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Managing carbon in a multiple use world: The implications of land-use decision context for carbon management

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ABSTRACT

Human land use contributes significantly to the growth of greenhouse gases in the atmosphere. Changes in land management practices have been proposed as a critical and cost-effective mechanism for reducing greenhouse gas emissions and promoting the storage of additional carbon in vegetation and soils. However many discussions of the potential for land use to mitigate climate change only take into account biophysical factors such as vegetation and land cover and neglect how the agency of land owners themselves affects whether additional carbon storage can be achieved. Unlike many potential REDD opportunities in developing countries, land management in the U.S. to enhance carbon sequestration would occur against a backdrop of clearly defined, legally enforceable land ownership. In addition, more than a third of the land surface in the U.S. is managed by federal agencies who operate under legal guidelines for multiple use and is subject to demands from multiple constituencies. We set out to investigate how the goal of enhancing carbon sequestration through land use is perceived or implemented in one region of the U.S., and how this goal might intersect the existing drivers and incentives for public and private land use decision making. We conducted a case study through interviews of the major categories of landowners in the state of Colorado, which represents a mixture of public and privately held lands. By analyzing trends in interview responses across categories, we found that managing for carbon is currently a fairly low priority and we identify several barriers to more widespread consideration of carbon as a management priority including competing objectives, limited resources, lack of information, negative perceptions of offsetting and lack of a sufficient policy signal. We suggest four avenues for enhancing the potential for carbon to be managed through land use including clarifying mandates for public lands, providing compelling incentives for private landowners, improving understanding of the co-benefits and tradeoffs of managing for carbon, and creating more usable science to support decision making.

1. Introduction

Carbon management through changes in land-use is a prominent topic in discussions surrounding the mitigation of climate change (Gibbs et al., 2007; Boyd, 2010). Human land-use change is the second largest contributor of increasing carbon dioxide in the atmosphere through land clearing for agriculture and other activities, and can mediate the uptake of carbon as well (Le Quéré et al., 2009). Studies have estimated that relatively large amounts of additional carbon could be stored through deliberate management of the land surface, when taking into account the historical rate of conversion of land from forest to agriculture and previous degradation of soils from agriculture (Kinsella, 2002; Heath et al., 2003; Lal et al., 2003; Sperow et al., 2003; Paustian et al., 2006; Richards et al., 2006).

Several types of land management practices can enhance carbon storage on land, either in vegetation itself or in soils (CCSP, 2007). The greatest amount of carbon in vegetation on land is found in forests, and practices such as halting deforestation, planting trees or using different forestry practices have the potential to sequester substantial amounts of carbon on a global basis (House et al., 2002; Jackson and Baker, 2010). Changes in practices in the agricultural sector such as reducing or ceasing tillage of soil, changing crop rotations and amendments, using cover crops, and changing rice cultivation practices can help to prevent the loss of soil carbon as well as causing more carbon input to soil (Post and Kwon, 2000; CCSP, 2007, p. 113).

Over the past few decades, therefore, society has been moving to considering deliberate management of carbon and establishing means for carbon governance (Dilling, 2007). With the recognition of land carbon sinks in Article 3.3 of the Kyoto Protocol in 1997, a

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number of forest-related offset projects were undertaken around the world using a variety of mechanisms, including the Clean Development Mechanism (CDM), the World Bank BioCarbonFund, and various voluntary pilot programs (Corbera et al., 2009; Caplow et al., 2011). In the past few years, international policy interest in forest protection and its carbon benefits has galvanized around REDD (Reducing Emissions from Deforestation and Degradation) and REDD has become a formal part of policy negotiations under the UN Framework Convention on Climate Change (Corbera et al., 2010; Agrawal et al., 2011).

Many of the case studies conducted thus far on projects related to REDD have occurred in the developing world in the tropics (Caplow et al., 2011). Despite the presence of substantial land carbon sinks in the northern hemisphere and elsewhere outside of the tropics (Goodale et al., 2002), fewer studies have been conducted on carbon and land-use decision making in the northern hemisphere and the U.S. in particular (although see Poudyal et al., 2010; Gosnell et al., 2011; Ellenwood et al., 2012).

No matter where carbon management is being attempted, carbon management goals are not imposed on a blank slate. Land is already intensively managed by a host of actors for a variety of purposes over much of the globe (Foley et al., 2005). Therefore, the potential for deliberate management of land to enhance carbon sequestration must be evaluated through the lens of human decision making and behavior (Failey and Dilling, 2010). Lambin et al. (2003) suggest that factors driving land use can be distinguished in many different ways: as proximate or underlying, as slow or fast, and as biophysical or human drivers. Drivers for land-use decision making in the private sector include broad trends such as market prices for commodities, policy levers such as incentives and subsidies, and biophysical factors such as climate and water supply (Lambin et al., 2001, 2003). In some countries, a substantial portion of the land surface can also be managed by government agencies rather than the private sector. Fig. 1 (adapted from Riebsame et al., 1994) provides a conceptual overview of the underlying drivers of land-use decision making in a U.S. context.

The potential for carbon management to be more widely implemented therefore depends on how private sector and public sector actors perceive carbon management goals, and how carbon management interfaces with their existing drivers and interests. Studies of payments for ecosystem services (PES) programs in general do not tend to focus on the factors that drive people's participation (Kosoy et al., 2008) or of the perceptions of individuals in important institutions managing the land in REDD-related projects specifically (Brown et al., 2011). We therefore set out to understand the existing drivers and incentives for public and private sector land owners and the extent to which carbon management goals were compatible with those drivers in a U.S. context. Since much of the REDD-related literature is also focused on the scientific characterization of the potential for lands to enhance carbon sequestration, we also investigated the role of scientific information in supporting decision making. We chose to focus our study on the state of Colorado in the United States, where there is a wide variety of land ownership types.

Colorado is home to privately held land (57%), a high proportion of public land managed by a variety of federal land agencies (36%), state government land (5%) and municipal governments (1%), with 1% managed by Native American tribes (Failey and Dilling, 2010).

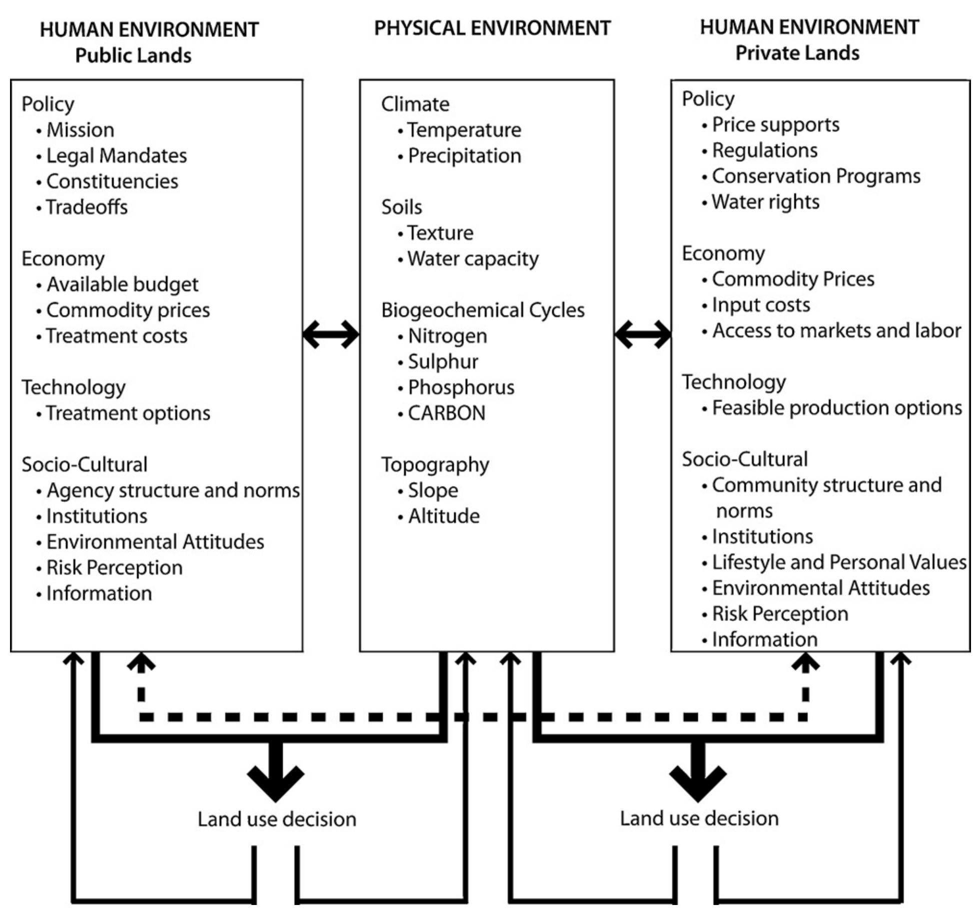

Fig. 1. Conceptual representation of underlying physical and human environment drivers of land use decision making and feedbacks. Human environment drivers are separated into those influencing public land managers and those influencing private land managers, as those human drivers can be quite different.
Adapted from Riebsame et al. (1994).