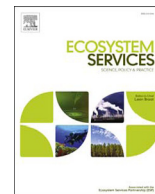




Contents lists available at ScienceDirect

Ecosystem Services

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

Interregional flows of ecosystem services: Concepts, typology and four cases

Matthias Schröter^{a,b,*}, Thomas Koellner^c, Rob Alkemade^{d,e}, Sebastian Arnhold^{c,1}, Kenneth J. Bagstad^f, Karl-Heinz Erb^g, Karin Frank^h, Thomas Kastnerⁱ, Meidad Kissinger^j, Jianguo Liu^k, Laura López-Hoffman^l, Joachim Maes^m, Alexandra Marques^m, Berta Martín-Lópezⁿ, Carsten Meyer^{g,o,p}, Catharina J.E. Schulp^q, Jule Thober^{h,r}, Sarah Wolff^q, Aletta Bonn^{a,b,s}

^a UFZ – Helmholtz Centre for Environmental Research, Department of Ecosystem Services, Permoserstr. 15, 04318 Leipzig, Germany

^b German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Deutscher Platz 5e, 04103 Leipzig, Germany

^c Professorship of Ecological Services, Faculty of Biology, Chemistry and Earth Sciences, BayCEER, University of Bayreuth, Universitätsstrasse 30, 95440 Bayreuth, Germany

^d PBL Netherlands Environmental Assessment Agency, Post Office Box 30314, The Hague, The Netherlands

^e Environmental Systems Analysis Group, Wageningen University, Post Office Box 47, Wageningen, The Netherlands

^f U.S. Geological Survey, Geosciences & Environmental Change Science Center, P.O. Box 25046, MS 980, Denver, CO 80225, USA

^g Institute of Social Ecology Vienna, Alpen-Adria Universität Klagenfurt and University of Natural Resources and Life Sciences, Vienna, Schottenfeldgasse 29, A 1070 Vienna, Austria

^h UFZ – Helmholtz Centre for Environmental Research, Department of Ecological Modelling, Permoserstr. 15, 04318 Leipzig, Germany

ⁱ Senckenberg Biodiversity and Climate Research Centre (SBIK-F), Senckenberganlage 25, 60325 Frankfurt am Main, Germany

^j Sustainability and Environmental policy group, Department of Geography and Environmental Development, Ben-Gurion University of the Negev, P.O.B. 653, Beer Sheva, Israel

^k Center for Systems Integration and Sustainability (CSIS), Department of Fisheries and Wildlife, Michigan State University, East Lansing, MI 48823 USA

^l University of Arizona, School of Natural Resources and Environment, and Udall Center for Studies in Public Policy, Tucson, AZ 85721, USA

^m European Commission—Joint Research Centre, Via E. Fermi 2749, 21027 Ispra, VA, Italy

ⁿ Leuphana University, Faculty of Sustainability, Institute of Ethics and Transdisciplinary Sustainability Research, Lüneburg, Scharnhorststr. 1, 21335 Lüneburg, Germany

^o Macroecology and Society, German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Deutscher Platz 5e, 04103 Leipzig, Germany

^p Faculty of Biosciences, Pharmacy and Psychology, University of Leipzig, Talstraße 33, 04103 Leipzig, Germany

^q Vrije Universiteit Amsterdam, Environmental Geography Group, De Boelelaan 1085, 1081 HV Amsterdam, The Netherlands

^r UFZ – Helmholtz Centre for Environmental Research, Department of Computational Landscape Ecology, Permoserstr. 15, 04318 Leipzig, Germany

^s Friedrich-Schiller-University Jena, Institute of Ecology, Dornburger Straße 159, 07743 Jena, Germany

ARTICLE INFO

Article history:

Received 12 September 2017

Received in revised form 11 January 2018

Accepted 5 February 2018

Available online xxxxx

Keywords:

Telecoupling
Teleconnection
Sustainability
Spatial flows
Drivers
Effects

ABSTRACT

Conserving and managing global natural capital requires an understanding of the complexity of flows of ecosystem services across geographic boundaries. Failing to understand and to incorporate these flows into national and international ecosystem assessments leads to incomplete and potentially skewed conclusions, impairing society's ability to identify sustainable management and policy choices. In this paper, we synthesise existing knowledge and develop a conceptual framework for analysing interregional ecosystem service flows. We synthesise the types of such flows, the characteristics of sending and receiving socio-ecological systems, and the impacts of ecosystem service flows on interregional sustainability. Using four cases (trade of certified coffee, migration of northern pintails, flood protection in the Danube watershed, and information on giant pandas), we test the conceptual framework and show how an enhanced understanding of interregional telecouplings in socio-ecological systems can inform ecosystem service-based decision making and governance with respect to sustainability goals.

© 2018 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

* Corresponding author at: UFZ – Helmholtz Centre for Environmental Research, Department of Ecosystem Services, Permoserstr. 15, 04318 Leipzig, Germany.

E-mail addresses: matthias.schroeter@ufz.de (M. Schröter), thomas.koellner@uni-bayreuth.de (T. Koellner), rob.alkemade@pbl.nl (R. Alkemade), sebastian.arnhold@uni-bayreuth.de (S. Arnhold), kjbagstad@usgs.gov (K.J. Bagstad), karlheinz.erb@aau.at (K.-H. Erb), karin.frank@ufz.de (K. Frank), thomas.kastner@senckenberg.de (T. Kastner), meidack@bgu.ac.il (M. Kissinger), liuji@msu.edu (J. Liu), laural@email.arizona.edu (L. López-Hoffman), joachim.maes@ec.europa.eu (J. Maes), alexandra.marques@ec.europa.eu (A. Marques), martinlo@leuphana.de (B. Martín-López), carsten.meyer@idiv.de (C. Meyer), nynke.schulp@vu.nl (C.J.E. Schulp), jule.thober@ufz.de (J. Thober), sarah.wolff@vu.nl (S. Wolff), aletta.bonn@ufz.de (A. Bonn).

¹ Our esteemed colleague Dr. Sebastian Arnhold sadly passed away in November 2017.

<https://doi.org/10.1016/j.ecoser.2018.02.003>

2212-0416/© 2018 The Authors. Published by Elsevier B.V.

This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

Please cite this article in press as: Schröter, M., et al. Interregional flows of ecosystem services: Concepts, typology and four cases. *Ecosystem Services* (2018), <https://doi.org/10.1016/j.ecoser.2018.02.003>

1. Introduction

Our increasingly globalized world is characterised by the distant interchange of people, goods, information, and ecosystem services (ES, contributions of ecosystems to human wellbeing). Interregional ES flows are a direct result of the physical links, policies, trade, and resource management decisions in one geographical region that can have significant impacts on ecosystems and biodiversity elsewhere (Kissinger et al., 2011; Koellner, 2011; Liu et al., 2015; Moser and Hart, 2015; Seto et al., 2012). Sustainability challenges are associated with interregional flows, such as the distribution of benefits derived from nature, globally associated costs and interregional dependencies, and broader considerations of equity and responsibilities for sustained ES management.

To date, different aspects of interregional connections have been addressed in largely isolated scientific disciplines. For instance, land system science is studying telecoupling, the complex interrelations between distant coupled socio-ecological systems (Friis et al., 2015; Liu et al., 2013) and displacement of land use (Bruckner et al., 2015; Lambin and Meyfroidt, 2011) or indirect land-use change (iLUC, Lapola et al., 2010). In ecological economics, a discourse on interregional sustainability (Kissinger and Rees, 2010; Kissinger et al., 2011) focuses on accounting for biophysical flows of natural resources, using ecological footprints (Weinzettel et al., 2014) or the human appropriation of net primary production framework (Erb et al., 2009; Haberl et al., 2009). Further, political ecology is addressing societal effects of change in land tenure (termed 'land grabbing') (Rulli et al., 2013). In the policy arena, national and international biodiversity strategies are calling for ecosystem assessments (European Commission, 2011; UNEP, 2010). However, most ecosystem assessments have ignored or underappreciated interregional ES flows (Pascual et al., 2017; Schröter et al., 2016). Considerable progress has been made to prioritize and structure ES research or policy action, and to support communication about ES among disciplines and sectors (Potschin-Young et al., 2017). Ever since the Millennium Ecosystem Assessment (MA, 2005), conceptual frameworks for ES have acknowledged the distinction between ecosystems and social systems, and the need for a connection between these subsystems to attain actual benefits of ES. The ES cascade (de Groot et al., 2010) frames the service itself as this connection and Villamagna et al. (2013) explicitly mention flows from ecosystems to beneficiaries. Several studies have acknowledged different scales in ecosystem service research (Costanza, 2008), and others have quantified or conceptualized flows from providing to benefiting areas (Bagstad et al., 2013; Serna-Chavez et al., 2014). Yet linkages between providing and benefiting areas have mainly been studied at smaller scales (e.g., García-Nieto et al., 2013; Kroll et al., 2012) and there is little knowledge on the magnitude, drivers and effects of interregional ES flows, in particular for regulating and cultural ES, with a few notable exceptions. For instance, López-Hoffman et al. (2010) described provisioning, regulating and cultural ES flows between Mexico and the U.S., and Liu et al. (2016) analysed the telecoupling of water-related ES across China. The UK national ecosystem assessment analysed biomass trade with other world regions and estimated the land requirements in exporting countries (UK NEA, 2011), while Yu et al. (2013) provided virtual land flow analyses for traded crops and timber indicating flows of provisioning services.

Our objective is to synthesise knowledge from various fields to better understand, analyse and support governance of complex interregional ES flows towards interregional sustainability. We develop a framework of interregional ES flows and a typology of four general flow types to guide future ES assessments by building on the concepts of telecoupling (Liu et al., 2013; Liu et al., 2015),

also referred to as societal teleconnections (Moser and Hart, 2015) and interregional sustainability (Kissinger and Rees, 2010; Kissinger et al., 2011). We illustrate our framework with four case studies on (a) trade of a provisioning service, coffee, produced under certified schemes in Colombia; (b) flow of cultural and food provision services through migration of the northern pintail duck (*Anas acuta*) between Canada and the U.S.; (c) regulating services through flood protection along the Danube River; and (d) cultural services derived from information flows of the existence of the giant panda (*Ailuropoda melanoleuca*) (Box 1). We then address the linkages between interregional ES flows and sustainability. We conclude with the identification of key knowledge gaps that would enable improved consideration of interregional ES flows in science and policy.

Box 1 Introduction to the case studies. (a) *Biophysical flow of traded goods: Certified coffee from Colombia as provisioning service*

Coffee production, a provisioning service, has been dominated by intensively managed, monoculture, sun coffee plantations, associated with significant environmental implications (Jha et al., 2014). Concerns over the environmental and social impacts of dominant coffee production systems have triggered a shift in consumer preferences in importing countries that has strengthened the market for certified coffee (Manning et al., 2012). Today, Colombia is one of the world's largest coffee producers. During the last decade, over 80% of the coffee produced in Colombia was exported (FAO, 2017). By 2010, more than 25% of farmers and over 30% of Colombian coffee were part of certification schemes (Rueda and Lambin, 2013). Within certification schemes, farmers are offered financial and technical support through donor agencies, research centres, non-governmental organisations and local cooperatives as well as the Colombian government and the Colombian Coffee Growers Federation (Hughell and Newsom, 2013; Rueda and Lambin, 2013).



Photo: Juan Arias

(b) *Biophysical flow through species migration and dispersal: Provisioning and cultural services provided by northern pintails migrating between Canada and the U.S.*

Northern pintails (*Anas acuta*) are medium-sized dabbling ducks that feed on plants and invertebrates in agricultural and wetland habitats. Due to their beautiful plumage and elongated tail feathers, pintails provide cultural ES through opportunities for bird watching and recreational sport hunting (Austin and Miller, 1995; Mattsson et al., 2012) as well as provisioning services as a food source for Arctic indigenous groups (Goldstein et al., 2014). Pintails migrate in spring from their wintering regions at the coast of California and the

Download English Version:

<https://daneshyari.com/en/article/6556290>

Download Persian Version:

<https://daneshyari.com/article/6556290>

[Daneshyari.com](https://daneshyari.com)