Accounting for soil resources

5.7.1 Introduction

Soil resources form a fundamental part of the environment. They provide the physical base to support the productivity and cycling of biological resources, provide the source of nutrients and water for agricultural and forestry systems and fulfil a complex buffering role against environmental variability (ranging from dampening diurnal and seasonal change in temperature and water supply to the storage and binding of a range of chemical and biological agents). They are also highly biodiverse. Soils themselves vary greatly – a soil with favourable mix of physical, chemical and biological characteristics will have a much higher potential for productivity in gross terms than one less favoured. A broader ecosystem view complicates this, however. For example, "poor" soils with low levels of nutrients can have highly diverse flora and fauna with high levels of endemism.

Accounting for soil resources therefore has many dimensions. Soil loss through erosion and other causes can be quantified – with the loss measured in soil volume and in the nutrients and biological resources that are redistributed or destroyed. More broadly, accounting for soil resources in terms of their types, volumes, nutrient content, and other characteristics is relevant for a more detailed examination of agricultural and forest productivity and the impact of changing land uses.

Research into measuring change in the quantity and quality of soil and in the capacity of soils and landscapes for various uses has been a longstanding undertaking in many countries – and is a staple activity in most national / regional soil surveys. This section explains how research on and mapping of soil can be combined with accounting for environmental assets[1]. A characterization of soil resources is provided together with discussion on accounting for soil resources in physical and monetary terms.

5.7.2 Characterization of soil resources

Soil resources are a form of environmental asset providing a range of ecosystem services. A key feature of soils is their delivery of supporting services including the formation of and function of the soil itself, nutrient cycling, water cycling, structural support of vegetation and soil biodiversity.

In the central framework the focus of accounting for soil resources is on the volume of soil, the various components and properties of soil. Soil components reflect the biogeochemical composition (e.g. mineral, organic, liquid or gas). Soil properties reflect the physical, chemical and biological characteristics of the soil – e.g. porosity, texture, pH level, microbial biomass.

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[1] For material examining this issue from a soil science perspective see, for example, Dominati et al, 2010, "A framework for classifying and quantifying the natural capital and ecosystem services of soils", Ecological Economics, Vol 69. 60

Using information on different combinations and arrangements of components and properties, the various soil types can be defined. It is these various soil types that can provide the basis for a generalised accounting for soil resources.

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Soil resources are distinguishable from land and associated water areas in physical terms since land is defined through its delineation of space. In monetary terms however, separating the values of these two environmental assets may be very difficult since it is unlikely that the soil resources can be physically removed from a given area except at the margin. Thus by convention, the value of land and soil is combined.

5.7.3 Accounting for soil resources

Soil resources are measured through a series of inventory processes – known collectively as soil survey. Typically, this produces maps of soil types, soil suitability for various purposes, hazards / degradation potential and, in some cases, maps of specific soil properties. Other important and complementary activities for soil resource accounting include site or area based measures of soil loss or erosion processes, simulation modelling which predicts the productivity of soil types for specific climate and land use settings, current and projected land use and remotely sensed changes in net and gross primary productivity. The availability of this suite of measurements varies between and within countries – and they are rarely integrated into an accounting approach. Nonetheless, an accounting approach can be devised which uses these elements.

Soil quality or soil value has utilised a range of measures. In most countries, soil capability or suitability for specific purposes is assessed through a standardised indexing procedure. FAO published a series of Guidelines for Land Evaluation in the 1980s; these illustrate the nature of these types of approaches. Most countries / regions have similar systems optimised for their approach to soil mapping and soil classification. Generally they rank soils in terms of productive capacity and/or tendency for degradation – and can then be mapped. Simulation models can be used to extrapolate from well-studied sites across the landscape and produce quantitative measures of productive yield, runoff and soil erosion – but this relies on the ability to derive model parameters from soil type maps.

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Deleted: Two important and relevant innovations in soil inventory are relevant. These fall under the Global Soils initiative in GEOSS – one is harmonising traditional soil maps and the other is developing a comprehensive, consistent and fine-scale grid of soil properties. When complete (subject to funding being secured), these initiatives will substantially simplify accounting for soils.

5.7.4 Accounting for soil resources in physical terms

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Baseline: The first stage of accounting will measure the area of soil types interpreted to express soil quality. This will be based on an index derived from the national / regional soil evaluation system moderated into a consistent international index.

Productive potential: Using a conceptual or simulation modelling approach linked to current land use maps, an index for productive potential will be derived against the 'best' use for a region or zone. Agricultural statistics on land use, yield, inputs and change will provide the data to develop a time series of productive potential change. In non-agricultural / forest areas, the soils can be assessed against their ability to support a 'reference condition' of flora and fauna.

Loss of soil and soil quality: This aspect of accounting will draw from each country's measurement of soil loss due to erosion, soil loss due to alienation (e.g. urban expansion), decline in soil quality due to degradation processes including acidification, salinisation, soil carbon decline, soil structural decline and the depletion of soil nutrients. These losses will be represented initially in various measures related to the loss process – but each can be expressed in terms of the loss of productive potential indexed against total potential. In non-agricultural / forest areas, the loss of soil and soil quality can be assessed as change to the capacity to support the 'reference condition' of flora and fauna.

The second stage in accounting for soil resources will measure the loss of the soil itself (including by alienation) and therefore the loss of the capacity to store water, nutrients and soil biodiversity and to mitigate environmental change. This aspect of accounting for soil resources is considered as part of SEEA experimental ecosystem accounts.

5.7.5 Accounting for soil resources in monetary terms

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In agricultural / forest landscapes: The various indices developed to measure change in physical soil resources can then be expressed in income increased or foregone, in changes needed to augment inputs such as fertilisers, pesticides and water, in amelioration to reverse the effects of soil degradation or to move or change practice. The most effective tool for this estimation is well validated simulation models but "rules of thumb" within conceptual models are useful if derived from a credible expert elicitation process.

In non-agricultural / forest landscapes, monetary estimates are less reliable and rely on various resource economic techniques to measure contingency costs or the cost / benefit of investment to avoid or mitigate loss.