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## A combined DPSIR and SAF approach for the adaptive management of beach erosion in Monte Hermoso and Pehuen Co (Argentina)

Vera Semeoshenkova<sup>a, b, c, \*</sup>, Alice Newton<sup>d, e</sup>, Mara Rojas<sup>f, g</sup>, M. Cintia Piccolo<sup>f, h</sup>,  
M. Luján Bustos<sup>f, h</sup>, M. Andrea Huamantincó Cisneros<sup>f, h</sup>, Leonardo G. Berninsone<sup>b, c, i</sup>

<sup>a</sup> University of Bologna, Via Sant Alberto, 163, Scienze Ambientali, 48123 Ravenna, Italy

<sup>b</sup> University of Cadiz, Campus de Puerto-Real, Puerto-Real, 11519 Cadiz, Spain

<sup>c</sup> La Fundación Universidad Empresa de la provincia de Cádiz, 11003 Cadiz, Spain

<sup>d</sup> CIMA – Gambelas Campus, University of Algarve, Faro 8005-139, Portugal

<sup>e</sup> NILU – IMPEC, Box 100, Kjeller 2027, Norway

<sup>f</sup> Universidad Nacional del Sur, 8000 Bahía Blanca, Argentina

<sup>g</sup> Instituto de Investigaciones Económicas y Sociales del Sur (IIESS – CONICET), 8000 Bahía Blanca, Argentina

<sup>h</sup> Instituto Argentino de Oceanografía (CONICET-UNS), Florida 4500, 8000 Bahía Blanca, Argentina

<sup>i</sup> AquaMarina – Centro de Estudios en Ciencias Marinas, Pinamar, Buenos Aires, Argentina

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### ABSTRACT

Coastal areas experience multiple pressures from anthropogenic activities that negatively change the ecological and environmental status of beaches and impact human welfare. The focus of this paper is coastal erosion, an issue that is very relevant for Argentina, the second largest nation in Latin America with an extensive coastline of nearly 5000 km. Coastal erosion decreases the attractiveness of coastal areas for tourism development, leading to considerable economic impacts. In this paper, two complementary approaches, the Driver-Pressure-State-Impact-Response (DPSIR) and the Systems Approach Framework (SAF), were used to analyse two beach resorts in Argentina: Monte Hermoso and Pehuen Co. Application of the SAF included stakeholder mapping, governance (institutional) mapping and issue identification. During the participatory meetings with stakeholders and decision makers, the problem of coastal erosion was identified as the most important in the region. The joint approach of DPSIR and SAF contributed to: (i) the determination and description of the economic drivers of coastal erosion; (ii) the identification of the associated activities and pressures; (iii) the assessment of the ecological and environmental state of coastal areas; (iv) the assessment of impacts of environmental changes on human wellbeing; and finally (v) a proposal of the possible management responses for mitigating the coastal erosion problem and the sustainable development of the region to the responsible authorities.

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## 1. Introduction, context and scope

### 1.1. Importance of beaches, pressures and need for adaptive management

Beaches are unique environmental systems where natural, socio-economic and administrative components interact (Ariza et al., 2008; James, 2000). They significantly contribute to human welfare, providing many different valuable goods and services such

as leisure and recreation, coastal defense, conservation, employment, cultural heritage and identity, nutrient cycling, habitat for plants and animals (Marshall et al., 2014; Lozoya et al., 2011). Beaches represent the most complex, dynamic and sensitive land-forms of coastal environments (Dahm, 2003; Hansom, 2001) that experience irreversible changes caused by natural and anthropogenic pressures. A high demand is placed upon beach resources to meet the high expectations of tourists for leisure and recreation.

Seaside tourism is one of the fastest growing areas of the contemporary tourism market (Hall, 2001; Holden, 2008; WTTC, 2014) that has significant environmental, cultural, social and economic effects, both positive and negative (Ghulam Rabbany et al., 2013). It is an important driver of socio-economic progress

\* Corresponding author. University of Cadiz, Campus de Puerto-Real, Puerto-Real, 11519 Cadiz, Spain.

E-mail address: [vsemeoshenkova@gmail.com](mailto:vsemeoshenkova@gmail.com) (V. Semeoshenkova).

through export revenues, the creation of jobs and enterprises, and infrastructure development (WTTTC, 2014). However, if not properly planned, tourism activities and associated urban development can have destructive effects on biodiversity and pristine environments, and consequently lead to the degradation of coastal resources (Ghulam Rabbany et al., 2013). In turn, the degradation of coastal resources compromises the delivery of many ecosystem services crucial to human welfare and national economies (Dayton et al., 2005).

The problem of environmental quality deterioration of coastal zones as a consequence of high anthropogenic pressures is an issue of worldwide concern (Brown and McLachlan, 2002; Brown et al., 2014; Newton and Weichselgartner, 2014; Schlacher et al., 2008). The most common problems of modern beaches include coastal erosion, water and sand pollution, deterioration of coastal dunes and harmful effects on biota (Brown and McLachlan, 2002; Calvao et al., 2013). The importance of beach management for the preservation of coastal areas has been recognised by the municipalities and local governments of coastal regions worldwide (Phillips and Jones, 2006). Beach management has become a very important component of Integrated Coastal Zone Management (Micallef and Williams, 2002) and improving beach quality is a shared goal for all stakeholders (Duvat, 2011).

### 1.2. Coasts and beach resorts of Argentina

Coastal areas represent 18% (about 515 000 km<sup>2</sup>) of the territory of Argentina where 36% of population live (CIA, 2014; Rojas et al., 2014). Intensive urban development of coastal regions exposes these to natural hazards that in turn negatively influence human wellbeing (Caló et al., 1998, 2005; Campuzano et al., 2013). Previous studies show that there are many challenges for the management of coastal areas in Argentina, but foremost is a lack of coastal management plans and established good practices (Fernandez et al., 2006; Lemay, 1998). Both the anthropogenic activities associated with tourism, infrastructures, industries, and non-anthropogenic effects such as climate variability aggravate the erosion problem.

Coastal tourism is a very important activity in Monte Hermoso and Pehuen Co, which developed based on beach tourism, hospitality and tourist activities. These localities are the warmest beach resorts in Argentina with relatively high water temperatures and therefore are one of the best beach destinations for tourists from all over the country (Huamantínco Cisneros and Piccolo, 2011) and are centres of intense touristic development. The population increases several fold during the prolonged 7 month beach season (London et al., 2013; Rojas et al., 2014). Monte Hermoso receives visitors even in the low season with an average stay of 2–3 days (London et al., 2012). These two sites were chosen for the study because of the multiplicity of ecosystem services they provide and the crucial importance of the ocean and coastal resources for the economy and daily life of the inhabitants (London et al., 2012).

The study sites present both similarities and contrasts. Monte Hermoso is a medium size town (about 6500 residents) with well-developed infrastructure and accommodation units. It is the tourist centre with the greatest growth and expansion in the southwest of Buenos Aires province (Caló et al., 2000; Censo, 2010; Vaquero et al., 2007). Tourists seek Monte Hermoso as a “sea and beach” holiday destination (UNS, 2008). Pehuen Co is a small town (about 700 residents) known as “a forest beside the sea”. It is a low density eco-tourism site with a fully preserved forested design of unpaved street and low houses (Celsi and Monserrat, 2008; Rojas et al., 2014). According to the surveys conducted by the Office of Tourism of Coronel Rosales, “pursuing peace and nature” is the main motivation of beach visitors. Despite these differences, both sites share the same issues: coastal erosion, sustainability of the

artisanal fisheries and a rapid urban growth without urban planning. According to London et al. (2013), in Monte Hermoso and Pehuen Co, the system will continue to be in danger of erosion if the human intervention persists in the same way, i.e. a “business as usual” scenario. There is an increasing need to address integrated coastal and beach management in Monte Hermoso and Pehuen Co, because the main source of income and economy of those areas is based on “sun and beach” tourism (Celsi and Monserrat, 2008; Fiori et al., 2004; London et al., 2013; Vaquero and Pascale, 2003).

### 1.3. DPSIR and SAF approach frameworks

The DPSIR framework, provides an overall mechanism for analysing environmental problems, with regards to sustainable development (Borja et al., 2006). Despite several criticisms and appreciations, the DPSIR framework is still a useful tool (Gari et al., 2015). The evolution of the DPSIR is traced from the Stress-Response framework, developed initially by the Organization of Economic Co-operation and Development (OECD) in 1993, but modified and adopted later by European Environmental Agency (EEA) in 1999 to its present form (Gari et al., 2015). The present interpretation of the DPSIR framework links cause-effect relationships among the 5 categories.

- (i) **Drivers** function through social, demographic and economic developments in societies and associated human activities that exert pressures on the system.
- (ii) **Pressures** (e.g. the changes in use of land and resources). These pressures result in changes in the state of the environment.
- (iii) **State** reflects the level and trends of degradation and relates to the current status of the environment and ecosystem that determines the consequent ability to support demands placed on it and to deliver sustainable ecosystem services to the benefit of humans.
- (iv) **Impacts** are effects of the changes in the state of ecosystem and environment on human welfare (e.g. human life and safety, public health and well-being) and society (e.g. economy and employment).
- (v) **Responses** include management measures and societal attempts to prevent, compensate, ameliorate or adapt to changes in the state of the environment (e.g. policies, regulations, adaptive management) (EEA, 1999).

The Systems Approach Framework (SAF) is a Decision Support Systems (DSS), developed by the Science and Policy for Coastal System Assessment (SPICOSA) project during 2007–2011 (<http://www.coastal-saf.eu/>). The application of SAF starts from issue identification (with consultation with stakeholders and managers) and continues with four steps: system design, system formulation, system appraisal and system output (Tett et al., 2011). The SAF approach considers coastal zone as an integrated ecological-social-economic system (Newton, 2012) and supports the efficiency of decision-making processes. In turn, efficient management decisions contribute to the improvement of the state of socio-ecological systems with regard to sustainability, economical efficiency, and social equity.

### 1.4. Objectives of the study

The objectives of this study are:

- (i) to analyse the main economic drivers of coastal erosion;
- (ii) to analyse the pressures derived from anthropogenic activities;

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