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Designing an integrated coastal orientation index: A cross-comparison of Mexican municipalities

Georges Seingier[a], Ileana Espejel[b,*], José Luis Fermán-Almada[a], Oscar Delgado González[c], Gabriela Montaño-Moctezuma[c], Isaac Azuz-Adeath[d], Guillermo Aramburo-Vizcarra[e]

[a] Facultad de Ciencias Marinas, Universidad Autónoma de Baja California (UABC), Mexico
[b] Facultad de Ciencias, Universidad Autónoma de Baja California (UABC), Mexico
[c] Instituto de Investigación Oceanológicas, Universidad Autónoma de Baja California (UABC), Mexico
[d] Centro de Enseñanza Técnica y Superior (CETYS Universidad), Mexico
[e] Instituto Municipal de Investigación y Planeación de Ensenada (IMIP), Mexico

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ABSTRACT

To better understand the relation between coastal areas and their influence on social and economic conditions of municipalities, a set of indexes were developed to characterize coastal Mexico with an interdisciplinary approach. The composite of these bio-physical, social and economic indexes is referred to as an "integrated coastal orientation index". Coastal characteristics should be taken into account in the coastal management policy formulation of a given region, and this index can be used to identify key areas for environmental protection or economic development at a national level. The results suggest that municipalities must manage their coastal jurisdictions, a large and diverse array of coastal space and ecosystems, medium to weak spatial demographics and settlement structures, infrastructure to improve quality of life, an overall low coastal population income, and various coastal activities. Spatial heterogeneity along the littoral zone in the coastal orientation led us to conduct a state analysis. We discuss these values and identify five highly coastal-orientated states in the extremes of the country. The development of this tool could help to pin-point different types of key areas within the regions studied and provide a tool to guide regional priorities. As an example, using a combination of extreme values of bio-physical, social and economic indexes was used to identify specific municipalities as candidates for environmental protection and others as areas where development can continue. Choices of indexes are discussed, and the relative importance given to each component of the coastal orientation (rather bio-physical, social and/or economic) will define the course of the coast's development and its sustainability.

1. Introduction

Some grouping studies of "coastal countries" focus on the countries' economic or social growth or problems (for example, Gallup et al., 1999), and others consider the coastal biodiversity and environmental issues in protected marine and coastal regions (Beatley, 1991; Gray, 1997). Integrated coastal zone management, coastal co-management, and coastal sustainable development are some of the planning efforts intended to view coastal localities from a holistic point of view. These efforts are described throughout the literature and can be found in specialized journals and books (Cicin-Sain, 1993; Olsen, 2003; Clark, 1996; Post and Lundin, 1996; Cicin-Sain et al., 1998; Belfiore, 2003; Talaue-McManus et al., 2003; McFadden et al., 2007; among many others). Worldwide projects and studies are also available (Sorensen, 1993, 1997; Martinez et al., 2007). However, nation-wide analyzes are not commonly published in international journals because most full national integrated reports are for nation self-coastal planning purposes and are not considered for publication in other contexts. Some reports for regional assessments regarding particular projects on integrated coastal zone management are available (Henocque, 2003; Thia-Eng, 1998; among others).

The issues of coastal countries are of utmost global importance because of climate change and rising sea level, and integrated coastal regions s interactions are needed to plan and manage coastal areas. Recent inundations, erosion and other potential issues arising from global change scenarios suggest a shift in common traditional (i.e., only economics-based) paradigms to a focus on. Our hypothesis is that this moment is crucial for most developing countries to shift from present economic developing paradigms to more sustainable coastal development. Lessons must be learned from

* Corresponding author at: Carr. Transpeninsular Tijuana-Ensenada km 103, Ensenada, Baja California, Mexico. Tel.: +52 646 1745925x126; fax: +52 2 646 1744560.
E-mail addresses: ileana.espejel@uabc.edu.mx, iespejel@gmail.com (I. Espejel).

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developed countries and from own errors, and for that purpose, national and regional integrated databases are needed to measure progress towards sustainable development (Hanson, 2003) and to compare, analyze, and project better coastal development and prioritize worldwide, national, regional or local preventive or adaptive efforts to deal with disasters, public health, poverty, protected land, etc.

Coastal areas are heterogeneous and show many geographic, environmental, social and economic differences and similarities (Spalding et al., 2007). Geographic disparities, coastal resource values (economic sectors linked to the coast), concentrations and types of development as well as populations have been suggested as indicators to describe a region's relationship to its coast (Sorensen and McCreary, 1990) and to indicate the potential importance or value of the coast (Hoagland et al., 2005; Hoagland and Jin, 2008). That value is expected to be important in the region's coastal management planning. The composite of these factors is referred to as the "coastal orientation", and its characteristics should be taken into account in the coastal management policy formulation of a given region. The coastal orientation can also be used to identify key areas for environmental protection or economic development at a national level. The development of this tool could help to pin-point different types of key areas within all of the regions studied. For example, the occurrence of the combination of the low social and economic component with a high bio-physical component could identify a given region as a candidate for environmental protection. This approach could provide homogeneous criteria for a national coastal environmental protection plan.

Theoretically, national strategies incorporate regional plans that include various municipal policies with different site plans, all of which are arranged in a hierarchical nested approach (Millennium Assessment, 2003, 2005, 2007; Olsen, 2003). In real life, at least in developing countries and despite multiple coastal planning efforts, most federal, state and municipal strategies promote new developments (e.g., cities, ports, energy and industrial areas, tourism, aquaculture, protected areas) in a disorganized and incongruent way that is biased toward economic issues. Social needs are occasionally considered, and scientific demands or environmental limitations are rarely properly considered. Besides environmental impact assessments, which evaluate single projects, integrated coastal zone management, regional planning and ecological ordinances are the main instruments for visualizing synergic responses and distributing land use in coastal areas. Some countries (Australia: Ward et al., 1998; Canada: Boyd, 2001) and groups of countries (Europe: Doody, 2003; EEA, 2006; Latin America: CIAT-World Bank-UNEP, 2000) are incorporating national strategies to organize marine and coastal areas. Experiences from the past and present (Shipman and Stojanovic, 2007; Ricketts and Harrison, 2007; Deboudt et al., 2008; Gallagher, in press) provide the best tools available to guide coastal development towards sustainability and to adapt to the effects of climate change and lessen the likelihood of coastal disasters.

This work proposes an evaluation and monitoring scheme for cross-municipal coastal orientation comparisons that can fall in a vision scheme to monitor and promote sustainable development of the Mexican coast. This scheme is based on the same principles as the national coastal and marine strategy. In this paper, we present a model of indicators based on an official census database that is oriented towards integrated coastal zone management and regional coastal planning for sustainable development. Indicators were chosen to represent more general phenomena (EEA, 1999). The use of these indicators in coastal management has been encouraged (Mageau and Barbière, 2003), and they have been evaluated using selection frameworks and guidelines (US EPA, 2000; Kurtz et al., 2001; Niemeijer and de Groot, 2008) and more recently in an ecology and environmental planning context (Heink and Kowarik, 2010).

We applied some indicators in this database to 169 municipalities by the sea. We present some ideas for which our database, which is arranged in a geographic information system (GIS), provides information for the following analyses related to coastal planning: national coastal length, regional analysis or grouping municipalities by any shared indicator, and identification of key areas. Establishing a set of common municipal indicators on a local spatial scale has the advantages of providing a coherent assessment framework, preventing the duplication of effort and enhancing the analyses of (a) symmetries within a region (Mascarenhas et al., 2010).

In this case, we provide an example of the potential use of an index named "coastal orientation" that provides a comparative characterization of the degree and type of coastal issues that Mexican coastal municipalities must handle. This index should be useful for managers to identify key areas for specific policies (e.g., environmental protection or economic development). The latter was made using interdisciplinary indexes (bio-physical, social and economic characteristics of the municipalities and their coastal plain) that have proven valuable for providing links between environmental, social and economic dimensions. These connections are vital for good policy making (Niemi and McDonald, 2004), especially because the climate is changing, which causes political priorities to change as well.

2. Study area

Mexico is a neoliberal, democratic, developing country. Its economy and social development are dependent on its neighbor, the USA. However, in contrast to the USA, Mexico is a country with recent coastal growth. Before the Spanish conquerors arrived in 1500, few coastal developments could be found, and the main Indian cultures were in central Mexico in the highlands (León, 2004). In the last century, coastal Mexico emerged, and cities grew in the coastal plains. However, most of the population still lives in small cities and towns (Gutiérrez de MacGregor and González Sánchez, 1999; Azuz-Adeath and Rivera-Arriaga, 2009). Although ports and gas and oil extraction are important to the country, Mexico is better known internationally for its coastal tourism; new cities like Cancun and Los Cabos are visited mainly by US and EEC citizens.

Because of its tourism industry, Mexico has much recent experience in coastal and marine regional planning (Rosete Vergés et al., 2006; Córdova y Vázquez et al., 2006, 2009). Three years ago, the Environment and Natural Resource Secretary published a strategy for Mexico's oceans and coastal marine zone (SEMARNAT, 2007). For the first time, the coastal area was officially divided into the following three types of municipalities: (1) areas with direct connections to the sea, (2) areas by a lagoon or estuary, and (3) inland areas with coastal vegetation. This strategy led to the formulation of a *Coastal Management National Plan* that generated an *Ocean and Coast Sustainable Development National Policy* (SEMARNAT, 2009) and the publication of the *Sea and Coasts Territorial Ecological Ordinance National Strategy* SEMARNAT (2007). The latter is based on the following driving principles: interdisciplinary focus, the use of the best available data, the delimitation of Mexico's coastal zone, the development of an information system for coastal environment evaluation and monitoring to orient, the communication and articulation of research, and the generation and exchange of information. Despite the planning efforts, no sea law yet exists, and neither the states nor the municipalities govern their seaside. Marine and coastal water affairs remain under the control of the federal government.