Ecological Economics 145 (2018) 451–460

Contents lists available at ScienceDirect

Ecological Economics

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

Analysis

A Spatially Accurate Method for Evaluating Distributional Effects of Ecosystem Services

Aliza Fleischer[a,*], Daniel Felsenstein[b], Michal Lichter[b]

[a] Department of Environmental Economics and Management, The Center for Agricultural Economics Research, Hebrew University of Jerusalem, P.O. Box 12, Rehovot 7610001, Israel

[b] Department of Geography, Hebrew University of Jerusalem, Mount Scopus, Jerusalem 91900, Israel

ARTICLE INFO

Keywords:
Ecosystem services
Equity
Welfare distribution
Synthetic spatial micro-data

ABSTRACT

The value of most ecosystem services invariably slips through national accounts. Even when these values are estimated, they are allocated without any particular spatial referencing. Little is known about the spatial and distributional effects arising from changes in ecosystem service provision. This paper estimates spatial equity in ecosystem services provision using a dedicated data disaggregation algorithm that allocates 'synthetic' socio-economic attributes to households and with accurate geo-referencing. A GIS-based automated procedure is operationalized for three different ecosystems in Israel. A nonlinear function relates household location to each ecosystem: beaches, urban parks and national parks. Benefit measures are derived by modeling household consumer surplus as a function of socio-economic attributes and distance from the ecosystem. These aggregate measures are spatially disaggregated to households. Results show that restraining access to beaches causes a greater reduction in welfare than restraining access to a park. Progressively, high income households lose relatively more in welfare terms than in low income households from such action. This outcome is reversed when distributional outcomes are measured in terms of housing price classes. Policy implications of these findings relate to implications for housing policies that attempt to use new development to generate social heterogeneity in locations proximate to ecosystem services.

1. Introduction

Ecosystems provide services to households located in their vicinity. Some of these services are not mediated through the market and thus their value is absent in national accounting. For example, if fees are not charged for the use of national parks, the cultural and recreational services they provide are missing from national accounts even though they contribute to the welfare of households. Economists have developed a variety of methods for estimating the value of ecosystem services where market prices are not perfect or do not exist but in general these values are allocated to the different ecosystems without any particular distributional referencing (Costanza et al., 1997). Very little is known about how changes in ecosystem service provision are distributed across population groups, for example, do high income households receive more services than low income households.

The evaluation of ecosystem services is invariably concerned with generating average values for different services and attaching real and shadow prices to a generally unpriced and heterogeneous good. For example, the main concern of the Millennium Ecosystem Assessments (Millennium Ecosystem Assessment, MEA, 2003) and other country level assessments (Bateman et al., 2011; Patterson and Cole, 2013) is to show the degradation of ecosystem services. It has become increasingly clear that global human population and consumption patterns are well above what can be supported without impairing vital life-support systems (Ehrlich et al., 2012). Thus, there is a need to develop mechanisms for integrating the consumption of ecosystem services into land use and resource decisions (Nelson et al., 2009). Because many ecosystems do not have a market value, they are typically undervalued[1] when policies and decisions are formulated and recognized only upon their loss (Daily et al., 2000). The evaluation of ecosystem services provides an economic measure which can be compared to private goods and used in assessment of global change.

Invariably, these assessments are undertaken in aggregate without concern for the issue of who benefits and who loses in the wake of change in ecosystem services provision. This paper contends that considering aggregate change is insufficient and that distributive effects

* Corresponding author.
E-mail addresses: aliza.f@mail.huji.ac.il (A. Fleischer), daniel.felsenstein@mail.huji.ac.il (D. Felsenstein).

[1] The context for this under-valuation is not explored here. The market may blind-side ecosystem services for reasons other than accounting inadequacies. For example, under-valuation may be a case of lack of 'voice'. Those who value ecosystem services may have little political influence or state agencies charged with their protection may have limited funding.

https://doi.org/10.1016/j.ecolecon.2017.11.019
Received 20 April 2017; Received in revised form 9 October 2017; Accepted 16 November 2017
Available online 01 December 2017
0921-8009/

across population groups need to be addressed. While the general notions of ecosystem services equity and environmental justice do occupy the literature, this attention is commonly focused on theoretical discussions of how to define distributive justice of ecosystem services (Matulis, 2014), macro-level analyses relating to poor and rich nations (Schomers and Matzdorf, 2013) or case studies, for example analyzing poor populations exposed to environmental degradation (Brulle and Pellow, 2006).

This paper deals with the empirical distribution of ecosystem services at the sub-national and local levels utilizing micro (household) data for Israel. It contributes to the methodology of ecosystem service assessment by introducing an approach for accurately assessing the spatial distribution of ecosystem service benefits and evaluating the welfare and distributional effects of changes in accessibility to ecosystem services. To create the high-resolution spatial microdata necessary for such an exercise, recent advances in data disaggregation and the generation of synthetic spatial microdata are exploited. The paper utilizes an allocation algorithm that downscales census tract data into households on a national basis. This allows for the automated calculation of the effects of change in ecosystem services provision at high levels of spatial resolution.

The paper subsequently estimates household benefits arising from the value of recreational visits at the microscale from three types of sites using a simulated consumer surplus[2]. These relate to beaches, national parks and urban parks which each belong to different ecosystems as defined in the Israeli National Ecosystems Assessment (IESA, 2014): marine ecosystem, Mediterranean ecosystem and urban ecosystem, respectively. We identify welfare change that can be linked to distance from the sites and the socio-economic attributes of the households consuming ecosystem services. The disaggregated economic value is embodied in the consumer surplus derived by different population groups. This surplus can be recombined into various welfare measures that show distributional impacts of changes in ecosystem services to different population groups at various spatial scales. The paper thus makes two contributions: methodological and empirical. In terms of method, we present a reproducible approach for the accurate spatial identification and estimation of ecosystem services benefits. The empirical contribution lies in the estimates of distributional and welfare impacts of these benefits under two different policy scenarios.

2. Literature Review

There is a growing theoretical discourse concerning ecosystem services and distributive justice. Sievers-Glotzbach (2013) offers a theoretical framework to consider the distribution of access rights to ecosystem services. She shows that the Rawlsian “Theory of Justice” (Rawls, 2009) can be extended to contain the justice issues of ecosystem services. Accordingly, the argument is that access rights to vital ecosystem services need to afford the greatest benefits to the least advantaged members of the present and actual future generations. Jax et al. (2013) contend that the distribution of benefits and costs associated with the provision of ecosystem services should be calculated across both spatial and temporal scales. Farley (2012) claims that in the case of ecosystem services that cannot be privately owned the principle of equal say for all in allocation decisions concerning ecosystem services should hold. These are all theoretical discussions of what is considered justice in the framework of ecosystem services.

The empirical literature, concerning the evaluation of ecosystems services, adopts two approaches to welfare and distributional issues of ecosystem provision. The first focuses on using payments for ecosystem services (PES) for poverty alleviation (Gauvin et al., 2010; Corbera et al., 2007; Paavola and Lowe, 2005). These payments go to the inhabitants of rural areas in return for supplying ecosystem services by refraining from intensive farming and adopting habitat-protective techniques. Since most of the global poor live in rural areas PES has an equity effect. The poor are paid for reducing environmental damages. The second approach deals with environmental inequalities. Some studies look at environmental disamenities showing how social and economic dynamics result in the poor being more exposed to environmental hazards than the rich (Ringquist, 2005). Others have looked at access to environmental amenities such as parks and open spaces and investigated their equitable distribution (Mitchell and Popham, 2008; Boone et al., 2009). There is a recent literature on environmental (in) justice with a wealth of case studies and some quantified facts in the wake of the work pioneered by Martínez-Alier (2002) and Hornborg and Martinez-Alier, (2016) (e.g., the results of the EJOLT project in Hornborg). Most of this genre analyzes the relationship between income and social attributes to accessibility to environmental disamenities or amenities. Very little attention has been paid to analyzing welfare effects of ecosystem services at a high level of spatial resolution capable of identifying local equity/social welfare outcomes.

Researchers have developed a variety of methods for estimating the value of ecosystem services when market prices are not determined in a perfectly competitive market (i.e. when there are subsidies or taxes) or where market prices do not exist. They include adjusted market prices, production function methods, damage cost avoided, averting behavior, revealed preference methods and stated preference methods (Bateman et al., 2011 Ch. 22 in NEA_UK). In general, these values are allocated without any particular spatial referencing and the main effort is directed towards extracting a value for a hard-to-measure service. The result is a plethora of case-study type investigations that deal with the evaluation of a given service in a particular place (Crossman et al., 2013). Similar research has also been conducted in Israel with a focus on idiosyncratic pricing of site contamination (Shelem et al., 2011) or agricultural landscapes (Fleischer and Tsur, 2009). Nevertheless, Bateman et al. (2013) develop a methodology for spatially sensitive and ecosystem-specific prediction of outdoor recreation visits and their value. Their major objective is the prediction of area-specific recreational value under different scenarios. They combine a trip generating function model and meta-analysis of per visit values to estimate the number of visits and the value of each visit for each 1 km grid square in their study area. Unlike Bateman et al. (2013), our units of analysis are households rather than grids. Furthermore, our focus of concern is the recipients of ecosystem services rather than the service-generating sites. We attempt to predict how these services are distributed among households under different scenarios.

Generally, estimating welfare and distributional effects across different communities is not possible as the data generally do not allow for spatial differentiation. For example, while the conversion of farmland to forests may generate general population-wide services such as carbon storage and land reclamation, it could be that the resultant recreation values might be much more selectively distributed across the relevant nearby urban population. The value of the ecosystem service in this case will be appropriated by a small sub-group of the population with the ability to benefit (the young, the mobile etc.) whereas the welfare of the overall population may not change or may even decrease, resulting in negative distributional outcomes.

3. Method

In order to evaluate the distribution of recreational services that households in Israel elicit from three types of ecosystems, we adopt a four-stage method (Fig. 1). The first stage involves an allocation algorithm that disaggregates census tract data into households and spatially allocates them into dwelling units. The allocation procedure uses the ‘synthetic reconstruction’ approach (see Hermes and Poulsen, 2012) for artificially generating data and iterative proportional fitting (IPF) for

[2] Consumer surplus is defined as the difference between the willingness to pay for goods and services and the amount actually paid. It is used a measure of welfare change in environmental economics (see Freeman, 1992, p. 48).