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An empirical analysis of cultural ecosystem values in coastal landscapes

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ABSTRACT

Coastal areas are especially important to human well-being with half the world's population living within 60 km of the sea and three-quarters of all large cities located in the coastal zone. Supporting and regulatory ecosystem services in coastal areas have received considerable research attention given human vulnerability to climate change, but cultural ecosystem services in the coastal zone are less understood. This study describes and analyzes the distribution of cultural ecosystem values found in coastal areas in multiple countries (n = 5) and compares the results with non-coastal areas. Mapped cultural ecosystem values were collected from public participation GIS (PPGIS) processes in the U.S., Australia, New Zealand, Norway, and Malaysia and analyzed to identify the type and intensity of ecosystem values located in coastal areas. Mapped ecosystem values were significantly more abundant in all coastal zones, regardless of ecosystem value category, country, population, or dominant land use. Compared to cultural ecosystem values, biological and life-sustaining values were mapped less frequently in the coastal zone. Economic and social values were significantly associated with developed (built) coastal zones, while aesthetic and recreation values were more strongly associated with natural coastal zones. Coastal access, especially by road, influences the mix of perceived values from nature-based values to anthropocentric values. Coastal zones will continue to be the principle location for potential future land use conflict given their high social and cultural value relative to other ecological values. Understanding trade-offs in coastal zone planning and management requires a systematic inventory of the full range of ecosystem services, including cultural services.

1. Introduction

Coastal ecosystems are among the most productive but threatened systems in the world, producing disproportionately more services than most other systems (Agardy et al., 2005). Further, coastal areas are especially important to human well-being with about half the world's population living within 60 km of the sea and three-quarters of all large cities located in the coastal zone (UNEP, 2016). From an economic perspective, many of these coastal systems that provide important ecosystem services have yet to be valued reliably (Barbier et al., 2011; Brenner et al., 2010). While research on provisioning, regulatory, and supporting services of coastal ecosystems may be characterized as inadequate, information about cultural ecosystem services (CES) in the marine and coastal zone is even more limited, with little knowledge from developing countries, and with most studies implemented in Europe and North America (Martin et al., 2016). Socioeconomic data suggest that people living in coastal areas experience higher well-being than those living in inland areas (Agardy et al., 2005), but there has been little systematic empirical research to identify the distribution of cultural ecosystem services provided within the coastal zone relative to non-coastal zone areas. This is not surprising as the general study of CES has been one of most neglected and poorly integrated within the ecosystem services framework (Chan et al., 2012; Daniel et al., 2012; Schaich et al., 2010). This research seeks to address this knowledge gap by examining the distribution of cultural ecosystem services found in coastal zones in study areas located in five countries.

Cultural ecosystem services (CES) are the nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic

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experiences (MEA, 2005). Cultural ecosystem services are considered intangible (Milcu et al., 2013) with most indicators of cultural services deficient in clarity of definitions, purposes and understanding, with relatively few indicators incorporating spatially explicit information (Hernández-Morcillo et al., 2013). Most CES are not directly observable in the physical landscape and require either proxy or indicator measures (see e.g., Raudsepp-Hearne et al., 2010) or empirical research such as participatory mapping (Klain and Chan, 2012). A logical consequence is that CES are rarely fully considered in ecosystem services assessments (Plieninger et al., 2013) with poor integration with management plans (De Groot et al., 2010; Arkema et al., 2015).

Participatory mapping methods variously described as public participation GIS (PPGIS), participatory GIS (PGIS), and volunteered geographic information (VGI) are suitable for the identification and assessment of CES (see Brown and Fagerholm, 2015; for a review of methods and applications). The terms PPGIS, PGIS, and VGI describe a range of participatory mapping methods where spatial data collection and use is a core component of the process (see Brown and Kyttä, 2014). As a social research method, participatory mapping identifies place attributes that range from objective place features to subjective perceptions of place and importance, including place attachment (Brown et al., 2015a). Participatory mapping is valid for identifying CES under the assumption that place values identify locations that directly or indirectly provide services or benefits to the participant. The terms ecosystem "service" and "value" are often conflated because the terms are closely related. Ecosystem services are the benefits people obtain from ecosystems. Ecosystem values are measures of how important ecosystem services are to people. An assumption of participatory mapping is that when a place is identified as valuable, it provides the mapped benefit or service such as scenery or recreation.

The mapping of CES can use variable methods where the types and locations of CES are emergent in the data collection process, for example, using interviews or small group processes (see Klain and Chan, 2012; Lowery and Morse, 2013; Rieprich and Schnegg, 2015) or through the use of pre-defined CES categories where study participants identify locations on a hardcopy or digital map. CES appear in "bundles" and their co-occurrence could be related to a range of conditions, including biophysical features as well as socioeconomic characteristics (Klain and Chan, 2012; Plieninger et al., 2013).

A number of typologies have been used to assess CES and many operationalize the cultural services described in the MEA (2005). While most of the identified CES can be accurately described as globally universal, the relative importance of CES can vary by geographic location and population. Just as provisioning, supporting, and regulatory ecosystem services are not spatially homogeneous, one would not expect CES to be spatially homogeneous either. As pressures on the coastal zone increase, there is an urgent need for spatially explicit, empirical assessments that can be directly used in coastal planning. As shown in a recent study by Arkema et al. (2015), the integration of ecosystem services into coastal planning can provide synergies and benefits for both nature and people. In that study, models were developed to quantify the ecosystem services provided by corals, mangroves, and seagrasses in coastal Belize. Through an iterative process that included stakeholder engagement, a coastal plan was developed that would result in greater coastal protection (nature benefits) and tourism (people benefits) than would be achieved with either conservation or development goals in isolation.

1.1. Coastal zone classification

There is no standard definition for what constitutes a coastal zone, but functionally, the coastal zone is a spatial area that includes the landward limit of marine influence and the seaward limit of terrestrial influence (Carter, 1988). Coastal zones are the *interface* where the land meets the ocean encompassing shoreline environments as well as adjacent coastal waters. This study is focused principally on the terrestrial or landward component of the coastal zone which includes both natural features such as river deltas, coastal plains, wetlands, beaches and dunes, mangrove forests, and lagoons, as well as artificial features associated with human development and occupation such as ports, cities, rural housing, manufacturing, resorts, and agriculture. In the absence of a standard definition for marine and terrestrial *influence*, the coastal zone is often operationalized as a fixed distance from the coastline. In this study, we operationalize the coastal zone as distance bands ranging from the coastline to 3000 m landward.

Coastal zones have been classified using a number of different systems that focus on physical and geomorphic characteristics. For example, the U.S. Geological Survey (USGS) provides a coastal classification system that accounts for both geomorphic features and human development to assist in coastal hazard assessment (USGS, 2014). Human development is described by the density of development and the structure present while undeveloped areas are described with physical descriptors such as beach scarp bluff, beach dune, and washover complex. Coastal classification systems thus emphasize the physical structure over the cultural services that are bundled with the physical features and there isn't a coastal classification system that accounts for the cultural ecosystem values associated with the coastal zone. Although it appears intuitive that there should be a relationship between the types of physical coastal features and the associated cultural ecosystem values (e.g., beaches provide enhanced opportunities for recreation and social interaction while coastal bluffs and escarpments provide scenery and inspiration), there has be little study of these putative relationships. This comparative analysis empirically explores the distribution of cultural values associated with the coastal zone.

1.2. Research aims

The purpose of this research is to examine the spatial distribution of cultural ecosystem values found within the coastal zone across diverse physical and social settings. The research represents a type of comparative analysis to identify patterns in the global distribution of cultural ecosystem services within coastal zones. As the first such coastal study, the research approach is largely inductive and non-theory driven. However, there are a number of presuppositions that can be derived from logical inference or previous cultural ecosystem values research. Given that (1) coastal zones now comprise a disproportionate share of human settlement, (2) cultural ecosystem services are linked to human activities and experiences, and (3) humans engage in geographic or spatial discounting when mapping—identifying values closer to home, one would expect higher proportions of cultural ecosystem values in coastal areas that are dominated by human settlement. Does this presupposition also apply to coastal areas with relatively sparse human settlement? If cultural ecosystem values are disproportionately greater in these latter coastal zones, what coastal attributes or features could account for these results?

Previous research found significant positive or negative spatial associations between mapped cultural ecosystem values and global land cover classes such as forest cover, water, and agriculture (Brown, 2013), as well as landforms such as mountains, valleys, and lakes (Brown and Brabyn, 2012). Similarly, one would expect some empirical associations to be evident in the coastal zone, especially between natural land cover features and human-modified areas.

Another important variable in the coastal zone is access that facilitates coastal use and development. Empirical evidence