ARTICLE IN PRESS

Ecosystem Services ∎ (∎∎∎∎) ∎∎∎–∎∎∎

Contents lists available at ScienceDirect

Ecosystem Services

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

In the eye of the stakeholder: Changes in perceptions of ecosystem services across an international border

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ARTICLE INFO

Article history:
Received 24 August 2013
Received in revised form
11 February 2014
Accepted 9 April 2014

Keywords:
Ecosystem services
Stakeholders
Trans-border
Hyper-arid ecosystems
Social research methods

ABSTRACT

Integration of the ecosystem service (ES) concept into policy begins with an ES assessment, including identification, characterization and valuation of ES. While multiple disciplinary approaches should be integrated into ES assessments, non-economic social analyses have been lacking, leading to a knowledge gap regarding stakeholder perceptions of ES.

We report the results of trans-border research regarding how local residents value ES in the Arabah Valley of Jordan and Israel. We queried rural and urban residents in each of the two countries. Our questions pertained to perceptions of local environmental characteristics, involvement in outdoor activities, and economic dependency on ES.

Both a political border and residential characteristics can define perceptions of ES. General trends regarding perceptions of environmental characteristics were similar across the border, but Jordanians tended to rank them less positively than Israelis; likewise, urban residents tended to show less affinity to environmental characteristics than rural residents. Jordanians and Israelis reported partaking in distinctly different sets of outdoor activities. While all groups reported little economic dependence on ES, rural Israelis reported the highest dependency.

We suggest that social approaches to ES assessment can complement the predominant ecological and economic approaches thereby strengthening the relevancy of ES assessments to policy-making.

1. Introduction

Ecosystem services (ES), defined as "the benefits provided by ecosystems to humans, which contribute to making human life both possible and worth living" (Millennium Ecosystem Assessment (MA), 2005), have become a prominent conceptual frame for environmental research and policy-making from the local to the global scale (e.g. Carpenter et al., 2009; de Groot et al., 2010; Collins et al., 2011; Kareiva et al., 2011). Introduced in the 1980s (Ehrlich and Mooney, 1983), the concept evolved slowly, but its prominence as measured by academic publications grew exponentially since the 1980s. At the turn of the 21st century, the concept rose to prominence in the academic and policy-making communities with the publication of the Millennium Ecosystem Assessment (MA) (2005), the establishment of the United Nations Intergovernmental Platform on Biodiversity and Ecosystem Services in 2010, and the proliferation of national-scale ES assessments like those in Great Britain (UK National Ecosystem Assessment (UK-NEA), 2011), Japan (Japan Satoyama Satoumi Assessment, 2010), and recently in Israel.

For scientists and practitioners, ES serve as (1) a conceptual and empirical link between ecological integrity and human survival and wellbeing (Millennium Ecosystem Assessment (MA), 2005; Müller and Burkhard, 2007), (2) a framework in which to integrate natural and social science research towards environmental sustainability (Collins et al., 2011), and (3) a vehicle with which to communicate the importance of nature conservation to policy makers and the general public, thereby generating more public support for conservation policy and research (Luck et al., 2012). The assessment of ES (identification, characterization, and valuation) has evolved into a major activity bridging the scientific and policy-making communities.

ES assessment, according to most researchers, demands an integrative approach that considers ecological, economic and social evaluation criteria (Burkhard et al., 2010). While this triumvirate of approaches is advocated in most major writings on the topic, social assessments lag far behind the others in both research and policy integration (Chan et al., 2012; Tengberg et al., 2012). The current research employs a conceptual approach and research methodology drawn from the non-economic social sciences in order to assess ES and explore how this knowledge

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http://dx.doi.org/10.1016/j.ecoser.2014.04.004
2212-0416/

Please cite this article as: Orenstein, D.E., Groner, E., In the eye of the stakeholder: Changes in perceptions of ecosystem services across an international border. Ecosystem Services (2014), http://dx.doi.org/10.1016/j.ecoser.2014.04.004

complements our current understanding of ES and their value to humans. In doing so, we find support for the claim that strengthening non-economic, social approaches to ES assessment can address some of the ethical concerns and critiques regarding the ES conceptual approach (e.g. Kosoy and Corbera, 2010; Dempsey and Robertson, 2012; Luck et al., 2012).

We offer two important caveats regarding the definition of ecosystem services. First, a strict and broadly applied definition of ecosystem services remains somewhat elusive. The MA definition provided above is the most common, but later definitions (e.g. UK National Ecosystem Assessment (UK-NEA), 2011) draw a distinction between ES (activities or functions of an ecosystem that provide benefits) and the benefits themselves (the ways that human wellbeing is enhanced through the processes and functions of ecosystems via ES; Mace et al., 2012). This distinction is important because in social assessments that are based on querying public perceptions (as in the current research), people relate to benefits that arise from ES (particularly provisioning and cultural services) and generally not to the underlying ES (Sagie et al., 2013).

Second, ecosystem services are generally defined as dependent on biodiversity (Millennium Ecosystem Assessment (MA), 2005), which introduces some ambiguity as to whether landscapes and seascapes are actually ES as defined in some of the literature (e.g. Gee and Burkhard, 2010; Sagie et al., 2013) if their value is not directly attributable to biodiversity. The UK National Ecosystem Assessment (UK-NEA), (2011) partially resolves this conundrum by emphasizing the importance of geodiversity alongside biodiversity. The inclusion of geodiversity opens the door to defining cultural landscapes as an important component of cultural ES. The importance of this connection is magnified in deserts, where the paucity of primary productivity exposes the geological landscape and, as will be shown here, contributes one of the most important cultural services in hyper-arid regions.

1.1. Ecological and economic approaches to ES assessment

As noted, the ES literature is explicit and consistent in its call for interdisciplinary assessment of ES. But most of the state-of-the-art research has taken either an ecological or economic approach, or a combination of the two (Raymond et al., 2013). We define an "ecological approach" to ES assessment to be one that (1) focuses on identifying, characterizing and quantifying the underlying ecosystem processes that provide ecosystem services and/or (2) focuses on supporting and regulating services (which, as ecological processes, are difficult to quantify in monetary terms). The central role of ecologists in ES assessment is understandable considering that the concept was born within this discipline (Ehrlich and Mooney, 1983) and the normative goal driving the proliferation of the concept has been the protection of biodiversity and ecosystem processes. In general, the ecological approach to ES is based on the much older concept of ecosystem structure and function (e.g. Wessman and Asner, 1998) that is linked to what is now considered supporting ecosystem services (de Groot et al., 2002; Millennium Ecosystem Assessment (MA), 2005).

The main methodological approach of ecological ES assessment has been spatial mapping and quantification of services (e.g. Naidoo et al., 2008; Kareiva et al., 2011). This activity uses ecological currencies for measurement, such as cubic meters of water, tons of carbon, numbers of species, etc., as well as the integration of monetary values of goods and services. This mapping approach is followed by modeling land use change and its impact on the provision of services. This approach generally focuses on one to several services at a time (Kareiva et al., 2011). A second ecological approach to ES assessment is conducting a general inventory of ES (presence/absence) over a spatial land use/land cover gradient. This approach can account for a large spectrum of ES, though only contributes to the first stage of ES assessment (identification; Dick et al., 2011; Orenstein et al., 2012).

As the ES conceptual framework became increasingly popular, economic-based ES assessment rose in prominence. While there is a broad diversity of economic approaches to ES assessment, we refer to economic approaches as those that focus on valuing ES in monetary terms, regardless of methodology. While economics-based ES assessment is a logical extension of classical natural resource economics, we attribute the now ubiquitous role of economists in ES assessment to two historical developments within academia. The first was the evolution of ecological economics (as distinct from classical natural resource and environmental economics), which predated the widespread proliferation of the ES concept, and which considered the human economy as embedded within and dependant on natural ecosystems (Costanza, 1996; Sattler and Matzdorf, 2013). This discipline's intellectual raison d'état prepared it conceptually and methodologically for the arrival of the ES concept (e.g. Costanza et al., 1997). Accordingly a large amount of ES work is published in the flagship journal of the discipline, Ecological Economics (e.g. Farber et al., 2002; Hein et al., 2006; Fisher et al., 2009).

A second development was a successful collaboration, starting in the 1990s, between classical (often natural resource) economists and ecologists (e.g. Arrow et al., 1995; Daily et al., 2000). Out of this relationship was born a common language of mathematical modeling and a mutual desire to monetize nature's capital. Thus, when the subject of valuation of ecosystem services rose to prominence (largely among the same research groups), this collaborative was poised to address new challenges of ES assessment. The strength of the economic-ecological disciplinary connection is reflected in the professional profile of the MA Panel, comprised of two co-chairs, an ecologist and an economist, and thirteen panel members including seven ecologists and six economists.[1] As such, there is a prodigious amount of interdisciplinary ecological-economic research on ES assessment (Nelson et al., 2009; Tallis and Polasky, 2009).

Reflecting these trends in the academic community, the most prominent policy initiatives emanating from the governmental and non-profit sectors also focused on economic (i.e. monetary) valuation of ES. Multiple efforts to develop common ES classification methods used monetary valuation, such as the Common International Classification of Ecosystem Goods and Services (Haines-Young and Potschin, 2013; TEEB, 2013), the UN's System of Environmental and Economic Accounting (which follows the System of National Accounts; United Nations Statistical Division, 2014), and the Economics of Ecosystems and Biodiversity (TEEB, 2013). Researchers focusing on the policy-uptake of ES assessments also emphasize economic valuation as a primary outcome of their policy-relevant research (Maes et al., 2012). To date, the most popular policy tool arising from the ES framework is the "payment for ecosystem services" (PES) program, which is constructed on the basis of monetary valuation of ES and which is widely endorsed by governmental institutions and international environmental organizations (e.g. World Wildlife Fund, 2007; Katoomba Group, 2008; Greiber, 2009). There is already a significant amount of experience implementing PES programs worldwide (Sattler and Matzdorf, 2013; Schomers and Matzdorf 2013).

While ecological and economic approaches to ES assessment have significantly advanced our ability to identify, characterize and value ES, the theoretical and practical implications of these approaches are also significant for their faults and limitations (Knights et al., 2013). Turnhout et al. (2013), for example, raise

[1] To be sure, it is likely that there are non-economist social scientists among the 700 authors and 1000 reviewers, but none among the leaders of the initiative.

practical concerns regarding the commodification of nature as a method to protect biodiversity:

> A concern shared by many… is that attempts to accumulate knowledge according to particular logics – in this case ecosystem services and economic logics – work inside and perpetuate the very logics that have produced biodiversity loss in the first place… Ironically, this brings to market ever more aspects of biodiversity, whereas other aspects of biodiversity that currently have no or little value within these logics risk not being conserved at all, or even destroyed. (Turnhout et al., 2013, p6)

Others argue more generally against the commodification of nature as ignoring the ethical dimensions of nature and biodiversity (Kosoy and Corbera, 2010; Luck et al., 2012).

Another strand of criticism focuses on an overemphasis on biophysical aspects of ES assessment and a purported lack of attention to the human dimension within the ES discourse (Menzel and Teng, 2009; Chan et al., 2012). These researchers suggest that the values and needs of local users (as measured in various non-monetary terms) should guide the ES assessment process. They call for an integration of social assessments that would, for example, record the intensity of stakeholder–environment interactions as indicators of ES value.

1.2. Importance of social approaches for ES assessment and precedents.

We cannot assess the benefits of ES without understanding who the beneficiaries are and how they respond to ecosystem service provision. Ecologist Kurt Jax suggests that "to assess ecosystem services in a particular region, we have to work our way backwards from society and its specific needs to ecosystem processes – and not vice versa, as scientists mostly do" (Jax, 2010, p70). We consider social approaches to ES assessment as those that: (1) apply research methods from the social sciences and humanities, including surveys, interviews, focus-group discussions, field observations of behavior, ethnographies, historical studies and others; (2) value ES in non-monetary terms, for instance in terms of intensities of response, narratives, behaviors, perceptions, values and identity, and; (3) explicitly make stakeholders the focal point of the research. Non-economic social approaches to ES assessment could significantly strengthen the value of assessments in general by complementing traditional economic and ecological approaches. Such advantages include:

- **Valuing cultural services**. Cultural services are often undervalued or not considered within ES assessments (Gee and Burkhard, 2010; Chan et al., 2012). Ecological assessment tools are not designed to assess human perceptions and economic assessment tools that rely on monetary measures often do not accurately identify and value cultural services, whose value would be more accurately measured in cultural or spiritual terms. Though some attempts are made to monetarily value cultural services directly, for instance via the economic revenue they generate (Uddin et al., 2013), or indirectly, scholars argue convincingly that economic approaches chronically undervalue cultural goods and services (Chan et al., 2012; and Throsby (2003), who was not writing about ES in particular, but the argument is nonetheless relevant). Interdisciplinary approaches, including social valuation, are needed to improve understanding of cultural ES.
- **Understanding complex socio-ecological systems**. In socio-ecological systems, ecosystem services are recognized as a connection between ecological processes and human behaviors. Social research is necessary for understanding the actual and potential human responses to changes in the provision of ES (Duraiappah and Rogers, 2011). Further, social knowledge is necessary to understand how societal characteristics such as culture, worldviews, and beliefs, affect policy and institutions, which in turn affect human impacts on ecosystems, which affect ecosystem processes, which then affect change in the provision of ecosystem services. Over the course of the past century, several "intellectual genealogies" have emerged that focus on social systems as embedded in and interacting with natural systems, including ecological economics, human ecology, political ecology, cultural ecology and environmental history (Singh et al., 2013). These disciplines assess socio-ecological systems holistically and thus are well placed for understanding human perceptions of and response to ecosystem service provision.
- **Assuring social relevance of the ES assessment process**. ES assessment is promoted as a tool to integrate diverse stakeholders into a more participatory policy and planning process (Cowling et al., 2008; Menzel and Teng, 2009; Maynard et al. 2010). Thus, ES assessment should be a social process that includes social learning. As the social sciences (sociology, anthropology, environmental psychology, and political science, for example) are people-centered disciplines, their research approaches and paradigms can be well suited to defining and integrating stakeholder concerns into policy and planning. Rogers and Schmidt (2011) suggest that social scientists can contribute to ES assessment particularly in the realm of stakeholder integration, including (1) the *scientific* identification of stakeholders for further research, (2) identifying *values* of stakeholders and (3) identifying the potential impact on stakeholder groups of various ES management scenarios.
- **Strengthening the policy relevance of ES assessments.** Policy making, while informed by science, is primarily a social process (Cohen, 2006). Natural scientists can and should have a role in environmental policy making, but they are only one of many stakeholder groups involved in the policy making process. Social scientists contribute both their disciplinary expertise towards successful policy making, but also, via their research, contribute their ability to reflect the perceptions and needs of stakeholders (see previous point). Chan et al. (2012) note that neglecting cultural values and services in ES-related programs can decrease the chance of successful implementation of the program; such neglect may presumably be avoided when assessments are conducted through a multi-disciplinary, inter-disciplinary or trans-disciplinary[2] lens. Indeed, one the most important motives for integrating natural and social science approaches is to promote more policy-relevant research (Redman et al., 2004; Haberl et al., 2006; Singh et al., 2012).

There has been a small amount of ES research employing social approaches. These works have contributed empirical data regarding human perceptions and valuation of ES and have offered a critical perspective on existing ES research, assessment and policy practices. Martín-López et al. (2014) used survey-based data, asking respondents to rank the most important ES, and used results to value ES in the socio-cultural domain. They then compare these results to data reflecting the monetary and the bio-physical value-domain. Sodhi et al., (2010), also using surveys, queried how much locals appreciate forest services in south-east Asia, and Aretano et al. (2013) used a survey-approach to detect whether local populations in small Mediterranean islands are

[2] "Trans-disciplinary" implies the inclusion of expertise from multiple academic disciplines *and* the inclusion of stakeholders (e.g. local residents, economic interests, policy makers, land use managers; Haberl et al., 2006)

conscientious of the changes in ES provision over time. Gee and Burkhard (2010) assessed ES from the perspective of stakeholders in Germany's North Sea coast through interviews, while other ES research employ textural analysis and focus group discussions to assess ES from the perspective of stakeholders (Maynard et al., 2010; Wilson and Howarth, 2002). Among this small body of work, there is a smaller body of trans-national comparative ES assessment, such as that of López-Hoffman et al., (2010) along the US-Mexican border and Sagie et al. (2013) in the Arabah valley of Israel and Jordan.

It is crucial to note that there are several academic disciplines that have a long and rich tradition of studying human–environment interactions (e.g. how people use their environment in physical and non-physical ways, and how values, culture and beliefs impact the way humans relate to their natural environment), and these works can inform our knowledge regarding stakeholder perceptions of ES. These include research in environmental psychology (Eisler et al., 2003), anthropology, environmental management (Fraser et al., 2006; Maynard et al., 2010), landscape architecture and urban planning (Zube and Pitt, 1981; Johnson et al., 2002).

Within the policy realm, particularly in the European Union, social assessment and valuation is gaining increasing attention. For instance, the PEER report, "A Spatial Assessment of Ecosystem Services in Europe" highlights the importance of recreational value of biodiversity and its multiple benefits (though here, too, values are primarily offered in monetary terms; Maes et al., 2012). The European COST project "Tourism, Wellbeing and Ecosystem Services" (TObeWELL) is adopting the ES framework for analyzing the health value of recreational activities. Within the context of this work, Smith (2013) builds upon the well-established connection between outdoor recreation and health, querying Hungarian students regarding their outdoor activities. Other EU-funded projects currently in progress, including "Ecosystem Science for Policy and Practice (OPERAs)," "Biodiversity and Ecosystem Services: Arguments for our Future Environment (BESAFE)," and "Motivational strength of ecosystem services and alternative ways to express the value of biodiversity (BIOMOT)," are focusing on alternative methods for valuing ES beyond monetary valuation. Knight et al. (2013) write of the BIOMOT project:

> "It is a premise of the BIOMOT project that despite increasingly sophisticated economic valuations consistently presenting substantial monetary figures for environmental goods, policy makers and publics remain insufficiently motivated to act in such a way that these goods are adequately protected, as evidenced by the fact that after many thousands of valuation exercises claiming that biodiversity and other environmental goods are worth the equivalent of substantial monetary sums, biodiversity loss in Europe continues… This leads to the hypothesis that there is something deficient about the motivational capacity of standard economic valuation methods." (Knight et al., 2013, p44)

The goal of the present research was to understand how stakeholders perceived the benefits they receive from ecosystem services. Specifically, we ask the following:

- How do local residents perceive and value ecosystem services in a hyper-arid ecosystem?
- How do perceptions of ecosystem services change, if at all, according to nationality (Jordanian or Israeli) and residential type (rural or urban)?
- What type of information can be collected using social approaches to ES assessment that can complement the knowledge derived from other disciplinary approaches?

We conducted surveys in the hyper-arid Arabah Valley of Jordan and Israel in urban and rural communities. Through stakeholders, we identify the ES they receive from their ecosystem and value them in social terms (e.g. level of ranked importance, level of perceived economic dependency). Since the study includes two countries and two residential types, we elucidate not only which ES are identified and valued by stakeholders, but how social-geographic factors might influence their assessment.

2. Material and methods

2.1. Research site

Our research area is the southern Arabah Valley (Fig. 1; "Arava" in Hebrew). The Arabah Valley is a hyper-arid desert with annual average rainfall of less than 30 mm. The valley is bounded by the Edom Mountains to the east, the Negev Mountains to the west, the Dead Sea to the north, and the Gulf of Aqaba/Eilat to the south. The political border between Jordan and Israel runs roughly down the middle of the valley from north to south. Our research area boundaries were chosen according to both administrative and topographic borders. The Jordanian research area included those communities in the Wadi Arabah sub-district within the Aqaba district. The Israeli research area included those communities in the Hevel Eilot Regional Council that were located on the valley floor. The rural communities in the Jordanian Arabah are Bedouin villages and the rural communities in the Israeli Arava are primarily kibbutzim (collective settlements). We also included the two coastal cities at the southernmost tip of the Arabah Valley, Aqaba in Jordan and Eilat in Israel.

The population of the Jordanian Wadi Arabah sub-district in 2011 was approximately 5570 and the population of Aqaba was 107,780 (Department of Statistics, 2012) The rural area is characterized by high unemployment and poverty rates, with 53% of the population living under the poverty line and 15.7% unemployment in the Aqaba Governorate in 2012 (compared to 12.2% nationally; Aqaba Governorate, 2005; Hashemite Kingdom of Jordan, 2004; Department of Statistics, 2012). Even among Jordanian pockets of poverty, Wadi Arabah is considered extreme

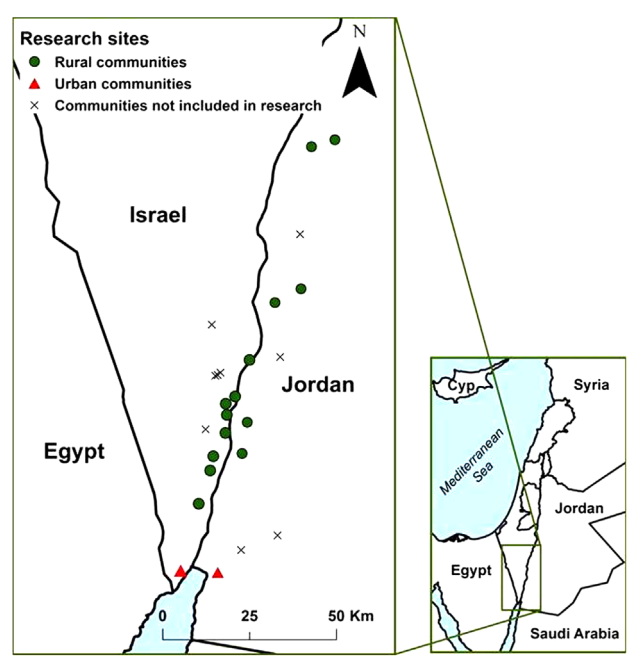

Fig. 1. Study site.

Table 1
Key social and demographic features of sample population (*relative to respective national average income). Data: Aqaba Governate, 2005; Central Bureau of Statistics, 2010; Department of Statistics, 2012.

Characteristic	Jordan-urban (Aqaba)	Jordan-rural (Wadi Arabah)	Israel-urban (Eilat)	Israel-rural (Eilot Regional Council)
Population size	107,780	5570	47,000	3000
Economic class*	Average	Low	Average	Average
Sources of income	Tourism, trade, services	Services, military, agriculture, livestock	Tourism, trade, real estate, small businesses	Agriculture, services, tourism, light industry
Religion	Islam	Islam	Judaism	Judaism

(UNDP, 2012). The primary forms of employment are government services, military, agriculture and livestock grazing. In Aqaba, employment is provided in tourism, trade, and government services. The population of the Israeli southern Arava Valley (Eilot Regional Council) in 2008 was 3000, all in kibbutzim and one exurban residential community. The population of Eilat was 47,000. Both Eilat and the Hevel Eilot Regional Council are in the middle range of Israel's socio-economic rankings (with a ranking of 5 on a scale of 1–10; Central Bureau of Statistics of Israel, 2008). Employment in Hevel Eilot is primarily in agriculture, services, tourism, and light industry. In Eilat, employment is in tourism, trade, real estate and other businesses. Key socio-economic and demographic differences are summarized in Table 1.

2.2. Preliminary interviews

Prior to designing the questionnaire, we conducted a series of 25 interviews with community leaders from Jordan and Israel to obtain relevant information regarding local environmental issues, perceptions and economic activities in the region, thereby strengthening the validity of the research. In addition to supplementing and fine tuning our questionnaire, we also learned from these interviews that the term "ecosystem services" is neither recognized nor intuitively understood by most respondents (also noted by the authors of the UK National Ecosystem Assessment (UK-NEA), 2011). The few individuals that understood the term and could identify some ES, like wood for construction and vegetation for carbon sequestration, also noted that the desert environment did not provide an abundance of those services. Others, when asked about how they "use" their environment mentioned the hydrological systems that assure fresh water, the use of bees in crop pollination, the esthetic beauty of desert landscapes and migratory birds that attract tourism, and solar radiation for crops or power production. Still others noted that the inhospitable desert provided only environmental nuisances (i.e. ecosystem disservices), and did not provide ES. Since the ES concept was not readily understood, and the questionnaire format would not provide the opportunity to explain the concept, we opted to formulate proxy questions for querying how people use and perceive ecosystem services.

2.3. Surveys

The design of the questionnaires was crafted to reveal whether local residents were aware of the services they receive from their ecosystem, though without explicitly mentioning ES. The method of survey distribution varied according to local constraints and concerns. In Israel, in each of the rural communities, the research team made contact with a local resident and/or with the political leadership of the community to choose the best way to distribute questionnaires within that community. In some sites, questionnaires were distributed door-to-door and completed surveys were collected several hours later. In others, questionnaires were distributed outside the communal dining hall during meal times. In the Jordanian villages, the research team distributed the questionnaires door-to-door and often sat with respondents to fill in the questions together. In both Aqaba and Eilat, researchers chose a variety of public areas (shopping malls, restaurants, schools, tourist sites) to distribute and collect questionnaires. We collected 407 completed questionnaires overall (Table 2). The Israeli rural sector was more heavily sampled than the three other population sectors. Rather than choosing not to use data, we chose non-parametric statistical tests that would not be sensitive to this sampling bias (see below).

Table 2
Classification of survey respondents.

Class	Categories (in parentheses, number of respondents and % of total; $n=407$)
Residential type	Urban (153, 38%), rural (254, 62%)
Country	Jordan (150, 37%), Israel (257, 63%)
Gender	Female (174, 43%), male (230, 57%)*

* 3 cases unspecified.

The current research analyzes responses to three batteries of questions that included 34 questions overall, including:

- Opinions regarding environmental characteristics (heat, aridity, landscape, animals, etc.), ranked from 1 (hate it) to 5 (love it).
- Level of involvement in outdoor activities (walking, running, biking, swimming in the Gulf of Aqaba, etc.), from 1 (never) to 5 (almost every day).
- Level of economic dependency on environmental resources (water, land/soil, insects, etc.), ranked from 1 (do not rely on this resource) to 4 (my income is completely dependent on this resource).

We analyze the results according to country of residence (Jordan, Israel), residential type (urban, rural), and gender (female, male).

2.4. Statistical analysis

We first calculated the mean values of the answers for each survey question. These values were compared graphically for each question according to the following three classifications: rural versus urban residents, Jordanians versus Israelis and women versus men. We then employed an exploratory data-mining technique, Classification and Regression Tree (or CART; Lewis, 2000). The CART method considers all of the answers in the specified battery of questions and, in stepwise fashion, identifies at each step the question that best discriminates between the two classes. The results are represented as a "tree" (see Fig. 2 for an example, where the paired classes are rural versus urban; Table 3 organizes the results). The tree begins with a "root node" on top that contains the entire data set. The root node is divided into two groups via "branches" according to a single explanatory variable.

The branches lead either to a "leaf" or to another split. A leaf is a subsample containing a relatively homogenous sub-group (e.g. mostly rural or mostly urban residents). The final tree graphically and statistically divides groups according to the survey question whose answers provide the most discriminating power between respondent groups (Breiman et al., 1998) and it is selected to be the one with the smallest cross-validation estimate of error. Based on the tree results, we conducted Chi-square tests to ascertain whether each group of subjects in a leaf was statistically different in its binomial distribution (e.g. the proportions of rural and urban residents divided into each leaf in Fig. 2).

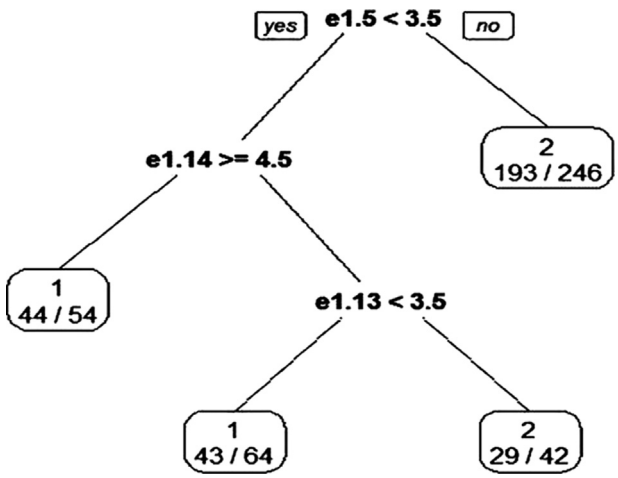

Fig. 2. CART decision tree discriminating between urban (1) and rural residents based on their answers to level of appreciation of environmental characteristics. E1.5, e1.14 and e1.13 are sand dunes, corals and acacia trees, respectively. Ranking is 1 (hate) to 5 (love). The "leaf" on the top right-hand side represents a group of rural residents, of which 193 ranked sand dunes higher than 3.5 (like or love), while 53 were misclassified in this "leaf" (i.e. were actually urban).

Table 3
Summary of the CART analysis results displayed in Fig. 2.

Group	Urban	Rural	Characteristic
1	53	193	Strong affinity for sand dunes (love, like)
2	44	10	Low affinity for sand dunes (neutral, dislike, hate) High affinity for corals (love)
3	43	21	Low affinity for sand dunes (neutral, dislike, hate) Lower affinity for corals (like, neutral, dislike, hate) Low affinity for acacia trees (neutral, dislike, hate)
4	13	29	Low affinity for sand dunes (neutral, dislike, hate) Lower affinity for corals (like, neutral, dislike, hate) High affinity for acacia trees (love, like)

Advantages of CART analysis include (1) it is non-parametric, thus useful with ordinal data, (2) it identifies those variables that best differentiate between classes and (3) it produces fairly intuitive, easy to understand results that can be used for generating hypotheses for later testing (Lewis, 2000). As our aim was to produce a "tree" to identify discriminating answers, this method did not include investigation of interactions between the classes.

3. Results

3.1. Level of appreciation of environmental characteristics

The first battery of questions queried the respondents about how much they enjoyed specific environmental characteristics in the southern Arabah Valley. These questions were formulated in the simplest way possible to capture perceptions regarding the cultural services offered by the desert ecosystem. Respondents indicated explicitly the degree of affinity they had for each environmental characteristic. Keeping in mind the ambiguity of what is considered an ecosystem service, our list included biological, geological and climatic characteristics of the environment.

In general, the population was favorable to most environmental characteristics, with most receiving average ranking of 3 (neutral) or higher (Fig. 3). The most highly valued characteristics were the landscape, quiet, mountains and corals, while the lowest were the dust/sand storms, insects, aridity, heat and isolation (distance to center of the country). In almost all categories, rural populations gave higher rankings than urban populations to environmental characteristics, with only a few exceptions: urban residents were slightly more favorable to coral, and urban/rural rankings for brightness and dust/sand storms were mixed. Israelis (urban and rural combined) ranked all characteristics higher than Jordanians, with one exception: shrubs. Some characteristics received much higher rankings from Israelis than Jordanians, including open space and sand dunes, and Israelis were less averse to environmental characteristics that were ranked low by both Jordanians and Israelis (e.g. insects, aridity and brightness). Genders ranked characteristics nearly equally, with men expressing slightly higher affinity to environmental characteristics overall.

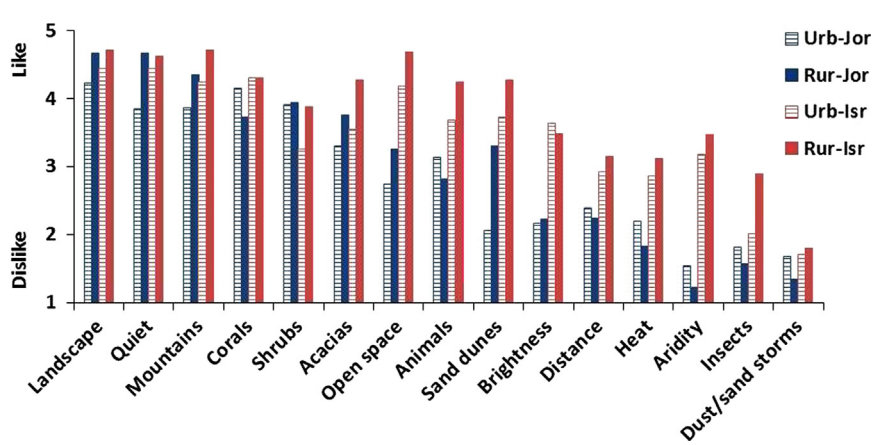

Fig. 3. Appreciation of environmental characteristics by residential setting (urban/rural) and country (Jordan/Israel).

Please cite this article as: Orenstein, D.E., Groner, E., In the eye of the stakeholder: Changes in perceptions of ecosystem services across an international border. Ecosystem Services (2014), http://dx.doi.org/10.1016/j.ecoser.2014.04.004

According to the CART analysis (Fig. 2; Table 3), the main characteristic that could discriminate between urban and rural residents was sand dunes (rural residents and Israelis expressing a high affinity). Urban residents expressed greater appreciation of corals. Between Israelis and Jordanians, Israelis were also characterized by a higher affinity for aridity and open space. Men had less aversion to heat than women, and rankings of acacias and open space could also discriminate between women and men. Chi-square tests run for each of the CART results suggest that, for all three classes, there were significant differences among the groups. However, these differences are limited to those between the classes themselves (urban and rural, Jordanian versus Israeli, and women versus men). There were no differences detected among the classes (e.g., there were no significant differences between groups of urban residents according to their preferences for environmental characteristics).

3.2. Level of outdoor activity

Cultural services also include the provision of recreational opportunities (Millennium Ecosystem Assessment (MA), 2005). The battery of questions querying levels of outdoor activity was devised to further investigate how respondents make use of their ecosystem. The activity questions included those that were highly dependent on exploiting biodiversity that underlies cultural ES (e.g. birding and collecting objects from nature) and those that were less so (e.g. off-road vehicle driving).

On average, respondents engaged in most outdoor activities only rarely (once/twice a month, once/twice a year), with the exception of walking outside, which was done once/twice a week on average (Fig. 4). Urban and rural residents are distinguished from one another by their outdoor activities, with urban residents engaging in higher levels of campfire building (primarily Jordanian urban residents), swimming in the Gulf of Aqaba, and off-road vehicle driving, while rural residents reported engaging more often in hiking, biking (primarily Israeli rural residents) and collecting plants and animals (again, primarily Israeli rural residents). Likewise, Jordanians engaged in campfire building, off-road vehicle (ORV) driving, camping and animal riding more often than Israelis, while Israelis reported walking, hiking, swimming and biking more often. With the exception of walking and building campfires, men reported partaking in all outdoor activities more often than women.

The CART analysis points to hiking, ORV driving and walking as activities that can distinguish between urban and rural residents. Urban residents rarely or never hiked, while rural residents tend to drive ORVs less. Among the cluster of respondents that rarely hiked, urban residents tended to walk outside more often than rural residents. Activities that distinguish between Jordanians and Israelis are swimming (Jordanian report that they rarely swim in the Gulf of Aqaba), campfire building (Jordanians more often than Israelis), and ORV driving (with most Israelis reporting that they do not engage in this activity). Women were best discriminated from men through swimming and hiking (men reported doing both more often). Again, the post-priori chi-square tests were significant. Differences were primarily along the lines of classes (urban/rural, Jordan/Israel, women/men). Walking, biking and birding, were more commonly reported Israeli recreational activities as compared to Jordanian rural residents.

3.3. Economic dependency on natural resources and environmental conditions

The third battery of questions addressed whether respondents perceive economic gain from ES. This could be in the form of cultural services that are utilized for tourism income or provisioning services. In all categories, rural residents reported that they are dependent on both local natural resources and environmental conditions more often than urban residents. Water, land/soil, and sun/heat were most often reported as needed for economic income among rural residents (Fig. 5). Israelis consistently reported higher economic dependency than Jordanians on natural resources and environmental conditions, and men and women reported nearly equal levels of dependency, with men reporting dependency slightly more often in all categories but insects.

The CART analysis emphasizes dependency on land/soil as the primary discriminator between urban and rural residents, with rural residents reporting higher dependency on this resource. Israelis were distinguished from Jordanians by their reported high dependency on sun/heat, along with higher reported dependency on water. Men were also distinguished from women based on their reportedly high dependence on land/soil, along with dependency on sun/heat. Once again, the chi-square analyses confirmed differences along class lines, but did not discern between unique groups within the classes.

Following this battery of questions, an open question asked respondents who had responded that they were dependent on various resources how they used the resource. Approximately 2/3 of the Israeli rural respondents provided answers. Of these, most cited the need for soil, water and sun for the agricultural sector. A smaller number cited the role of insects in crop pollination and sun for solar power production and algae farming, and birds and

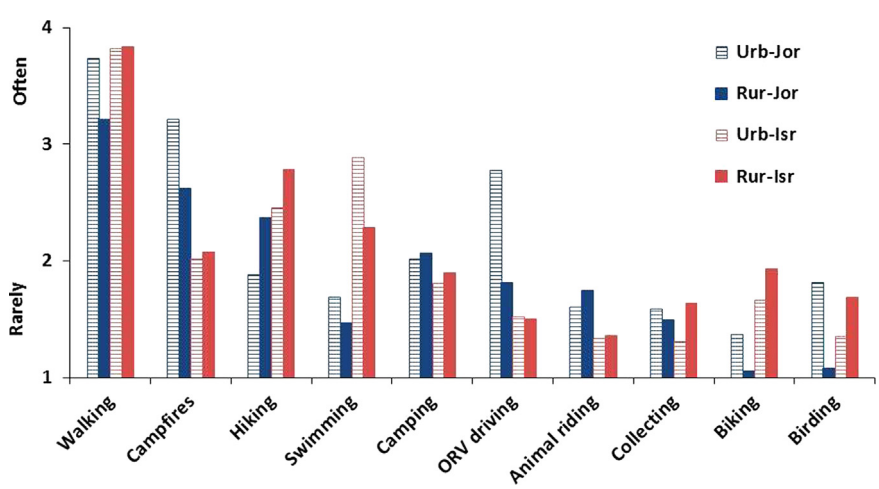

Fig. 4. Outdoor activity by residential setting (urban/rural) and country (Jordan/Israel).

Please cite this article as: Orenstein, D.E., Groner, E., In the eye of the stakeholder: Changes in perceptions of ecosystem services across an international border. Ecosystem Services (2014), http://dx.doi.org/10.1016/j.ecoser.2014.04.004

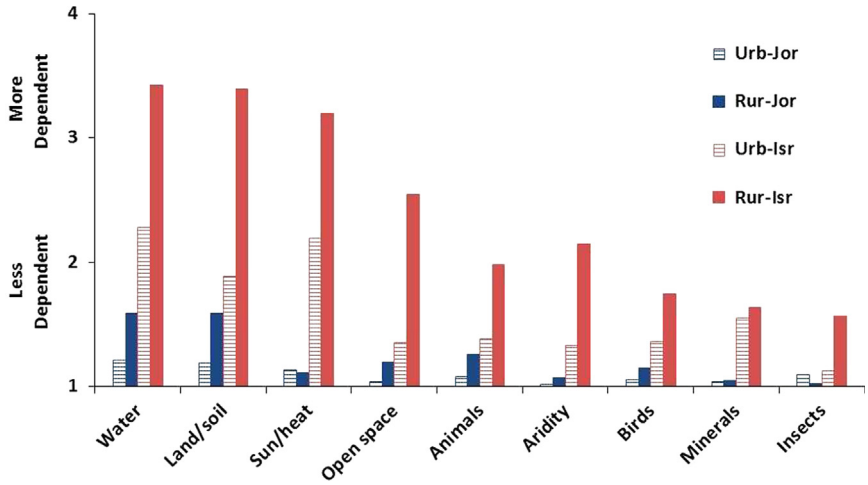

Fig. 5. Economic dependency by residential setting (urban/rural) and country (Jordan/Israel).

corals for bringing tourists. Approximately 1/3 of the Israel urban respondents provided an answer for the open question, and those answers focused mainly on the sun, sand and sea that enable a tourism industry. Only five Jordanian respondents answered the open question, and those noted the resources were needed for supporting livestock and agriculture, with one respondent noting corals as used for economic income.

4. Discussion

This research elucidates how Jordanians and Israelis appreciate and use their hyper-arid ecosystem. Both similarities and differences were detected between countries and additional differences were recorded between urban and rural residents. While the research findings are important in their own right and contribute to the literature on cross-cultural, environmental assessments of landscapes, our emphasis here is to bring this knowledge and research tradition into the burgeoning field of ES assessment. In particular, we focus on how non-economic social research can contribute to a more robust inter-disciplinary ES assessment. Accordingly, the discussion section is divided into two parts, including (1) a discussion on the possible variables influencing the differences found between population groups and implications for planning and policy, and (2) suggestions regarding the potential contribution of this work to the growing body of literature advocating for a greater role for social approaches in ES assessment.

4.1. Cross-cultural differences in social valuation of ecosystem services and implications for management and policy

Since the pioneering work of Zube and Pitt (1981), it has become axiomatic that different cultural groups use and perceive the landscape in different ways (Kaplan and Herbert, 1987, Lothian, 1999, Buijs et al., 2009). This, in turn, has led scholars to question whether there is any objective measure of landscape value (Lothian, 1999, Daniel, 2001). The axiom that different cultural groups perceive landscapes differently must be integrated into ES assessment. If this integration is successful, "cultural services" will no longer defined as a homogenous set of esthetic, recreational and spiritual services, but rather a broad and diverse category of services that vary in character and importance between individuals and groups. This realization makes the identification, characterization and valuation of cultural services somewhat more complex than the other categories of ecosystem services, but other research traditions can be of particular use to help navigate the complexity, such as the aforementioned research on cross-cultural landscape assessment, and cultural heritage research (Tengberg et al., 2012).

4.1.1. The potential role of affluence

In general, Jordanians and Israelis of the southern Arabah Valley appreciate similar characteristics of their ecosystem. The differences, however, seem to emphasize the cultural and economic context of each country. For example, despite the overall similarities, Israelis (particularly those in the rural sector) ranked even the less favorable aspects of the local environment (aridity, heat, dust/sand storms) higher than Jordanian residents. While we cannot separate potentially confounding variables of nationality and affluence, we suggest that relative affluence plays a role in the differences detected across the Arabah border. The Israeli rural sector in the Arabah Valley is an ideologically-driven, educated and economically strong population (Sagie et al., 2013). While agriculture traditionally formed the basis of their economic income, the community is enthusiastically expanding its economic base to combine modern technologies with the region's environmental advantages (aridity, sunlight, open space). Such economic activities include solar power production, algae farming, eco-tourism, and boutique agricultural products. With a relatively strong economic base, they have material comforts that buffer them from the extremes of the environment (e.g. air conditioning, gardens, and swimming pools). The Jordanian rural sector is economically weak, even relative to the rest of Jordan (UNDP, 2012), but more so in comparison to the Israeli rural communities with whom they share a common ecosystem. There is high unemployment and low levels of formal educational achievement. While they have water and electricity in most cases, they do not have such comforts as central air conditioning and swimming pools. Their overall lower rankings of environmental characteristics may reflect this economic reality. In fact, among environmental characteristics, only shrubs (a staple for supporting grazing animals and a source of fuel for campfires) are ranked higher by Jordanians than Israelis.

The urban Israelis in the city of Eilat have a distinctly urban economy based on traditional coastal tourism ("sand, sun and sea") and services, which may have an impact on their rankings of the region's environmental characteristics: High rankings overall, but lower than residents in the rural sector. Corals stand out as an exception, with urban residents expressing higher affinity than rural residents. The cities of Aqaba and Eilat are coastal and

proximate to the coral reefs, whereas the rural communities are tens of kilometers north of the coast (Fig. 1).

The way in which people recreate in their environment also may reflect culture and affluence. Israelis can partake in recreational activities such as biking and hiking, and they value open space and rare sand dunes as cultural services providing esthetic, spiritual, recreational and psychological benefits (Sagie et al., 2013). Jordanian rural respondents report higher engagement in distinctly traditional (i.e. Bedouin) recreational activities including ORV driving, animal riding (camels and donkeys), and building campfires in the mountains.

Interestingly, Jordanians report less economic dependency on ES than Israelis. At first consideration, this result seems surprising, as the traditional economic activities of the Bedouin communities include grazing, hunting, gathering herbs and limited agriculture, which are all dependent on their ecosystem. However, these activities occur in parallel to newer employment activities which are disconnected from, or only indirectly connected to, natural resources, including military, government services and tourism in and around the city of Aqaba. The field and hothouse agriculture that exist in the Jordanian Arabah are owned not by the communities who live alongside the fields and greenhouses, but by private owners from other parts of Jordan who hire the local residents (and Egyptian migrant workers) to work there. In some cases, these areas are off-limits to the villagers (Sagie et al., 2013).

It seems that social valuation of ES strengthens with economic wellbeing. But, although rankings were systematically lower among Jordanians than Israelis for various ES and environmental characteristics, it may not be the case that poorer populations actually value ecosystem characteristics any less than their more well-off neighbors. Rather, these communities (1) may not have direct economic interests rooted in ES; (2) did not have the economic capacity to buffer themselves against the more harsh aspects of the ecosystem (ecosystem disservices), e.g. to purchase air conditioning units and build swimming pools and (3) did not have the economic capacity to utilize their environment for recreational activities (e.g. swimming and biking) or more technologically-advanced economic opportunities. To develop the region sustainably will require economic development coupled with education and maintenance of the existing affinity that these residents have for their natural environment.

4.1.2. *Landscapes as cultural ES*

Landscape is among the most highly valued characteristics of all population sectors. Previous studies also found landscape (or seascape) was among the highest regarded environmental characteristics, including Gee and Burkhard (2010) in the North Sea coast of Germany and Tengberg et al. (2012) in rural and coastal landscapes in Sweden. Other research emphasized that among Israeli respondents, the pristine and beautiful nature of the Arabah landscape compensated for the isolation and harsh climatic conditions of the desert. Jordanians also expressed very high regard for the cultural and spiritual value of the landscape (Sagie et al., 2013).

Similarly to Gee and Burkhard (2010), the use of questionnaires allowed us to bring out the intangible values residents received from their environment. While questionnaire-based research has known limitations (Christie et al., 2008; Gee and Burkhard, 2010), in this research the intangible benefits from the ecosystem could not have been accurately determined via economic valuation methods for several reasons. The Israeli communities are collective communities that do not have traditional economies at the individual and household scale, and so monetary valuation techniques like hedonic pricing method (e.g. Geoghegan, 2002), for example, would be of little use. In fact, most Israeli rural respondents could not evaluate their own monthly income, as they are members of cooperative communities which pool resources and provide most material needs (along with a small allowance for the discretionary use of individual members). The rural community on the Jordanian side of the border poses many of the methodological challenges to economic valuations comprehensively reviewed by Christie et al. (2008). In such cases, they recommend non-economic approaches. The current research methodology gave residents the opportunity to express the high value they place on cultural ES without relying on monetary measures.

The high importance of landscape to local residents in this and previous research (Gee and Burkhard, 2010; Tengberg et al., 2012; Sagie et al., 2013), lends credibility to advocates of a place-based ES assessment approach (Potschin and Haines-Young, 2013; Brown, 2013). Brown (2013) suggests introducing into the lexicon "landscape services" as a complementary, yet unique, concept alongside that of ES. These spatially explicit approaches offer promising next steps to the current research, which has brought into sharp relief the importance of geographically specific landscapes in the eyes of local residents.

4.1.3. *Creation of ecosystem services*

Like the proverbial tree falling in the woods, or a tree providing shade in the desert, is there an ES if no one is there to appreciate it? If an ecosystem process becomes a service only if someone derives benefit from it, does this imply that we can create a cultural ES if we teach people to appreciate a certain aspect of the ecosystem? The current research suggests that the roles of accessibility, education and management open a new, important and underexplored aspect of ES assessment.

Affinity towards sand dunes was identified as a key discriminating characteristic separating Jordanians and Israelis. Due to the increasing rarity of Arabah sand dunes (Yom Tov, 2013), the small Israeli dune of Samar in the Israeli Arava were the subject of an intense political and educational campaign to save them from mining during the period of this research. Further, this dune is in close proximity to several rural Israeli communities and is a common destination for recreational walks and ecological research. In contrast, the few dunes that exist on the Jordanian side of the border are in closed military areas and thus inaccessible to the residents. Accordingly, they engender little affinity or even awareness among Jordanian residents. We suggest that education and access can therefore create a formerly unidentified cultural ES. Likewise, Sodhi et al. (2010) noted that environmental education heightened people's valuation of ES in a multi-site study across south-east Asia.

In research in the northern Negev desert of Israel, Orenstein et al. (2012), relying on expert knowledge to assess presence/absence of ES in long-term ecological research (LTER) sites, found that the land management agency was the most significant factor determining the package of ecosystem services available at a site. They observed that when the Israel Ministry of Agriculture managed the site, there was a higher amount of provisioning services, whereas in sites managed by Keren Kayemet L'Israel (Israel's quasi-governmental forest service) there were more cultural services (e.g. presence of bird watchers and picnics). Both results were consistent with the management directives of the given management agency, and they suggest that management agencies can turn potential ES into actual ES and their associated benefits.

Both the sand dune example and the results from the Northern Negev study challenge those engaged in ES assessment to understand when and how cultural ES are created by people. The presence/absence and the value (economic or social) of cultural (and provisioning) ES are often the result of public discourse,

education, accessibility, market preferences, and management and policy decisions. We note that this discussion, while very relevant to cultural and provisioning ES, is less relevant to regulating services. The latter (including climate control, hydrological cycling, soil maintenance and others) are crucial for human wellbeing, regardless of whether humans are aware of them or not.

4.2. The contribution of social approaches to ES assessment

Critics of the ES framework argue that its logic inevitably leads to a single monetary measure of nature's value, which they argue is wrong for ethical and practical reasons (Kosoy and Corbera, 2010; Spangenberg and Settele, 2010; Rogers and Schmidt, 2011; Knight et al., 2013; Turnhout et al., 2013). We and others suggest that there is an unmet demand within the ES assessment process to integrate social approaches and that this missing component exacerbates shortcomings of the ES framework. We concur with Turnhout et al. (2013), for example, that while IPBES (and by extension, other ES assessment bodies) "does recognize the need for pluralistic inputs to its processes… so far… this appears to be a nod to social inclusion that has taken place largely in the margins." We suggest, following Knight et al. (2013), that by raising the profile and emphasizing the importance of social and cultural value of ES, in particular of cultural services, we can move towards rectifying the problems noted above. As exemplified by recent work of Martín-López et al. (2014), a truly interdisciplinary analysis can then open the field to a more pluralistic identification and valuation of ES.

The social approach to ES assessment, like the economic approach, is anthropocentric; the valuation is in purely human terms. However, rather than measuring monetary value, we measure ES in terms of "emotional attachment, cultural meaning [and] esthetic experience" (Luck et al., 2012, p1025). As Luck et al. point out, and what is supported in the policy literature, is that "deeply held personal values may trump economic rationalism" (*ibid*) in policy decision making processes. Such personal values regarding cultural ES prove to resonate strongly with local residents and yet they have been given only modest attention in the academic literature and policy reports (Chan et al., 2012; Tengberg et al., 2012). In the context of the Arabah desert, social assessments assign high value to scenic landscapes, mountains sand dunes, and biodiversity.

Social approaches also show clearly that, according to the residents themselves, one ecosystem can provide a very different set of benefits to residents depending on their nationality, culture, settlement type, and even gender. Thus, ES offer different benefits depending on who one asks. As such, a robust social ES assessment should be a trans-disciplinary, collaborative process starting with an inquiry into the values, perceptions and needs of stakeholders (Menzel and Teng, 2009). Multiple methodologies can and should be applied, many of which are reviewed elsewhere in the context of biodiversity valuation (Christie et al., 2008). The knowledge generated by the stakeholder mapping and subsequent studies can then be used to generate an iterative public discussion over pertinent land use and natural resource management issues (Chan et al., 2012). Through such a process, the policy maker emerges with a more nuanced understanding of the ecosystem under consideration.

Social approaches to ES assessment are also *de facto* tools for stakeholder integration into the science and policy process. Through social research, the ES framework becomes a more stakeholder-driven process insofar as their responses to survey questions become the core of the research and subsequent valuation (Menzel and Teng, 2009).

In our experience as co-authors of the Israel National Ecosystem Assessment, there is an explicit suspicion among some scientists and policy makers that integrating stakeholders may not always lead to ideal ecological outcomes. What if, for example, stakeholders decide to consistently favor economic and infrastructure development over nature conservation? These fears are real. However, we do not advocate removing ecological or economic considerations nor to resign to populism. Ecologists and conservation biologists (and other experts) remain a crucial part of the process, especially by providing their expert knowledge regarding human dependency on regulating services and other crucial ecosystem processes, and social assessments are advocated as a complement to other approaches (Martín-López et al., 2014). And in the local context, top-down decision-making has not led to optimum ecological outcome (Yom Tov, 2013; Dolev and Perevolotsky, 2002). Most of the scientific literature in natural resource management emphasizes that stakeholder integration and collaborative decision-making is crucial for assuring optimum ecological outcome in natural resource policy (e.g. Clark, 2011).

The interview and survey-based approaches are only first steps in integrating social methods to ES assessment. Follow-up surveys, iterative community discussions and scenario development are important next steps to full integration of social tools (Chan et al., 2012). The goal, in the international, national and local context, is both to teach and learn from local residents regarding the benefits they receive from their ecosystems, to develop a truly inclusive decision-making process, and to ensure via planning and policy the long-term, steady provision of these benefits, equitably distributed inter- and intra-generationally.

Acknowledgments

We gratefully acknowledge our Jordanian colleagues for their indispensable assistance in all aspects of this research. We thank Hila Sagie, Inna Kaplan, Danielle Cohen, Roy Zaidenberg, Margorie Strom and Avigail Morris for their research assistance, and Ayala Cohen and Nadia Bordo for their assistance with the statistical analyses. Funding was provided through a trans-border cooperation grant from the Israel Ministry of Regional Cooperation to the Dead Sea and Arava Science Center.

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