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Monitoring changes in surface elevation of blanket peat and other land cover types using a novel InSAR processing technique

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There is considerable interest in techniques which could detect changes in peat volume, of which surface elevation is an important measure. We used new technique for processing InSAR (satellite) to accurately measure changes in the elevation of soil and vegetation across an area of north Wales (UK) which includes a large region of blanket peat (10 km^2). We applied a novel technique for processing InSAR data; Intermittent Small Baseline Subset (ISBAS; Sowter *et al.*, 2013). This technique considers pixels within the input radar stack which are only coherent for subsets of the total time period for processing. We applied the ISBAS technique to satellite data between 1993 and 2000 over a large region of interest (4460 km^2) that encompasses several land use, soil and bedrock combinations† (Emmett B.E. and the GMEP team, 2013). In two cases, the period between individual satellite acquisitions was short (24 hours), whilst in general it was longer (35 days). The pixel size of each elevation measurement after processing is a square area with side length 100 metres (10 000 m^2). We collated historical measurements of weekly rainfall and predictions of potential evapotranspiration (each in mm) to identify major periods of wetting and drying.

We used the short-interval scenes to estimate change in surface elevation over 24 hours for different land cover types. In each case the mean change was close to zero (range –0.03–0.02 cm) whilst its standard deviation in areas dominated by peat (5.2–5.8 cm) was substantially larger by comparison to areas of improved grass, forest and heather (1.7–3.2 cm) and areas dominated by bedrock (0.5 cm). In each case these distributions of change were not strongly skewed (range of skewness coefficients –0.44–0.34), but they generally had heavy upper and lower tails (range of kurtosis values 0.6–15; leptokurtic). We focussed on data from the areas of blanket peat. We computed change in elevation between the start and end of three of the driest and one of the wettest periods (between 105 and 175 days in duration). The mean change in elevation for these dry and wet periods was also close to zero (–0.05–0.1 cm) whilst their standard deviation (5.4–5.7 cm) was similar to those of the 24 hour periods (over peat). The similarity of changes in surface elevation over these very different timescales (and moisture regimes) suggests that the dominant processes controlling peat surface elevation occur over the short timescale. There was no evidence to suggest that extended wet or dry periods led to an overall change in surface elevation across the area of peat. We computed variograms for the peat elevation data (relative to a fixed point) to explore the nature of any autocorrelation, and cross-variograms to investigate joint spatial variation in elevation over time (changes in elevation for each pixel). The variograms fitted to the semi-variance estimates for change in peat elevation over the short periods (and the wet/dry periods) did not exhibit spatial autocorrelation, indicating that the dominant processes controlling surface elevation occur at scales shorter than the pixel resolution (<100 metres) and are not closely related to larger scale climatic factors (rainfall and evapotranspiration).

† ERS-1/2 SAR images were made available to BGS via ESA Category-1 project ID 13543.

† see also Cigna, F. *et al.* 2014. Intermittent Small Baseline Subset (ISBAS) InSAR of rural and vegetated terrain: a new method to monitor land motions applied to peatlands in Wales, UK (EGU 2014: session NP4.2 Satellite Time Series Analysis.)

Emmett B.E. and the GMEP team, 2013. Glastir Monitoring & Evaluation Programme. First Year Annual Report to Welsh Government (Contract reference: C147/2010/11). NERC/Centre for Ecology & Hydrology (CEH Project: NEC04780), pp. 393

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