Ecosystem Services 30 (2018) 14–26

Contents lists available at ScienceDirect

Ecosystem Services

journal homepage: www.elsevier.com/locate/ecoser

Mapping ecosystem services supply chains for coastal Long Island communities: Implications for resilience planning

Anthony Dvarskas

School of Marine and Atmospheric Sciences, Stony Brook University, 167A Endeavour Hall, Stony Brook, NY 11794, United States

ARTICLE INFO

Article history:
Received 5 August 2017
Received in revised form 30 December 2017
Accepted 15 January 2018

ABSTRACT

Ecosystem services have become an important component of planning discussions at local, state, national and international levels. These services have also more recently figured into discussions of community resilience to hazard events. For the majority of ecosystem services, some contribution of human capital inputs, which we term Enabling Economic Inputs (EEIs) in this paper, are necessary to convert the raw ecosystem service flow into an ecosystem service benefit obtained by people. This paper evaluates a subset of EEIs related to coastal ecosystem services associated with (1) fishing and shellfishing; (2) recreational boating; and (3) recreational beach use. After developing a conceptual approach for EEIs, this research develops a methodology for spatially evaluating EEIs. Using a hot-spot analysis of establishments based on the North American Industrial Classification System codes, nodes in the supply chain for ecosystem services within the Long Island region are identified and analyzed. The paper concludes with an evaluation of how information on the supply chain of ecosystem services may assist in resiliency planning in coastal communities. Further research is needed to fully evaluate the conveyance system that translocates ecosystem services from supply areas to demand areas, and this research is an initial step in that direction.

1. Introduction

Ecosystem services have become an important component of coastal and ocean planning discussions at local, state, national and international levels (Braat and de Groot, 2012). These services have also more recently figured into discussions of community resilience to hazard events. For the purposes of this paper, resilience is defined according to the definition of the Intergovernmental Panel on Climate Change as "the ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner..." (IPCC, 2012). In 2015, guidance from the United States Office of Management and Budget (OMB) directed government offices to integrate ecosystem services information into project decisions (Office of Management and Budget, 2015). In the context of a changing climate it becomes important to determine how ecosystem services, with their connection to human health and well-being, may change under various hazard scenarios, particularly in coastal areas. Ecosystem assets located in coastal areas, such as beach and marsh habitats, produce a flow of potential ecosystem services that are modified by anthropogenic and natural hazard influences. Coastal storms that erode beach locations or lead to diminished water quality through runoff and increased stress on municipal wastewater infrastructure may reduce the value of the ecosystem services provided by those resources (and potential visitation to those areas). Multiple studies have demonstrated the values associated with wider beaches and cleaner waters for a range of recreational and human uses (Bockstael et al., 1987, Gopalakrishnan et al., 2011, Landry and Hindsley, 2011, Lew and Larson, 2005, Loomis and Santiago, 2013, Huang et al., 2007, Landry et al., 2003, Massey et al., 2006, Parsons et al., 2013, Pendleton et al., 2011, Whitehead et al., 2008, Whitehead et al., 2010).

Delineation of the supply chain from ecosystem asset to ecosystem service to received benefit provides a framework for identifying the ways that ecosystem change and coastal hazards may impact that supply chain, thereby interrupting the flow of ecosystem services from supplying areas to demand areas and impacting the resilience of coastal communities. Prior work has argued for a careful delineation between intermediate ecosystem components, final services, and benefits (Boyd and Banzhaf, 2007). Such an approach is also consistent with recent approaches to classifying ecosystem services, such as the EPA's draft Framework for Ecosystem Goods and Services, which involve a "handoff" between ecological and economic production processes (Landers and Nahlik,

E-mail address: anthony.dvarskas@stonybrook.edu

https://doi.org/10.1016/j.ecoser.2018.01.008
2212-0416/

2013). In this approach an ecological production function generates an ecosystem service that then reaches the beneficiary through an economic mechanism (e.g., transport networks, retail establishments). The National Ecosystem Services Classification System (NESCS) further details the potential connection between the ecosystem and explicit end users of product categories (United States Environmental Protection Agency, 2015).

A recent advance in the evaluation of flows of ecosystem goods and services and their relationship to ecosystem assets is the 2012 Experimental Ecosystem Accounting (EEA) component of the System of Environmental-Economic Accounting (SEEA) (United Nations, 2014) of the United Nations Statistic Division. This work aims to create a rigorous accounting structure that can parallel existing approaches to calculating Gross Domestic Product through the System of National Accounts (SNA) (European Communities, 2009). The SEEA EEA explicitly focuses on a spatial evaluation of ecosystem assets and flows, which we have adopted in this paper. The supply chain "nodes" as envisioned by this paper are the sequence of handoff points in the broader flow of ecosystem services from ecosystem to beneficiary; as such, this work aims to better understand the location and risks to those supply chain nodes. Recent research has started the process of applying the SEEA EEA in a real-world context (Duku et al., 2015, Keith et al., 2017, Schröter et al., 2014).

For some ecosystem goods, such as those related to fisheries, the presence of explicit markets enables treatment and evaluation of the supply chain in a manner consistent with typical market goods. As with these market-oriented goods, the movement of any ecosystem good or service from producer to the final recipient is a multi-step process involving a combination of the ecosystem asset and some amount of human-built capital such as roads, rail, ships, or tourist facilities. Approaches such as the FEGS-CS and NESCS can assist in evaluating the beneficiaries impacted by disruptions in the supply chains. While much effort has focused on the mapping of potential ecosystem services and/or their values using land cover and population datasets (Bagstad et al., 2013, Brown et al., 2015, Clarke et al., 2015, Garciá-Nieto et al., 2013, Häyha et al., 2015, Holt et al., 2015, Maes et al., 2012, Malinga et al., 2015, Remme et al., 2014, Schirpke et al., 2014, Teague et al., 2016), the landscape delineation of economic establishments required to translate potential coastal and marine ecosystem services into realized ecosystem service flows has received less attention. In this study, we provide a focused evaluation of the human-produced assets (i.e., the economic industries and establishments) that support coastal and marine ecosystem service supply chains, and consideration of their associated vulnerabilities, that will improve evaluation of potential impacts from changing environmental conditions.

2. Enabling Economic Inputs

The focus of this paper is on the economic industries that may be impacted by ecosystem shifts related to climate change, such as storms or flooding or changes in ecosystem condition (e.g., changing shellfish and fish stock location, detrimental impacts to water quality). This disruption of the supply chain, or flow from the ecosystem asset to potential human beneficiaries, will negatively affect the industries themselves and, consequently, the conversion of potential ecosystem services into final ecosystem services. Understanding, from a geographic perspective, the location of the various components of the supply chain on the landscape can assist in predicting the effects of coastal hazards on communities as well as prioritizing investments to limit economic disruption.

Building from previous conceptual models linking ecosystem function to ecosystem service flows to beneficiaries (Boyd and Banzhaf, 2007, Haines-Young and Potschin, 2010, Landers and Nahlik, 2013, Remme et al., 2014), we define Enabling Economic Inputs (EEIs) for the purposes of this research as those economic establishments that facilitate the transfer of the ecosystem services from the ecosystem supply area to the areas of ecosystem demand, thereby permitting potential ecosystem services to become realized ecosystem services (see Fig. 1). These EEIs are divided into three broad categories: (1) access-related facilities that provide a connection for the user to the ecosystem asset (e.g., parking, marinas, boardwalks, roads), (2) visitor experience-related facilities that modulate the level of satisfaction related to a user of the ecosystem asset (e.g., hotels and restaurants, but also wastewater treatment plants), and (3) market intermediaries that provide market goods or marketplaces for goods related to the acquisition of the ecosystem service (e.g., bait and tackle shops, fish and seafood markets). Table 1 provides examples of these EEIs by category. These categories include a diverse set of classifications as defined by the SNA; for example, fishing piers are fixed assets, local, state, and national parks may be classified as non-produced assets and wholesalers, fish and seafood markets, and bait and tackle shops represent different points in the intermediate and final consumption categories of SNA supply and use tables. While outside the scope of the current study, future work can harmonize these ecosystem service-related EEI categories with national accounting categories to better support eventual national SEEA EEA applications.

Significant work in the field of economic geography has researched the development of clusters and the distribution of economic activity across the landscape (Porter, 2000; Martin and Sunley, 2003). Evaluation of this distribution can permit an understanding of inequalities across geographic areas and awareness of

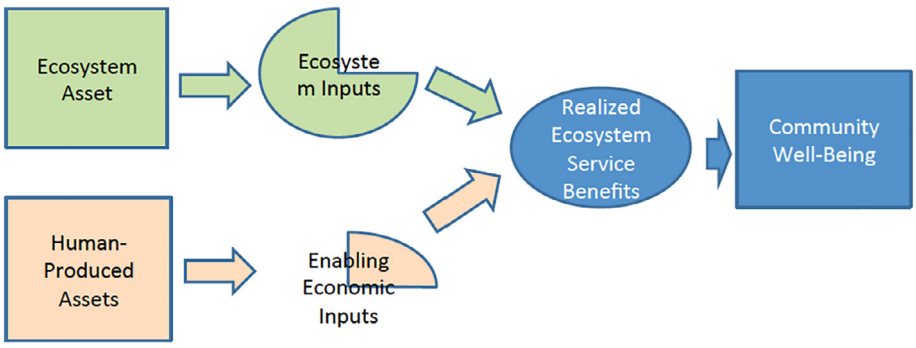

Fig. 1. Conceptual Map Linking Ecosystem with community well-being showing role of Enabling Economic Inputs.