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ANALYSIS

Do we ecologically model what we economically value?

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ABSTRACT

For the period 1991–2005 inclusive we categorise peer-reviewed journal output depending on whether it pertains to case-studies in a) cropland or b) aggregate semi-natural and natural terrestrial (ASNNT) ecosystems for three applications in ecological modelling: 1) modelling of terrestrial carbon and nitrogen fluxes; 2) modelling of terrestrial root systems; 3) geographic information systems. Next we compare these research output magnitudes for case-studies in cropland and ASNNT ecosystems with estimates of the total economic value (TEV) of either system.

For applications 1) and 3) the magnitude of research output for ASNNT ecosystems between 1991–2005 is greater than for cropland and research into the former is increasing at a faster rate over time compared to the latter. Given that the TEV of ASNNT ecosystems is 82 times greater than the TEV of cropland we deem these trends in research output as desirable under the assumption that value and research should be interdependent. However for application 2), although research into ASNNT ecosystems is increasing at a faster rate compared to cropland, total research output between 1991–2005 is greater for cropland. We conclude that increased research output which focuses on ASNNT ecosystems in this particular application should be a priority, given the high TEV of ASNNT ecosystems relative to cropland.

1. Introduction

It is widely accepted that socially excessive amounts of environmental degradation and pollution occur because of missing markets for ecological goods and services but the potential impact of these missing markets on influencing environmental research output has only been examined in relation to the study of modelling terrestrial carbon (C) and nitrogen (N) fluxes (Stapleton et al., 2004).

Research and value are interdependent in the context of environmental systems: research can help optimise our use, management and defence of both cropland and aggregate semi-natural and natural terrestrial (ASNNT) ecosystems.[1] However, there is an economic incentive to research market-oriented systems such as croplands in terms of financial returns — an incentive which is lacking for ASNNT ecosystems. For example, researching nutrient cycling in crops can inform the efficient use of fertiliser. By contrast, research into ASNNT ecosystems is more likely to benefit society as a whole in terms of non-marketed commodities rather than through financial returns to an individual or organisation. This provides an explanation as to why research might be biased towards cropland with relatively less effort expended on researching ASNNT ecosystems.

In this paper we investigate research output which pertains to cropland compared to research output which pertains to ASNNT ecosystems between 1991–2005 inclusive relative to the

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[1] ASNNT ecosystems incorporate: forests; grass and rangelands; wetlands; tundra; ice and rock.

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total economic value (TEV) of either system. Research output is examined for three applications: modelling of terrestrial C and N fluxes; modelling of terrestrial root systems; geographic information systems (GIS). The analysis of research output in modelling of terrestrial C and N fluxes is an extension of work presented in Stapleton et al. (2004) where data were reported for 1991–2002 inclusive. The analysis of the latter two applications has not previously been reported elsewhere.

2. Methodology

2.1. Applications

If value and research are interdependent then in the absence of missing markets the following equality would hold:

$$\frac{\text{Cropland research output}}{\text{Cropland TEV}} = \frac{\text{ASNNT ecosystem research output}}{\text{ASNNT ecosystem TEV}} \quad (1)$$

Put differently, in a situation where all the values associated with cropland and ASNNT ecosystems were captured by economic markets, then research would be equally proportional to the value of either system. For this proportionality assumption to hold, the area of research under investigation would need to be equally important to both cropland and ASNNT ecosystems. Fig. 1 outlines three criteria – commonality; qualitative assessment of equal interest; quantitative assessment of equal interest – which need to be fulfilled in order for a research area to be classed as equally important to both cropland and ASNNT ecosystems. In terms of *Commonality*, the first criterion in Fig. 1, C and N cycling is a common phenomenon across cropland and ASSNT ecosystems (first application) and both crops and plants have roots for anchorage and for accessing water and nutrients (second application). Finally, a priori, there is no reason why GIS cannot be applied to case-studies in cropland or ASSNT ecosystems (third application). An alternative, unsuitable application that meets this first criterion is the application of biodiversity and community ecology which can be studied in relation to cropland as well as ASNNT ecosystems. However such an application would fail against the second criterion of *Qualitative Assessment of Equal Interest* because research output in this application is understandably biased towards ASNNT ecosystems which are more biodiverse. By contrast we could argue that C and N cycling, root system modelling and GIS are equally applicable regardless of whether the case-study is cropland or ASNNT ecosystems. Going beyond this to the third criterion in Fig. 1, *Quantitative Assessment of Equal Interest*, involves specifying that research in a particular application yields the same value, in proportional terms, to both cropland and ASNNT ecosystems. In practice this is impossible to specify, therefore our analysis proceeds on the basis of a qualitative assessment that our three applications are of equal interest to case-studies in cropland and ASNNT ecosystems.

2.2. Categorisation

Using the online Web of Science® available from the Institute of Scientific Information, peer-reviewed journal articles, reviews and notes in the three applications identified above were located and categorised depending on whether they pertain to case-studies in cropland or ASNNT ecosystems. We did not attempt to measure the quality of this research output. This amounts to a sampling of research output because this database does not include the grey literature or books for example which avoids the issue of how to weight these different forms of research output against peer-reviewed journal output. This is important in light of a study of 400 scientists who unanimously agreed on the importance of peer-reviewed journal publications, with no agreement as to the relative importance of other forms of research output (Australian National Board of Education and Training, 1993). Additionally, evidence also suggests that the propensity to publish peer-reviewed journal articles in agricultural and environmental research is similar (Butler and Visser, 2006) i.e. differences in peer-reviewed journal output for case-

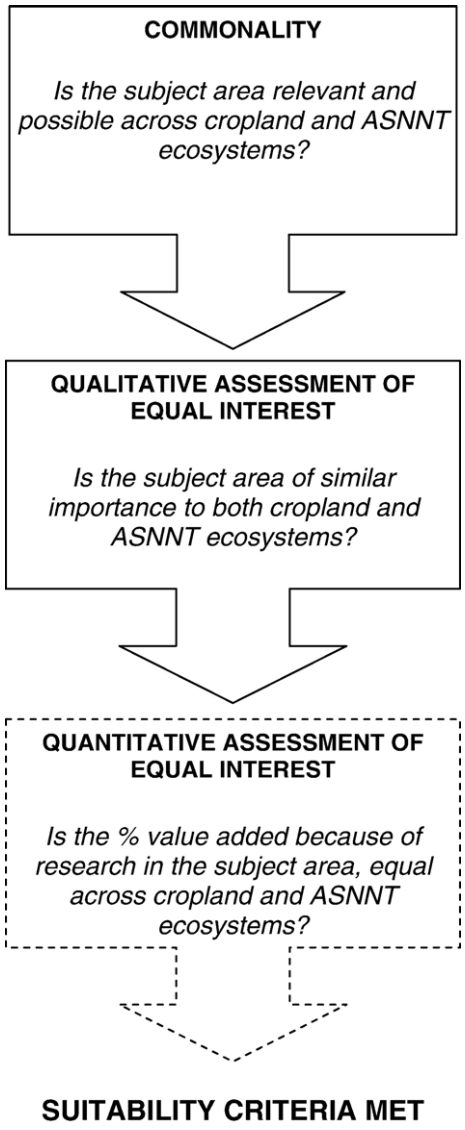

Fig. 1 – Flow chart illustrating the criteria which an area of research needs to meet before an assessment of research output relative to total economic value (TEV). Dashed lines denote a theoretical, non-operational criterion.