Overview:
Plant roots live in close association with diverse communities of microbes, including prokaryotes such as bacteria, and eukaryotes such as fungi, which together constitute the root ‘microbiome’. These microbes are selectively recruited from the diverse communities which inhabit soil as a result of their growth on carbon exuded from roots. Root associated microbes interact with the plant in a myriad of ways; some act as symbionts which promote plant growth, while others are parasites which can have deleterious impacts on growth and development. As a result, understanding and harnessing interactions in the root zone (termed the ‘rhizosphere’) has enormous importance for ensuring food and energy security.

Research at Warwick has demonstrated that a variety of factors control the composition of microbial communities which inhabit the root zone, including plant identity and developmental stage, local environment and geographical distance. Furthermore these communities change over time; some of these changes reflect seasonal preferences of microbial taxa, which may be associated with environmental variables and plant physiology, while others are less predictable and reflect ecological drift. During the course of long term monitoring of rhizosphere microbial communities in bioenergy willow plantations we have found that extreme weather events have major impacts on rhizosphere microbial communities. Prolonged extreme rainfall during the summer of 2012 had a sudden, massive impact on the diversity and composition of the rhizosphere biota, reducing the diversity of beneficial mycorrhizal fungi and promoting growth of pathogens and endophytes which live within the root. These effects dwarfed the normal seasonal patterns of microbial community dynamics which occurred in previous years.

Figure 1 Field sampling during the summer storms of 2012

With extreme weather likely to increase in frequency and intensity as climate change proceeds, there is a need to understand how extreme weather impacts ecosystem functions, and the factors which control the severity of these effects and their recovery. You will investigate the impact of extreme weather on rhizosphere communities, and determine the significance of these events for microbial functioning, including interactions with plants.

Figure 1 Extreme weather effects on diversity of different fungal families in the rhizosphere of a bioenergy willow plantation. Extreme weather events in June 12 impacted families highlighted with *, so that the community profile in 2012 was very different to 2011 and 2010. Note the drastic
impacts on the mycorrhizal families Cortinariaceae and Russulaceae.

**Methodology:** You will use a range of experimental platforms to investigate the impact of extreme weather—particularly heavy rainfall and drought—on rhizosphere communities. This will include monitoring at existing field sites used in earlier work, and new experiments using the unique NERC CEH ‘plunge bed’ platform. This allows control of the water table at a semi-field scale, enabling plots with realistic drought and extreme rainfall events to be established and compared to ‘standard’ weather conditions. We will use wheat crops in these studies, so that the links between extreme weather and food security can be established. You will use a variety of molecular approaches to characterise microbial and plant responses to extreme weather. This will include DNA and RNA extraction and purification, PCR, sequencing using next generation platforms and bioinformatic analysis. In particular there will be scope to use ‘metatranscriptome’ approaches, in which mRNA is extracted, sequenced, and used to profile the responses of plant and microbial gene expression to extreme weather.

**Partners and collaboration (including CASE):** This project would run alongside a large NERC-BBSRC programme grant funded as part of the Soil and Rhizosphere Interactions for Sustainable Agri-ecosystems programme [http://www.nerc.ac.uk/press/releases/2014/28-soil/](http://www.nerc.ac.uk/press/releases/2014/28-soil/) providing opportunities to collaborate with a range of industrial, institute and academic stakeholders in the agricultural sector.

**Possible timeline:**

**Year 1:** Experiments to investigate rhizosphere community responses to extreme weather events using the plunge bed platform. Monitoring rhizosphere responses to weather at existing field sites. These approaches will focus on microbial community assembly and composition using next generation sequence analysis.

**Year 2:** Continued use of plunge beds and field sites to build up a long term data set of rhizosphere community recovery from extreme weather events. Investigation of factors which affect the severity of the impact, and length of recovery from, extreme events.

**Year 3:** Metatranscriptome analysis of selected materials generated in year 1 and 2 field experiments and monitoring sites to investigate extreme event impacts at the level of gene expression.

**Further reading:**


**Further details:**

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