Ecosystem services provided by sustainable grazing land management in semiarid areas

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Introduction

Climate variability and climate change pose significant risks to the sustainability of silvo-pastoral systems. For many semiarid regions, climate projections foresee less rainfall, more extreme weather events, and hotter and longer hot spells, resulting in decreased water availability, lower primary production potential, increased soil erosion and flood frequency (Moreno Rodriguez, 2005). Climate change adaptation programs are being developed but still require crucial scientific underpinning regarding their biophysical, socioeconomic and cultural possibilities, limitations and effectiveness. The French Initiative 4/1000 (which advocates an annual increase of organic matter in soils of 0.4%), highlights the potential role of agricultural soils in mitigation activities. Grazing lands are particularly important in this context as they account for an estimated 25% of potential carbon (C) sequestration in world soils (Follet and Reed, 2010), yet they have so far been grossly underrepresented in climate change mitigation strategies (Milne et al., 2016). For any potential sequestration activity, a holistic analysis is needed, including consideration of risk of land use conversion in the future and the permanence of any C sequestered, but also impacts on other ecosystem services and possible tradeoffs. In areas where C sequestration rates are likely to be lower (arid, semi-arid) but cover extensive land areas, projects should include C sequestration as part of a package of multiple benefits in which practices that sequester C in grasslands enhance productivity, improve livelihoods, increase biodiversity and benefit multiple ecosystem services (Milne et al., 2016). To support integrated analysis of management alternatives, we evaluated the potential of a range of sustainable grazing land management measures to contribute to climate change adaptation and mitigation and provision of crucial ecosystem services.

Methods

The evaluation is based on a review of 33 technologies of grazing land management applied in semiarid areas and documented in the WOCAT (World Overview of Conservation Approaches and Technologies) database. Grazing land management represents a range of practices aiming to optimize the amount and type of vegetation and livestock. Examples include pasture rotation, rotational fertilization, livestock drinking ponds, reduced stocking rates, breeding of more effective and adapted livestock, communal grazing management, and sowing of grasses that are more palatable. Typically, these techniques aim to prevent overgrazing by reducing animal pressure and improve soil quality and production potential. Here, we discuss aspects of grazing land management related to: i) human and environmental characteristics, ii) cost-benefit ratio during implementation and maintenance phases, iii) socioeconomic and environmental impacts at local and regional scales, and, iv) impacts on ecosystem services.

Results and Conclusions

Our review highlights that the main positive impacts from sustainable grazing land management are an increased farm income, enhanced quantity and quality of fodder production (figure 1), increased biodiversity, improved soil cover and reduced soil loss (figure 2). At larger scales, these changes contribute to reduce wind erosion, flooding and damage to neighbouring fields (figure 3). Moreover, its implementation contributes to social learning on relevance of soil erosion and conservation and strengthening of social networks (figure 4).

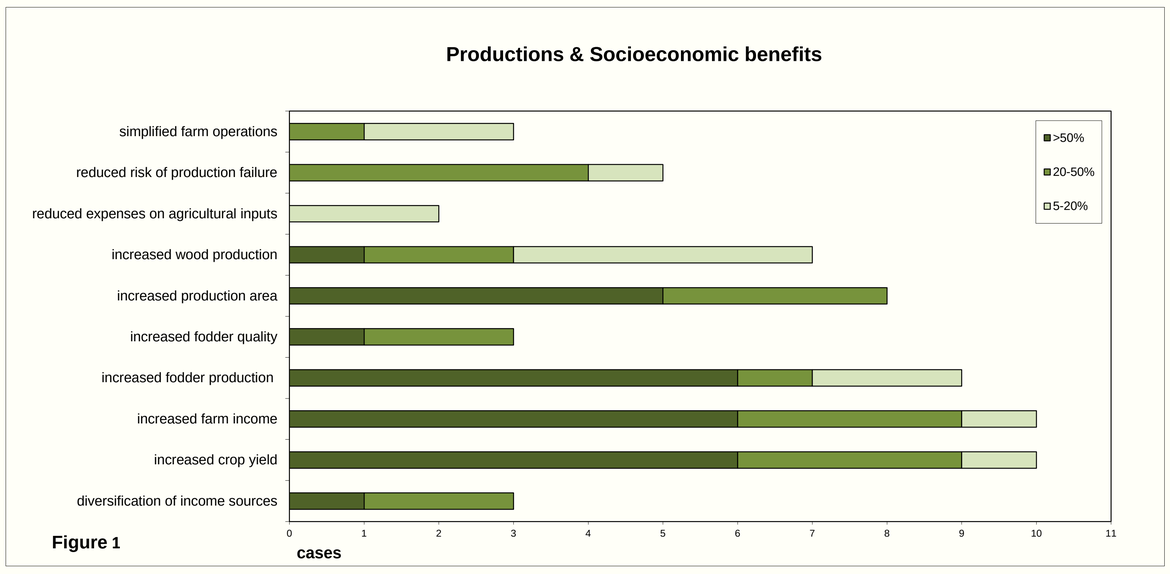

Figure 1

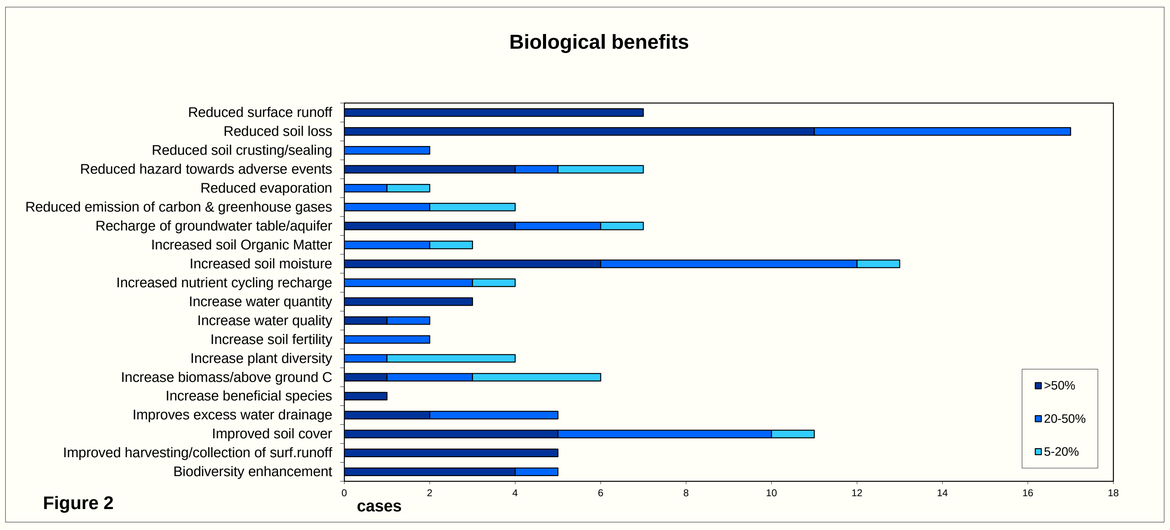

Figure 2

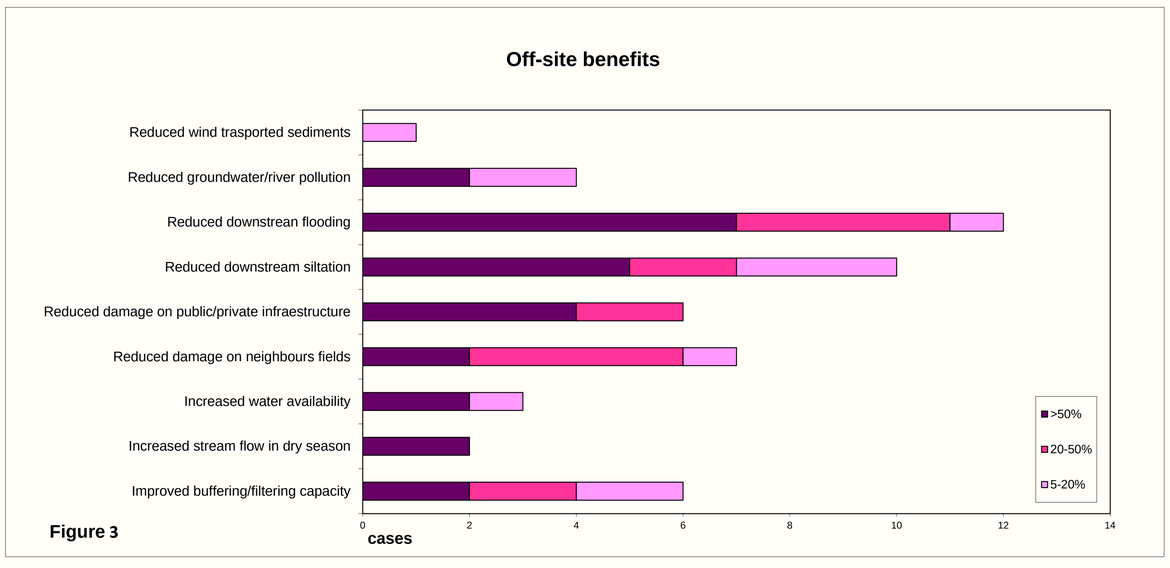

Figure 3

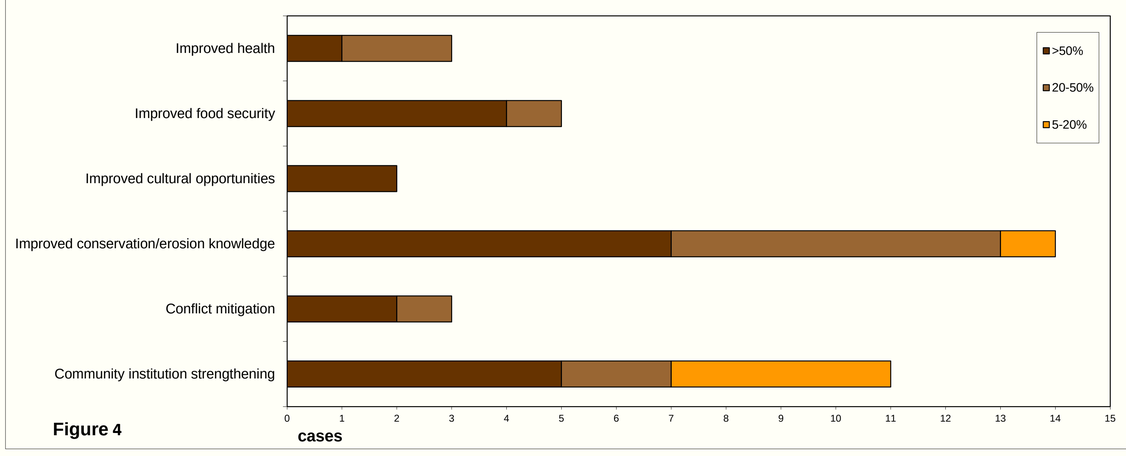

Figure 4

On the other hand, some cases reported reductions in production, labour constraints, economic inequity, and increased conflicts (figure 5) following implementation of specific types of grazing land management under particular local conditions. Further, many positive off-site impacts (e.g. flood reductions) benefit wider society, wile the costs are made by the land owners, indicating the need for political support and regulation.

Fraser et al. (2014) demonstrated that mixed upland grazing systems not only improve livestock production, but also benefit biodiversity, suggesting a 'win-win' solution for farmers and conservationists. As such, in some cases the positive impacts of sustainable grazing land management directly contribute to a range of provisioning (fodder and food production), regulating (erosion control, carbon sequestration), supporting (genepool protection, soil nutrient cycling), and cultural ecosystem services (cultural, educational and recreational use) as can see in figure 6.

Our results highlight the importance to select measures that fit to local environmental, socioeconomic and cultural conditions and in some cases the need for political support.

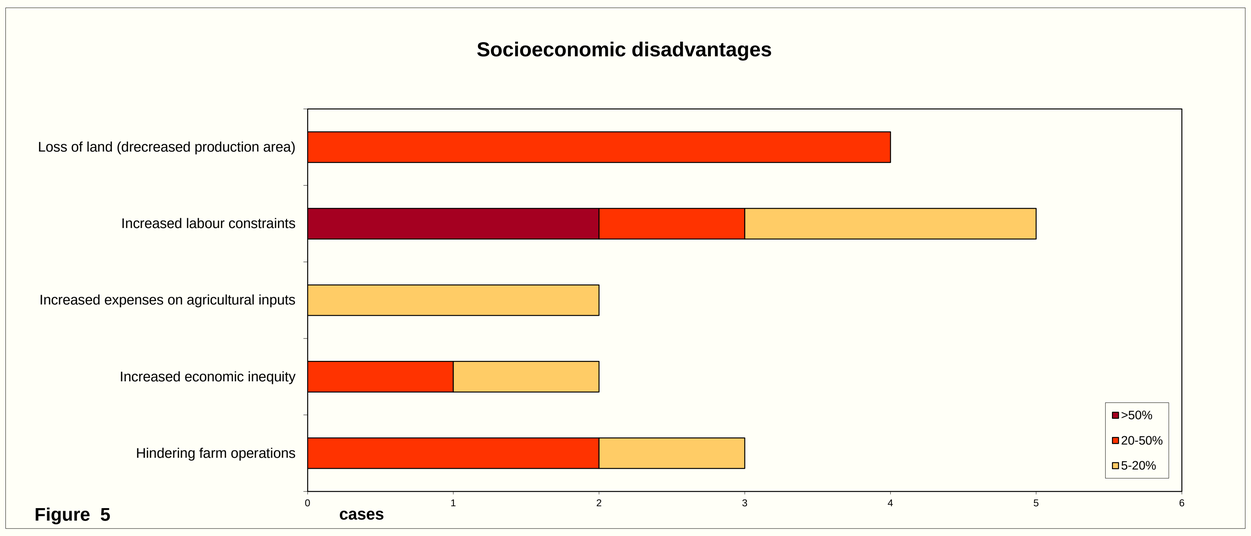

Figure 5

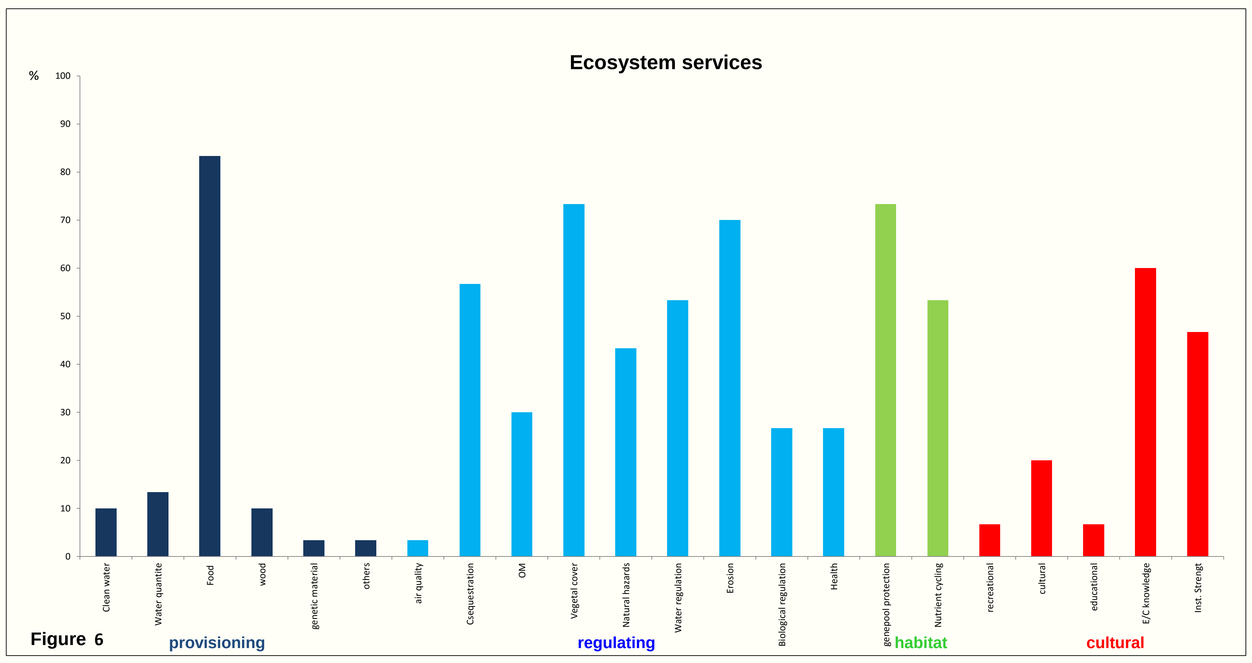

Figure 6

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Acknowledgements

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