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Review

Examining links between soil management, soil health, and public benefits in agricultural landscapes: An Australian perspective

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ABSTRACT

Public expectations of soil management are gradually expanding beyond traditional primary production requirements to include diverse ecosystem services. In Australia, as in many other countries, the accommodation of these new expectations will require shifts in the practice of private land managers. In turn, this may require public intervention and the expenditure of public funds. However, public net benefits from soil management interventions are rarely established, in part due to a lack of understanding of the conceptual links between management changes, soil health, and associated services and benefits. This paper uses an ecosystem services-based approach to examine these links from an Australian perspective.

Entrenchment of the popular soil health concept in field-based assessments of agricultural production potential was found to limit the concept's applicability to questions of broader public benefit. Without expanding soil health to include more ecological indicators, the concept risks remaining peripheral to contemporary visions of multiple-outcome soil management in Australia. Conceptual and case study links were examined between soil properties and processes, soil-based services, and private and public net benefits. In this framework, benefits were produced from services, and were considered a more tangible point for public understanding and valuation than services. The qualitative case study highlighted many knowledge gaps relating to non-agricultural services and benefits from soils, particularly in the scaling-up of sub-paddock measurements, and in the form and constancy of relationships among services and benefits. Criteria for identifying priority public benefits from soil management were examined, namely, likelihood, degree, consequence, scale, direction, time lag, and valuation. Assumptions about these criteria require rigorous testing so that the what, where, when, and how of public benefits from changed soil management can be more clearly defined.

Contents

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1. Introduction

Soil is that 'invaluable, diverse, and fragile natural resource at Earth's terrestrial surface that provides for life support' (Wilding and Lin, 2006). Most appreciated for its role as a medium for providing nutrients and water to agricultural plants, soil is equally fundamental to a range of services including carbon sequestration, water quality and flow regulation, remediation of wastes and pollutants, and habitat provision for soil biota (Costanza et al., 1997; Daily et al., 1997; Lal, 2004).

While the importance of soil to life is indisputable, soil resources worldwide continue to degrade. The problem of ongoing soil degradation becomes particularly critical given projections of future global food requirements – e.g. 63% increase in average cereal yields by 2050 – most of which need to be met by land already under agriculture (Lal, 2009). This has resonance in Australia where expanding food markets in Asia present considerable export opportunities, but soil degradation remains a 'very significant' problem that is likely to intensify under climate change (Campbell, 2008).

International commitment to addressing soil degradation and improving soil management is evident in various government programs and strategies. One enduring example is the United State's Conservation Reserve Program, which pays private landholders to retire erosion-prone soils from crop production, with the demonstrated aim of improving the joint production of soil conservation, farm income, and water quality in agricultural landscapes (Lant et al., 2005). At a broader policy level, the European Commission (EC) has adopted a 'Thematic Strategy for Soil Protection' (Commission of the European Communities, 2006), which has led to the development of national policy statements like England's recent 'Safeguarding our Soils' strategy (Defra, 2009). However, soils are not receiving such strong policy interest in all parts of the world. In Australia, for example, government focus on soil conservation has decreased in the last two decades (Campbell, 2008), despite substantial increases over the same period in federal government expenditure on natural resource management programs (Hajkowicz, 2009).

It has been suggested that one factor that has contributed to the loss of focus on soil conservation in Australia is an apparent failure to 'join the dots' between good soil management and broader environmental, societal, and economic outcomes (Campbell, 2008). This indicates a lack of clarity on links between paddock-level aspirations for soil management – often represented by the soil health concept (MacEwan, 2007; Kibblewhite et al., 2008) – and broader expectations, like those encapsulated in the concepts of ecosystem services and human welfare benefits (Millennium Ecosystem Assessment, 2005; Fisher et al., 2009). Thus, even at a conceptual level, it is difficult to answer the question 'what will we get for expending public (government) funds on soil management?' (Hajkowicz, 2009). This disconnection between on-site management and broader public benefits is a key impediment to defining realistic goals for soil conservation policy in Australia, and, as in natural resource programs worldwide, to clearly linking expenditure with tangible outcomes (Claassen et al., 2008; Hajkowicz, 2009).

Soil-based ecosystem services were implicitly acknowledged in the seven broad soil 'functions' of the EC's Thematic Strategy (Commission of the European Communities, 2006). This acknowledgement reflects growing recognition of the links between land degradation and global public good (Pagiola, 1999; FAO, 2002). However, it is only recently that broad links between the concepts of soil health and ecosystem services have been explicitly examined (Robinson et al., 2009). Moreover, while broad-scale costs and benefits of addressing soil degradation have previously been considered (FAO, 2001), few studies have integrated service-based frameworks into cost-benefit analyses of soil management.

This paper uses a service-based approach to examine links between soil management, soil health, and public benefits in Australian agricultural landscapes. First, it expands on the context of public intervention in (mostly private) soil management, and examines the place of the soil health concept within a service/benefits framework. Soil-based ecosystem services and disservices are then identified, and broad conceptual links with defined public benefits are established. These links are then applied to a regional case study that evaluates potential public benefits from soil management change. This regional-level approach is consistent with recommendations for implementing the EC's Thematic Strategy (Bouma and Droogers, 2007), with the clear difference that it highlights soil-derived benefits rather than soil threats, thereby supporting a shift away from a common damage-centric focus (Defra, 2007). The case study highlights key knowledge gaps in estimating both public and private net benefits from changed soil management, including the need for criteria to identify priority public benefits at policy-relevant scales. The paper aims to contribute to a new narrative on the importance of better soil management in Australia (Campbell, 2008), and to provide a stronger basis for articulating objectives and anticipated outcomes in public policies for soil conservation.

2. The context: public benefits from private soil management

It is inevitable that many of the Earth's soils will continue to be managed with a strong production focus. Agriculture remains the main land use in many countries (Hamblin, 2009), and has transformed about one-third of the Earth's land surface (Vitousek et al., 1997). Globally, the main agricultural practices of cropping and grazing account for 78% of human appropriation of net primary production (Haberl et al., 2007). Strong demand for food and fiber is set to increase given projections of a rapidly expanding human population (Matson et al., 1997). Production pressures on soils are certain against a backdrop of continuing low food prices, rising input costs, and ongoing pressures to exploit the soil capital in pursuit of short-term economic gain (Tilman et al., 2002).

In addition to production requirements, public expectations of natural resources like soils are expanding due to increasing awareness of 'ecosystem services' (e.g. carbon sequestration, water quality regulation, water yield), which provide the many benefits that humans derive from natural systems (Costanza et al., 1997; Burger, 2009). Just how agricultural landscapes should be managed to meet the dual challenges of production and ecosystem services is an issue of ongoing discussion. Some advocate retirement of non-productive agricultural land (Hamblin, 2009), and/or increasing yields from productive land to reduce the need to convert remaining native systems (Green et al., 2005). However, this 'land sparing' approach ignores probable increases in negative off-site effects associated with more concentrated inputs of water and nutrients (Matson and Vitousek, 2006), leading to arguments that agricultural land should be less intensively managed as part of a 'wildlife friendly' matrix (Vandermeer and Perfecto, 2007).

Whichever the land-use configuration, it is often the case that shifts in agricultural management to meet public expectations require shifts in the practice of private land managers. Unfortunately, there are very few circumstances under which private managers are able or willing to make substantial personal investment for the greater good (Lant et al., 2005), particularly where there are significant production opportunity costs (House et al., 2008). This realization has led to ongoing calls for publicly-funded instruments of change, often in the form of incentive payments for ecosystem services (Tilman et al., 2002; Harvey et al., 2008; Hamblin, 2009). Nonetheless, others warn that payments are not a