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J.R.Olarieta

Abstract

The objective of this paper is to discuss the socio-economic aspects of land evaluation and to advance in the development of land evaluation as an ecological economics of soils. The principles of the FAO Framework are considered a sound basis but further emphasis is needed in the analysis of the land utilization types and in the quantification of inputs and outputs of the land-use system. We discuss the approaches developed in the field of economics for the analysis of soil resources. These approaches date back to the classic economists of the 19th century, who recognised the spatial variability of soil characteristics and their influence on the formation of rent. The development of ecological economics at the end of the 20th century builds a bridge for further dialogue as it calls for the availability of soil maps as accounts of the soil resources and for land evaluation as the methodology to account for the land-use types and for the fluxes of services and other outputs from the land-use system.

Introduction

Land evaluation (LE), as developed in the FAO Framework (FAO, 1976) (FF), has mostly disappeared from the scientific literature, even though a few papers may still use some of the terms typical of the methodology. The 1996 debate in Geoderma (Rossiter, 1996, and associated discussion) was arguably the last effort to develop LE before a long draught set in.

The review of the FF undertaken in 2007 (FAO, 2007) falls short of providing new insights and perspectives for LE. It quite rightly argues for an increased recognition of the multiple functions of land and of the role of stakeholders in the process of LE. But both issues were clearly stated in the 1976 FF when it set itself to answer, among others, the following questions: "which uses offer possibilities of sustained production or *other benefits*?", and "what *other uses* of land are physically possible and *economically and socially relevant*?" (emphasis added). Smyth (1977), one of the authors behind the FF, further insisted that "the possible alternative uses of a piece of land…are controlled and constrained on three sides; on one side by the social and political aspirations, or shall we say the desires, or objectives, of the people; on another by social and economic constraints; and thirdly, of course, by the physical factors of the land itself".

But as we have already discussed, later applications of the FF have mostly ignored, or downplayed the concept of 'land utilization type' in which such issues are embedded (Olarieta, 1996; Olarieta et al., 2000). They have reduced this concept to the definition of the crop species (in agricultural applications), or at best to some general statement about the level of inputs used (such as 'high', or 'low'). Relying on "expert" opinion, they have ignored the objectives, aims and constraints of the farmer/direct land user and the objectives of land-use policies formulated by the various scales of society, which may give priority to some functions at the expense of others. All in all, the socio-economic context of LE has been dumped, even though it was one of the basic principles of the 1976 FF.

On the other hand, the 2007 revised framework insists on some of the pitfalls of the original FF, namely the central role of the suitability concept, and the reliance on monetary analysis as the basic criterion in the definition of suitability classes. We have previously argued that the definition of the suitability class is an exercise in value judgement and therefore not in the domain of the scientist but the matter of political discussion (Olarieta, 1996; Olarieta et al., 2000). Land evaluation should involve the comparison of all the inputs and all the outputs of the land use system as stated in one of the principles of the FF. Further elaboration of these inputs and outputs into a single metric (in this case, the suitability class, but whichever this metric may be) will always involve some kind of value judgement and/or a non-trivial loss of information (Olarieta, 1994; Vatn and Bromley, 1994). Such value judgement, both in the FF and in the papers applying it, has been the maximization of yield (quantitative physical evaluation) or some financial variable (quantitative economic evaluation). We will discuss monetary evaluations later on but suffice to say here that both criteria represent outcomes of the land-use system and therefore do not necessarily provide reliable assessments of the soil resources.

The literature on 'soil quality', although has a similar objective (i.e. linking soils to its uses (functions) has not developed a coherent framework. Our basic argument is that in this direction we remain not far away from land capability classifications or parametric systems, in the sense that we assess soil/land from a pre-defined set of concepts of what is "good" or "bad" without any interaction with the socio-economic system at its various scales (plot, farm, village, region,…). And similarly to LE, the reliance on a single metric hides the conflicting aspects of land use.

But even though LE was considered an economic concept (Dent and Young, 1981) not much effort has been put into developing the socio-economics of LE, except for a very few exceptions (e.g., Turner, 1985; Rossiter, 1995). It cannot serve as an excuse but a similar picture appears in the field of Economics. In a book about “Socio-economic Factors in Land Evaluation" (Boussard, 1988), all papers but one fail even to mention the FF and only talk about the exchange value of land, i.e., its market price, but not about the use value of land. Nevertheless, the 'Concluding Remarks' and 'Conclusions and Recommendations' of this book read very much like the principles and basic ideas of the FF.

By the late 1980s, Ecological Economics was developing as a branch of Economics with the aim of building bridges with natural systems. In fact, some of these proposals were saying exactly the same things as LE. That both approaches have not met is a striking example of how far we are from true transdisciplinarity. It is our objective in this paper to discuss the soil as an economic object and to propose a way forward in what we may call 'soil economics' after briefly summarizing the economic literature that has dealt with soils.

Ideas from the 19th century

The idea of soil variability influencing their suitability for agricultural production was part of the basis of the economic ideas, and the concept of rent in particular, developed by Adam Smith in his 1776 book “An Investigation on the Nature and Causes of the Wealth of Nations”, James Anderson in 1777 in “An Enquiry into the Nature of the Corn Laws” and David Ricardo’s 1817 “Principles of Political Economy and Taxation”. Smith's theory about the rent of land is based on differences in soil fertility, whether natural or produced by men, amount of land available of various classes of fertility, and their location in relation to cities: “the rent of land does not only vary as a result of its fertility, whatever its products, but also as a result of its location, whatever its fertility”.

He argued that the most fertile soils would be the first to be used for agriculture while the poorer soils would be left for pasture. The balance between these competing used would be struck according to the supply and demand for grain and meat. He acknowledged the importance of specific land characteristics for specific products such as wine, and how rice requires very wet soils that are not good for wheat or vineyards. In this case, he argues that land uses would not be competing for land and therefore would not influence each other's rents. He also discussed the difficulty in comparing different produces when he stated that land sown to potatoes would yield much more than if sown to wheat but that the nutritional value of the former is lower than that of the latter.

James Anderson, in his 1801 book "A Calm Investigation on the Circumstances that have Led to the Present Scarcity of Grain in Britain", argued, as Karl Marx would also insist later on, against the urban-rural divide as it was leading to the loss of nutrients from agricultural soils and their waste into the river Thames (Foster, 2000).

National accounting systems

Lucas Olazabal (1857) produced the first soil map of Bizkaia (northern Spain) and argued for soil information to be included as part of the statistical accounting of the country, in opposition to some of his contemporaries who judged the agricultural capability of land merely on the basis of degree of slope. He acknowledged the importance of natural vegetation and manuring by farmers in maintaining or improving soil conditions, and therefore argued that the value of soils cannot be ignored in the accounting systems but represents "the significant amount that needs to be invested before a desert land may be cultivated". He also put forward an important issue that would only be discussed again more than 100 years later, namely that the time horizon of an individual may be counted by days, but the time horizon of countries should be counted by centuries.

But such ideas were swept aside for a long time, and it was only in 1975 that efforts were started to introduce natural resources in the national accounts. These approaches were based on the translation of ecosystem services into monetary units (Peskin, 1975; Ahmad et al., 1989; Repetto et al., 1989) and have been applied to assess the impact of soil degradation at national scales (e.g. Adger and Grohs, 1994; Alfsen et al., 1996). Recently, the global "The Economics of Ecosystems and Biodiversity" (TEEB, 2010) study follows the same direction. We will briefly discuss the monetary evaluation of soil degradation later on.

At the same time, Jurdant et al. (1977) acknowledged the need for an accounting system of ‘natural capital’ based on ecosystem or ecological mapping as an integration of ‘partial’ surveys of soils, vegetation, geomorphology, etc. The neglect of natural systems in national accounting systems led economist José Manuel Naredo (1987) to propose an ‘ecointegrative model’ based on the premise that economic objects need not be measured indirectly in monetary terms, but natural systems in particular should be considered on their own terms, and therefore such model requires the support of the various branches of science dealing with natural systems. He suggested the development of location-specific ‘Accounts of the Natural Heritage’ that therefore require thematic maps to be provided for each resource, and should include:

- ‘Accounts of Resource Inventories’ measured in the specific metrics appropriate to each resource,
- ‘Accounts of the Fluxes from the Utilization Systems’ including the inputs used and the outputs resulting from land use, and
- ‘Accounts of Fluxes of Residues’ that result from land use.

In 1986 he had specifically applied this model to soils as resources for agricultural production on the basis of their yield of dry matter of the species most suitable in each region. While some of these proposals may require further discussion, their close connections with soil survey and land evaluation cannot be denied.

Monetary evaluation of soils

The dominant economic discourse considers that natural systems will only be take into account in public policies and private practice when valued in monetary metrics. Soils, or land in more general terms, have also been the subject of this kind of analysis, whether valuing the contribution to agricultural production (e.g. Alexander et al., 1998), their degradation (e.g., Scrimgeour and Shepherd, 1998, for structural degradation; Borgaard et al., 2003, for soil erosion; Janmaat, 2004, for soil salinization), their conservation or improvement (e.g. Hochman et al., 1989, for acid soils; Zekri et al, 1990, for saline soils; Posthumus and de Graaff, 2005, for bench terraces), or the sequestration of carbon in soils (Sparling et al., 2006).

We have discussed the shortcomings of these approaches somewhere else (Olarieta, 1994; Olarieta, 2000; Olarieta et al., 2008), but they basically stem from the contradiction of using a framework, mainstream economic analysis, that has historically neglected natural systems and therefore has not developed the principles nor the methodologies suited to these systems. Furthermore, reducing the multiple functions of soils to a single metric involves some value judgements and/or some loss of information. Specifically in relation to soils, methods based on the agrarian productivity are flawed because they only consider the production function of soils, and even then not a soil output but the output of the whole land-use system, and nevertheless, the synergistic interactions between ecosystem services and capital do not allow to properly account for each other's contribution. Methods based on the rehabilitation cost treat soils as mere stocks of nutrients for plants, and cannot consider many of the processes of soil degradation. In any case, the discount rates commonly used in monetary analysis imply that the recovery or improvement of most soil characteristics is worthless given the time-scales of these processes (Sparling et la., 2003).

Energy value of soils

Energy analysis (and/or its variants, in terms of emergy or exergy) has been proposed as a better framework to study the value of natural systems than monetary analysis (Pimentel, 1973; Odum, 1994) but has rarely been applied to soils. Minasny et al. (2008) review various methods developed to study the energy involved in soil formation, including the model proposed by Volobuyev and the entropy model developed by Smeck et al.

Further to these efforts, Svirezhev (2005) proposes a thermodynamic model of soil degradation based on two processes, loss of organic matter and the destruction of soil aggregates down to their elementary particles. Cohen et al. (2006) have evaluated soil erosion in Kenya through emergy analysis on the basis that "soil organic matter is the "value bearer" for soil and other functional attributes are subsumed under that component" but also considering the input from weathering. Nevertheless, these approaches can only explain certain aspects of soil behaviour and not the full range of soil variables, some of which may not be the result of energy flows but simply reflect characteristics of the parent material, such as nutrient content.

The (implicit) economics of the FAO Framework

The link between LE and economics was explicitly recognized from the outset of the FF. Land evaluation was defined as an 'economic concept' that needs information from three sources: land, land use, and economics (Dent and Young, 1981). There are two areas in which economics clearly enters the FF: the requirement to consider all the inputs and outputs of the land-use systems, and the use of economic analysis to define the suitability of land units.

By considering all inputs and outputs, the FF is acknowledging that land-use systems, as any human activity, produce utilities, but also residues, and consume resources. Unfortunately, most exercises on LE have only considered one output (yield per surface unit), and have furthermore used this as the sole criterion to define suitability. In some other cases, only those inputs and outputs that may be translated into monetary units have been considered and used to obtain some index of monetary performance of the land-use system. As we have previously discussed, this kind of analysis cannot adequately account for all the aspects of these systems, and in particular those related to the soil resource. But as a result of their neglect of the input-output budget, most LE exercises have not provided any better approach to the analysis of soil degradation.

Land evaluation as an ecological economics of soils

Economics in its original sense was related to the analysis of the use of resources to satisfy human needs (Naredo, 1987). Such definition fits well with the FF approach to LE which seeks to assess how land resources may satisfy the needs of land users through specific land utilization types. And the resemblance between approaches such as those proposed by Naredo and other ecological economists and the principles of the FF demands a step towards further matching both approaches.

Following the concepts developed by Faber et al. (1995), soils are funds, that is, systems that provide services, material or immaterial, to other natural systems, reproduce themselves and are therefore indefinite concerning their time scale. As funds, soils may provide three types of services:

- those of immaterial nature, e.g., soil providing anchorage for plants, or soils as rare or threatened specimens,

- those that involve components of the fund the extraction of which does not directly compromise the survival of the fund, e.g., soil nutrients for plants. These components may be considered as 'partial funds' because they behave as funds but only exist as part of the soil ecosystem,

- those that involve the whole fund or some essential component, e.g., soil as physical space for urban development. In this case, the soil behaves as a stock, that is, as a resource available in finite amounts.

It therefore follows that the metric of the various services provided by soils (e.g., kg of phosphorus or cubic metres of water) is not the same as the metric of soils (e.g. hectares of Typic Udorthent), unless the soil is used as a stock.

This framework requires the provision of information about the stocks of different soils and about the different land use systems demanding different types of services from soils, providing the connection to the 'ecointegrative model' of Naredo, and to soil survey and land evaluation as the providers of such information. We will now briefly present some examples of land evaluation exercises, at macro and micro scales, that show the possibilities of integration of this information.

Macroeconomic scale

Using a supply-demand model of land use based on the land unit maps of Ontario and on the societal demand for urban expansion and for agricultural, livestock and forest products, respectively, Smit et al. (1981, 1984) developed a model that allows the assessment of the land use flexibility, the degree to which some land units are critical for the supply of certain products or services, and the effect that changes in the future availability of services provided by soils (because of land degradation) and /or energy or materials (such as fertilisers), i.e., the sustainability of the land use types, may have on the provision of those products and services and on the spatial distribution of land uses.

Bouman et al. (1999) developed a similar model in order to assess various land-use possibilities at different scales, from the village to the region, in order to achieve various objectives, including monetary benefit, employment, decreasing use of biocides, etc.

The consumption of soils by urban and infrastructure development represents the case of soil providing services as stocks. A relatively simple system developed in New Zealand, based on their land capability classification as the accounting system of soils, clearly shows how this process of urbanization is preferentially occupying land in the lower classes of the capability classification and the threat that it represents to the sustainability of their agri-food system (Rutledge, 2008).

Other functions of soils, for example as support for ecosystems with high biodiversity, may be considered at this scale. Huston (1993) has argued that the agricultural production and the 'biodiversity production' function of soils would not, in general, enter into competition as there is a negative relation between diversity of plant species and agricultural productivity.

At this scale, other considerations may be taken into account, such as the existence value of soils as rare specimens. While this concept is quite popular for plants and animals and even for geological formations, it is not the case for soils. We have previously argued (Olarieta, 1994) that the reason for this is cultural, certainly not scientific, and various authors have put forward the case for the protection of such soils (González, 1981; Hagvar, 1998; Drohan and Farnham, 2006).

Microeconomic scale

At the plot scale, and considering land utilization types that do not use soils as stocks, i.e. agricultural, pastoral, or forestry uses, the input-output budget in relation to the initial state of the soil would indicate whether we are using soil components as funds or as stocks, and in the latter case, at what rate we are depleting such stock.

Bruijnzeel (1992) studied the input-output budget of teak plantations in coarse-textured Inceptisols in Venezuela involved a net extraction of phosphorus, potassium, calcium, and magnesium, and that calcium was the critical resource as its net extraction represented over 50-80% of the original stocks of this nutrient. A similar study with radiata pine plantations in northern Spain concluded that phosphorus was the critical resource, and that it may be depleted in two or three 40 year-rotations on shallow, acid Typic Udorthents (Olarieta et al., 2006).

Conclusions

The lack of development of land evaluation, sensu FAO (1976), into socio-economic areas is the result of a superficial interpretation of the

FAO Framework, and of the neglect of the principles of detailed consideration of the land utilization type and comparison of all inputs and outputs. On the other hand, there is a tradition in the field of economics, even if not part of the dominant discourse, that seeks to build bridges with natural sciences and has developed methodologies for the assessment of soils that are strikingly similar to land evaluation.

In this paper we put forward some suggestions in the direction of developing such soil economics from the starting point of land evaluation. The consideration of the soil as an economic object, as a fund, implies that it is at the centre of the analysis and not just a producer a flows to other scales of the system. Soil survey is the basic accounting system of the soil resources and land evaluation is the methodology to account for the land-use types and for the fluxes of services and other outputs from the land-use system.

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