Farmers in metropolitan areas: managers of natural capital

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Abstract

Natural capital is the stock of natural resources (like soils, water and biodiversity) that supplies a stream of ecosystem services to society. Incorporating natural capital through the value of ecosystem services in accounting systems of farmers will add natural capital to economic decision making. For valuation and decision making it is important to be able to isolate the natural capital element within the production of goods. Such an accounting system should be acceptable and recognized for different users.

Keywords: natural capital, ecosystem services, property rights, farm level accounting

Introduction

Benefits of natural capital are typically generated in combination with other forms of capital like people, knowledge or equipment (e.g. Fisher et al., 2008). People and equipment are traditionally listed in farm accounting systems. Accounting in this paper is defined as "the process of identifying, measuring and communicating economic information to permit informed judgement and decisions by users of the information" (Drury, 2001; cited in Spurgeon, 2014). Adding natural capital in annual farm accounting systems for keeping track of natural capital value development can serve different users and can serve as a tool for sustainable development (Guerry et al., 2015). Users can be farmers, tax authorities, investors and other stakeholders like the general public.

The Common Agricultural Policy (CAP) provides instruments and measures to encourage the conservation and enhancement of natural capital (e.g. EC, 2013; EEA, 2015). The so-called first pillar of the CAP (i.e. direct farm subsidies and market support) contains measures to prevent land abandonment and fragmentation of agricultural holdings. Agro-environmental practices are supported through the second pillar (i.e. promoting rural development and structural improvements in farming). These payments foster the coherence of landscape elements (e.g. hedgerows, buffer strips and terraces, etc.), the management of field boundaries and the conservation of terraces. Natural capital is at risk in densely populated metropolitan regions in the Netherlands. Multiple, multifunctional and simultaneous functions are performed in these areas dealing with different elements of the Nexus: food, energy, land, water and climate. Still, metropolitan areas depend on rural areas for food and leisure activities. The aim of this paper is to gain insight in the potential role which accounting for natural capital can play in the farming sector.

We start with the meaning of natural capital for metropolitan farmers. A global overview of the main ecosystem services supplied by Dutch agricultural natural capital is presented: food and feed. For this purpose different provisioning services are mapped for the Netherlands. In Section 3 we will go into more depth on the ecosystem production function of agriculture. The paper will end with the main conclusions.

Natural capital for metropolitan farmers

Natural capital builds up from natural energy resources. Natural capital in this paper is defined as earth's lands and waters and their biodiversity (Daily et al., 2008). Ecosystem services provide services from natural capital to society such as food and fibre. They link natural capital to the socio-economic system. However, it is not the only link: humans have different positive/negative impact on natural capital and harvest the services of natural capital

as in the case of food and fodder. Human interventions often have impact on other services the ecosystem can perform such as a reduction of regulating services or cultural services (see Braat and Groot, 2012). Figure 1 presents an overview of the link between natural capital (stock) and the socio-economic system via ecosystem services (flow) and management of natural capital. We need to keep in mind that the stock-flow framework does not give the full picture of the ecological, economic, and political complexities of the challenges we actually face (Norgaard, 2010). Food, feed and fibre are provisioning services (see Maes et al., 2013 for classification of ecosystem services) and are part of the total flow of ecosystem services, together with regulating services and cultural services.

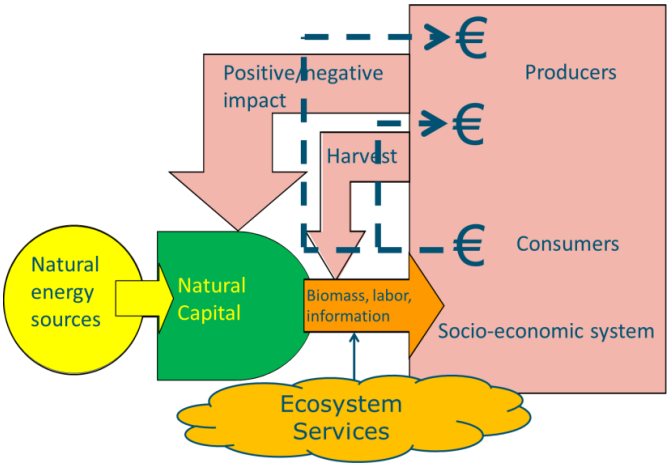

Figure 1: Natural capital and ecosystem services (adapted from Braat and Groot, 2012)

Maintaining natural capital on agricultural farms is essential for future flows of ecosystem services (Guerry et al., 2015). In addition, farmers are also dependent on the green infrastructure in the neighbourhood of their farm. This capital can be other farms or non-farming landscape elements, for instance for pollination. It is important to infer relevant spatial characteristics for sustainable biodiversity management (see Schouten et al., 2013) to develop spatial cohesion in natural capital at landscape level. In this paper we focus on the on-farm natural capital.

Ecosystem services are often managed as combination of private goods, such as food, raw materials and ornamental plants (provisioning) and public goods, such as open space. If the public ecosystem service is technologically tied to agricultural land use (joint inputs), potential non-agricultural providers have to adopt a similar mode of land-use. This means that an ecosystem service is not separable in terms of land-use and that no separate production functions can be written to both outputs (cf. Chambers, 1988: 288). If, however, public ecosystem services and the production of private goods are not joint in terms of input quantities, each output is produced by a separate production function, with the supply of production factors allocated to the different outputs. This means that the attributes of land can be produced or managed by different parties. The trade-off in land use decisions in agriculture determines the value of ecosystem services and biodiversity at the (local) level (Bateman et al., 2013). Often only a part of the total flow of ecosystem services is analysed, e.g. only provisioning services like food or fibre.

Conventional land-use decision-making emphasizes market values and ignores ecosystem services (Bateman et al., 2013). In discussions of ecosystem services the distinction between quantities and values is often lost (Boyd and Banzhaf, 2007). However, ecosystems services are not produced in isolation but the result of joint production as shown

for food and wildlife and landscape (e.g. Peerlings and Polman, 2004 and Boyd and Banzhaf, 2007). Therefore it needs to be kept in mind that in case of food and feed production, multiple services are produced simultaneously and/or jointly. Maximising one service like food production without considering other services like biodiversity can have negative effects for both (see Science for Environment Policy, 2015), for instance when a farmer maximizes provisioning services like food and fibre in the short term but thereby reduces natural capital through the depletion of soils (stocks).

Ecosystem services are the result of a "production process", which can be represented by a production function. A production function describes the maximum output one can get with a given amount of input. It is important to recognize that production is not only the result of natural capital, but also from additional inputs for harvesting and animal holdings, e.g. labour, energy, veterinary care, fertilizers and capital inputs including machinery. Technological constraints are depicted by the production set which depicts also technologically feasible combinations of inputs and outputs and the production function (e.g. Varian, 2010). The stream of ecosystem services is not constant over time or space because it depends on, respectively, weather and soil type. Flows of ecosystem services are not always sustainable and are influenced by natural and socio-economic shocks (e.g. Schouten et al., 2013). Droughts reduce food production, whereas high labour costs or energy prices will affect the actual consumption of provisioning services. For food and feed the distance between supply and demand can be vast and indirect given the complexity of value chains. The maps provide insight in the spatial distribution of agricultural provisioning services in the Netherlands. The level of detail is the individual plot, but although the land use of each plot is known, for the output quantity average values need to be used.

To analyse natural capital and ecosystem services, we mapped the ecosystem service food and feed production for the Netherlands, for the dairy sector, arable farming and horticulture. A proxy for net value added per agricultural plot was used. In order to obtain that value, the average output value for each type of crop (including fodder crops such as grass or maize) per hectare was calculated for each plot of farmland in the Netherlands (cropland and pasture land). For fodder, we used the value of on-farm use through harvesting (from storage) or grazing. Values per plot were calculated for a period of four years (2011-2014), so as to take crop rotations into account. These total output values were converted into value added by using a branch-specific coefficient for pasture-based livestock (mainly dairy), arable farming, and four types of horticulture (not including greenhouses). Strictly speaking, of course, it is not value added that should be the measure of the value of ecosystem services, but resource rents (e.g. UN et al., 2012 and Remme et al., 2015), i.e. the value accruing to the extractor or user of an asset after all costs and normal returns have been taken into account. However, although coarse estimates can be made, no accurate calculation of crop-specific labour and capital costs is possible from available data.

Intensive poultry and pig farming and greenhouse horticulture are left out of the analysis, because they are not viewed as ecosystem services per se as the inputs for their production are not directly linked to Dutch farmland or local ecosystems. They rely primarily on fodder from non-local ecosystems for feedstuffs like soya and cereals (see also Remme et al., 2015). Land-use and output values will change over time depending on climate change and product prices. Scenario studies show different potential development paths (e.g Bateman et al., 2011 for the UK or Polman et al., 2012 for the Netherlands).

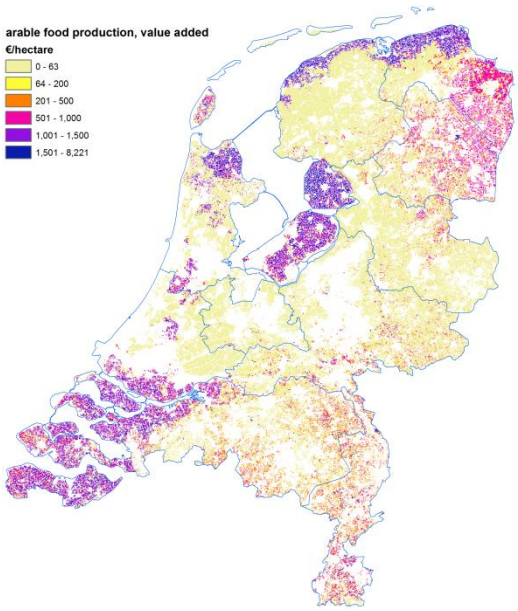

Figure 2: Value of ecosystem services from arable farming (food)

From figure 2 it follows that provisioning services from arable farms are located in three main clay areas in the Netherlands: the south-west, the reclaimed areas of Flevoland (in the centre) and the north-east. The value of services differs regionally, depending on the crops grown like potatoes, sugar beets or grain. The value of provisioning services depends on regional differences in production per hectare due to natural capital like soil type (e.g. clay, sand or peat) and water management. Other factors are regional and local differences in climate like a more moderate climate due to the proximity of the sea and economic factors. Crop production is mostly driven by yield maximisation (i.e. biomass production) given e.g. crop choice and rotations. Other soil functions like the capacity to filter, buffer and transform between the atmosphere, the ground water and the plant cover, biodiversity (or gene) pool, and geological and cultural heritage (see Blum, 2005). Important for maintaining functions are cropping system, nutrient management and tillage.

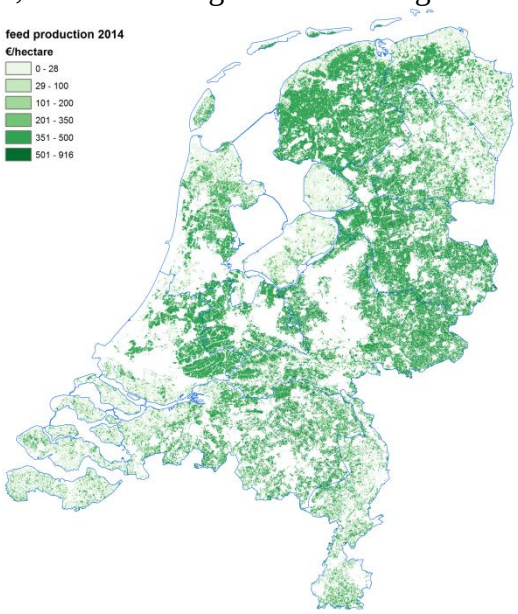

Figure 3: Valuing provisioning services from agriculture: feed production

Feed production is less concentrated in the Netherlands (Figure 3). High values are concentrated in areas with dairy farming. Dairy farming is located in less fertile clay and peat soils in the Friesland, North-Holland, and South-Holland. Compared to arable farming, dairy farming is more equally distributed over the Netherlands (Berkhout, 2015).

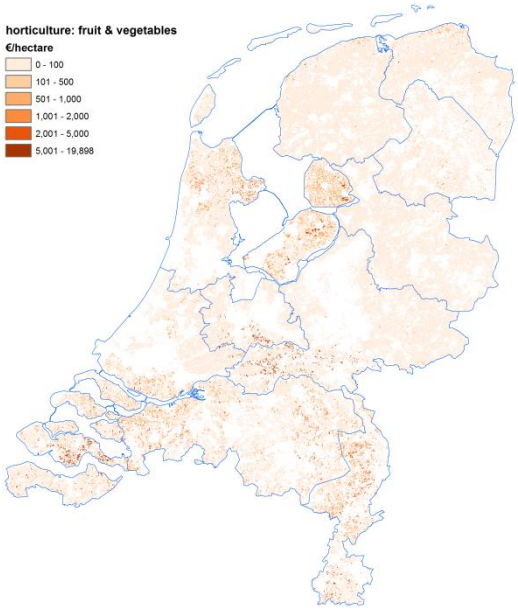

Figure 4: Valuing provisioning services from agriculture: horticulture food production

The area of horticulture for food production is concentrated in certain parts of the Netherlands (Figure 4). In the period between1988-2013 (see Berkhout, 2015), food production from horticulture (i.e. fruits and vegetables) gained importance in the central reclaimed areas, and in the eastern part of Noord-Brabant, in the south of the Netherlands. Limburg has retained its importance for horticulture. Soil types and location near to markets are important determining factors.

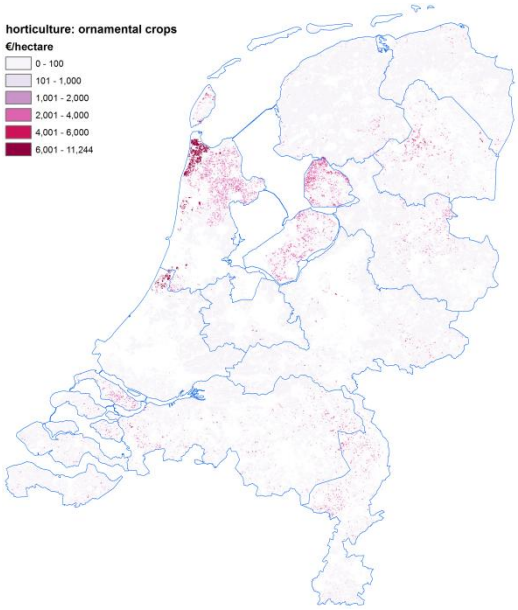

Figure 5: Valuing provisioning services from agriculture: ornamental crops

The largest non-food product from farming in terms of value is flower-bulbs (Figure 5, north-west). Values are high compared to arable production and feed production. These ecosystem services are concentrated in areas with soil types that suit these production types. Natural capital is also under pressure in these areas. The maps show the regional differences in the production of provisioning services. From Berkhout (2015) it follows that regional production of ecosystem services is not constant in time. Changes in supply of provisioning services in the past are connected to agricultural techniques applied. The basic mechanism behind agricultural land use change is a change in relative prices of inputs and outputs (Strijker, 2005). In this sense, general economic development has determined the changes in provisioning services from agricultural natural capital.

Natural capital in agricultural economic decision making

To gain insight in practical aspects of natural capital for farming and ecosystem services for agriculture, an expert workshop with farmers and forest owners was held in December 2014. The concept of natural capital was relatively new to the participants. Therefore, one of the main issues discussed in the workshop was the concept of "natural capital". Agricultural entrepreneurs as large users of farmland argued that everything that "grows and prospers" can be seen as natural capital. Nature regulates the business processes by regulating biodiversity, hedgerows and soil fertility. Every type of management (Figure 1) of natural capital gives a return to the farmer in services like food, feed or fibre. This section starts with the property rights to the natural capital stock and its flows of ecosystem services. These flows determine the value of ecosystem services that accrues to the owner or user. The bundle of farmers' property rights has consequences for the decisions they can make and the value of these rights on the balance sheet.

Natural capital; from property rights to value

Access to natural capital in the agricultural sector can be characterized by the bundle of property rights in use by farmers. The bundle of property rights consists of: the rights (1) to use natural capital, (2) to acquire income from natural capital and its ecosystem services, (3) to change the form and substance of natural capital, (4) to exclude others, and (5) to transfer the land to others through markets or to their heirs (see also Furubotn & Richter, 2005). Especially the income and transfer rights through ecosystem services mark the economic significance of ownership of natural capital.

Land, as an asset with valuable natural capital, delivers many different ecosystem services. Some services are excludable like the use of land for agricultural purposes (provision service), and some are nonexcludable like wildlife and scenery (cultural services). Furthermore, some ecosystem services are rival in consumption, like the using of land for agricultural production, while others are non-rival like wildlife and landscape. The question is: who has the property rights over these ecosystem services (attributes)? For the use of land for agricultural production this seems clear: the landowner has property rights. However, establishing effective control over natural capital is difficult and the property rights are often unclear; an example is the right to pollute the groundwater, which will affect other landowners. In general, the size of a landholding will be closely correlated to the ecosystem service that most influences the value of land (cf. Lueck, 1989: 300). Therefore ownership of farmland is related to agricultural production. This implies that the ownership pattern of land -

which itself has a variety of valuable uses - often does not coincide with the actual "territories" of valuable natural capital stocks (cf. Lueck, 1989: 300).

People tend to delineate their property rights more carefully as the value of these rights increases and less so as their value declines (Polman, 2002). Imperfect delineation of property rights is sometimes a result of the choice of owners not to exercise all of their rights. Owners find or deem some of their rights too expensive to exercise and choose to place them in the public domain (Barzel, 1997: 93). In the past farmers have left (or placed) the gain from natural capital (ecosystem services) in the public domain, for instance because of high transaction costs. They did not claim the property rights.

Natural capital in farm level decision making

It was recognized in the workshop that the use of natural capital could also lead to depletion of soils, erosion, pollution and compaction and decreasing biodiversity. Biodiversity was not seen as financially profitable; however it contributes to a license to produce. An increase of natural capital is expected to result in an increase in appreciation from society. In the end, a transition to an economic transaction is seen as requirement. The value of natural capital depends on time and place and changes due to changing societal norms and values; which confirms the preceding analysis.

Maintaining natural soil quality for food production receives growing interest in economics. Soil quality can be defined as the ability to provide ecosystem services (see Tóth et al., 2007). Examples are measuring the quality of soils in land lease contracts. Increasing vulnerability to organic matter, soil fertility, compaction, weeds and pathogens (Lahmar 2010) as a result of soil management (e.g. cropping system, nutrient management and tillage) will reduce the value of land in that it will provide less provisioning services to the user. In certain areas the quality of the soil is measured at the beginning and the end of a lease contract. It was argued that high lease prices for short term contracts could potentially lead to depletion of soils. A similar argument can be found in Slangen et al., (2003). However, the ability to measure the quality of soils is open to question.

The farmers at the workshop considered themselves part of the natural cycle and also as ambassadors of natural capital. If farmers are supported in their role in the natural cycle, the quality of natural capital is expected to improve. Natural capital is seen as a long term issue, implying the need to secure its management. A traditional orchard contributing to natural capital has only a low value just after plantation, whereas in the long run, value increases. Accounting was seen as a relevant issue, because the need to prove was recognized. It was argued that metrics are needed at farm level and it should give an advantage to entrepreneurs when exploiting natural capital and adding to the balance sheet. A farm will report on natural and other capital if they are inputs in the production process, since profitability will generally be affected by the condition of these forms of capital (e.g. Flower, 2015).

Value can be seen as value to investors or value to society. In the latter case a farmer should report the impact of his activities on all forms of capital (Flower, 2015). However, if natural capital is considered free, there will be no monetary value allocated (Pretty and Smith, 2004). Market signals (e.g. the value of food and fibre) will indicate the value of natural capital increases when it is converted into a flow of goods. The profit from converting natural capital into food or fibre is counted, while the loss of natural capital and its connected ecosystem services is not, resulting in incomplete information.

Accounting is at the core of economic decision-making (e.g. Obst and Vardon, 2014). Incorporating natural capital through the value of ecosystem services in accounting systems of farmers will add natural capital to economic decision-making (e.g. Guerry et al., 2014). In

general, there is a growing interest of incorporating natural capital into (non-statutory) accounts (e.g. a "shadow" balance sheet) (see e.g. Natural Capital Coalition) . Green accounting is used to facilitate environmental improvement at farm level (e.g. Halberg et al., 2005) and is linked to accounting for natural capital. It could serve as an evidence base for sustainability claims. Aggregating over different farms accounts may highlight a regional "natural capital deficit" that may require policy intervention (Guerry et al., 2014). However, loose definitions will undermine accounting systems (Boyd and Banzaf, 2007). In the Netherlands, natural capital is not explicitly mentioned in the financial balance sheets of farms, nor was it frequently used as a concept within the agricultural sector in Netherlands. Natural assets will only be partially included in farmland prices (Caldecott et al., 2013), for instance because of the importance of soil quality for agricultural production.

To secure an accounting system for natural capital in agriculture in the long run, it is crucial to integrate natural capital in the farming business. Property rights to natural capital define who owns which attributes of natural capital and what the owner can do with what he owns. Examples of attributes are soil composition, shape of parcels, and ground- or ditch-water level. Such ownership can be temporarily rented out to a tenant. Clear property rights encourage development valuable natural capital and transferability contributes that the property ends up in the hands of those who can use it most efficiently. Property rights in the form of use rights or the right to exclude others from using represent a value to the owner of those rights. However, conventional accounting systems focus on short term reporting rather than longer term issues like climate risks (Linnenluecke et al. 2015).

The income generated from agri-environmental schemes is relevant for calculating profits or losses from the farming business. Natural capital is not yet included on the balance sheet and cannot be traded separately from land. Natural capital attributes such as landscape elements or wildlife are in fact a disadvantage, because they often result in a lower income. It was suggested to split the different values of farmland: e.g. income value and natural capital value. An advantage would be that natural capital would become visible. It could also imply a potential for trade-off between natural and financial capital (Flower, 2015).

Summary and conclusions

Natural capital is a stock of natural resources providing a flow of different ecosystem services. Agricultural natural capital encompasses land, the quality of soils, as well as the landscape and open space of agricultural areas. Central to agricultural natural capital are provisioning services like food, animal feed and fibre. Different other ecosystem services are produced jointly with food and fibre: cultural services (leisure) and various regulatory services, depending on the man-made agro-ecosystem.

Property rights to natural capital describe the way people can use capital: transform, transfer to others, and change of land use. Property rights also determine opportunities to alter the stream of ecosystem services. Property is a bundle of different rights, representing a value depending on the size of the bundle and on the ecosystem services provided. The bundle can be restricted by the institutional environment in which the landowner operates. To attach a value to natural capital in economic transactions implies that this value needs to be administered as well. To guarantee sustainable development, accounting for the long term is needed, because natural capital changes in the course of time, partly due to how it is managed and to the "harvesting" of ecosystem services.

A balance sheet shows the amount and composition of capital of a farm at the date the sheet reflects. Currently, natural capital is not included or accounted for on most farms, either commercially or fiscally. The type of accounting depends on the user of the data.

From our analysis, it follows that keeping record of (evolution in) natural capital can give an advantage to farmers as users of the data. To make this happen, an incentive for accounting for natural capital and property rights is needed (e.g. fiscal deduction or development rights). For valuation and decision making it must be possible to isolate the natural capital element within the production of goods (see also Bateman et al., 2011). Finally, such a system should be acceptable for and recognized by other stakeholders (users of accounting data).

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