N cycling processes in forest ecosystems are faced with different global environmental shifts including increased atmospheric reactive nitrogen (Nr) deposition, exposure to elevated atmospheric CO₂ and changing climate. An understanding of the response of N transformation processes in soils to these global change issues is critical for:

1. Shifts in the rates, timing and location of N transformation processes with implications for biological N fixation, NO, N₂O and N₂ emissions in to air and leaching of Nr in to water.
2. Estimating relative N availability to plants to support carbon capture.
3. Managing forests to adapt to climate change and sustain biodiversity and biogeochemical functions.

**KEY FINDINGS OF ONGOING RESEARCH AT BIFoR**

1. **Response of Denitrification to Reactive N (Nr) Addition**

Addition of Nr to riparian forest soils at Mill Haft led to higher denitrification potential than sediments under woody debris and non-vegetated sediments (Fig 1).

An increase in Nr availability may thus lead to higher denitrification and N₂O production, unless plant demands for Nr uptake is elevated at the same time.

![Graph showing denitrification potential of soils and sediments at Mill Haft forest.](image)

2. **Net Nitrification and Phenol Oxidase Activity**

Soils under oak and ash trees exhibited net nitrification while soil under pines showed net immobilization (Fig 2). However, the interplay between mineral N uptake by trees and microbes against reduction to N₂ and N₂O gases under elevated CO₂ may change.

Phenol oxidase activity was higher under oak trees than ash and pine (Fig 3). A future suppression or enhancement of extra-cellular enzyme activity due to elevated CO₂ and/or Nr deposition may be induced with implications for soil C and N sequestration. *This baseline provides a framework for tracking future N and C cycling enzyme response trajectories at BIFoR.*

3. **Chronic N Saturation under Elevated Nr Deposition or Business as Usual with Elevated CO₂?**

*In situ* denitrification (N₂O and N₂) is only able to remove up to 66 % of the Nr input, making forest ecosystems vulnerable to chronic N saturation in the UK (Fig 4)1,2. **A key question arise if elevated CO₂ would balance the Nr input through enhanced primary productivity without chronic N saturation of soils?**

Whilst forests are net sources of N₂O with varied contribution of denitrification to total N₂O flux depending on edaphic conditions (Fig 5), the total N₂O flux may reduce under elevated atmospheric CO₂ concentration, when the demand for mineral N uptake by plants is increased.

The additive impacts of elevated CO₂ and Nr deposition on the N pool and fluxes including denitrification and N₂O source partitioning is being proposed for further research at BIFoR.

![Graph showing denitrification rates in two UK forests.](image)

---

**REFERENCES**
