# Responses to Simulated Climate Change (Drought) in Heathland Vegetation

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## Introduction

There is considerable evidence that the northern temperate zone will undergo anthropogenically induced climate change in the next century. The effects of increased summer drought on the vegetation of a heathland were studied using the VULCAN manipulation. The ecophysiological and growth responses and the disease incidence were measured in the three main vascular species (*Calluna vulgaris* [1a], *Vaccinium myrtillus* [1b] and *Empetrum nigrum* [1c]).

**Fig 1a. *Calluna vulgaris***

**1b. *Vaccinium myrtillus***

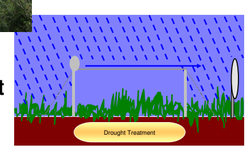
**1c. *Empetrum nigrum***

## Method

The VULCAN manipulation (2a) uses a series of retractable covers activated by rainfall (2b) to create drought conditions in study plots. Six plots were examined in this study (three drought and three control).

**Fig 2a. VULCAN experimental site**

**Fig 2b. Drought treatment**




Data was collected in 2005 during the pre-drought (May-June) and drought periods (July-August). Measurements of ecophysiological response, photosynthesis (A), transpiration (E) and water use efficiency (A/E) were taken using an infra-red gas analyser. Leading shoot length was measured to estimate growth in August. A fungal infection (*Pucciniastrum vaccinii*) was visually graded in *V. myrtillus* plants as none (0), mild (1), moderate (2) or severe (3) in August.

## Results

*Calluna vulgaris* responded positively to the drought treatment with significant increases in growth (3a) and live (3b) canopy cover.

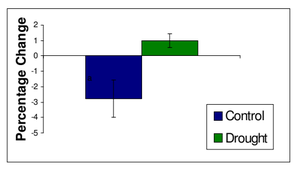



**Fig 3a. Percentage change in *C. vulgaris* cover**

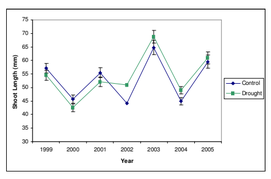



**Fig 3b. Mean shoot lengths of *C. vulgaris***

*Vaccinium myrtillus* showed no significant response to the drought in terms of growth or biomass. The drought significantly increased its photosynthetic rate and water use efficiency (3c) and increased shoot length was significantly associated with decreased soil moisture (3d).

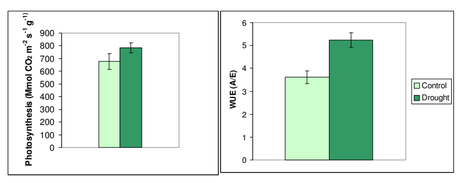



**Fig 3c. Photosynthesis and WUE in *V. myrtillus***

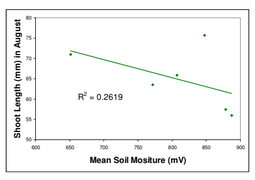



**Fig 3d. Soil moisture-shoot length correlation in *V. myrtillus***

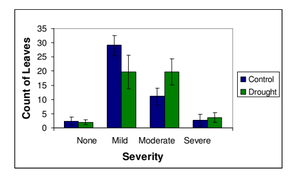



**Fig 3e. Count of classes of severity of *P. vaccinii***

This positive effect, however, was mitigated by an increase in the severity of the fungal infection *Pucciniastrum vaccinii* in drought plants (3e).

*Empetrum nigrum* responded negatively to the drought, it was found to have decreased biomass (3f) and grew significantly shorter shoots in the drought plots (3g).

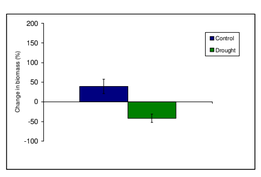



**Fig 3f. Percentage change in biomass in *E. nigrum***

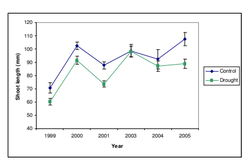



**Fig 3g. Mean shoot length of *E. nigrum***

## Discussion

*Calluna vulgaris* thrived under drought conditions, this could be explained by an increase in free soil nitrogen (1) and decreased transpiration in the drought plots combined with increased phenological development (2) in the droughted plants.

The observed increase in photosynthetic rate and WUE in *Vaccinium myrtillus* under drought conditions may be because *V. myrtillus* is generally waterlogged on the heathland and the drought treatment brings the soil moisture levels closer to optimum conditions. However, this effects is negated by an increase in the severity of the fungal infection *Pucciniastrum vaccinii*, possibly because the drought has created an imbalance in amino acid metabolism making *V. myrtillus* more susceptible to infection (Nordin, *pers. comm.*).

The non-responsive ecophysiological behaviour of *Empetrum nigrum* to the drought may have let the other two species competitively exclude it for light, space and resources.

## Conclusion

Climate change (drought) is likely to have a significant effect on heathlands and many other ecosystems as soil moisture availability is one of the most important factors governing a species distribution. Different species will show different responses and the results of this study suggest that under drought conditions *Calluna vulgaris* will prosper and *Empetrum nigrum* will decline. As *E. nigrum* is on the southern tip of its distribution in North Wales, an increase in drought intensity may lead to a local extinction of this species.

## References

1. Emmet, B.A. *et al* (2004) The responses of soil processes to climate change: Results from manipulation studies of scrublands across an environmental gradient. *Ecosystems* **7** 960 6 625-637.
2. Speed, J. (2004) The Ecophysiological Responses of sub-montane heathland vegetation to simulated climate change. Centre for Ecology and Hydrology, Bangor.

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