U-GRASS: Understanding and enhancing soil ecosystem services and resilience in UK grass and croplands

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Humans are exerting increasing pressure on the Earth's soils to produce food crops and provide us with other natural resources. With growing populations and possible climate change it is important that we protect our soils so that they can continue to deliver these essential resources. Soils also provide many other "services" which benefit us; such as greenhouse gas regulation, nutrient cycling, and controlling the flows and quality of our waters. Unfortunately our knowledge and ability to predict how these services are affected with changes in land use and climate is limited. Many different soils are found globally in different environments, making it hard to predict responses over large scales. Soil, and therefore soil services is made through the activities of a wide variety of soil organisms, but they are traditionally hard to study and so we also know little about how this biological diversity acts to provide us with soil and wider services. New ways to study soil organisms are now revealing more information on the types of organisms which live in different soils around globally, and a key challenge is to learn how these organisms act to sustain soils and soil functions, and how these interactions are affected by climate and the way we manage our land. This project seeks to address these issues by building on recent global-scale research and knowledge regarding the different organisms found in soil. Essentially we now know more about which organisms are found in different soils, and we now seek to examine whether this knowledge can help explain the different responses of our soils to land use and climate change. We will do this firstly using a survey approach, examining the effects of land use change on soil biodiversity, soil properties, and soil services in different soil systems around the UK. We will then take these soils and subject them to climate change to examine whether we can predict the changes in soil services based on the changes we observe in biodiversity. These data will provide fundamental knowledge on how different soils and their biodiversity and functions respond to change in land use and climate. A second aim of our research is to examine the specific ways in which soil biodiversity regulates soil and its services. This "mechanistic" understanding could provide us with new ways to manage the land to deliver more sustainable soil stocks, giving us food, fibre and a healthy environment well into the future. Firstly we will examine how soil nutrient inputs affect the soil biota's activities in cycling carbon. This is important as soil organisms are primarily fed by nutrients from plants, but they can also respire carbon back to the atmosphere as CO2, and can also feed off existing organic matter decreasing soil carbon stocks. How soil biodiversity, land use and climate affect the balance of these processes is a large unknown in soil research and can have important consequences for our ability to predict future response of soils to change. We also seek to examine how the biodiversity itself drives these processes. Often in field studies we find differences in soil communities and processes, but the soil physical and chemical conditions also differ, so we can't determine if it is the environment or the biodiversity that is responsible for the difference in process rates. By manipulating soil diversity but maintaining a constant environment we can address these issues, and importantly validate approaches for enhancing soil biodiversity with new management practices to deliver soil security in field scenarios. All of our research will be integrated using computer modelling approaches which will attempt to predict soil processes under different soil, management, and climatic scenarios. A

major challenge is to see whether the incorporation of biodiversity parameters in these models will help predict responses over large landscape scales.