Ecosystem Services Typology: a Wind Farm Siting Tool

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ABSTRACT

Rhode Island’s Coastal Resources Management Council (CRMC) has been leading an Ocean Special Area Management Plan (SAMP) resulting in zoning of the state’s coastal water to accommodate offshore wind farms. The wind farm siting issue has been previously considered as an optimization problem between wind resources and technological constrains (Spaulding et al, 2010). In this study we explore the ecological constrains in an Ecosystem Based Management (EBM) conceptual framework of ecosystem services using spatial multivariate statistical analysis (Principal Component and Cluster analysis), to provide an ecological typology of the coastal area based on ecological variables. The value of the resulting ecological sub-regions is assessed in term of biodiversity and resilience to the wind farm impact, expressed in terms of biodiversity and impact indices. Additional indices are developed to express other ecosystem services such as fisheries (food provisioning service and recreational service). Combining ecosystem services value with technological constrains and wind resources in a Wind Farm Siting Index (WiFSI) provides a tool to identify optimal areas to site wind farms. The method is applied, in this paper, to lattice jacket supported wind turbines, as currently proposed for Rhode Island waters, and identifies optimal potential wind farm sites in coastal and offshore Rhode Island waters.

KEY WORDS: Wind farm siting; Index; multivariate statistical analysis; principal component; cluster analysis ; EBM; offshore

INTRODUCTION

Rhode Island’s Coastal Resources Management Council (CRMC) has been leading an Ocean Special Area Management Plan (SAMP) resulting in zoning of the state’s coastal water to accommodate offshore wind farm. The wind farm siting issue has been previously considered as a solution to an optimization problem between wind resources and technological constrains (Spaulding et al, 2010) and led to the development of a technological development index (TDI), the ratio of the technological constrains associated with a specific site to the potential wind resource at this site. In the present study we expand the set of constrains involved in wind farm siting by integrating the ecosystem services as additional constraints to the technological ones. This results in a Wind Farm Siting Index (WiFSI), whose value at each potential site gives a measure of the local global constraints relative to the local resources. The index provides a convenient tool to help in wind farm siting decision. The method is applied to the Ocean SAMP area in Rhode Island coastal water with a 250 by 250 m discretization. An ecosystem based management (EBM) approach provides the conceptual framework for the ecosystem valuation (McLeod and Leslie, 2009; Arkema et al. 2006; Lester et al. 2010). In an EBM approach, the ecological and social domains are explicitly integrated in their dynamics and the interface between those domains is defined as the ecosystem services, the services the ecosystem provides to the human being (Figure 1).

Figure 1: Ecosystem Services conceptual definition. From McLeod and Leslie, 2009.