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Research article

Assessing the feasibility of carbon payments and Payments for Ecosystem Services to reduce livestock grazing pressure on saltmarshes

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ABSTRACT

Saltmarshes provide important services including flood control, climate regulation, and provisioning services when grazed by livestock for agriculture and conservation purposes. Grazing diminishes aboveground carbon, creating a trade-off between these two services. Furthermore, saltmarshes are threatened by overgrazing. To provide saltmarsh protection and ensure the continuing delivery of ecosystem services, there is a need to incentivise land managers to stock environmentally sensible densities. We therefore investigated the possibility of agri-environmental schemes and Payments for Ecosystem Services (PES) to compensate for lost livestock revenue under reduced grazing regimes and provide carbon sequestration and other benefits. This is the first study to consider the benefits arising from a potential carbon market to saltmarshes, although similar schemes exist for peatland and woodland. We calculated the net economic benefit (costs of livestock production are removed from revenue) to farmers obtained from a hectare of grazed saltmarsh under low (0.3 Livestock Units per hectare per year), moderate (0.6), high (1.0) and very high (2.0) stocking densities accounting for livestock revenue, carbon benefits, and agri-environmental subsidies. We repeated the procedure considering additional benefits transferred from the literature in terms of provisioning, regulating and cultural ecosystem services provided by protected saltmarshes. The net benefits were assessed for a range of market carbon prices and social costs of carbon, e.g. the opportunity cost of carbon for society. Applying the model to Scottish saltmarshes we find that the current range of market prices could prompt transitions from high to moderate regimes in areas where livestock value is low, however break-even prices for transitions showed high spatial variability due to spatial variability in livestock values. In some areas of the West Highlands, the break-even carbon price is negative, indicating that the current agri-environmental schemes are able to more than compensate for the lost revenue accruing to farmers by a reduced grazing density. However, in other areas, such as the Outer Hebrides, the break-even carbon price is positive. Private PES schemes or increased public subsidies should then be provided to generate net benefits. It is reasonable to infer that a pure carbon market may have limited scope in incentivising consumers to buy carbon services, especially in areas with limited local number of buyers and corporates of small size. Under this circumstance, a premium carbon market offering bundled ecosystem services may help reduce grazing pressure across a larger number of Scottish saltmarshes, thereby providing globally important climate regulation services and at the same time protecting sensitive habitats.

1. Introduction

Saltmarshes are coastal habitats dominated by terrestrial plants that experience regular tidal inundation. They provide a wide range of ecosystem services including flood defence and wave attenuation (Pethick, 2002); water filtration and pollutant retention (Barbier et al., 2011); nutrient cycling (Burden et al., 2013); reservoirs for rare and specialist species (Jones et al., 2011); nursery for fish (Laffaille et al., 2000); habitat for grazing livestock (Olsen et al., 2011); and blue carbon sequestration (Beaumont et al., 2014). Despite their importance, considerable human activity has involved land reclamation for agriculture and urban development (Burden et al., 2013). As a result, saltmarsh cover in the UK has declined by 15% since 1945 (Beaumont et al., 2014) and quality has deteriorated, thereby compromising the capacity of saltmarshes to adapt to future sea level rise and climate change (Jones et al., 2011).

In recent years the UK has recognised the importance of protecting saltmarshes and taken steps towards their restoration, including

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landward retreat of coastal barriers and flooding of reclaimed land (Garbutt et al., 2006). There is general agreement that the value of ecosystem services thus restored far outweighs the cost of restoration, but unless these services are marketed there is a lack of finance for such restoration projects (Environment Bank, 2015). At the same time, there has been growing interest in creating novel markets to allow private investment in ecosystem service provision (Reed et al., 2013). One such option of finance is a scheme of Payments for Ecosystem Services (PES) (Kinzig et al., 2011; Natural Capital Committee, 2015).

PES schemes currently existing in the UK fall under the category of carbon sequestration under the Woodland Carbon Code for newly planted woodland (Forestry Commission, 2017) and carbon sequestration with bundled co-benefits under the Peatland Code for restored peatland (IUCN, 2015; Reed et al., 2013). These Codes provide the verification and accreditation rules replacing voluntary standards such as the Verified Carbon Standard that are often characterised by high transaction costs (Bonn et al., 2014). Different forms of markets for peatlands are reported by Bonn et al. (2014) who classify different schemes according to the services paid, whether they are publically or privately funded, and whether they are international or regional in scope. For example, the UK Peatland Code is a market based on corporate social responsibility (Bonn et al., 2014), covering restoration costs of peatland due to business potential investment. Other transactions are based on public money arising from agri-environmental schemes on carbon emission reduction (Reed et al., 2014) justified on the basis of paying for the fullest possible range of ecosystem service benefits, although they are poorly quantified (Reed et al., 2014). The above mentioned PES applied to peatlands fall in the category of voluntary transactions (private for carbon markets, and government mediated for agri-environmental schemes) between providers and users of resource-use proxies rather than ecosystem services (which are difficult to measure) and have the properties to show conditionality on specific agreed rules amongst parties (Wunder, 2015).

There is no equivalent Code for saltmarshes, although a comparable small-scale scheme is underway in the Deben estuary where funds for services are designed to meet costs of restoring degraded saltmarsh (Environment Bank, 2015). Notably, the current UK action plan for saltmarsh protection does not take into account the value of carbon sequestration services but only the compensation of lost habitat and flood reduction benefits (Natural Capital Committee, 2015). The creation of new saltmarsh for flooding regulation is considered more valuable than managing sustainable agricultural practices of existing saltmarshes. However, considering the valuable service of climate regulation that saltmarshes provide in the face of current climate change threats, there is a potential to establish a PES market to help finance saltmarsh protection and ensure continuing services.

Compared with other vegetated habitats, saltmarshes have a great carbon capture and storage capacity as a result of high primary productivity and tidal trapping of organic matter (Chmura et al., 2003). Saltmarshes in Scotland sequester an estimated 2.35–8.04 t CO_2 ha^{-1} yr^{-1} and have a total carbon stock of 569.7 t ha^{-1} (Beaumont et al., 2014). Unlike freshwater wetlands which are often significant sources of methane, methane emissions from saltmarsh are negligible (Bridgham et al., 2006). Regular inundation promotes anoxic soils that delay decomposition, such that the carbon captured in saltmarsh soils is a long term sink (Yu and Chmura, 2010) well suited for targeting of a carbon emissions reduction market scheme.

In addition to the carbon sequestration service they provide, saltmarshes in the UK are widely grazed for both agricultural purposes and as a conservation tool to enhance floral and faunal biodiversity (Bouchard et al., 2003). Grazing significantly influences vegetation structure and community composition (Yates et al., 2000), thus influencing the services provided. For example, biodiversity is generally maximised under a light grazing regime replicating a natural system of native duck and geese grazing which hosts a wide range of plant, invertebrate and bird species (Adnitt et al., 2007). Light grazing promotes reverse succession and greater species diversity; whereas, ungrazed and intensively grazed regimes tend to produce monocultures (Fleischner, 1994).

The relationship between carbon sequestration and grazing on the other hand is quite complex, resulting from an interaction of stocking density, grazer type, saltmarsh zone, seasonality, and other abiotic parameters. Results from the few existing studies have been contradictory, perhaps exposing geographic differences or the overriding importance of abiotic factors. Grazed saltmarsh in Canada (Yu and Chmura, 2010) and the Netherlands (Elschot et al., 2015) had higher soil carbon contents than ungrazed sites while grazed saltmarsh in Denmark had lower soil organic matter content than ungrazed sites (Morris and Jensen, 1998). A large-scale study in England and Wales found grazing to reduce aboveground vegetation, but to provide relatively small effects on belowground carbon stores (Kingham, 2013). In addition, Kingham (2013) found that effects of grazing on above and belowground carbon stores were generally quite small compared to effects of abiotic factors. This is likely because changes in aboveground carbon stores take time to translate to changes in belowground carbon stores, and mechanisms such as plant compensatory growth do not occur instantly in response to a stressor (Holland et al., 1996).

In this study we investigate the use of livestock grazing as a management tool for saltmarsh climate regulation services, a concept familiar to terrestrial systems (Bhogal et al., 2011; Ma et al., 2006), and the extent to which the monetary valuation of this service can be translated into a financial tool (PES). In contrast to traditional PES schemes implemented in woodland and peatland ecosystems which rely on habitat restoration and creation, the study scenario only involves changing land use. A PES scheme for carbon benefits would operate by compensating farmers for the revenue lost due to reducing stocking density. Providing an economic incentive to farmers who manage saltmarshes to reduce grazing pressure would not only help combat climate change, but ensure that the managers themselves have a vested interest in the protection of the saltmarsh, thus limiting the need for extensive regulation. Nonetheless, a relevant effort in monitoring would be required to show that a saltmarsh managed under a PES project is providing additional benefits compared to the baseline, and fast, reliable and economic tools (such as simple spreadsheet) to do it must be proposed. Grazing management is already widely used as a conservation tool (Bouchard et al., 2003) and is easily adapted to address saltmarsh carbon sequestration, as light levels of grazing have the dual benefit of enhancing biodiversity and minimising the loss of aboveground carbon (Adnitt et al., 2007; Yu and Chmura, 2010).

The aim of this study is to assess the economic conditions or private economic benefits for saltmarsh agriculturists under a range of grazing regimes promoted by a PES scheme for above ground carbon emissions reduction and agri-environmental incentives subsidising reduced grazing pressure. Moreover, social benefits of saltmarshes protected by the SSSI scheme (Sites of Special Scientific Interest that best represent UK natural heritage in terms of flora, fauna, geology and geomorphology) are assessed through benefit transfer approach.

There are several reasons to consider a voluntary carbon PES for saltmarshes. For one, restoring and maintaining climate regulation services of saltmarshes can contribute to Scotland meeting carbon emission reduction targets laid out in the Climate Change (Scotland) Act 2009. At the same time, saltmarsh protection will help meet targets under the Habitats Directive (EC, 1992). This is the first study to investigate the use of grazing management in saltmarshes for the purpose of climate regulation services. While the scope is limited to Scotland, as data and values are specific to this country, the methodology is applicable to a wider context.

The paper is structured in two parts: the first (methodology and results) illustrates the economic conditions under which the current voluntary carbon market prices may compensate the opportunity cost of reducing grazing and the social-economic benefits (quantified in monetary terms) arising from a bundle of ecosystem services (using a