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A worldwide country-based assessment of social-ecological status (c. 2010) using the social-ecological status index

Ronald C. Estoque*, Yuji Murayama

Faculty of Life and Environmental Sciences, University of Tsukuba, 1-1-1 Tennodai, Tsukuba City, Ibaraki 305-8572, Japan

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ABSTRACT

It is not uncommon today that countries worldwide are assessed or ranked using major composite social (e.g. human development index) or ecological (e.g. biodiversity index) indicators. However, until today they have not been assessed or ranked using a social-ecological status indicator. Knowledge of the status of a social-ecological system, a system that includes human and environmental subsystems interacting together, is important for socio-economic development and for natural resources and disaster management. Hence in this article, we assessed the social-ecological status of various countries around the world (c. 2010) using a composite social-ecological status indicator built upon the three pillars of sustainability (economic prosperity, social justice, and environmental quality), called the SESI (social-ecological status index). The value of the SESI ranges from −1 (least desirable) to +1 (most desirable). Out of the 144 countries evaluated, 69 (47.92%) have SESI values that are below the overall average SESI value (0.197). Geographically, most of the countries with low SESI are distributed across the continents of Asia and the Americas, but especially Africa. The results can be used for conveying to the public the social-ecological status of various countries around the world, including their potential sources of social-ecological resilience and pressure.

1. Introduction

With sustainability as a key driving force, the understanding of the relations between humans (social) and the environment (ecological) has become the focus of an important paradigm, i.e. the socio/social-ecological system (SES) (Gallopin et al., 1989; Berkes and Folke, 1998; Anderies et al., 2004; Young et al., 2006; Ostrom 2007, 2009; Petrosillo et al., 2015), also known as the coupled human-environment system (Turner et al., 2003) and the coupled human and natural system (Liu et al., 2007). Prior to the advent of this paradigm, the focus was on a paradigm characterised by unidirectional relations between human and natural systems, that is, either human systems are constrained by or with input from/output to natural systems, or natural systems are subject to human disturbances (Liu et al., 2007; An 2011; An and Lopez-Carr 2012). The SES paradigm and its variants are designed to better understand the multifaceted complexity in many human-environment systems, particularly feedback and dynamics (An and Lopez-Carr, 2012).

For the purpose of providing a better understanding of the complexity of an SES and to help make better decisions about sustainability, various conceptual models and frameworks have been proposed (e.g. Anderies et al., 2004; Redman et al., 2004; Ostrom 2009; see also Estoque and Murayama, 2014a). The common goal of these conceptual models and frameworks is to help in the management of social-ecological resources (sources of resilience) as well as perturbations and disturbances (sources of pressure) in order to achieve ecologically sustainable socio-economic development (Estoque and Murayama, 2014a). However, the challenge regards how these models and frameworks can be deduced and operationalised so that the status of an SES at any particular point in time can be assessed. Furthermore, there is still no consensus as to what or which measure should be used to indicate the status of an SES. It is for these reasons that the social-ecological status index (SESI) has been proposed (Estoque and Murayama, 2014a) (see Section 2 for the overview of the SESI).

It is not uncommon today that countries worldwide are assessed or ranked using major composite social (e.g. human development index) or ecological (e.g. biodiversity index) indicators. However, until today they have not been assessed and ranked using a social-ecological status indicator that is as comprehensive as the SESI. Knowledge of the status of an SES, a system that includes human and environmental subsystems interacting together, is important

* Corresponding author.
E-mail addresses: estoque.ronald.ga@u.tsukuba.ac.jp, rons2k@yahoo.co.uk (R.C. Estoque), mura@geoenv.tsukuba.ac.jp (Y. Murayama).

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for socio-economic development and for natural resources and disaster management. Hence, the purpose of this article is to assess the social-ecological status of various countries around the world (c. 2010) using the SESI. In this article, the SESI is also compared with other major social and ecological indicators. Its main features and potential limitations are also discussed.

2. Brief overview of the SESI

Like some of the major indicators of use today that make use of normalised data, e.g. the human development index (HDI) (HDR 2013) and the world risk index (WRI) (World Risk Report, 2011), the SESI measures the status of an SES relative to the other SESs. At the country level, the HDI and WRI measure the level of human development and risk, respectively, in one country also relative to the other countries.

The SESI in general is based on the concepts of resilience and pressure (Holling, 1973; Adger, 2000; Anderies et al., 2004; Folke, 2006; Gallopin, 2006; Folke et al., 2010; Halpern et al., 2012; Selig et al., 2013; Castonguay et al., 2016; Müller et al., 2016), concepts that are both related to the Sustainable Development Goals (SDGs) (http://www.undp.org). In particular, these two concepts build the two main components of the SESI, namely the potential sources of social-ecological resilience (R_{SE}) and potential sources

Table 1
List of indicators used for the six dimensions of the SESI and their sources.

Component/Dimension	Indicator	Description	Date	Data source
R_{SE}				
• Socio-economic integrity (I_{SO})	• HDI	This is a summary measure of key dimensions of human development. It measures the average achievement in a country on three basic dimensions of human development: a long and healthy life (life expectancy), access to knowledge (education), and a decent standard of living (income). The HDI is the geometric mean of normalised indices from each of these three dimensions.	2010	UNDP (2014)
• Governance integrity (I_{GV})	• World governance indicators – government effectiveness (WGI-GE)	Government effectiveness (GE) is one of the six dimensions of governance monitored by the World Governance Indicators (WGI) project. GE reflects perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.	2010	WGI (www.govindicators.org)
• Ecological integrity (I_{EC})	• Biocapacity (BC)	Biocapacity quantifies nature's capacity to produce renewable resources, provide land for built-up areas and provide waste absorption services such as carbon uptake. It acts as an ecological benchmark against which the ecological footprint can be compared.	2008	WWF (2012)
	• Global environment facility benefits index for biodiversity (GBIBIO)	GBIBIO is a composite index of relative biodiversity potential for each country based on the species represented in each country, their threat status, and the diversity of habitat types in each country.	2008	World Development Indicators (http://data.worldbank.org/)
P_{SE}				
• Exposure to hazard (P_{EH})	• Exposure to hazard (EH)	Exposure to (natural) hazard is one of the two main components of the World Risk Index (WRI) (the other is vulnerability). The WRI is designed with a focus on the natural hazards that occurred from 1970 to 2005. In the WRI, five natural hazards were considered: earthquakes, storms, floods, droughts, and sea level rise.	2011	World Risk Report (2011)
• Sensitivity to hazard (P_{SH})	• Population density (PD)	Population density is mid-year population divided by land area in km^2. Population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship – except for refugees not permanently settled in the country of asylum, who are generally considered part of the population of their country of origin. Land area is a country's total area, excluding area under inland water bodies, national claims to continental shelf, and exclusive economic zones. In this study, population density is one of the two proxy measures used for sensitivity to hazard.	2010	World Development Indicators (http://data.worldbank.org/)
	• Protected area density (PAD)	Protected area density is determined by calculating the percentage of protected area in one country relative to the country's land area. In this study, the World Database on Protected Areas (WDPA) was used. The WDPA is the most comprehensive global spatial dataset on marine and terrestrial protected areas available. In this study, protected area density is one of the two proxy measures used for sensitivity to hazard.	2013	IUCN and UNEP-WCMC (2013)
• Environmental pressure (P_{EN})	• Ecological footprint (EF)	The ecological footprint tracks humanity's demands on the biosphere by comparing humanity's consumption against the Earth's regenerative capacity, or biocapacity. It does this by calculating the area required to produce the resources people consume, the area occupied by infrastructure, and the area of forest required for sequestering CO_2 not absorbed by the ocean.	2008	WWF (2012)
	• Carbon dioxide (CO_2) emissions	Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during the consumption of solid, liquid, and gas fuels and gas flaring.	2010	World Development Indicators (http://data.worldbank.org/)

Note: This structural composition of the SESI is based from Estoque and Murayama (2014a).