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Carbon dioxide and energy exchanges in two intensively managed grasslands in the maritime climate region

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Introduction

Managed grasslands constitute 55% land area and thus the major land use/cover type in Ireland. The characteristics of the maritime climate (e.g. long growing season, frequent rain events) as well as various management practices (e.g. harvest, grazing, re-seeding) may exert strong controls on the exchanges of carbon dioxide (CO_2) and energy with implications on the regional carbon balance and climate. Here we present results from multi-year eddy-covariance (EC) measurements at two intensively managed grassland sites.

Materials and Methods

Ecosystem exchanges of CO_2 (NEE, GEP, ER) and energy (LE, H) were determined using the eddy-covariance technique in two grasslands sites (Dripsey & Wexford) in southern Ireland. Meteorological and soil environmental sensors were installed to monitor environmental conditions. Among years, management was constant at Dripsey (1/3 harvested; 2/3 grazed) but highly variable at Wexford. An annual index of management intensity was developed based on the frequency and duration of individual management events.

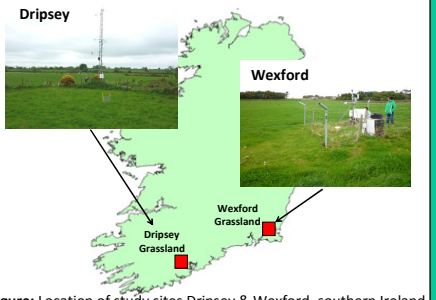


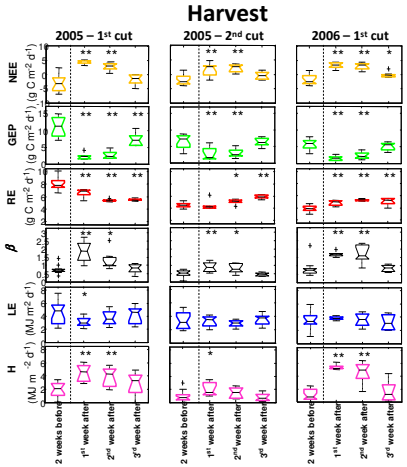
Figure: Location of study sites Dripsey & Wexford, southern Ireland

Table: Annual management activities at Dripsey & Wexford grasslands

Year	Dripsey	Wexford
2003	33% harvest; 66% grazing, 1% fallow	Grazing; 30% cut once
2004	33% harvest; 66% grazing, 1% fallow	Grazing, 30% cut once
2005	33% harvest; 66% grazing, 1% fallow	Grazing, 100% cut twice
2006	33% harvest; 66% grazing, 1% fallow	Grazing, 30% cut once, 20% kale planting
2007	33% harvest; 66% grazing, 1% fallow	Grazing, 30% cut once, 20% kale planting, 20% grass reseeding
2008	33% harvest; 66% grazing, 1% fallow	NA
2009	33% harvest; 66% grazing, 1% fallow	NA

* The % is the relative number of field paddocks to all fields (similar size) within footprint

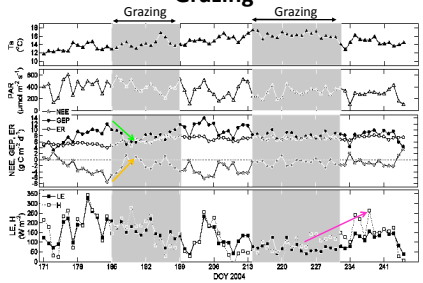
Results (1) – Harvest *vs.* Grazing Effects



Harvest events turned negative NEE (uptake) into positive (loss), reduced GEP and ER, increased H and B for 2-3 weeks. Effects on LE were limited.

Effects on CO_2 and energy fluxes were more moderate after the 2nd cut compared to the 1st cut.

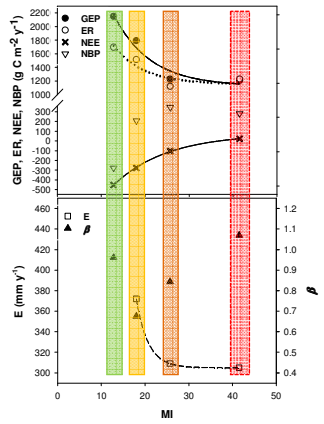
Higher post-harvest Tair and PAR relative to pre-harvest conditions further modified flux response and recovery times following the harvest event in 2006.

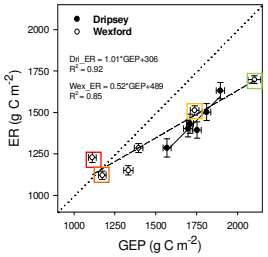


In contrast to harvest events, NEE remained negative (uptake) and ER unaffected during grazing periods, meanwhile B increased >1 due to enhanced H.

Effects on CO_2 (energy, i.e. H) fluxes were more moderate (enhanced) during late summer compared to early summer grazing.

Results (2) – Management Regime

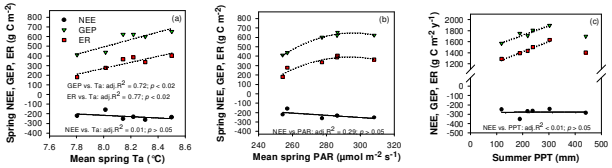




70% Grazing, 30% cut once
70% Grazing, 100% cut twice
50% Grazing, 30% cut once, 20% kale
30% Grazing, 30% cut once, 20% kale, 20% reseed

The annual GEP-ER ratio and NEE remained stable under similar management regime at the Dripsey grassland. In contrast, the annual ER/GEP ratio, NEE, NBP and B increased while ER, GEP, and E decreased with increasing management intensity/disturbance of vegetation and soil associated with harvest, kale planting and grass re-seeding practices during the growing season at the Wexford grassland.

Results (3) – Climatic Controls



Year	Start (W/D)		End (W/D)		Length (W/D)	
2003	Mar 4	Mar 14	Nov 3	Oct 27	244	227
2004	Mar 7	Mar 16	Oct 20	Oct 20	227	228
2005	Mar 16	Feb 22	Oct 23	Oct 24	221	244
2006	Feb 17	Feb 21	Oct 4	Nov 5	238	257
2007	Feb 20	Mar 17	Nov 1	Oct 16	241	201
2008	Feb 23	Feb 17	Oct 19	Oct 4	232	237
2009	Feb 15	Feb 9	Oct 13	Oct 13	249	243
Mean	**Feb 26**	**Mar 1**	**Oct 22**	**Oct 20**	**236**	**234**

Climatic controls (e.g. Tair, PAR, PPT) resulted in similar GEP and ER responses and thus did not affect NEE on an annual scale at Dripsey.

A prolonged growing season (3 days of GEP > 3 gC/m²/day) of ~235 days may support enhanced annual CO_2 uptake.

Results (4) – Global Comparison

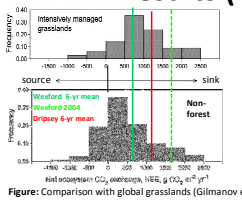


Figure: Comparison with global grasslands (Gilmanov et al., 2010)

Mean annual CO_2 uptake at Dripsey and at Wexford in undisturbed years (e.g. mainly grazed, 2004) is at the upper end of intensively managed grasslands and non-forest ecosystems.

Summary

- ❑ Contrasting effects on CO_2 and energy fluxes were observed from harvest versus grazing events.
  - ➢ The grassland switched to being a net CO_2 source following harvest but remained a sink during and following grazing events.
  - ➢ Grazing events caused increases in the Bowen ratio via enhanced H fluxes in late summer while similar effect following harvest occurred in early summer
- ❑ Management regime and intensity were related with annual CO_2 and energy balances
  - ➢ Enhanced uptake of CO_2 occurred under grazing regime
  - ➢ Grass re-seeding and forage crop planting considerably reduces the net CO_2 uptake
- ❑ In comparison with global grasslands, enhanced annual CO_2 uptake in maritime grasslands may be associated with longer growing season

References

Gilmanov, T. et al. (2010). Productivity, Respiration, and Light-Response Parameters of World Grassland and Agroecosystems Derived From Flux-Tower Measurements. *Rangeland Ecology & Management* 63: 16-39

Peichl, M. et al. (2011). Six-year stable annual uptake of carbon dioxide in intensively managed humid temperate grassland. *Ecosys.* 14: 112–126

Peichl, M. et al. (2011). Management effects on CO_2 and energy exchanges in intensively managed grassland. *Agr Forest Meteorol* (in revision)

Acknowledgements

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