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Research article

Identifying conflict potential in a coastal and marine environment using participatory mapping

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ABSTRACT

Planning for coastal and marine environments is often characterized by conflict over current and proposed uses. Marine spatial planning has been proposed as a way forward, however, social data are often missing impeding decision-making. Participatory mapping, a technique useful for providing social data and predict conflict potential, is being used in an increasing number of terrestrial applications to inform planning, but has been little used in the marine realm. This study collected social data for an extensive coastline in northwestern Australia via 167 in-depth face-to-face interviews including participant mapping of place values. From the transcribed interviews and digitized maps, we inductively identified 17 values, with biodiversity, the physical landscape, and Aboriginal culture being most valued. To spatially identify conflict potential, values were classified in matrices as consumptive or non-consumptive with the former assumed to be less compatible with other values. Pairwise comparisons of value compatibilities informed a spatial GIS determination of conflict potential. The results were overlaid with the boundaries of nine marine protected areas in the region to illustrate the application of this method for marine spatial planning. The three near shore marine protected areas had at least one third of their area exhibiting conflict potential. Participatory mapping accompanied by conflict potential mapping provides important insights for spatial planning in these often-highly contested marine environments.

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1. Introduction

Use of coastal and open sea areas has expanded rapidly in recent years contributing to conflict (Douvere, 2008; Douvere and Ehler, 2009; Weslawski et al., 2010; Yates et al., 2015). These can be user-user conflicts, for example between oil and gas development and fisheries, or between human use and the environment. Of particular concern are cumulative effects on the environment caused by the combined effects of over-fishing, pollution, and climate change (Douvere, 2008). Marine biodiversity continues to decline in the face of these cumulative impacts, with none of the planet's marine ecosystems unaffected by human influence (Halpern et al., 2008; Devillers et al., 2015). Marine spatial planning provides a means to identify potential conflicts based on use locations to develop management alternatives (Douvere, 2008; Douvere and Ehler, 2009).

Marine spatial planning (MSP) is increasingly seen as a way to achieve sustainable use of the seas by arbitrating between competing uses and long-term protection of the natural environment (Douvere, 2008; Yates et al., 2015). Spatial planning has a long history in land use planning, but is a relative newcomer to marine planning (Douvere, 2008; Douvere and Ehler, 2009; Kidd and Ellis, 2012). MSP is widely regarded as having conservation-based beginnings in the development of marine protected areas (Day, 2002; Douvere, 2008; Jay et al., 2012; Vince, 2014). Until recently, it was largely sectoral-based, limiting its capacity to identify and manage conflict between sectors (Douvere, 2008). In the last decade, MSP has increasingly been adopted in marine policy and management, with applications reported from Dutch, Belgium, German, Norwegian, U.K., Canadian, U.S., and Australian efforts (Douvere, 2008; Douvere and Ehler, 2009; Kenchington and Day, 2011; Jay et al.,

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2012; Jentoft and Knol, 2014; Vince, 2014).

Characteristics of MSP are its ecosystem-based approach, spatial focus, integration across sectors, and multi-level policy framework (Jentoft and Knol, 2014; Vince, 2014). Allocating use within three-dimensional space, and ecological, economic, and social objectives are other essential elements (Douvere and Ehler, 2009). MSP is explicitly recognized as a tool for managing conflicting uses, with Douvere and Ehler (2009) noting the leadership role taken by several European countries in using MSP to resolve marine conflicts and achieve conservation objectives. A spatial approach implies mapping which enables conflicts and compatibilities of human use to be made spatially explicit and therefore potentially manageable. Such mapping includes ecosystems and their features, and the human activities affecting these ecosystems (Douvere, 2008).

Marine protected areas are an ongoing focus of MSP (Day, 2002; Kenchington and Day, 2011) and the management tool of choice for conserving biodiversity for most jurisdictions (Agardy et al., 2003, 2011; Veitch et al., 2012; Pajaro et al., 2010). Such areas are a response to growing concerns regarding the impacts of anthropogenic activities including resource extraction (especially fishing), land-based pollution, invasive species, and climate change (Devillers et al., 2015; Halpern et al., 2008). Designation and management of marine protected areas, however, have been plagued by conflict. Marine protected areas are widely perceived as a conflict between conservation and fishing (Klein et al., 2008) where designation can increase conflict between fishers over a limited or declining resource (Agardy et al., 2003, 2011).

Understanding and managing possible conflicts associated with marine protected areas (MPAs) is essential for the future of the ocean's biodiversity. Although MPAs are a widely recognized conservation tool, they currently cover 8.4% of areas within coastal and marine national jurisdiction and only 0.25% of the seas beyond, in comparison to the 15.4% of the terrestrial world covered by protected areas (Juffe-Bignoli et al., 2014). The Aichi Biodiversity Targets, set as part of the Convention on Biological Diversity, prescribe formal protection of 10% of coastal and marine areas by 2020 (COB, 2016). More areas are needed, with conflict over current and intended uses being the largest obstacle (Devillers et al., 2015). Spatial approaches to their establishment are a widely touted solution (Yates et al., 2015).

Minimizing conflict can be achieved through an integrated approach to management underpinned by spatial planning (Douvere, 2008; Jentoft and Knol, 2014). MSP offers a potential solution and opportunity to identify priority MPAs across a region, and link MPA planning with other local, regional, and national planning efforts (Agardy et al., 2011). Ideally, MPA planning through the MSP rubric interprets conservation requirements within a broader framework of sustainable resource use (Kenchington and Day, 2011). MSP can also help move MPA planning beyond small, discrete sites to regions. Such a broadening is essential given that megafauna such as whales often traverse multiple national jurisdictions (Agardy et al., 2011).

A commitment to spatial planning, however, is not enough. Such efforts must include mapped information about people and their communities. Trouble in MPA establishment is likely when the presence of people in the systems is not recognized (Agardy et al., 2011). St Martin and Hall-Arber (2008) refer to a "cartographic silence" in current mapping of the human dimension of the marine environment. They note that current data collection efforts for MSP do not capture the complexity of human communities or their relationships to places and resources. This gap has persisted despite the awareness that marine ecosystems include human values, knowledge, needs, processes, and impacts. A comprehensive mapping of the social landscape, similar to that utilized for the biophysical landscape, is recommended (St Martin and Hall-Arber, 2008). Other MSP commentators have noted a lack of capacity to collect, analyze, and communicate data more generally (Vince, 2013) and difficulties in assessing compatibilities and tradeoffs because information on the spatial distribution of human impacts is missing (Halpern et al., 2008).

Mapping place-based values offers a way forward to address the social dimension of the marine environment and better understand conflict. Land suitability analyses using mapped values have been undertaken for over a decade (Reed and Brown, 2003) and have evolved into a decision support model called *values compatibility analysis* (Brown and Reed, 2012) where various land uses are examined for their compatibility (or not) with the values mapped in specific locations. Underpinning suitability and compatibility analysis is the idea that current and prospective land uses ought to be consistent with the types of values expressed in specific geographic locations. Brown and Weber (2012) note that mapped values identify *relationship* values that bridge fundamental *held* values and *assigned* values (i.e., values attached to things), and can help managers identify potential conflict areas, assess the compatibility of land uses (e.g., zoning in parks), and provide public input to manage public lands (and waters).

A common method for identifying place values has been Public Participation Geographic Information Systems (PPGIS) relying on participants, recruited in a variety of ways (Brown, 2016), to indicate places they value on maps. Brown and Raymond (2014) and Hausner et al. (2015) elaborate a number of methods for identifying and calculating conflict potential indices using PPGIS data, some based exclusively on mapped values, and others that include mapped land use preferences. Lowry et al. (2009) note the need for technical assistance on conflict resolution, with PPGIS mapping able to help by identifying the spatial location of potential conflict (see Brown and Donovan, 2013). The majority of PPGIS efforts to date, however, have been directed towards land use planning; coastal and marine mapping studies by Brown (2011), Klain and Chan (2012), Ruiz-Frau et al. (2011), and Brown et al. (2016) are notable exceptions.

As such, *the main aim of this paper is to develop and apply a spatial methodology for analyzing conflict potential in a large coastal area* while demonstrating that participatory mapping can provide much-needed social data for MSP. This study meets two outstanding research needs identified for effective MSP. The first is applying a participatory mapping methodology to assess the social dimension in MSP, described as the "missing layer" (St Martin and Hall-Arber, 2008). The second is providing a methodology for revealing and analyzing conflict, a central concern in planning for the future of the marine realm (e.g., Weslawski et al., 2010).

2. Methods

2.1. Study area and policy context

The Kimberley coastline, 13,296 km in length, bounds the remote northwestern corner of Australia. The Kimberley region, at 423,500 km^2, and three times the size of England, has a population of only 34,795 people, with 40% identifying as Indigenous (ABS, 2011). Economic activities associated with the coast include commercial fishing and aquaculture, oil and gas extraction and processing, iron ore mining, ports, tourism, and pastoralism. Broome, Derby, Wyndham and Kununurra are important service centres (Fig. 1).

The Kimberley region's rugged coastline encompasses sea cliffs, secluded beaches, coastal waterfalls and 1710 islands.[1] Wilson

[1] Obtained from intersecting our study area with 1:250,000 scale island layers.

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