining their diversity" (EC, 1997). Official announcement of a European Strategy for ICZM was done in September 2000 (EC, 2000). The structure of the EU ICZM strategy and its priorities were determined by the analysis of the EU Demonstration Projects, the thematic studies, and the national responses.

The strategy states that:

- European coastal zones are facing serious problems of habitat destruction, water contamination, coastal erosion and resource depletion.
- There has been a lack of knowledge, inappropriate and uncoordinated laws, a failure to involve stakeholders, and a lack of coordination between the administrative bodies.

The strategy was designed to meet prior commitments to the sustainable management of the coastal and marine area. However, the strategy does not go far enough to have a significant impact as it lacks the force of a legislative framework (Connolly & Cummins, 2002).

In 2002, the European Council and Parliament signed the ICZM Recommendations to encourage action on ICZM within Member States (Recommendation 2002/413/CE). The Recommendations towards the EU Member States propose the formulation of national strategies and measures based on the principles of integrated coastal management, which includes "working with natural processes and respecting the carrying capacity of ecosystems". To support member states in the implementation of the recommendations, in 2003, an EU ICZM Expert Group was set up. The Expert Group, which includes representatives from all 20 coastal Member States and from two Candidate Countries, established a Working Group on Indicators and Data (WG-ID) to advise it on how countries can assess whether they are moving further towards, or away from, a more sustainable future for their coasts. Particularly, the WG-ID was commissioned to draw up a list of indicators and assist in coordinating the definition of the way to calculate them (EEA, 2006b). The WG-ID suggested Member States and Candidate Countries adopt two sets of indicators:

An indicator to measure progress in implementing ICZM (the 'progress indicator').

A core set of 27 indicators of sustainable development of the coastal zone (the 'sustainability indicators').

Used together, the two sets should reveal the degree to which implementation of ICZM can be correlated with progress in achieving sustainable development of the coast (EEA, 2006b).

Aiming at the evaluation of the utility of indicators for optimal decision making on the coast, following the principles and criteria established by the EU Recommandation on ICZM, a trans-national project concerning ICZM was approved (**DEDUCE -** Développement Durable des Côtes Européennes). Nine partners representing all decision-making levels (European, national, regional and local) carried out the project, which ran from October 2004 to June 2007.

The broad objective of DEDUCE was to validate the methodological tools necessary for optimal decision making at the coast. Its main task was to develop the methodology, calculate and validate the WG-ID indicator set at different levels and scales: European, national, regional and local, to measure and monitor sustainable development in coastal zones. The methodological framework developed in DEDUCE included 3 tools for indicator calculation (Standard Indicator Format, Reporting Sheet and Indicators Fact Sheet) and a proposal for a system and format for data storage and communication (DEDUCE Consortium, 2007).

At the end of the project five recommendations were released aiming at a further implementation of the indicator system.

- the indicator list must be improved including

new indicators about not monitored issues and deleting redundant indicators. It is suggested to develop new indicators following the formats proposed during DEDUCE programme.
- indicators' hierarchy should be revised taking into account the model adopted by water framework directive
- to define reference values in sustainability terms in order to characterize the acceptability threshold for each indicator. This could be achieved taking into account the work of Blue Plan and must consider legal requirements
- coastal sustainable development indicator set should be implemented together with the progress indicator on ICZM in order to link sustainability levels with different forms of governance
- to create a coastal European observatory for data gathering and aggregation at the European level.

During 2007 and 2008 some of the authors applied DEDUCE indicator set to a number of study cases along the Ligurian coast (North Western Italy). The application of the methodology, the data gathering process, the data treatment and the results discussion lead to some further evaluation concerning the indicator set and its applicability. In particular, according with the upper recommendations we may report the following statements.

Improvement of indicators' list

The proposed method lacks information regarding the resource consumption and the state of the natural ecosystem. Few indicators are referred to the quantity of natural resources exploited such as the fish landing quantity and the water consumption. Moreover the ecosystem state is investigated in a narrow perspective neglecting the overall functioning of the system and its ability in providing services. Revision and implementation of the standard indicator formats (SIF) and indicator fact sheets (IFS) is preparatory for this task since only 33 over 45 SIFs and 13 over 27 IFSs have been accomplished by now and they are necessary for a uniform application of the method.

Indicators' hierarchy

Aiming at the determination of the sustainability level, measurements, indicators and goals should be prioritized assigning weights in relation to their different importance. This procedure should be preceded by a typological characterization of different coastal zones. The main objective of the characterization is the establishment of type-specific reference conditions for each coastal type, which requires the definition of the indicators that shall be considered. A similar procedure has been established in Water Framework Directive (WFD). In WFD the different type of water body is recognized by means of physical and geological descriptors (i.e. eco-region, altitude, geology and size). In the case of sustainability indicators for coastal zone the descriptor should include socio-economic, environmental and biological information

Reference values

A more effective application of indicators should be achieved by the identification of threshold values in sustainability terms. These could be obtained by the preparatory collection of reference values (minimum and maximum values must be assigned to each indicator) coming from legal requirements (still to be adopted) or mean representative values at European level. Anyhow, the selection of reference values needs the involvement of relevant players through participatory processes.

Progress indicator

In the WG-ID set of ISD, the majority of the indicators are of the pressure, state or impact type. Few measurements address management responses. Authors identified 5 over 47 measurements that may be identified as response metrics[1]. It is necessary to improve the response indicators number and integrate their results in a comprehensive indicator of ICZM progress.

Coastal European observatory

Data gathering process is often complex due to a lack of coordination between administrative institutions. As a consequence the set up of bodies for the data collection and treatment at different spatial levels coordinated at European level is strongly recommended.

Particularly, considering the usefulness of Geographical Information Systems (GIS) as a key tool for coastal data analysis and management, this issue must be addressed in view of the ongoing initiatives for the implementation of the INSPIRE Directive (Directive 2007/2/EC, establishing an Infrastructure for Spatial Information in the European Community), focusing on the specific needs of coastal and maritime zones.

The application on the field lead finally to characterize a further core issue: the high number of measurements, their heterogeneity and the lack of information about the integration procedure from measures to indicators and objectives in turn cause some difficulties once the entire indicator set has been applied. In particular, the interpretation of the results, together with the previously mentioned lack of reference values, is most often complicated and poorly intelligible to policy makers and territory managers.

[1] These measurements are: 8.1 – Area protected for reasons of nature conservation, landscape or heritage; 11.1 – Number of local products with regional quality labels or European PDO/PGI/TSG; 15.1 – Number of tourist accommodation units holding EU Eco-label; 26.1 – Length of protected and defended coastline; 26.3 - Area and volume of sand nourishment.

Solutions toward whole system approach

The integration into a unique comprehensive measure able to assess the sustainability level is an urgent issue. A possible solution to this task is the application of whole system methodologies. The need for the application of whole system indicators has been reckoned in the last years at the European level. Through the "Communication on Sustainable Urban Development in the European Union: a Framework for Action" (COM (1998) 605), the European Commission identified the reduction of the Ecological Footprint of urban activities as an overall policy objective.

Moreover, in 2002, during the final phases of the "European Common Indicator (ECI)" process, the Ecological Footprint Index has been included in the ECI set. This is a set of ten indicators for the evaluation of the environmental sustainability at the local level. The Working Group on Sustainable Indicators, that originally developed the ten indicators set, recommended that ecological footprint should be used as an "umbrella" indicator over and above the ten current ECIs.

Specifically referring to coastal zone sustainability, in the context of the Mediterranean Strategy for Sustainable Development Blue Plan proposed a set of 34 indicators in 2005. In the absence of a composite indicator able to summarize the progress assessed by Mediterranean countries towards sustainable development, they suggested to apply whole system indicators such as the UNDP index for human development and the ecological footprint.

Among most applied methodologies for systemic approach authors applied ecological footprint and emergy analysis to the same area together with WG-ID indicators set. Both methodologies allow to assess in a whole system approach the sustainability level of a territory giving a unique perspective on the behaviour of the system.

Ecological footprint

The Ecological Footprint (Wackernagel and Rees, 1996) accounts how much of the annual regenerative capacity of the biosphere, expressed in mutually exclusive hectares of biologically productive land or sea area, is required to renew the resource throughput of a defined population in a given year, with the prevailing technology and resource management of that year. For example, renewable resources like timber and crops need space to grow. Non-renewable resources are included in the Footprint insofar as they put a demand on the regenerative capacity of the planet, such as the energy needed to concentrate and process them and to absorb the waste from processing and using them.

Ecological footprint is able to asses if a territory (or a population) exploits biological resources more rapidly than the biosphere can replenish them or assimilate their waste, thereby breaching the principle of strong sustainability. This is a condition termed ecological overshoot. In such a situation the system would literally be liquidating natural capital to service exports. A global ecological deficit always means ecological overshoot, since there is no other planet from which to import. However, an absence of ecological deficits (at the global, national or local level) does not necessarily indicate truly sustainable resource management, since local overuse can still lead to local overshoot or other systematic overuse of natural capital.

Emergy analysis

Emergy is defined as the ultimate amount of energy of one type that was required to make another type of energy (Odum 1996). When dealing with the biosphere and environmental systems the convention in emergy synthesis has been to determine the ultimate amount of solar energy embodied in each type of energy, material or currency used to operate the system of interest. Thus, emergy synthesis has the unique ability to place all of the inputs necessary to operate a human-nature system on a single quantitative basis. Regardless of whether a key system driver is commonly measured in energy, mass or money, emergy synthesis can convert all to their ultimate amount of solar energy. Thus, the valuation of environmental inputs that are usually regarded as free in economic analysis can be compared with inputs measured in money. Emergy considers a system with larger boundaries and realizes the environmental inventory together with the evaluation of the human impact on them (Odum, 1996). This inventory includes the sorting of fluxes according to their origin and/or renewability. That is, emergy allows evaluating the quantity and quality of resources employed in a process (Vassallo et al., 2009) and this is why we could refer to it as an environmental sustainability indicator. In fact, the greater the emergy flow necessary to sustain a process, the greater the quantity of solar energy consumed or, in other words, the greater the environmental cost (Bastianoni et al., 2001). Moreover, in Daly's (1990) perspective a process is sustainable only if the resources consumed are used at a rate that does not exceed the rate at which they are renewed. As a consequence one gauge of system sustainability is its ability to support itself for an extended period of time. Long term sustainability means to rely solely upon indigenous, renewable energy sources (Tilley, 1999).

Even if these methodologies provide a wider perspective on the system sustainability and devote particular attention to the resources consumption, some

Tab. 1 - Comparison of different approaches to coastal zone sustainability evaluation

	Strengths	*Weaknesses*
Indicators set	Focus on each component separately and prompt evaluation of critical subsystem of different sectors (economic, social, and environmental), mainly based on existing and official data). Ready to use outputs. Specifically targeted to the evaluation of coastal zone sustainability level	Lack of a comprehensive view of the system. Few indicators focused on the evaluation of resources consumption and characterization. Environmental aspects of marine area partially neglected.
Whole system analyses	Integration of different components of the system and effective evaluation of externalities and emerging properties. Immediate assessment and characterization of exploited resources balance in relation to their origin and replacement rate.	Scarce attention devoted to social sector and lack of an appropriate index to evaluate welfare. Technical background required for the interpretation of results

lacks can be identified. In particular, the non-ecological aspects of sustainability are poorly considered and analyzed. For instance, social well-being also needs to be tracked, but this is not measured by these methodologies. They also make no attempts to evaluate the long-term viability of social structures, economies, or political systems. Neither do they identify the drivers; they document one particular ecological outcome, the demand on nature resulting from human activities that occurred at a given time.

Moreover, results from emergy analysis are hardly intelligible and require a solid technical background for the interpretation. On the contrary, ecological footprint results are easily understandable and allow an effective communication but, the methodology is strongly reliable at national (or wider) level while it is still to be improved at smaller scales (Kitzes and Wackernagel, 2009).

Concluding remarks

Sustainability is fundamentally an integration issue aimed at gaining a sound balance among environmental, social and economic development of populations at whatever social or administrative level. Integrated coastal zone management is a proactive process aimed at addressing conflicts interests for coastal space and resources as well as at finding the balance between short term economic and long term environmental issues (EEA, 2006a). That is, ICZM must be located in the framework of sustainability, overcoming sectional approaches. Taking into account these concepts we tackled the issue of sustainability level evaluation by means of a critical examination of two different perspectives, adopting respectively a top-down (indicators set proposed by WG-ID) and a bottom-up (whole system analyses) approach.

None among the two approaches can be considered as the panacea for the effective evaluation of coastal zone sustainability. Strengths and weaknesses have been identified in both approaches and here briefly summarized in table 1.

Since sustainability has been here defined as an emergent property of human systems, it seems advisable to face the sustainability evaluation adopting a holistic approach. In this perspective whole system methodologies seem to represent an appropriate response to the coastal zone sustainability assessment, to be usefully integrated to integrated indicators-based approaches.

Particularly, the relative youth of proposed methodologies and the process of methodologies setting up that is still in progress generate lacks that need further improvements (i.e. human well being assessment) and thus, by now, WG ID indicators set may helpfully support whole system analyses by filling gaps and helping during results interpretation.

References

Bartelmus, P. 2003. Dematerialization and capital maintenance: two sides of the sustainability coin. Ecological Economics 46: 61-81.

Bartelmus, P. 2007. SEEA-2003: Accounting for sustainable development? Ecological Economics 61: 613–616.

Bastianoni, S., Marchettini, N., Panzieri, M., Tiezzi, E. 2001. Sustainability assessment of a farm in the Chianti area. Journal of Cleaner Production 9: 365-373.

Belfiore, S. 2003. The growth of integrated coastal management and the role of indicators in integrated coastal management: introduction to the special issue. Ocean & Coastal Management 46: 225-234.

Billé, R. 2007. A dual-level framework for evaluating integrated coastal management beyond labels, Ocean & Coastal Management 50: 796–807.

Chua, T.E. 1993. Essential Elements of Integrated Coastal Zone Management. Ocean & Coastal Management 21:81-108.

Cicin-Sain, B. 1993. Sustainable Development and Integrated Coastal Management. Ocean & Coastal Management 21:11-43.

Cicin-Sain, B., and Knecht, R.W. 1998. Integrated Coastal Management: Concepts and Practices (? Editor?)

Cicin-Sain, B. 2002. Sustainable Coastal Management, Sprinter (Springer?)

Connolly, N. and Cummins, V. 2002. Integrated Coastal Zone Management (ICZM) in Ireland, with particular reference to the use of Geographic Information Systems (GIS) and the EU ICZM Demonstration Programme. In: Convery, F. and Feehan, J., (Eds) Achievement and Challenge: Rio+10 and Ireland (Publisher?).

Craige, B.J. 2001. Eugene Odum: Ecosystem Ecologist and Environmentalist. The University of Georgia Press, Athens.

DEDUCE Consortium, 2007. Indicators guideline: to adopt and indicator-based approach to evaluate coastal sustainable development, Kowalczyk Ed. . http://www.deduce.eu/PDF-NewsLetter/indicators_guidelines.pdf

Daly, H.E. 1990. Towards some operational principals of sustainable development. Ecological Economics 2:1 – 6.

Daly, H.E. 1991. Elements of Environmental Macroeconomics. In R. Costanza (Ed.), Ecological Economics: The Science and Management of Sustainability. Columbia Press, New York.

EC (European Commission) 1997. Better Management of Coastal Resources. A European Programme for Integrated Coastal Zone Management. ECSC-EEC-EAEC, Brussels, Luxembourg.

EC (European Commission) 2000. Communication from the Commission to the Council and the European Parliament on Integrated Coastal Zone Management: a Strategy for Europe (COM/2000/547), adopted 27 September, 2000 http://ec.europa.eu/environment/iczm/comm2000.htm

EC (European Commission) 2001. EU Focus on Coastal Zones. Turning the tide for Europe's coastal zones, Directorate General Environment, pp. 36. http://ec.europa.eu/environment/iczm

EEA (European Environment Agency) 2006a. The changing face of Europe's coastal areas. Report n°6.

EEA (European Environment Agency) 2006b. Report on the use of the ICZM indicators from the WG-ID - A contribution to the ICZM evaluation. http://ec.europa.eu/environment/iczm/pdf/report_wgid.pdf

Glavič, P. and Lukman, R. 2007. Review of sustainability terms and their definitions. Journal of Cleaner Production 15:1875-1885

Hediger, W. 1999. Sustainable development and social welfare. Ecological Economics 32:481–492.

Hediger, W. 2000. Sustainable development and social welfare. Ecological Economics 32:481-492.

Henocque, Y. and Denis, J. 2001. Steps and Tools towards Integrated Coastal Area Management: Methodological Guide Volume II. IOC Manuals and Guides 42. UNESCO, Paris.

Kitzes, J. and Wackernagel, M. 2009. Answers to common questions in Ecological Footprint accounting Ecological Indicators 9:812-817.

Müller, F. and Nielsen, S.N. 2008. Emergent Properties. Encyclopedia of Ecology, Pp. 1212-1218

Odum, H.T. 1996. Environmental Accounting. Emergy and Environmental Decision Making. John Wiley and Sons, New York.

PAP/RAC 2002. Integrated Coastal Zone Management in the Mediterranean: from concept to implementation. MAP/METAP Workshop: CAMP: Improving the Implementation, Malta, 17-19- January 2002.

PAP/RAC 2003. Feasibility Study for a Legal Instrument on Integrated Coastal Area Management in the Mediterranean, Split.

Sorensen, J. 2002. Baseline 2000 Background Report: The Status of Integrated Coastal Management as an International Practice, Second Iteration, 26 August 2002. http://www.uhi.umb.edu/pubblications.htm

Tilley, D.R. 1999. Emergy Basis of Forest Systems. PhD thesis, University of Florida.

UNEP/MAP/PAP 2001. Good Practices Guidelines for Integrated Coastal Area Management in the Mediterranean. Split, Priority Actions Programme.

UNESCO 2006. A Handbook for Measuring the Progress and Outcomes of Integrated Coastal and Ocean Management. IOC Manuals and Guides, 46; ICAM Dossier, 2. Paris.

Vassallo, P., Paoli, C., Fabiano, M. 2009. Emergy required for the complete treatment of municipal wastwater. Ecological Engineering 35:687-694

Wackernagel, M., Rees, W.E. 1996. Our ecological footprint: reducing human impact on the Earth. New Society Publishers. Gabriola Island, British Columbia, Canada.

WCED 1987. Our common future: The Brundtland report. Report from the World Commission on Environment and Development (WCED). Oxford University Press, Oxford.