Soil erosion by aeolian action at an intensively cultivated lowland peatland

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Background

Drainage of UK lowland peatlands has been undertaken over the last 400 years to exploit the productivity of carbon (C) rich peat soils. Management practices are such that many hectares of drained peatland remain un-vegetated for large periods of the year leaving the peat exposed and vulnerable to erosion and transportation by wind action, in events locally known as 'fen blows' in East Anglia. The impacts of management activity on peatland C budgets have received much attention in relation to losses of soil C in the form of carbon dioxide (CO_2), whereas transport of C through aeolian pathways has remained largely unquantified and values reported contested (Van Oost *et al.*, 2007).

Windblown sediment yield was quantified and relationships between wind speed and near-surface soil moisture content was investigated.

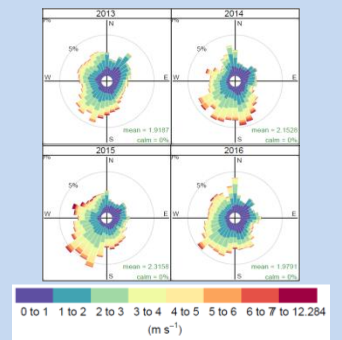

Figure 1. Wind rose diagrams demonstrating dominant south-westerly wind direction.

Study site

Methwold Farm, Norfolk in the East Anglian Fen's. The area is separated into field parcels (of roughly 6-8 ha in area) by hedgerows and ditches and dominated by agricultural land practice. Land is intensively managed to produce vegetables including celery, leek, lettuce, radish, maize, onions, potatoes, and sugar beet, and wheat. Measurements were made over three full consecutive years 2013-16, characterised by three crop cycles of leek, lettuce and celery crops separated by periods of fallow.

Sediment yields (t ha^{1})	Soil types	Source
0.46 – 0.48	Upland blanket bog	Warburton, 2003
-32.6 – 37.5 (128 fields) (net 0.6)	Lowland agricultural soil (loamy sand)	Chappell and Warren, 2002
4.14, 2.5, 13.1 (2013, 14, 15)	Lowland agricultural peat soil	This study, 2017

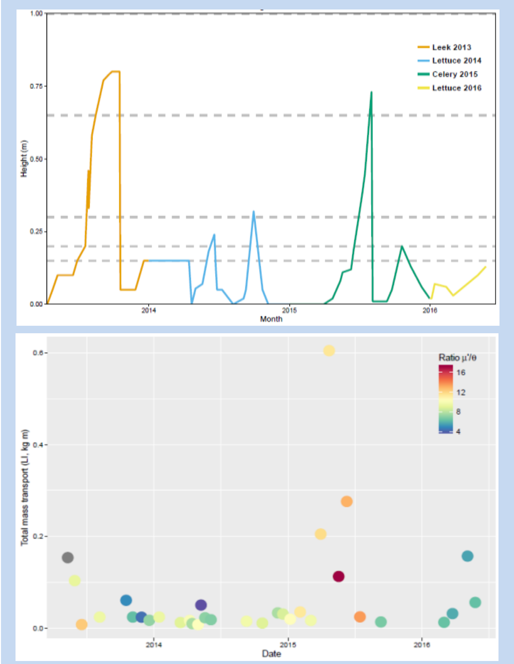

Figure 2. Upper: vegetation profiles over the period of measurement with dashed lines representing BSNE measurement heights. **Lower:** Integrated total mass transport with a ratio of wind speed to soil moisture

Methodology

- Big Spring Number Eight wind samplers (Fryrear, 1986) were installed at 1, 0.65, 0.3, 0.20, 0.15 m
- Supporting meteorological measurements were made by instrumentation at the same location (CSAT3 sonic anemometer (Campbell Scientific, Ltd., Lincoln Nebraska, USA), time domain reflectometer CS616 (Campbell Scientific, Ltd., Shepshed, UK))
- Samples were decanted using distilled water into polypropylene bottles.
- Samples were dried in a laboratory oven for 48-72 hours then weighed using an analytical balance (OHAUS Adventurer, Parsippany, New Jersey, USA) with a precision of 0.0001 g.
- Where enough sample was present loss on ignition analysis was undertaken.

Photos above: of BSNE samplers in the field, and one with sample ready for collection, taken by amjc1. **below:** possible destinations for windblown peat

Conclusion

Vegetation cover provides the best mitigation for wind-blown soil losses, however when lack of vegetation combines with low soil moisture and high wind speed, as in spring 2015, large quantities of sediment are transported.

Wind blown sediment is contributing to a movement of 0.6 – 3 t C ha^{-1} yr^{-1} across and possibly out of cultivated lowland peatland field systems in addition to that already lost by oxidation. These figures are in keeping with previous estimates by other measurement techniques.

More work is required to calculate the contributing footprint of wind-blown peat and its destination.

Carbon	Eddy Covariance (t C-CO_2 ha^{-1} yr^{-1})	Dust (t C ha^{-1} yr^{-1})	Net crop import/export (t C ha^{-1} yr^{-1})
2013 (Leek)	6.67	0.97	1.38
2014 (Lettuce)	7.92	0.59	-0.18
2015 (Celery)	7.85	3.07	0.02

References: **Chappell, A. and Warren, A.** (2003) Spatial scales of 137Cs-derived soil flux by wind in a 25 km2 arable area of eastern England. *Catena*, 52, 209-334. **Fryrear, D. W.** (1986) A field dust sampler. *Journal of Soil and Water Conservation,* 41**,** 117-120. **Van Oost, K., T. A. Quine, G. Govers, S. De Gryze, J. Six, J. W. Harden, J. C. Ritchie, G. W. McCarty, G. Heckrath, C. Kosmas, J. V. Giraldez, J. R. da Silva & R. Merckx** (2007) The impact of agricultural soil erosion on the global carbon cycle. *Science,* 318**,** 626-9. **Warburton, J.** (2003) Wind-splash erosion of bare peat on UK upland moorlands. *Catena,* 52**,** 191-207.