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Access to Peatland for Restoration – physical limitations

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Summary

The area of peatland that can be restored each year is limited by a number of factors, including physical accessibility. For example, if a site is covered by snow there may be problems to access the site with machinery, and such periods when sites are inaccessible may be different for sites located in mountainous regions to, for example, sites in low lying areas. Similarly, access is dependent on how far a site is from the nearest road or track. This can differ for sites with different restoration needs, for example, erosion tends to be more common in peatlands at higher altitude, whereas peat extraction would commonly have occurred close to existing habitation and so have better road access.

This short project combined snow cover surrogate data from the Met Office and calculations of the degree of difficulty for access in order to estimate the proportion of time in an average year when restoration would not be possible.

We looked at a number of peatland condition categories to generate a first estimate of such physically inaccessible periods. Our analysis did not consider how competing land management interests affect accessible periods for restoration. We used long term observations (1981-2010 averages) from the UK Met Office on the days of ground frost at 1 km resolution, alongside a second dataset that was an estimate of the time required to get machinery to a given location. This second data layer was a rescaled version of the SNH Remoteness layer, which itself is part of the composite SNH Wildness Index.)

Key findings

- Our results suggest that, nationally, during periods of between 2 to 100 days per year, conditions could make sites physically inaccessible to efforts to carry out peatland restoration. This will vary depending on the specific site location, and our model is able to provide such data for individual locations.
- Peatland condition categories more likely to be located at higher altitude (e.g. eroded peatland) or further from access roads (e.g. heather- or grass-dominated modified bog) had higher average number of days that would be inaccessible than condition categories associated with better human access (e.g. peat extraction, cropland conversion, intensive grassland).
- The values were mostly determined by the estimate for snow cover, with only a smaller proportion attributed to the additional time required to access a site.
- This analysis is highly sensitive to the assumption that the Met Office days of ground frost are an appropriate proxy for the number of days a site would be inaccessible due to snow on the ground. It does not take into account other restrictions to access.

Contents

Estimating annual access to peatland for restoration

The majority of Scotland's nearly 2 million hectares of peatland have suffered from some form of damage and a significant proportion are net emitters of carbon in various forms, thus contributing to the net GHG emissions for Scotland (ClimateXChange 2018[1]). Peatlands in their near-natural state are net carbon sequestering or neutral, and the currently available evidence suggests that rewetted peatlands release significantly less carbon than in their former degraded state (Evans et al., 2017[2]).

Peatland restoration is cost-effective, and therefore considered a viable mitigation strategy[3]. However, carrying out restoration management takes time. Machinery and restoration materials (e.g. timber or plastic dams, straw bales, stone for blocking drains and gullies) need to be transported onto the site to be restored. The actual restoration effort itself also takes time, as tracked machines that physically move peat for drain-blocking or reprofiling purposes have a limit in terms of how much area can be covered in a given time period.

This research was commissioned to generate a first estimate of the proportion of time in a year that peatland restoration is physically not possible, and whether these periods of inaccessibility differ for different categories of peatland that could be restored. These categories were taken as the condition categories used in the proposed methodology for formal UK national greenhouse gas reporting (Evans et al., 2017[2]).

Estimating days with no access

Peatland restoration cannot be carried out when the site is covered in snow. Although snowfall, and the average period of snow lying on the ground, are not mapped across Scotland, an assumption can be made that the average number of ground frost days as a reasonable proxy for the limits to access a site due to snow or adverse access track conditions. A second consideration is that adverse weather conditions would cause a contractor or site manager to decide to postpone or cancel planned work.

The likely number of additional days that no work would be carried out as a result of an adverse weather forecast was estimated based on the physical accessibility of a given site. The physical accessibility of a site was estimated

[1] https://www.climatexchange.org.uk/media/3141/peatland-restoration-methods-a-comparative-analysis.pdf

[2] https://naei.beis.gov.uk/reports/reports?report_id=980

[3] https://www.theccc.org.uk/publication/net-zero-the-uks-contribution-to-stopping-global-warming/

by rescaling the SNH Remoteness Index[4], to instead indicate the likely amount of time that would be required to take machinery on-site, and, secondly, how many days would likely be lost due to a decision not to mobilise machinery in the first place due to a poor weather forecast (see Appendix for full methodology). The addition of these two constrains generated a map of the number of inaccessible days across the whole of Scotland (not shown), which was then constrained to show just the peatland areas (Figure 1).

The range of inaccessible days was between 2 and 100 days, with the highest number of inaccessible days predictably in upland areas. Split by peatland condition category (Table 1), there are a higher average number of inaccessible days for condition types more likely found in the uplands, i.e. eroded and modified heather/grass-dominated bog. The influence of lack of good access roads and/or island locations is, however, also represented, and therefore this could be considered a reasonable first estimate of the physical limitations to peatland restoration.

Please note that the average values given may not always be the best estimate of a central value (Table 2) as not all observations in all classes follow a normal distribution. Using the median (or modes in bimodal cases) may be better central estimates.

Table 1. Average number of inaccessible days (per year) for peatland in different starting categories.

Land cover category	Drainage status	Average number of inaccessible days (per year)	Range	Proportion of year
Woodland	Drained	23.2	2-83	0.063
Cropland	Drained	17.1	3-51	0.047
Eroded Modified	Drained/Undrained	41.4	4-100	0.11
Heather-dominated	Drained/Undrained	31.1	3-99	0.085
Grass-dominated	Drained/Undrained	27.6	2-94	0.074
Intensive Grassland	Drained	16.8	2-63	0.047
Extensive grassland	Drained	19.8	2-80	0.055
Extracted (industrial)	Drained	18.2	4-50	0.049
Extracted (domestic)	Drained	18.3	3-56	0.049

Uncertainties and gaps in knowledge

The assumptions used to estimate the number of days that a project would be called off for in advance of a poor weather forecast are creating uncertainty. Further work would be advocated to ensure the assumptions used in this first attempt to estimate limits to peatland restoration are valid. It is not known how often a snow forecast would result in a decision to delay or halt mobilisation. If an adverse weather forecast was close to the deadline for delivery of the project, a decision might be made to delay the project until another financial year. We were unable to capture such information for this project. Our estimate of the time it takes a tracked machine to access restoration locations was based on a very small number of anecdotal observations, and so may be highly inaccurate. It was sense checked in the data layer for two locations where we had timed observations of machinery

[4] The SNH Remoteness Index is an estimate of the "theoretical time it would take to walk or cycle, taking account of distance, relative slope, ground cover and barrier features". It is part of a composite set of data that together indicate relative levels of wildness, the SNh Wildness Index, available at: https://gateway.snh.gov.uk/natural-spaces/dataset.jsp?dsid=WILDNESS-CMP.

access and. The time it takes to access any restoration location in Scotland that the model estimated, was always below 12 hours, which makes the result least sensitive to errors in this estimate.

It is also highly uncertain whether the 'days of ground frost' layer provides a good proxy for snow covered ground or inaccessible track conditions. As mentioned above, the data presented here are highly sensitive to the assumption that the days of ground frost are an appropriate proxy for the number of days a site would be inaccessible due to snow on the ground.

Another uncertainty is implicit in the age of the SNH Remoteness index. It will not feature roads or tracks built in the last 5 years, and so certain areas may now have less of an access constraint than presented in this work.

It was not feasible to estimate additional physical constraints, such as water-logged ground that may be too dangerous to access with tracked vehicles. This could potentially be calculated using models of antecedent soil moisture, or, more simplistically, the number of days of rainfall above a certain threshold. There was no off-the-shelf data product for these available within the deadline for this project.

Other physical limitations are conflicting management options. These may involve conservation interests, such as restricting access so that there is no disturbance to ground nesting birds, otters, water voles, or other biota with a conservation interest and/or international obligations. Alternatively, stalking and/or grouse shooting interests may also limit the number of days during which peatland restoration work can be carried out. Such potential conflicts can be partly negotiated on a case-by-case basis.

Finally, it must be noted that the peatland map as well as the map of peatland condition types used to derive Figure 1, and to calculate the figures present in Table 1, are themselves based on models. There are known inaccuracies in both data sources. Therefore, the information presented here should be considered no more than a first attempt at estimating physically inaccessible periods.

Potential future research

The estimates of physical limits to restoration in this report are heavily biased on the extreme end of 'hard' constraints due to accessibility for people, machinery and materials, whether in terms of the pathway to a certain location or in terms of weather conditions that limit restoration to be carried out.

It would be beneficial to add data on other access constraints. Logical additional layers would include competing biodiversity objectives that would limit access at other periods of the year, rather than the winter season (e.g. conservation of raptors, ground-nesting birds, otters, water voles). Another example is competing economic interests such as stalking and grouse-shooting, and also infrastructure developments in relation to renewable energy production or development of the future water, transport and electricity grids. It is only when these other types of constraints are added that we can more fully understand the realistic limits to peatland restoration.

On a technical matter, the limitations of the layer as presented here could be revisited once better information on e.g. antecedent moisture conditions, an update on the road/track network or a well-validated model of snow cover duration and timing is available. There is an existing model on snow cover for Scotland (Poggio and Gimona, 2015[5]), but the resolution of the data are incompatible with the needs of this work.

[5] https://www.semanticscholar.org/paper/Sequence-based-mapping-approach-to-spatio-temporal-Poggio-Gimona/5d211e596e4c828958431f91e75fe9d9c2f4d126

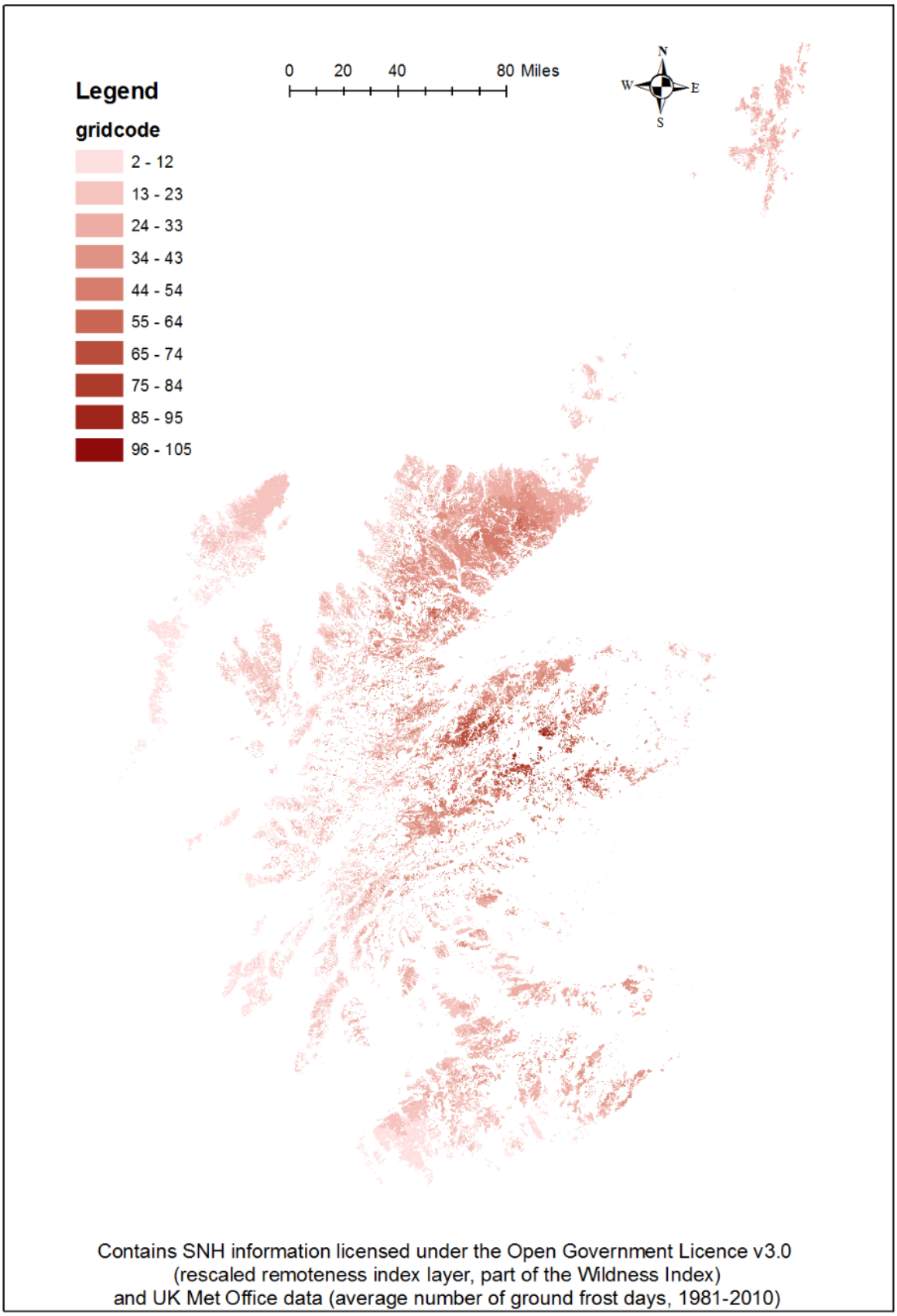


Figure 1. Mapped number of inaccessible days per year for peatland restoration across Scotland.

Appendix 1 - Methodology

The UK Met Office average (1981-2010) data for number of ground frost days were downloaded from CEDA[6]. As this dataset is at 1 km resolution, it was converted to a nominal higher resolution of 25 m using the same information for each 25 m cell within a given 1 km block (Figure 2). This was required in order to match the resolution of the SNH Remoteness index.

The SNH Remoteness Index[7], itself an estimate of the "theoretical time it would take to walk or cycle, taking account of distance, relative slope, ground cover and barrier features, such as open water and very steep ground, from the nearest public road, ferry landing or in one case a railway station (being the point of public mechanised access), is calculated at 25m cell resolution. The Remoteness index (scaled 1-256) was rescaled for machinery access (assuming a tracked vehicle was used) as follows:

The remoteness index was a scaled version of the actual time (in seconds) that it takes to travel, using equal intervals. Therefore, the index only had to be rescaled to the (slower) time that a tracked machine would require. Based on a very limited number of observations of the time it takes a tracked machine to reach a certain location (from two restoration projects and a small number of observations within each of these) we estimated that it takes a machine 2.5 mins travel time per raster value. This recalculation puts the furthest time for machine access in Scotland at 640 mins from the nearest point of public mechanised access.

Then this reclassified machine travel time was further rescaled to a 'penalty' time aiming to reflect the likely length of time that a restoration project may get called off for before adverse weather conditions (<1 hour= no penalty; 1-2 hours = 1 day; 2-4 hours = 2 day, 4-5 hours = 3 days; 4- 5 hours= 4 days; more than 5 hours = 5 days). This 'penalty time' (Figure 2) was added to the number of ground frost days, and GIS intersected with a map of peatland area in Scotland (Artz et al., 2019[8]), to arrive at Figure 1.

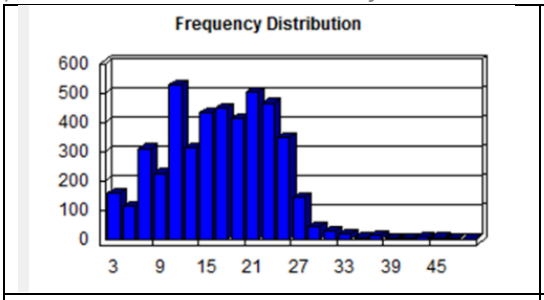
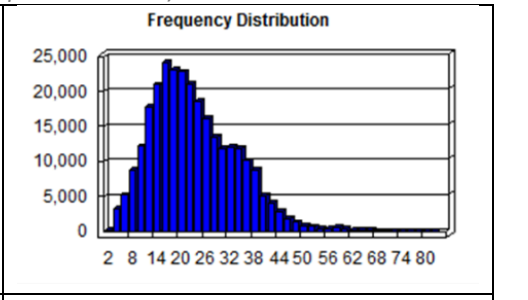
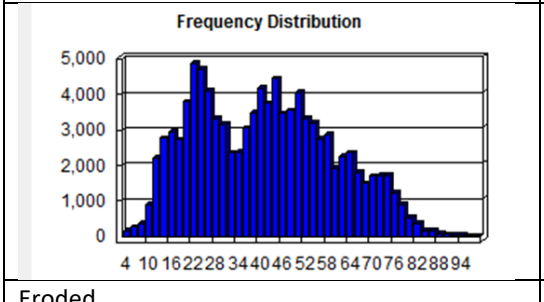
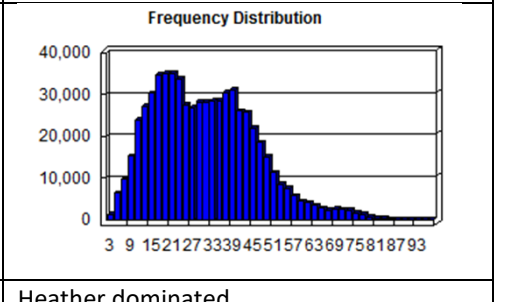
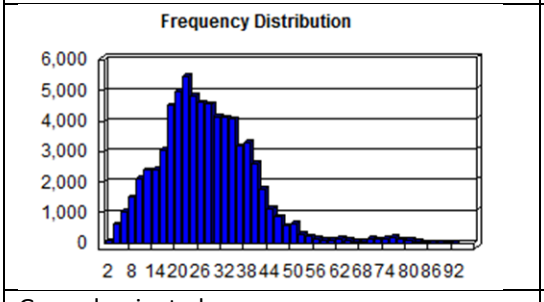
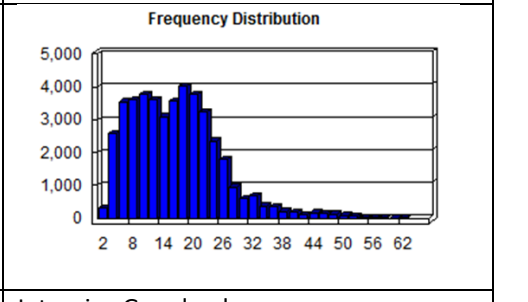
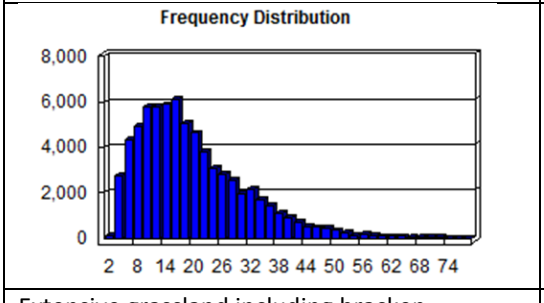
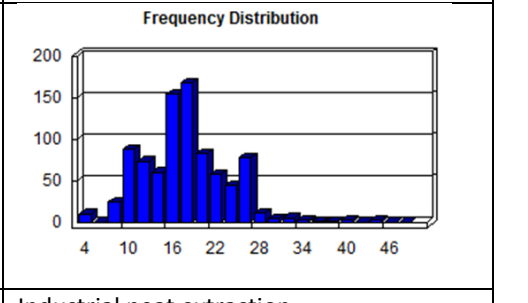
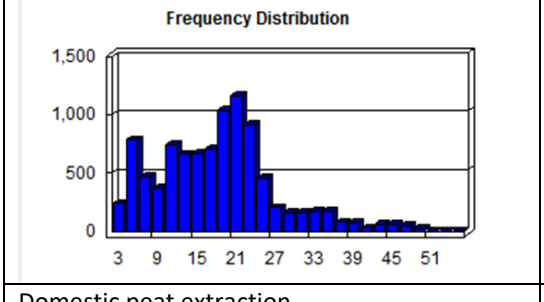
The final calculation of the number of inaccessible days per peatland category used information about the condition of peatland as per the Land Cover of Scotland (1988), which was updated in areas of forestry cover using the National Forest Inventory for Scotland (2013 data). The resulting updated layer was reclassified to the condition categories used in the proposed methodology for the implementation of the Wetland Supplement into the UK national emissions inventory (Evans et al., 2017[2]).

[6] http://data.ceda.ac.uk/badc/ukmo-hadobs/data/insitu/MOHC/HadOBS/HadUK-Grid/v1.0.0.0/1km/groundfrost/ann-30y

[7] Method description of the Wildness index: https://www.nature.scot/sites/default/files/2018-02/Mapping%20Scotlands%20Wildness%20-%20non-technical%20methodology%20-%20June%202014.pdf

[8] https://www.sciencedirect.com/science/article/pii/S0048969718352124

Table 2. Frequency distribution of time limits to carrying out peatland restoration by condition category (x axes = time in days). Note: There were two entries for access time > 100 (both 105 days). These related to sites in near-natural or unknown condition (no cover data in the Land Cover of Scotland 1988 parent dataset).

	
Arable	Woodland
	
Eroded	Heather dominated
	
Grass-dominated	Intensive Grassland
	
Extensive grassland including bracken	Industrial peat extraction
	
Domestic peat extraction	

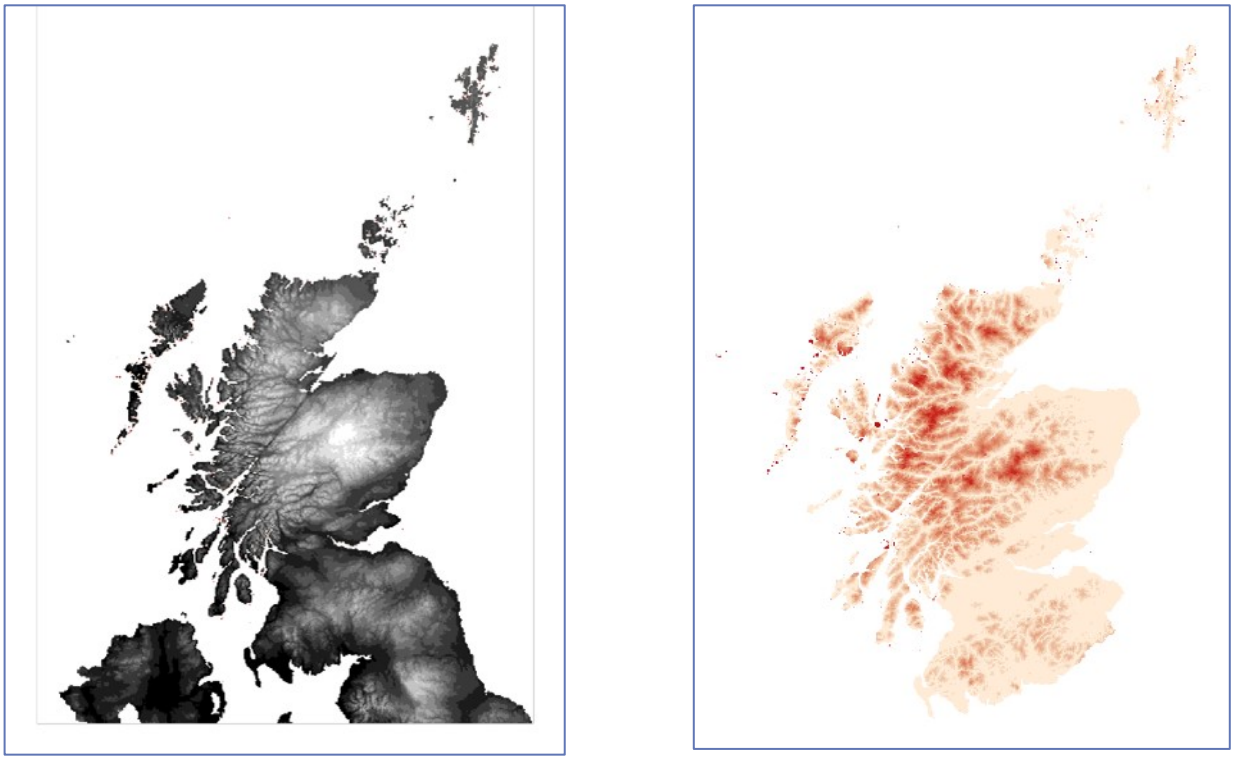


Figure 2. Maps showing the spatial extent of the input data, UK average ground frost days (left, lighter values are higher numbers of days) and the likely number of additional days ('penalty') that a site would be considered inaccessible due to an adverse forecast (right, darker values are higher numbers of days). Legend excluded to avoid confusion as the spatial extent of these input data is wider than the peatland extent.