FUNCTIONAL LAND MANAGEMENT FOR MANAGING SOIL FUNCTIONS – THE TRADE-OFF BETWEEN PRIMARY PRODUCTIVITY AND CARBON STORAGE

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Abstract. *The simultaneous demand for food security and sustainability prompted the development of the Functional Land Management Framework (FLM) (Schulte et al., 2014).This is a tool designed to support policy making to manage soil functions to meet the multiple demands on the soil resource. Soil functions are soil-based ecosystem services and FLM focuses on five that are delivered through agriculture. Notably, FLM is designed for use at a national or regional level and is not designed for local level planning or zoning of land use. This research provides a first example of a practical application of the concept relevant to policy stakeholders, wherein the trade-off between two soil functions – 'primary productivity' and 'carbon cycling and storage' is assessed. This is measured in response to the intervention of land drainage systems applied to poorly and imperfectly draining managed grasslands in Ireland.*

This trade-off is examined spatially using integrated mapping within ArcGIS. National level datasets on land use were combined with an indicative drainage map. Drainage class was used as the dominant classifier for soil types. This allowed both the spatial heterogeneity of soil in terms of biophysical constraints/endowments and their complex interaction with land use to be mapped at a national level. Outputs from DNDC biogeochemical modelling based on Irish Soil Information System Data were used to develop an indicative soil organic carbon loss map used to derive the associated CO_2 loss. Application of the Hybrid Soil Moisture Deficit model was used to determine the impact of drainage on productivity to compute the decreased number of days at which soils are untrafficable and this data was used to develop a productivity difference map. These were combined, and the trade-offs explored as a function of the nominal price of 'carbon credits', measured against productivity gains associated with drainage, which based on previous research was set at €5.50 per hectare per day. Although the standard discount period of 30 years wasapplied, a sensitivity analysis was also carried out using variable discount periods.

The research explicitly quantified the trade-offs between these two soil functions. The application of land drainage could potentially yield productivity increases by up to €302.50 $ha^{-1}a^{-1}$ but simultaneously decreases soil carbon stocks. Moreover, the prioritisation and incentivisation of these competing soil functions is primarily a function of the CO_2 price. A clear divergence emerged between the priorities of different stakeholders. At the current CO_2 price, the agronomic benefits are far larger than the monetised environmental costs. Therefore, the incentive is for farmers to drain particularly as the environmental cost does not translate into a change in income, or into a direct and observable change in the quality of the countryside. Even at future projected prices, this finding remains true for almost all of the land area however the sensitivity analysis showed that this is highly dependent on the discount period. Reducing the discount period to ten years, for example, could result in an inverse observation materialising. This scenario could result in incentives for policy makers and legislators to discourage the installation of drainage systems. Finally, this study showed large geographic variation in this environmental cost: agronomic benefit ratio. This could allow for more specific and hence effective prioritization of the two contrasting soil functions.

Key words: *Soil functions, sustainability, policy, ArcGIS.*

REFERENCE

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