Evaluating the importance of blanket bog in northern Spain using traditional and remote sensing techniques

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Introduction

Peatlands play an important role in the global carbon cycle owing to the accumulation and long-term storage of organic matter. Blanket bogs are rare types of ombrotrophic peatland that are also recognised internationally for their flora and fauna. Although many recognised areas of blanket bog are degraded and currently acting as carbon sources, restoration intervention can return these ecosystems to carbon sinks (e.g. Nugent et al., 2018).

Blanket bogs form primarily in areas with an oceanic climate and have been studied extensively across Europe in countries such as the UK, Ireland and Norway. In Spain, this habitat is under investigated and has only been recognised in Galicia and the Basque Country leaving a large gap in the peatland inventory across parts of the Cordillera Cantábrica mountain range (Heras, 2002). Unmapped and unprotected areas of peatland are exposed to a range of anthropogenic pressures including grazing, burning and wind farm installations (Heras, 2002).

To promote the recognition and protection of blanket bogs in Spain, my PhD research focusses on identifying, classifying and evaluating the state of unmapped areas using a combination of traditional and remote sensing techniques. This paper presents the approach developed to assess unmapped blanket bog and focusses on one new area identified between the regions of Castilla y León and Cantabria (additional areas to be published in the forthcoming months).

Methods

Identification of potential blanket bogs

Potential areas of unmapped blanket bog present in the Cordillera Cantábrica were initially delineated using environmental conditions in ArcGIS. Climate data were obtained from WorldClim (Hijmans et al., 2005) and used to identify areas where precipitation was > 1,000 mm yr-1 and mean annual temperature was < 15°C. Aerial photography and digital elevation models (DEMs) from 2017 were then used to delimit water-shedding areas where altitude was > 600 m above sea level (masl) and exposed peat was visible.

Classification of blanket bogs

For each blanket bog identified, a 15 m systematic square grid of points was created and peat depth was measured in the field at each point using 1 m long sections of connectable steel rods. Depth values were interpolated in ArcGIS using a spline algorithm to obtain the total volume of peat and the extent of each blanket bog was constrained to the area where peat depth is over 40 cm.

Evaluation of blanket bog status

The status of each peatland was examined using remote sensing techniques. Surface change of exposed peat was quantified using a FARO Focus3D X330 terrestrial laser scanner (TLS) and annual rates of change were calculated from point clouds collected in five different surveys using a Mesh to Cloud (M2C) algorithm in CloudCompare. Surveys were undertaken between May 2017 and May 2018 using a single repeat scan strategy with fixed markers to reduce registration errors. Historical aerial photographs from 1977, 2002, 2009 and 2017 were used to map the evolution of exposed peat. A peat core was taken from each site and the amount of organic carbon (OC) contained was assessed at 5 cm intervals to obtain a high-resolution characterisation of carbon in the peat profile.

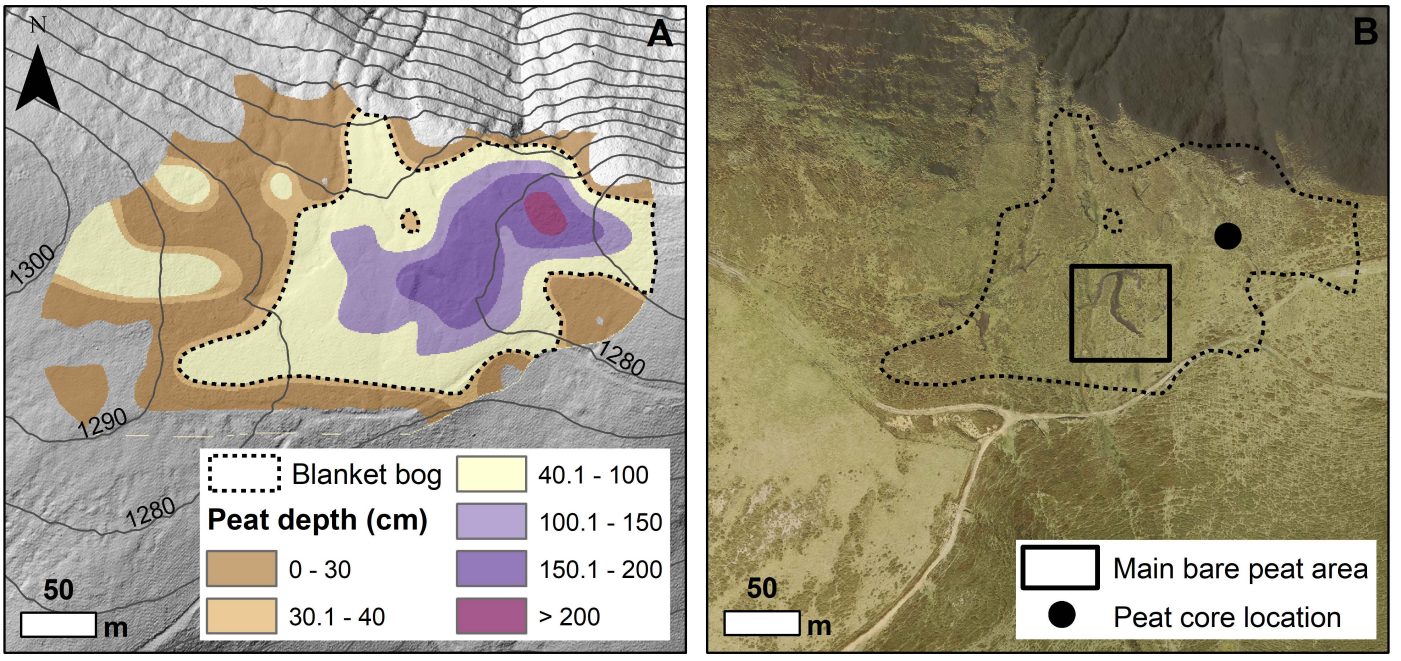

Figure 1. A) Peat depth in Ilsos de Zalama highlighting the main blanket bog area (Chico et al., in review; B) Main bare peat in Ilsos de Zalama from Aerial photo of 2017 (Mapas Cantabria, 2017).

Results

Identification and classification of blanket bogs

Ilsos de Zalama was identified as a blanket bog and is located only 500 m away from Zalama blanket bog, a recognised and restored peatland (Chico et al., in review).

Located at 1,280 masl, Ilsos de Zalama contains a total of 41,783 m3 of peat covering an area of 3.1 ha (peat > 40 cm deep; Chico et al., in review). This blanket bog is extensively grazed by livestock and bare peat surfaces are exposed in the central area of the peatland (Fig. 1B). Nevertheless, some areas are still vegetated and appear to be in good condition with peat depth measured up to 2.16 m (Fig. 1A).

Evaluation of blanket bogs

The dominant surface process identified at Ilsos de Zalama was erosion (-31.28 mm yr-1.); however deposition of peat was also determined (28.37 mm yr-1). Therefore, between May 2017 and May 2018, the area surveyed showed an overall surface loss of peat of -7.73 mm yr-1. Seasonal analysis demonstrated that surface change was significantly different ($p < 0.001$) between the time period where livestock graze the area (May to October 2017) and the time period when no livestock are present. The overall change during the period with livestock was negative (-13.17 mm) while in contrast the overall change in the period without livestock was positive (6.06 mm).

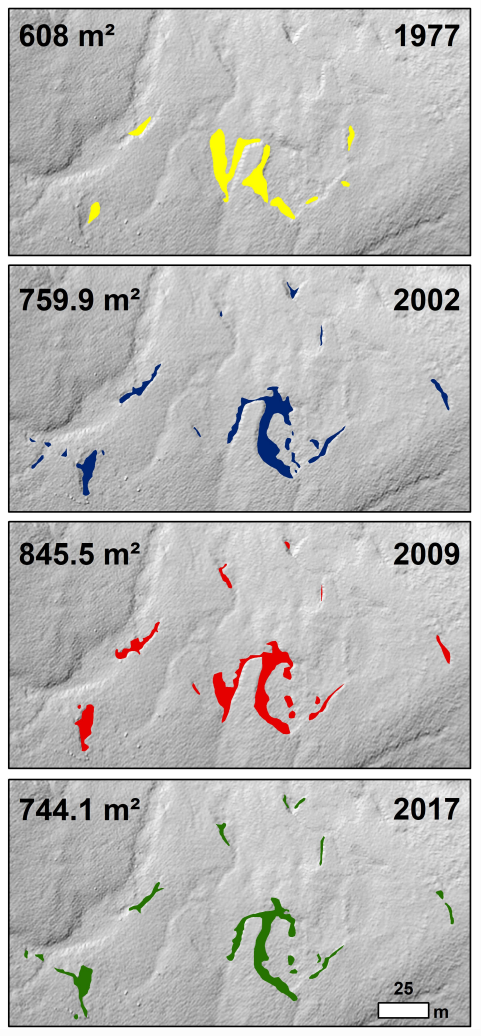

Figure 2. Historical evolution of the exposed peat surface at Ilsos de Zalama.

Over the period 2002 – 2009, the area of exposed peat in Ilsos de Zalama have increased at twice the rate (12.2 m2 yr-1) of the increase over the period 1977 – 2002 (6.1 m2 yr-1). Interestingly though, over the last period of assessment (2009 – 2017) the area of exposed peat have decreased (-12.7 m2 yr-1; Figure 2).

On average the peat contained 73.2 ± 13.8 kg C per m³ (Fig. 3) indicating that Ilsos de Zalama contains 3,299.2 t C. If the rate of surface change determined using TLS is consistent across all areas of exposed peat at Ilsos de Zalama, this blanket bog lost 454 kg of long-term carbon storage in 2017.

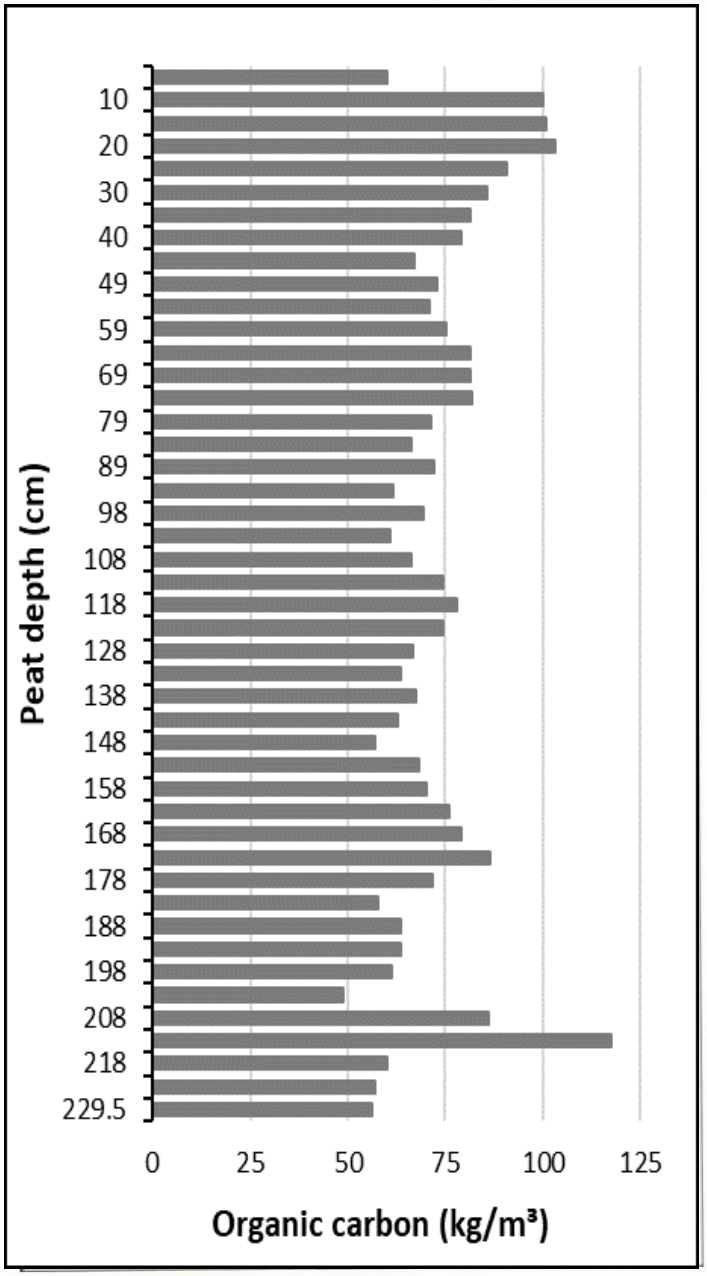

Figure 3. Total of organic carbon in the peat core every 5 cm.

Discussion

Peatlands are the largest store of terrestrial carbon, so protection and restoration of these areas could be an approach to help mitigate climate change. While many peatlands are degraded, there is growing evidence that restored blanket bogs could act as carbon sinks (Nugent et al., 2018). This PhD research has identified four unmapped blanket bogs covering an area of 43 ha and highlights an urgent need to update of the extent of this habitat in Spain.

The unprotected areas here are exposed to anthropogenic pressures and are eroding at higher rates than restored peatlands in the area. All blanket bogs identified in this research show an increasing trend of degradation highlighted by the increasing area of exposed peat to 2009. The apparent reduction in exposed peat observed between 2009 and 2017 could be due to an increase in vegetation cover or, of greater concern, may actually indicate total loss of peat deposits from some areas. The current rates of erosion determined in unprotected areas such as Ilsos de Zalama will result in a complete loss of the habitat. As it has been demonstrated that livestock increase the rate of surface change, simple exclusion using fencing would slow such loss but the additional threat from wind farm developments also need addressing. In fact, a new wind farm was proposed to be installed over Ilsos de Zalama in 2017 but received strong opposition from local councils due to the proximity to the protected and restored Zalama blanket bog.

In terms of carbon storage, the areas identified in this research could contain more carbon than the largest blanket bog complex currently recognised in Spain and not only would these areas play an important role in regional scale carbon budgets but could form part of the national strategy to combat climate change.

Conclusion

My PhD research has identified four currently unmapped blanket bogs in North Spain and has

evaluated the current state of degradation and rate of carbon loss. Anthropogenic pressures such as overgrazing and wind farms are increasing the rate of degradation, and there is an urgent need to recognise and restore these areas to preserve the carbon storage.

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Guaduneth Chico is a final year PhD student at Nottingham Trent University where he is investigating the potential of remote sensing techniques such as Terrestrial Laser Scanner to evaluate and identify new blanket bogs in North Spain. He also has research projects with Bizkaia Council monitoring peatland restoration and has collaborated in LIFE EU projects.