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Valuing ecosystem services for improved national accounting: A pilot study from Madagascar

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ABSTRACT

The present paper proposes a micro-econometric methodology for the economic valuation of the impact of ecosystem services in selected economic sectors. In the context of natural capital and ecosystem accounting, we built a four steps valuation protocol. The methodology is applied to the valuation of freshwater in the Ankeniheny-Zahamena Forestry Corridor (CAZ), Madagascar – a country partner with the Wealth Accounting and the Valuation of Ecosystem Services (WAVES). Our results corroborate the intuition that understanding the value of water in its alternative uses is a key to fostering informed debate on water management and allocation in the CAZ area. More generally, this study provides a solid contribution towards a more effective way to elicit and record nature's ecosystem services contribution to the economy.

1. Introduction

Natural resources and ecosystem services flows account for over 20% of the wealth of world's nations, as estimated by their contribution to economic sectors such as tourism, food, and manufacturing (World Bank, 2011a). Acknowledging the contribution of nature's ecosystem services (ESs) to different economic sectors spurs us to attempt to quantify the magnitudes of such a contribution. This contribution, in fact, is currently invisible in the national account systems, despite its importance among different economic sectors. The proposed framework is based on the use of production functions, where ESs are interpreted as economic inputs (see Barbier (2007) and Dasgupta (2012)). In this context, ESs together with other technical inputs of production, such as labor and capital, are responsible for the determination of the overall supply of the final economic sector's output. By conceptually framing ESs as production inputs, we are not claiming that the only purpose of nature, and its ESs, is to be used to produce an economic output. We argue that just like labor and capital, the economic valuation of ESs can be estimated by investigating their marginal contribution to the production of selected (market) outputs.

The micro-economic valuation methodology has been chosen because computations are based on market transactions, and therefore based on the information reported in the system of national accounts. For these same reasons, the underlying ES economic value estimates are aligned with, and can be compared to, the national accounting data. According to Obst et al. (2013) an ecosystem valuation approach that is aligned with the national accounting principles "*aims to record the "output" generated by ecosystems, given current uses of ecosystem capital; thus, monetary values represent exchange values consistent with the principles of national accounting", (pag. 420).* We therefore propose to apply an economic valuation framework that is both able to estimate the value of ecosystem services and that respects the principles of national accounting. We test this framework in Madagascar, a core implementing partner of the World Bank-led global partnership WAVES – Wealth Accounting and the Valuation of Ecosystem Services.[1] Accounting for fresh water has been identified as a high priority by the National Government of Madagascar. In this context, we attempt to elicit the economic invisibility of fresh water in

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[1] WAVES aims to promote sustainable development by ensuring that natural resources are mainstreamed in national economic accounts and development planning. Consult www.www.wavespartnership.org for more details.

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the region by assessing its (marginal) contribution to key economic sectors that rely on water as a production input, including agriculture, mining, hydroelectricity production, and tourism sectors.

The paper is organized as follows. Section 2 sets the scene for valuing ecosystems for improved national accounting and presents the methodological apparatus. Section 3 discusses the field work and data collection in the CAZ area. Section 4 addresses the technical implementation of the proposed econometric-valuation approach in the study area. Section 5 shows the estimation results and discusses its informational value for policy makers. Section 6 concludes.

2. Measuring and accounting for ecosystem services: setting the scene and methodological apparatus

2.1. National natural capital and ecosystem services accounting

The seminal work of Pearce and Atkinson (1993) posits a practical linkage between sustainable development and a measure of national wealth that includes natural assets and their ecosystem services flows. If sustainable development is a matter of meeting the needs of the present without compromising the ability of future generations to meet their own needs, then it would be a question of maintaining wealth – as measured by savings rates adjusted to reflect depletion and environmental degradation. More recently, Arrow et al. (2012) proposed a natural wealth based theoretical approach to assess whether economic growth is compatible with sustainable development. The authors highlight the need for adequate measurements for estimating and recording natural capital and underlying ESs, as well as any additions and improvements. It has become increasingly evident that not only are natural resources an important share of national wealth, but the composition of natural wealth varies widely across developing countries and regions. This is particularly important when considering that widely used growth indicators such as Gross Domestic Product (GDP) do not take into account the depletion of natural resources (Lange, 2007a, 2007b; World Bank, 2011a). Therefore, recognizing the impact of natural capital and ecosystem services in national production, and the related economic value is the first, and foremost, step in the design and implementation of sustainable development policy. From this perspective, it is important to demonstrate formally the contribution of nature's goods and services to the economy.

An important step in this direction is represented by the recent adoption of the System of Environmental-Economic Accounting (SEEA) Central Framework – see (SEEA, 2012). This is first international statistical standard for environmental-economic accounting by the United Nations Statistical Commission, which places important nature benefits into the core of official statistics, within the constraints and boundaries of the International Standard System of National Accounts (UNSD, 2013). The SEEA Central Framework is complemented by the SEEA Experimental Ecosystems Accounts – designed as a state of the art systems approach in ecosystems accounting – as well as the SEEA Extensions and Applications, which will focus on how SEEA can be used to inform policy analysis.[2] There are, however, no agreed international standards on how to implement national ESs accounting. In fact, measurement of nature's ecosystem benefits for the purpose of their integration into a national accounting framework is a complex task, involving assumptions that have important implications for the measurement's estimates and interpretation of the value magnitudes. In this context, the paper attempts to address this gap, embracing an interdisciplinary economic valuation study that is characterized by the use of a micro-econometrics based methodology that links the valuation of ESs to national accounting. This methodology is presented and discussed in the following sub-section.

[2] Efforts to pilot such approaches are coordinated by the World Bank-led global partnership on Wealth Accounting and the Valuation of Ecosystem Services (WAVES), now it is second phase: WAVES+

2.2. A micro-economic method for the valuation of ecosystem services

To our knowledge, many approaches have been proposed (see Barbier (2011) for a survey), but few were tested or operationalized.[3] For instance, Pattanayak and Kramer (2001) constructed a combined micro-econometrics-hydrological model to measure the contribution of upland forests to farm productivity downstream. Barbier (2000, 2007) and Green et al. (1994) used formal ecological models to compile a catalogue of the various services that are provided by wetlands. Duraiappah (2003) developed a range of dynamic optimization coupled socioeconomic-ecological models to capture a variety of ecosystem services including tidal fishing, water purification and biomass evolution. In our study, the proposed economic valuation analysis is articulated as follows. First, we interpret the selected ecosystem service, together with other economic factors, as an input for the production of a market good or service. Second, we model and estimate production functions taking into account the information collected on the selected economic factors and ESs. We want to estimate the marginal productivity of the input-ecosystem service. This indicator shows the effect on total production, i.e. total quantity of produced output, associated to the use of an additional unit of the selected ecosystem service. The indicator provides information about the (economic and technological) efficiency of the production process but does not convey information about its economic value, expressed in monetary terms. In this perspective, we need to compute the value of marginal productivity. Such monetary indicator is a measure of how much additional revenue varies with the use of an additional unit of the selected input-ecosystem service.[4] This monetary value is computed by multiplying the estimated marginal productivity times the output market price, as reported in the national account spreadsheets. The value of the marginal productivity of the selected ecosystem service bridges the technological characteristics of production to the economic revenues of production, where the ecosystem service plays a determinant role as an economic factor. Finally, we propose to scale up this value to the national level.

Formally, we can define a ‘production function’ as follows:

$$Q_t = f(L_t, K_t, ES_t, Z_t) \tag{1}$$

where Q_t is the output of selected market goods at time t, L_t is a vector of labour input (e.g. number of working hours); K_t is a vector of capital input (e.g. number of machines); ES_t denotes a vector of ES-input and; Z_t is a vector of other inputs. From a micro-economic perspective, water is here interpreted as a fundamental production input impacting the market based performance of key economic sectors in the study region under study. The marginal productivity of a production input is calculated as a partial derivative of the production function with respect to the selected input. In this context, the marginal productivity of the ES is calculated by Eq. (2):

$$MP_{ES} = \frac{\partial Q}{\partial ES} \tag{2}$$

Once the marginal productivity of the ES is estimated, one can compute the economic value of the marginal productivity of the selected ES. This economic value is defined by Eq. (3)

[3] Barbier makes an attempt to adjust the net domestic product for the contribution of ecosystem services derived from mangroves in Thailand, see Barbier (2012, 2016). In the study, we do not attempt to adjust net domestic product but make visible the contribution of the selected ecosystem service to the reported domestic product.

[4] The value of the input marginal productivity can also be interpreted as an opportunity cost, that is the cost of a forgone unit of ES destined to an alternative allocation from the one currently considered.