



Forty years of coastal zone management (1975–2014): Evolving theory, policy and practice as reflected in scientific research publications



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ABSTRACT

Since its implementation as public law in the United States in 1972, the theoretical foundation of coastal management has moved forward in diverse directions. Given the time elapsed since the passage of this influential legislation and the growing number of disciplines and scientific papers published on the topic, this work employed bibliometric and social network analysis methods to quantitatively and qualitatively assess coastal management literature published during the period from 1975–2014. The results indicate that coastal management research has increased significantly over time. The emergence of the topic in scholarly work coincides with passage of the Coastal Zone Management Act of 1972 (US Public Law 92–583), and increases in productivity can often be tied to the passage of important legislation or the publication of major policy documents for action on coastal issues. Social network analyses (SNA) indicate loosely connected networks of researchers and institutions, with highly collaborative subgroups that have a significant impact on the field. SNA results also highlight the importance of federal governments and international organizations in driving research and encouraging integrated management. The results indicate that the discipline is evolving to focus more on cross-boundary management strategies, systems perspectives, and consideration of both marine and terrestrial environments.

1. Introduction

Coastal management is a dynamic process that covers the development and implementation of coordinated strategies to allocate resources and achieve conservation and sustainable multiple use of coastal areas (French, 1997). The tendency for use of the coast by many different sectors has led to a proliferation of controlling and interested coastal management stakeholders. Because of the complexity of these interactions and spatial domains, the management of coastal areas is divided into smaller units, each with its own management hierarchy, policies, and protection strategies. Consequently, theoretical and empirical studies about coastal management have flourished since the implementation of the Coastal Zone Management Act of 1972 (US Public Law 92–583). As theory has been refined, diverse drivers have taken more relevance and single-sector theories have waned in favor of more integrated approaches. For the purposes of this study, coastal management relates to the theory, policy, and decision-making processes associated with coastal resources. As such, it is our goal to identify the major trends in the evolution of the theory and practice of coastal management. Our objectives were as follows:

- To perform bibliometric (*sensu* Pritchard, 1969) and social network analyses of the literature published since passage of the CZMA;
- To provide an assessment of publication characteristics overall and over time to better understand the authors, institutions, journals, and interactions that have contributed to theory and practice;
- To provide an evolutionary timeline of associated management paradigms, and;
- To provide insight into past development, current trends, and future directions in the field.

The origins for theory of coastal management evolved from a collection of land use, recreation, and environmental conservation interests and practices (Godschalk, 1992; Zile, 1974). The concept, policies, and implementation mechanisms were firmly established with the creation of the Coastal Zone Management Act of 1972 (CZMA), which “established a national policy and developed a national program for the management, beneficial use, protection, and development of the land and water resources of the Nation's coastal zones, and for other purposes” (US Public Law 92–583). In 1966, the United States Congress enacted the Marine Resources and Engineering Development Act,

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focusing unprecedented attention on the nation's ocean and coastal resources (Merrell et al., 2001). The 1966 Act provided the first coordinated national program in marine science, as well as the mandate for the Commission on Marine Science, Engineering, and Resources (later known as the Stratton Commission) tasked with investigating of all aspects of coastal and marine science to recommend a national path forward for sustainable resource management (Merrell et al., 2001; Scheiber, 1998). Based in large part on the Stratton Commission's recommendations, passage of the CZMA in 1972 made the United States the first country to ratify comprehensive national coastal legislation (Godschalk, 1992). Since then, many countries have realized the problems associated with management and mismanagement of coastal resources, and have undertaken their own legislative initiatives (Conway and Lorah, 1995; Crawford, 1992; Ngoile and Horrill, 1993; Ngoile and Linden, 1997; Rosier and Hastie, 1996; Sorensen, 1993, 1997). While national legislation varies from country to country, implementation of several international conventions, treaties, and programs has increased capacity and cooperation for the protection and management of coastal and marine resources. This has raised the profile of coastal management in the international arena, resulting in an increased awareness and research activities addressing local, national, and trans-national management issues (Van Dyke, 1996).

Since its implementation as public law the theoretical foundation of coastal management has moved forward in diverse directions. From the earliest research focusing primarily on the land use and legal ramifications of the CZMA, the incorporation of a wide range of disciplines (e.g. ecology, environmental science, fisheries management, international relations, geography, disaster management; Forst, 2009) and methods have made the theory more holistic and encompassing regarding environmental and human development issues (Glaser and Glaeser, 2011; Risser, 1985). This is due, in large part, to the recognition that management of socially and ecologically complex coastal zones requires extensive scientifically-based knowledge (Nobre, 2011; Tintoré et al., 2009). Scientific publications on various aspects of coastal management have exhibited a marked increase in quantity, and the field has increasing become international in focus over the last four decades. Given the time elapsed since the passage of this influential legislation, and the growing number of disciplines and scientific papers published on the topic, several questions emerged: How have the research emphases in coastal management shifted over time? What authors, institutions, and journals have made the greatest contribution to coastal zone theory and policy development? What networks of authors and institutions are most influencing coastal management and policy? Most importantly, what are current and emerging trends, and potentials for future research? In their long-term analysis of the evolution of ecology, Neff and Corley (2009) described bibliometric analysis of publication characteristics as a powerful tool that analyzes research trends and priorities over time and across disciplines. The present study used a combination of bibliometric and social network analyses focused on the above questions.

Bibliometrics, a term and methodology introduced by Pritchard (1969: 348) as "the application of mathematics and statistical methods to books and other media of communication," refer primarily to the research methodology employed by library and information sciences for citation and content analysis. Bibliometrics apply mathematical and statistical methods to citation and content data to assess publication characteristics (e.g. journal output, authorship, and institutional impact), and thus identify trends in published research. Conventional bibliometric methods (e.g., publication and authorship counts; means and annual trends, etc.) have been widely applied to various fields to assess research trends through an analysis of publication characteristics (Fourqurean et al., 2008; Harrison, 2006; Ratz and Conk, 2013). Network analysis has been used extensively in both the social and physical sciences (Luke, 2015) to assess the importance of context between authors and institutions (Toral et al., 2012). Social network analysis (SNA) examines the interactions and strength of connections between

individual agents in relational networks. These metrics and visualization techniques create an intuitive and quantitative way to understand those interactions. SNA provides two distinct types of relational information: characteristics of networks and characteristics of the agents that form each network (Scott, 2013). Previous research using SNA in bibliographic analysis has shown how distant disciplines have contributed to interdisciplinary research and how current problems are being addressed using these multidisciplinary approaches (Chen et al., 2015), or how, through time there are increases in cooperation and interaction among individuals (Bornmann et al., 2014).

The goal of this study was to apply several bibliometric and SNA methods to quantitatively and qualitatively assess the literature published in the field of coastal management since passage of the CZMA. The analysis was conducted to identify global research trends in journal output, authorship, collaboration, and subject over time. This type of bibliometric assessment has been conducted, for example, in urban ecology (Young and Wolf, 2006), landscape ecology (Wu et al., 2012), wetland research and ecosystem restoration (Zhang et al., 2010), constructed wetlands (Zhi and Ji, 2012), fisheries management (Jaric et al., 2012), and estuarine and coastal research (Fourqurean et al., 2008). To date there has not been a similar study conducted in the field of coastal management. This information can provide valuable insight into the evolution of research tendencies and priorities that could be of interest for the academy, policy developers, and practitioners.

2. Materials and methods

A number of systematic review articles have been published since 1972 on some aspect of coastal research, including insights on human development, natural processes, and biochemical change. A number of systematic review articles have been published since 1972 on some aspect of coastal research, including insights on human development, natural processes, and biochemical change. As the field of coastal zone management has evolved, several efforts were undertaken to synthesize current knowledge. For example, Cicin-Sain and Belfiore (2005) reviewed the challenges to incorporate marine protected areas under an integrated marine management approach. Similarly, Kroon and Brodie (2009) discussed adaptive approaches to watershed management in connection with coastal water quality. Curtin and Prellezo (2010) also provided an in-depth literature review as a means to understand marine ecosystem-based management. Finally, Liqueite et al. (2013) examined the effects of incorporating ecosystem services (as opposed to just extractive activities) into new approaches for management and conservation of coastal and marine ecosystems. However, there has not been a historical perspective analysis on the field of coastal zone management.

To address this deficiency, we initiated an unsupervised search of two of the most comprehensive reference databases (Scopus and Web of Science) for articles that included the words 'coastal management' in the keywords and/or title to compile a bibliography of all papers related to some aspect of coastal management between 1972 and 2016. Scopus is a multidisciplinary database of Elsevier that indexes 20,800 peer-reviewed journals (including 2600 open access journals) from more than 5000 publishers (Elsevier B.V., 2014). This includes citation references across the disciplines of science, technology, medicine and social science. Web of Science is the multidisciplinary database of Thomson Reuters. According to Journal Citation Reports (JCR), it indexes over 12,000 scientific and scholarly journals with seven citation indexes focusing on the applied sciences, but also including the social sciences and art and humanities. We drew citation reference counts from Google Scholar, a reference database that indexes across an array of scholarly databases and thus provides the most accurate count of total article citations. These databases were chosen to complement each other, as none of the resources are all-inclusive, but together they establish a relatively comprehensive look at social and applied coastal science research (Adriaanse and Rensleigh, 2011).

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