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Integrating agriculture and climate change mitigation at landscape scale: Implications from an Australian case study

Penny van Oosterzee [a,c,d], Allan Dale [b], Noel D. Preece [a,c,d,*]

[a] Biocarbon Pty Ltd., PO Box 1200, Atherton, QLD 4883, Australia
[b] The Cairns Institute, JCU, Townsville, QLD 4811, Australia
[c] James Cook University, Cairns, QLD, Australia
[d] University Fellow, Charles Darwin University, Darwin, Northern Territory, Australia

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ABSTRACT

Rural and regional hinterlands provide the ecosystem service needs for increasingly urbanised communities across the globe. These inter-related ecosystem services provide key opportunities in securing climate change mitigation and adaptation. Their integrated management in the face of climate change, however, can be confounded by fragmentation within the complex institutional arrangements concerned with natural resource management. This suggests the need for a more systemic approach to continuous improvement in the integrated and adaptive governance of natural resources.

This paper explores the theoretical foundations for integrated natural resource management and reviews positive systemic improvements that have been emerging in the Australian context. In setting clear theoretical foundations, the paper explores both functional and structural aspects of natural resource governance systems. Functional considerations include issues of connectivity, knowledge use and capacity within the natural resource decision making environment. Structural considerations refer to the institutions and processes that undertake planning through to implementation, monitoring and evaluation.

From this foundation, we review the last decade of emerging initiatives in governance regarding the integration of agriculture and forests across the entire Australian landscape. This includes the shift towards more devolved regional approaches to integrated natural resource management and recent progress towards the use of terrestrial carbon at landscape scale to assist in climate change mitigation and adaptation. These developments, however, have also been tempered by a significant raft of new landscape-scale regulations that have tended to be based on a more centralist philosophy that landowners should be providing ecosystem services for the wider public good without substantive reward.

Given this background, we explore a case study of efforts taken to integrate the management of landscape-scale agro-ecological services in the Wet Tropics of tropical Queensland. This is being achieved primarily through the integration of regional natural resource management planning and the development of aggregated terrestrial carbon offset products at a whole of landscape scale via the Degree Celsius initiative. Finally, the paper teases out the barriers and opportunities being experienced, leading to discussion about the global implications for managing climate change, income generation and poverty reduction.

1. Introduction

Rural areas provide the ecosystem services for increasingly urbanised communities across the globe (IUCN, 2006; Daily et al., 2009). These services include productive soils, forests and pastures, quality water, bio-energy, temperature control and shade, storm and wave attenuation and faunal and floral biodiversity. They provide the foundations for life and underpin our economy and our social and cultural wellbeing. Integrated and sustainable management of the natural resources that supply these services helps to balance competing demands for them and, through synergies, could potentially enhance the role of rural regions in the delivery of greenhouse gas abatement (World Bank, 2009). Healthy and inter-related ecosystem services provide the

* Corresponding author at: PO Box 1200, Atherton, QLD 4883, Australia. Tel.: +61 407996953.
E-mail addresses: penny@biome5.com.au (P. van Oosterzee), alland@terrain.org.au (A. Dale), noel@biome5.com.au (N.D. Preece).

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best opportunities for regional landscapes and communities to adapt in the face of climate change (Tompkins and Adger, 2004).

Conventional management practices in production-oriented systems tend to be uni-dimensional, however, favouring policies for the use of natural resources for short-term enterprise profits. This comes at the expense of other ecosystem services on which rest the foundations of our society (United Nations, 1997; Millennium Ecosystem Assessment, 2005). Grazing pressures in certain pasture and soil types, for instance, are often aimed at securing maximum beef production in the short term at the expense of longer term soil health, productivity and other essential ecosystem services. In many places across the tropical world, water quality has declined or water has been allocated beyond the flows that are required for a healthy river system (UNEP, 2008). Land has been over-cleared, creating threats to biodiversity and local climate and emitting considerable atmospheric carbon. Soil health (including organic carbon levels) has often declined, enhancing erosion, reducing longer term productivity and requiring an ever increasing dependency on energy-intensive cultivation and nutrient inputs (Doran, 2002).

Alternatively, moving away from such a uni-dimensional approach to production can often both enhance longer-term productivity and enhance multiple ecosystem services across the landscape, including carbon biosequestration (CSIRO, 2009). Taking grazed riparian zones out of pastoral production and providing incentives for reafforestation with native vegetation, for example, can sequester carbon, create new habitat for endemic biodiversity, increase connectivity between habitats, reduce heat stress in livestock and enhance water flows and quality (Fleischner, 1994; Weinberg et al., 2011).

Optimising long term agricultural productivity and achieving local and regional food security will rely on better integrating multiple ecosystem service benefits in agricultural landscapes (Goldstein et al., 2012). Poorly integrated catchment and floodplain management (inclusive of both water quality and quantity issues) is increasing the risk of food security problems as well as exacerbating the impacts of extreme climatic events like droughts, floods and cyclones (Penning de Vries et al., 2003). The main impacts of climate change on agriculture include soil production decline, water security declines, increasing frequency of weather extremes and sea level rise (Hoffman, 2011). These impacts increase the risks of political instability and food security in both the developing and developed world (Holden et al., 2005). How land is managed is central to achieving a balance between productive and other ecosystem services, locally, regionally, and in the case of greenhouse gas budgets, globally (Houghton, 2007).

A key international challenge facing the improved management of ecosystem services in the face of climate change is the lack of regionally differentiated management approaches since climate change causes regionally differentiated impacts (Steffen et al., 2009). The global response to climate change and food security will require regionally-specific solutions, management approaches and transaction costs (Robledo and Blaser, 2008). Regions, in this instance, refer to agro-ecological regions (Williams et al., 2002), many of which are also closely aligned to recognisable socio-political communities and/or cultural landscapes. Many of the issues of agricultural sustainability and natural resource management such as water quality and quantity, biodiversity and the sustainable use of soil and pasture resources can be measured and addressed technically at a regional scale, closer to the local community (Holling and Meffe, 1996) following the principle of polycentric governance (Walker et al., 2009), where organisations have considerable autonomy at a range of scales, and subsidiarity (Marshall, 2008), where tasks are decentralised to the lowest level of governance capable of dealing with them satisfactorily. Regional organisations are often best placed to provide improved integration of politics and the administrative arrangements needed to balance the economic, social and ecological dimensions of development. Integrated approaches to land management at the regional scale have been evolving across the globe for several decades and are seen increasingly to be appropriate for effective landscape-scale management of natural resources (Dale et al., 2008).

Through a case study in Australia's Wet Tropics, this article explores the associated link between climate change mitigation and adaptation in agricultural landscapes using Australia's regional natural resource management framework as the basis for aggregating the abatement activities of small landholders. We provide a brief history of regionalism as it pertains to agriculture and natural resource management in Australia and examine the barriers and opportunities experienced in using this pilot approach. While the case-study is an ongoing learning-by-doing experience not yet fully travelled, we suggest that providing incentives for abatement activities within this natural resource management framework can achieve a more resilient system in that it will have the ability to shift and transform rural landscapes and communities in the face of continuing climate change. The framework provides the potential to contribute to both mitigation and landscape-scale adaptation, enhancing longer-term food security. We also show how sudden shifts in policy can potentially undo many of the hard-won benefits of a stable regional governance approach.

While the concepts of mitigation and adaptation are often treated as being separate, in agricultural landscapes they are integrally linked. Mitigation builds the adaptive capacity of a landscape, which results in enhanced resilience. Preventing soil carbon emissions through improved agricultural practices, for example, both mitigates new emissions as well as making soil more resilient to water and nutrient loss and erosion risk (Doran et al., 1998). Rehabilitating tropical watercourses both sequesters new carbon and can help secure flows for consumptive use, and so on.

We have also made an attempt to use the case study in this article to inform new and related theoretical constructs on resilience and social-ecological systems, greenhouse gas mitigation, climate change adaptation and longer-term decision-making about natural resource management and food security. While we write from a developed world perspective, our experience could provide lessons worldwide. Our discussion and conclusions outline the case study implications and some lessons for tropical agriculture.

2. The limits of centralised regulation as the primary approach to landscape management

In recent historical times, Australia's primary response to natural resource problems has been to regulate the management of key natural resources. While this has achieved significant environmental outcomes, it has come at an economic and social cost to the rural and remote communities that manage these resources through unpaid opportunity costs (Productivity Commission, 2003). Implicit in much of the thinking behind more regulatory approaches have been assumptions that rural and regional communities alone should pay for securing the ecosystem services required by wider (largely urban) society. Poorly managed regulation has hence led to resentment towards government and less than adequate management outcomes. Adopting changed practices or new innovations are mostly driven by landholders' self-interests (Marsh and Pannell, 2000). Limited and well-defined vested interests enable cooperation and stewardship, even though recent studies (Gilmour et al., 2012) have shown resource users' behaviour to be complex and best contextualised within the

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