An Ecosystem Service Value Chain Analysis Framework: A Conceptual Paper

Jonathan M. Rawlins

ABSTRACT

Modern day societies and economies are becoming increasingly vulnerable to the continued erosion of the stocks and flows of essential ecosystem services (ESs) (De Groot et al., 2010a; Vihervaara et al., 2010). The inherently conflicting nature of the current mainstream economic model and ecology provide complex, transdisciplinary and multi-scalar management challenges faced with ever increasing economic costs of inaction (Stern, 2007; TEEB, 2010). Since the 1970s, the development of the ES concept has brought about a myriad of ES management approaches (Gómez-Baggethun et al., 2010), yielding robust means for modelling, mapping, valuing and measuring ESs and their linkages to the wider economy.

1. Introduction

Modern day societies and economies are becoming increasingly vulnerable to the continued erosion of the stocks and flows of essential ecosystem services (ESs) (De Groot et al., 2010a; Vihervaara et al., 2010). The inherently conflicting nature of the current mainstream economic model and ecology provide complex, transdisciplinary and multi-scalar management challenges faced with ever increasing economic costs of inaction (Stern, 2007; TEEB, 2010). Since the 1970s, the development of the ES concept has brought about a myriad of ES management approaches (Gómez-Baggethun et al., 2010), yielding robust means for modelling, mapping, valuing and measuring ESs and their linkages to the wider economy.

Global recognition of the economy as a sub-system of the environment and rigorous scientific research in ESs is still developing, thus, robust means for modelling, mapping, valuing and measuring ESs are yet to be standardised (Gómez-Baggethun et al., 2016; Rockström et al., 2009; Sagoff, 2016; Small et al., 2017). New schools of thought purporting the interconnectedness and co-dependencies of environmental sustainability and social justice (Raworth, 2017) further emphasise the importance of holistic socio-ecological frameworks for ES management to be able to reconcile the incongruity between ecology and economics (Gómez-Baggethun and Barton, 2012).

John Stuart Mill (1822), in his famous book A System of Logic, first posited the notion of inductive inquiry, which structures any analysis of things in the natural science domain according to their individual components. Understanding intricate socio-ecological systems requires a clear definition of key system components and their associated cause and effect relationships as well as a description of the relationship of the system to other systems (De Groot et al., 2010b; Ford, 1999; Limburg et al., 2002). Complexity is a characteristic common to all coupled human-environment systems (Löehle, 2004) and thus the challenge to communicate the functionality of such systems lies within explaining the relationships between key elements of the system in a simple and transparent way.

This paper presents and critically analyses an ecosystem service value chain analysis (ESVCA) framework that applies basic system dynamics modelling in the form of causal loop diagrams to facilitate an alternative analysis of ecosystem service value chains. A scoping application of the framework is applied to a case study for flood attenuation services in the Baviasanskloof catchment in South Africa. The framework enables the identification of forward linkages and rippling effects in individual value chains of final ecosystem services as well as the identification and assessment of challenges and opportunities within individual causal pathways. Ultimately, providing the potential to advance strategies for improving the efficiency and effectiveness of final ecosystem service provision.

ARTICLE INFO

Keywords:
Ecosystem services
Value chain analysis
Causal loop diagram
Africa. Lastly, the strengths and limitations of the approach are discussed alongside directions for future research.

2. Value Chain Analyses and Ecosystem Services

Value chain analyses are conceptual frameworks used to map and categorise chosen economic, social and environmental processes in service and product value chains, ultimately aiming to help create a better understanding of how and where enterprises and institutions are positioned within the value chain and identifying opportunities and potential leverage points for improvement (Sterman, 2000). Traditionally, value chain analyses trace the value being added in each step in the life cycle of a particular good or service, from the process of production/harvesting through various steps of value adding until final consumption or utilisation and waste disposal (Baleata and Pegram, 2014; Kaplinsky and Morris, 2000).

Since the popularisation of the ES concept in the Millennium Ecosystem Assessment (MA, 2005), defining and measuring ESs has been the subject of significant scholarship (Potschin and Haines-Young, 2016). The complex and dynamic nature of socio-ecological systems make system behaviour as a function of human and natural disturbances difficult to predict (Costanza, 2015; EC, 2013), thus the incorporation of ES thinking into value chain assessments is still in its infancy. Complex system dynamics make provisioning and some regulating services more amenable to a detailed analysis because of the relative ease of logic in determining multiple intermediate services (i.e. services that only provide benefits to humans indirectly through impacts on final ESs first) (Fisher et al., 2009; Johnston and Russell, 2011).

Directly incorporating ESs into traditional market value chain analyses, albeit uncommon, has been conducted for several provisioning services such as coral reef fish (Thyresson et al., 2013), timber (Van Den Berg et al., 2013) and shade-grown coffee (Jha et al., 2011). However, there has been no attempt to map and analyse the value chain of intermediate ESs that contribute towards the production of final ESs.

ESs have been indirectly addressed through approaches to increase the sustainability of value chains, these include certification schemes, corporate social responsibility, risk management and mitigation initiatives (Grigg et al., 2009; Weiss et al., 2011). There have been numerous multi-actor activities addressing how biodiversity is and can be integrated into value chains (Bolwig et al., 2010; Van Den Berg et al., 2013). Some of these include the IUCN Global Business and Biodiversity Program (BBP) (Bishop et al., 2008), the EU Business and Biodiversity platform, the UNDP protecting biodiversity in working with agriculture project (Leibl, 2012) and the Business and Biodiversity Offsets Program (BBOP) (Van Den Berg et al., 2013). These initiatives and research endeavours emphasise the limits of market-based approaches for value chains, which range from unorganised and powerless workers and the lack of true market values for ESs to difficulties in product and service commercialisation (Wood, 2001).

Product and service value chains are geared towards linear processes and private goods that form part of a conventional neoclassical market setup. Hence, the notion of incorporating public goods (such as ESs) that generally do not have defined market values nor are traded in formal markets, into a value chain analysis will require an alternative approach to conventional linear techniques (Henderson et al., 2002).

3. Causal Loop Diagrams

System dynamics is a branch of systems thinking theory often used to explain intricate ecosystem structure and function and illustrate the outcomes of potential management strategies by graphically representing system feedback structures (Kirkwood, 2013; Richardson and Pugh, 1989). CLDs, influence diagrams or cognitive maps are a qualitative diagramming language aimed at graphically illustrating feedback-driven systems (Schaffernicht, 2010; Sterman, 2000). The next stage involves defining stocks and flows of the system and quantifying the interactions between elements to incorporate associated time delays (Ford, 1999).

A typical CLD comprises of a group of symbols representing a particular dynamic system’s causal structure. This includes all relevant variables, causal links with a polarity (either negative or positive) and symbols which identify feedback loops and their polarity (Fernald et al., 2012). Each arrow is labelled with either a + or a − sign (polarity) which represents the cause-and-effect relationship between the two variables. A + sign is used to represent a relationship where the two variables change in the same direction while a − sign indicates that the variables change in opposite directions (Kirkwood, 2013; Sterman, 2000).

Conceptualising a complex ecological system not only requires a clear definition of the key elements of the system and the cause and effect relationships between these elements, but also an account of the relationship of the system with other systems. The challenge to communicate the functionality of such a system lies within explaining the relationships between key elements of the system in a simple and transparent way. CLDs facilitate a common understanding and improved insight among stakeholders (Schafermicht, 2010). Consequently, the relationship between event and behaviour is regularly counterintuitive. These limitations highlight how system behaviour is only inferred from CLDs, emphasising the importance of verification and validation of system processes.

Reynaards and Lanzanova (2017) quantitatively explored the antagonistic and synergistic relationships between ESs provided by lakes, this research highlighted the importance of understanding ES feedbacks and interactions at the system scale. Advancing CLDs to represent natural systems addresses the challenge of building support and consensus for management strategies focusing on the trade-offs between environmental conservation and socio-economic benefits (Evans, 2004). These challenges are derived mainly from difficulty in communicating the value of ESs and the complexity of the underlying ecosystems to a broad audience consisting of different technical backgrounds and potentially conflicting perspectives (Costanza and Ruth, 1998; Lane, 2008; Morecroft, 1982).

4. Methods

4.1. Ecosystem Services Value Chain Analysis (ESVCA) Framework

Our ESVCA framework comprises the five iterative process steps illustrated in Fig. 1. The method is separated into two distinct phases, the ‘CLD development’ phase (1–3) and the ‘CLD analysis’ phase (4–5). Further iterations of the analysis phase are possible once the problem and/or objective has been reconceptualised in light of a prior analysis.

Table 1 illustrates how each step of the above-mentioned processes is included in the two-phased approach. This two-phased approach is based on an adaption and amalgamation of the major system dynamics analysis processes (A1–6) suggested by Ford (1999), the general three-step modelling process (B1–3) outlined by Costanza and Ruth (1998) and the practical value chain analysis steps (C1–3) put forward by Mindtools (2014).
دریافت فوری متن کامل مقاله

امکان دانلود نسخه تمام متن مقالات انگلیسی
امکان دانلود نسخه ترجمه شده مقالات
پذیرش سفارش ترجمه تخصصی
امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
امکان دانلود رایگان ۲ صفحه اول هر مقاله
امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
دانلود فوری مقاله پس از پرداخت آنلاین
پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات