Change in land use influences mitigation of methane emission from soils

Methane facts
- Methane (CH$_4$) is a greenhouse gas and contributes to ~20% of global warming
- 21-25 times more potent than CO$_2$ (1)
- 56% of world emissions due to human activities (e.g., agriculture, landfills, etc.)
- Removal by natural processes (35% by atmosphere; 5% by soils)
- CH$_4$ oxidation by soil bacteria (methanotrophs), particularly in temperate forests

Objectives
- Determine methane fluxes from grassland, pine forest, bog, moorland, and birch forest
- Estimate their contribution and the effect of land-use change to the national CH$_4$ budget
- Identify the methanotroph communities present in each land use and determine the shift in their structure when land management is altered

Measurements of CH$_4$ fluxes from different land uses
- Four sites in Scotland sampled
- Observation of seasonal changes
- Laboratory incubation of soil cores
- Measure changes in CH$_4$ concentration in closed-chamber by gas chromatography (2)

Contribution of land uses to national CH$_4$ budget
- Upscaling of local CH$_4$ flux data to a yearly estimate
  - CH$_4$ emission (flux) in non-forested areas
  - CH$_4$ oxidation/sink (flux) in forests
- Relate the CH$_4$ flux of each land use to their area in Scotland to calculate their contribution to the national CH$_4$ budget
  - Balance between sources and sinks is a positive CH$_4$ emission from non-forested areas (2 kt)

Take-home messages
- Afforestation (land conversion into forest) has a positive impact on CH$_4$ mitigation
- Bog afforestation would be more potent at mitigating methane than moorland or grassland afforestation
  - Bog afforestation could offset methane emissions from non-afforested areas
  - Additionally, it could offset almost 7% of the CH$_4$ emissions due to animal production

Effect of land-use change on CH$_4$ mitigation
- Based on the conversion of 50% of the original land use
  1. Grassland conversion into pine forest:
     - Balance between sources and sinks is neutral
  2. Moorland conversion into birch forest:
     - Balance between sources and sinks is a positive CH$_4$ sink by forests (-2 kt)
  3. Bog conversion into pine forest:
     - Balance between sources and sinks is a positive CH$_4$ sink by forests (-7 kt)

Future work
- Molecular approaches: Information on how land-use changes affect structure and diversity of methanotrophs
  - Identification of specific bacterial species and genera (T-RFLP, cloning) (4)
  - Linking community structure with function (PLFA-SIP, DNA-SIP) (4)