WISE Peatland Choices

A decision support tool for peatland restoration in Scotland

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Introduction

Peatlands are a major part of Scotland's iconic landscape. Covering 1.7 million hectares, they make up 22% of the land cover and the carbon contained in peat soils is more than half of the entire soil carbon stock. Much of the peatland resource, however, is in a poor or highly modified state, with an estimated 90% of lowland raised bogs and 50% of blanket bogs no longer resembling their natural state. Degraded peatlands are often net emitters of carbon, in the form of carbon dioxide or dissolved organic carbon. In order to return degraded peatlands to their naturally C sequestering state, restoration measures such as drain blocking, grazing reduction and physical removal of non-peatland vegetation and/or introduction of peatland vegetation is often essential.

The Climate Change Act (Scotland) 2009 enshrines a target of a 42% cut in greenhouse gas emissions relative to 1990 by 2020 and an 80% reduction by 2080. The Second Report on Policies and Procedures (2013) for a Low Carbon Scotland sets out potential targets for an *annual* restoration area of 21,000 ha. Peatlands are priority habitats under the EU Habitats Directive and Scotland has a target to ensure that 600,000 ha is in good condition by 2015. As part of the intended measures to achieve this goal, a specific funding package for peatland restoration activities, the Green Stimulus Peatland Restoration Project, was implemented. So far, £1.7 million is supporting this work in 2013-14 and a further £15 million have been pledged in September 2013. Funding for peatland restoration has often been found from European sources or private investment from the corporate social responsibility sector.

An important consideration, given the high targets for emissions reduction and habitat restoration, is to consider where peatland conservation and restoration may be most desirable. To aid this process, a decision support tool has been developed that summarises all of the information that is available at national scale on peatland locations and various condition indicators. This, the WISE Peatland Choices tool, is still undergoing development and we seek your views on how useful this tool is at present to help decision making, what other information could be incorporated in the tool, and how the tool could be best used to inform national strategic decisions.

WISE output

The WISE Peatland Choices tool returns site scores at 100 m resolution (Figure 1). The darker the shade, the higher the cell score for the total assessed criteria. Higher scores indicate higher probability of being suitable for peatland conservation or restoration. Areas with lighter shades however should not be excluded from further assessment as these generally carry higher uncertainties (Figure 2). The uncertainty associated with the scoring was assessed by calculation of uncertainty scores. Although every layer underpinning the decision support tool has some uncertainty within it (e.g. the Land Cover of Scotland 1988 can have an up to 30% misclassification error for some land cover types) we have no spatial information regarding the variation of such errors across the landscape. The highest source of variation occurs within the rule weights and rule classes (see below).

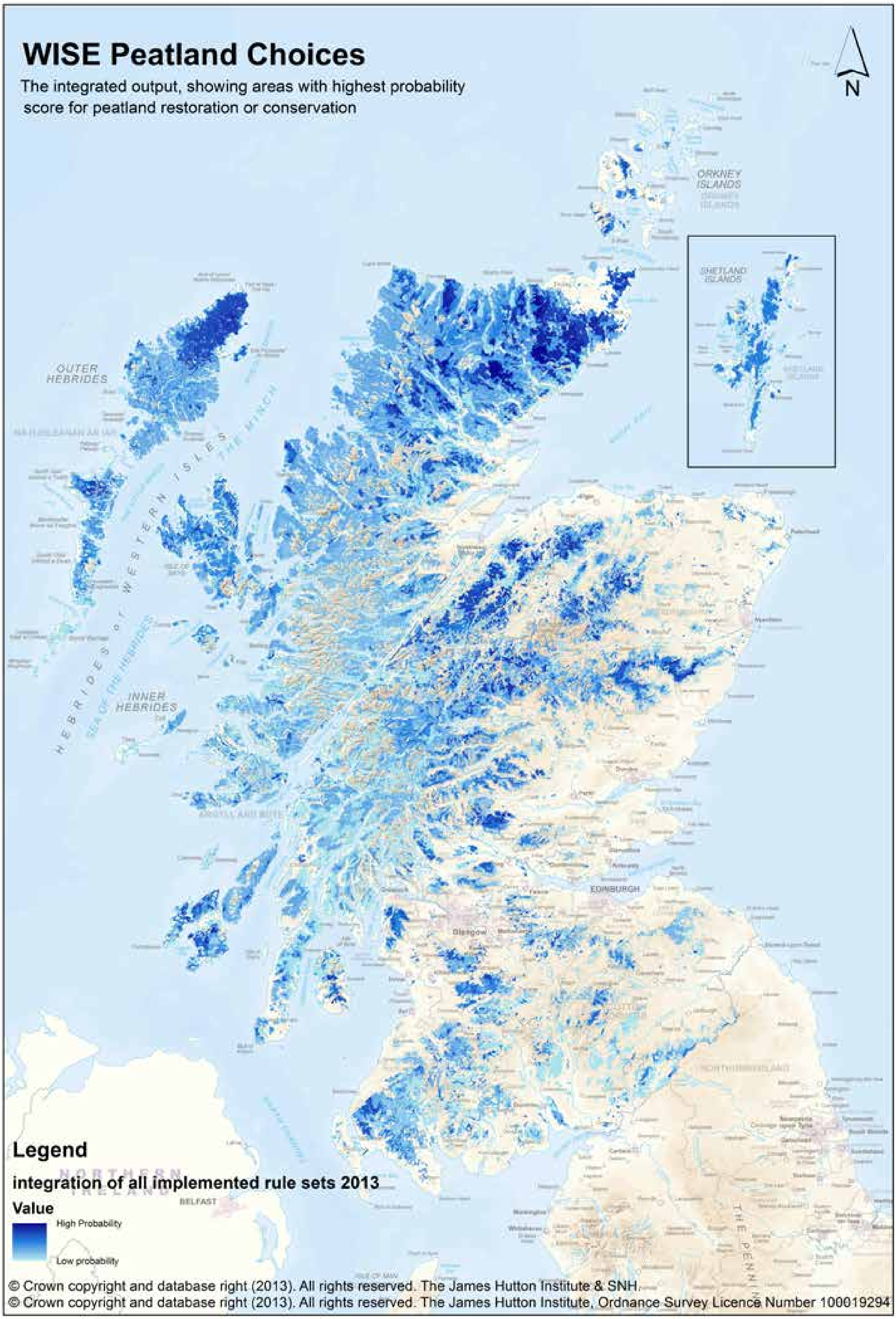


Figure 1: WISE Peatland Choices probability scores, as based on 6 implemented site selection criteria.

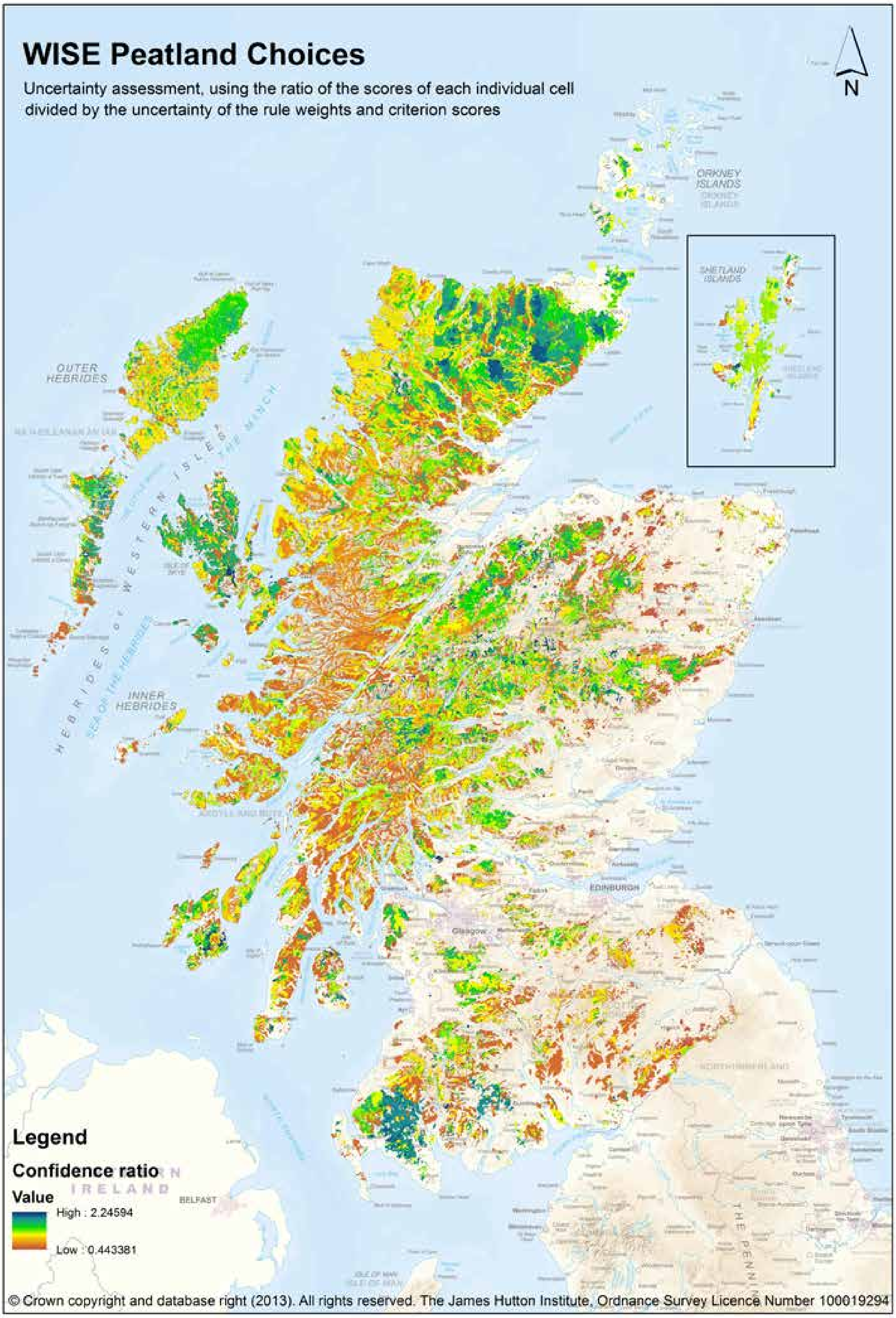


Figure 2: Uncertainty of the probability scores in Figure 1.

WISE Peatland Choices – how it was designed

The basis of the decision support tool is essentially a spatially explicit form of multiple criteria decision making. The often-used analogy is how a person would decide to buy a car. A number of criteria would be deemed important, for example the fuel efficiency, age, service record and perhaps a brand. Of these, an individual may perceive that, for examples, fuel efficiency is twice as important as the service record. In deciding to buy one car over another, the information available for each criterion is weighed up and a resulting 'total score' is calculated. The WISE Peatland Choices decision support tool functions in a similar way, with the information it uses being national scale datasets in GIS format (Figure 3).

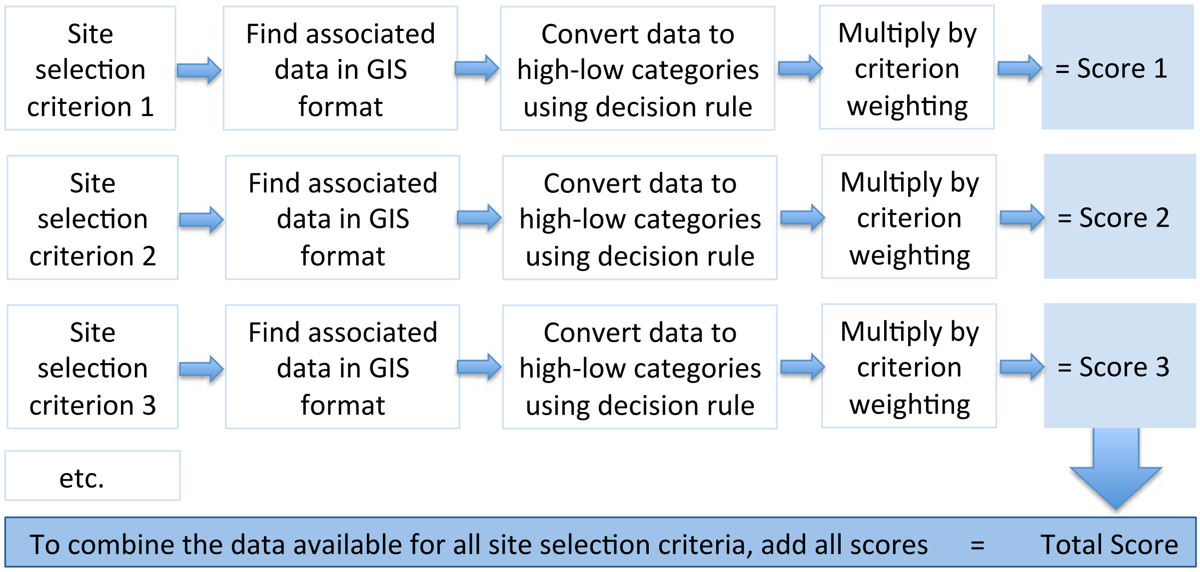


Figure 3: The logical steps in the calculation of a score for the WISE Peatland Choices tool. The criteria and weightings can be found in Table 1.

We started the process by engaging with a group of stakeholders to produce a set of ideal site selection criteria and their associated weightings. We asked a group of 62 attendees at a workshop (Carbon Landscapes and Drainage network, CLAD) for a list of criteria for a restoration site that they would wish to have data on. Attendees included individuals with backgrounds ranging from peatland site managers of blanket bogs, land owners, conservation groups, policy regulators and renewable energy consultants to academics in restoration ecology.

The initial list of 45 criteria was condensed by the same group of attendees to result in 19 site selection criteria (Table 1). We subsequently conducted a web-based survey of the weight that people attributed to each of these criteria, i.e. whether they felt that a site meeting certain criteria would be more important than others. The survey resulted in the weights presented for each individual criterion in Table 1. Decision rules were built for those site selection criteria where there was sufficient and suitable information in GIS format. Data were converted to 100 m resolution raster layers and grouped by the most relevant site selection criterion.

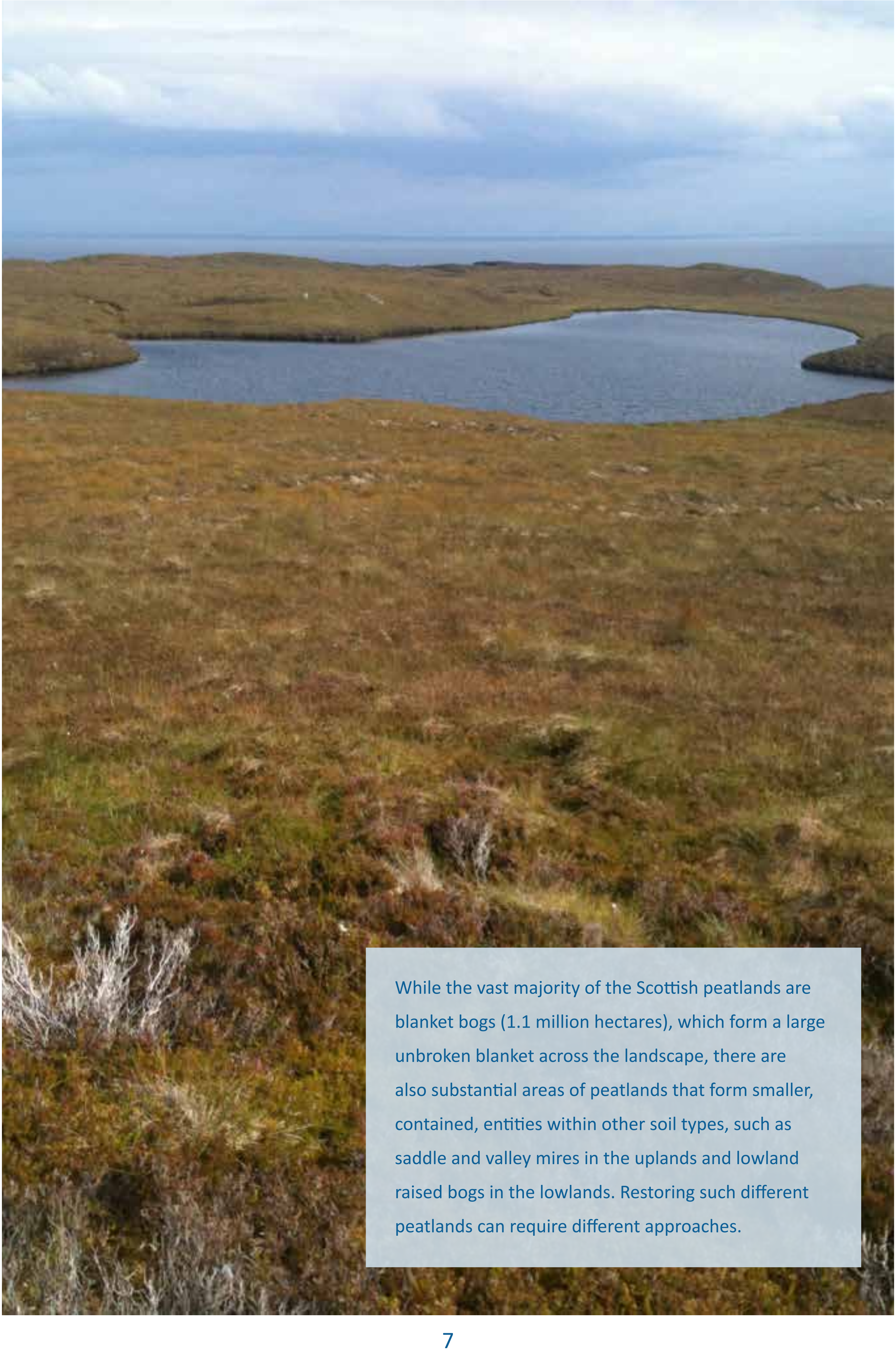
At present, 6 site selection criteria have been implemented in the tool (Table 1), as information was not readily available for all site selection criteria. The information was based on 8 datasets:

- The Land Cover of Scotland (1988), Macaulay Institute (now James Hutton Institute)
- The Land Cover Map (2007) Centre for Ecology and Hydrology
- The 1;250,000 Soils of Scotland, James Hutton Institute
- The 1;25,000 Soils of Scotland, James Hutton Institute
- Forestry Commission Scotland holdings (FCS)
- Common Standards Monitoring data on designated sites (Scottish Natural Heritage)
- Onshore renewables location and status (Scottish Natural Heritage)
- Land ownership from the WhoOwnsScotland database (Andy Wightman)

This resulted in a layered GIS tool, with 6 layers representing the implemented rules. The output from each 6 rules was weighted according to Table 1, and then added to form one single integrated map (Figure 1) to show a spatial representation across Scotland of the potential for peatland restoration.

Site selection criterion	Weight of criterion	Site selection criterion	Weight of criterion
1. Current type and condition of vegetation and other species assemblages	6.91	11. If non-designated, are there existing management option limitations or requirements for consents?	4.58
2. Potential for functional peat bog to regenerate under present and future climate	10.59	12. Sustainability of current and historic land use	2.23
3. Potential to be biologically connected to surrounding landscapes and biodiversity	5.55	13. Existing management and/or guarantees for the future	5.17
4. Conflicts with existing biodiversity from changes to other desired land uses	4.39	14. Timescale and deliverability of restoration efforts	4.02
5. Level or rate of current physical degradation	9.40	15. Is the site managed as a hydrological unit?	2.61
6. Ease of access or potential access issues	2.58	16. Conflicts in sources of income from current versus potential management	4.01
7. Geophysical attributes: area/altitude and variation within site	5.02	17. Availability/continuity of funding for restoration from agri-environment schemes and other sources	7.32
8. Peat type and depth	5.19	18. Would restoration offset other costs (e.g. water treatment costs) or create socio-economic benefits (e.g. rural jobs)	6.94
9. Is there a site designation in place?	4.35	19. Potential for partnerships (e.g. private companies, conservation groups and local population working together)	6.03
10. If non-designated, is there monitoring or are there existing historical data?	3.10		

Table 1: Site selection criteria used in the WISE Peatland Choices tool and their weightings for the overall score. Site selection criterion implemented as per October 2013 are shown in yellow, with criteria in blue implemented, but not presently used in the calculation for the overall score due to incomplete cover.



While the vast majority of the Scottish peatlands are blanket bogs (1.1 million hectares), which form a large unbroken blanket across the landscape, there are also substantial areas of peatlands that form smaller, contained, entities within other soil types, such as saddle and valley mires in the uplands and lowland raised bogs in the lowlands. Restoring such different peatlands can require different approaches.

As the WISE system is designed to integrate information from multiple sources, it must also be able to integrate the uncertainty from these sources and express this uncertainty in relation to the scoring given to each location. The sources of uncertainty include the datasets used, the variation in the weighting that is applied to each of the rules used for assessing different criteria, and the uncertainty in the rule evaluation for each of the rankings that is given (i.e. an expression of how confident we are that the ranking of 1, 2 or 3 is correct). Integrating the variation from these multiple sources is not straightforward, as the effects of the weightings and rankings are multiplicative.

It is also difficult to assess the level of uncertainty in each case. The first step that was taken was to assume that each of the underlying datasets was 100% accurate, as there is little or no information in each case about the spatial variation of uncertainty in the values given in the different land cover, land ownership, condition assessment and carbon stock maps that are used. Although we know this not to be the case (for example there can be a 30% misclassification error of blanket bog in the LCS88 actually being heather moorland cover and vice versa) we have no reliable information as to whether such misclassification errors vary by geographical region. However we assumed that the uncertainties in the weightings and rule evaluations would be larger than in the underlying datasets.

Rule weightings uncertainty information was provided in terms of the standard deviation that was seen in the rule scorings from subjective evalutions by a sample group of people. Uncertainty in the ranking assignment rules was evaluated subjectively, with each ranking of either low, medium, and high (1,2 and 3) given an uncertainty of 0.5 as an indication of the variation in the value. It is difficult to evaluate whether some rankings are more confidently assigned than others, as each ranking is subjective and is made on the basis of expert knowledge.

For each of the five implemented rules, the combined effects of these two uncertainty factors are integrated with the rule weighting and the ranking score weight, which also has a scaling impact on the integrated uncertainty from each rule. The ‘rule uncertainty’ values that are determined are squared and summed, and the square root of this sum taken. This allows the uncertainties to be combined in a manner that is more realistic than simply summing the uncertainty values from different rules. The integrated uncertainty value for each 100m grid cell is evaluated and reported as a ratio of the total score for that cell (Figure 2). Overall this shows that the level of uncertainty is higher in regions where peatland cover and/or deep peat deposts are more scattered amongst the landscape.

Landscape scale restoration of former plantation forestry on deep blanket peat at the Forsinard Flows

The individual layers in WISE

The individual components for the map in Figure 1 were constructed as follows.

For **site selection criterion 1**, the current, remaining, land cover of peatland vegetation was assessed together with an indication of the condition of sites where such data existed. These components were added to form three categories of high, medium and low (Figure 4), where a 100 m^2 cell with predominantly peatland vegetation and in good condition as assessed by SNH's site monitoring programme would be placed in the high category. Cells with predominantly peatland vegetation in an unfavourable condition, or without condition data, would be placed in intermediate categories. Finally, cells where peatland vegetation was only a minor component (for example where most of the vegetation cover was of a different sort such as heather moorland) were placed in the low category.

For **site selection criterion 5** (Figure 5), the same initial assessment of remaining peatland cover as for site selection criterion 1 was used as a starting point for high categories, but areas that showed minor erosion or peat cutting features were placed in intermediate categories. Cells with dominant erosion or peat extraction were placed in low categories as these can be difficult to restore from a practical perspective.

Site **selection criterion 7** (Figure 6) currently assesses the total area of peatland that could be recreated, by assessing the total size of the underlying continuous peat deposit. In other words, it disregards current land use and simply calculates the total potential peatland area. The larger this value, the higher the resulting category for each of the cells in the same peat deposit. Altitudinal and other within-site variations have not yet been assessed.

Site **selection criterion 8** (Figure 7) assesses the type of peat and its associated carbon content. For many areas in Scotland, peat is not present as large deposits, rather there may be small deposits dotted around in a landscape of shallower organic or organo-mineral soils. This site selection criterion set placed areas with a higher peat soil percentage into higher categories, together with sites with high soil carbon content.

Site **selection criterion 12** (Figure 8) is difficult to assess, as we have no current functional definition of what a sustainable land use on peat soils is. As the most extreme scenario, we have chosen to assume that any land use that is not currently resulting in peatland vegetation is not sustainable. This was chosen on the basis of literature data that suggest that other land uses generally result in net greenhouse gas emissions from such soils, whereas pristine or near-natural peatlands are generally net greenhouse gas sinks. Under our current definition, site selection criterion 12 places areas with the fewest non-peatland land uses into the highest categories, and areas with two or more such land uses in the lowest categories.

Site **selection criterion 19** has not yet been fully implemented, partly because the information in the WhoOwnsScotland database does not have complete coverage, but also because it does not provide any information that could be used to develop a classification of, for example, different groups of land owners on the basis of likely potential for partnerships. It does, however, aid the process of starting a dialogue on whether a site could be restored by providing contact details.

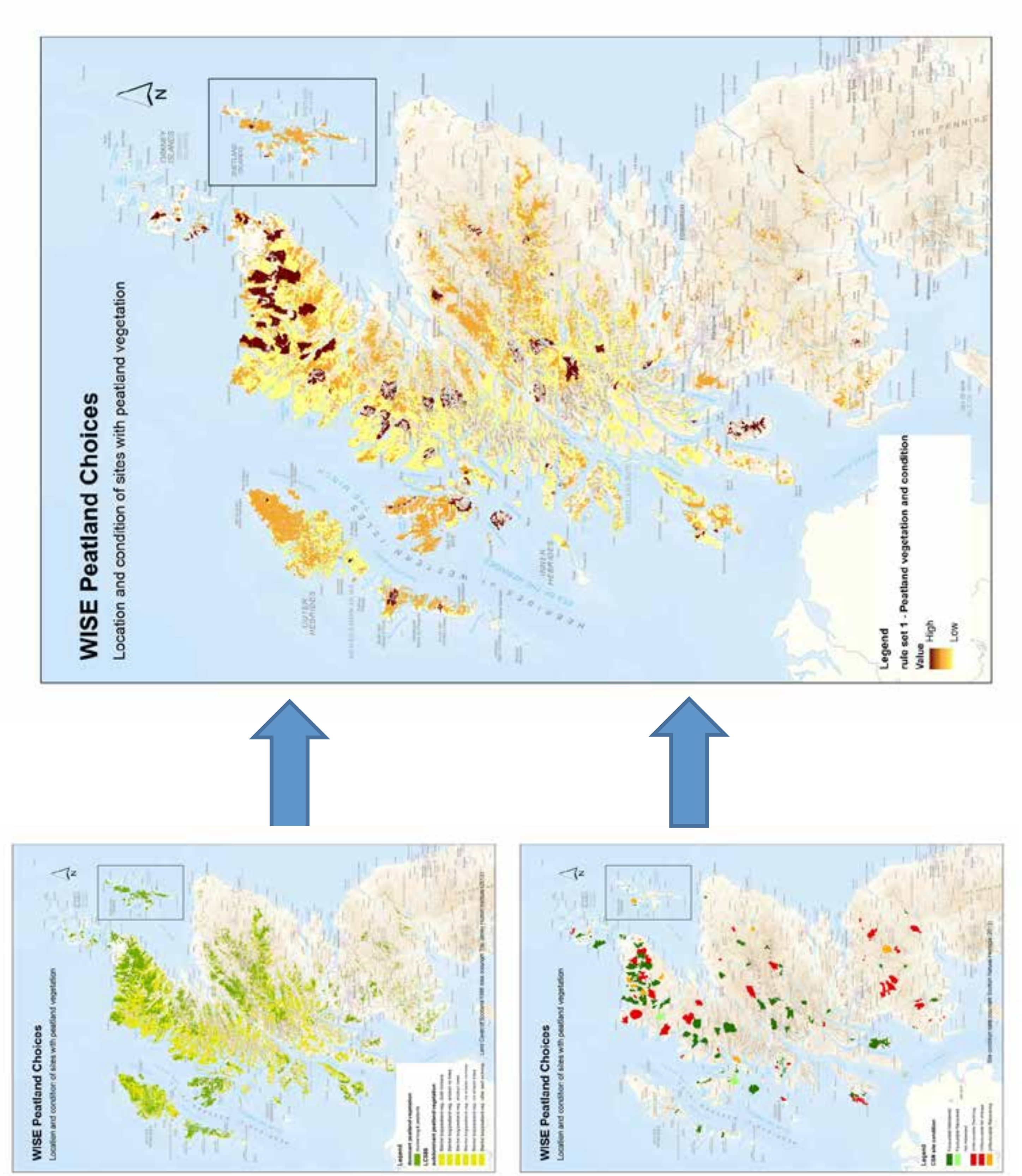


Figure 4: Data on where peatland vegetation is dominant or subdominant in the Scottish landscape are added to condition assessments from SNH's Common Standards Monitoring for designated peatlands to form the categories for site selection criterion 1.

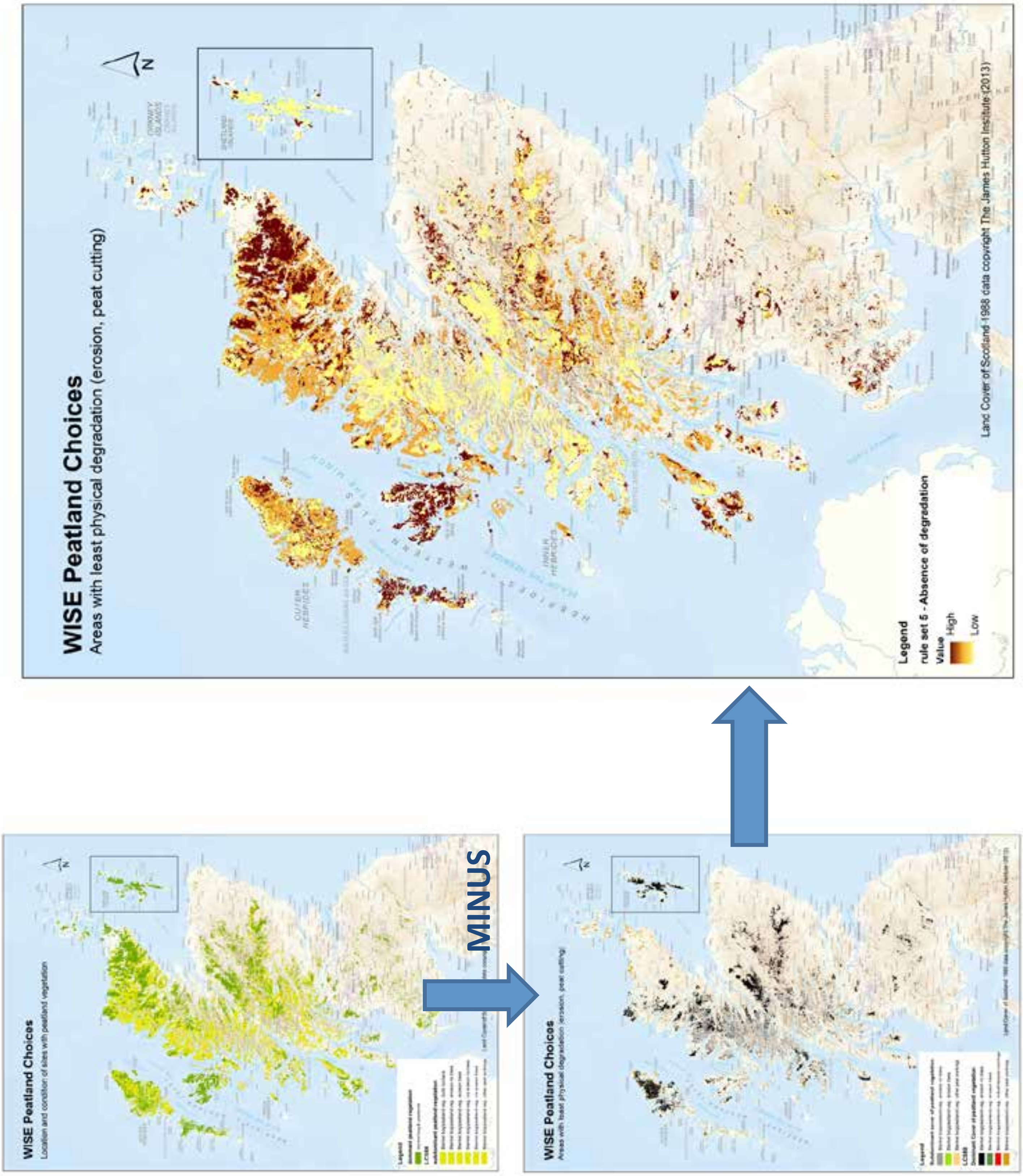


Figure 5: Data on where peatland vegetation is still part of the landscape forms the basis of this rule set, with areas where erosion or peat extraction are dominant or minor parts of the landscape scoring lower in criterion 5.

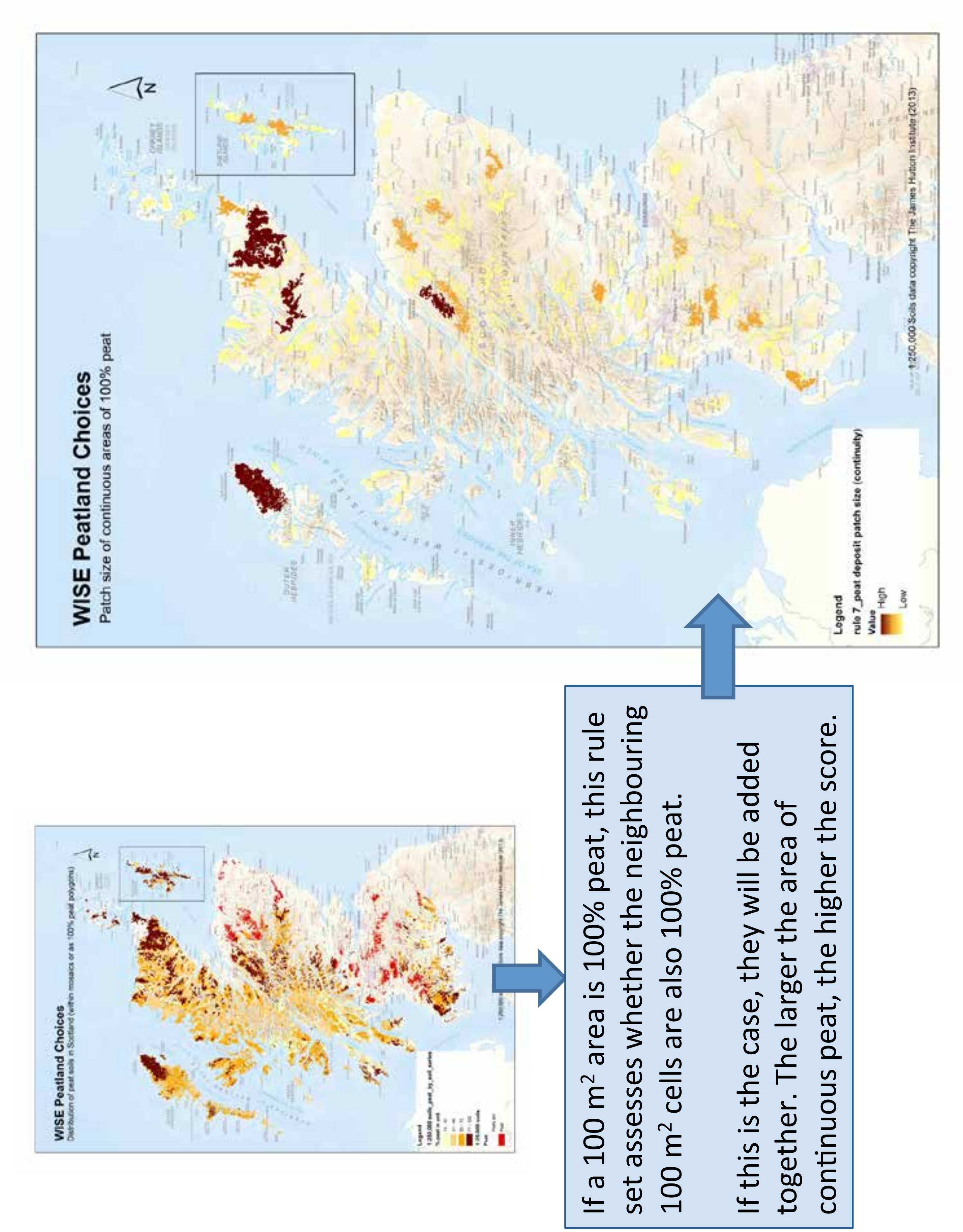


Figure 6: Site selection criterion 7 assesses peat deposits on the basis of their total area.

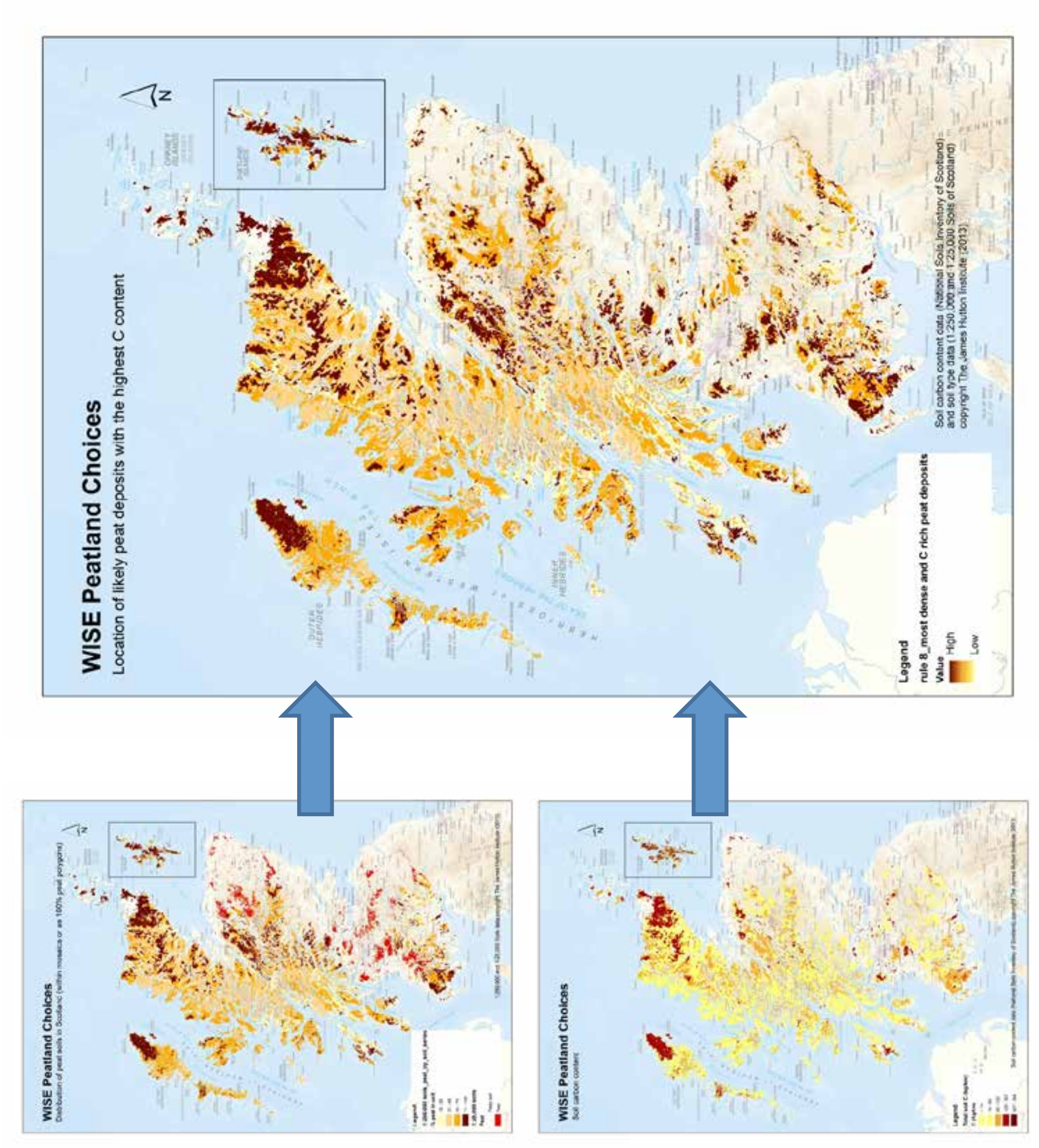


Figure 7: Site selection criterion 8 gives highest scores to areas that are 100% peat and subsequent lower scores for small areas of peat within shallower organic or organo-mineral soils and adds this to information obtained on soil carbon content.

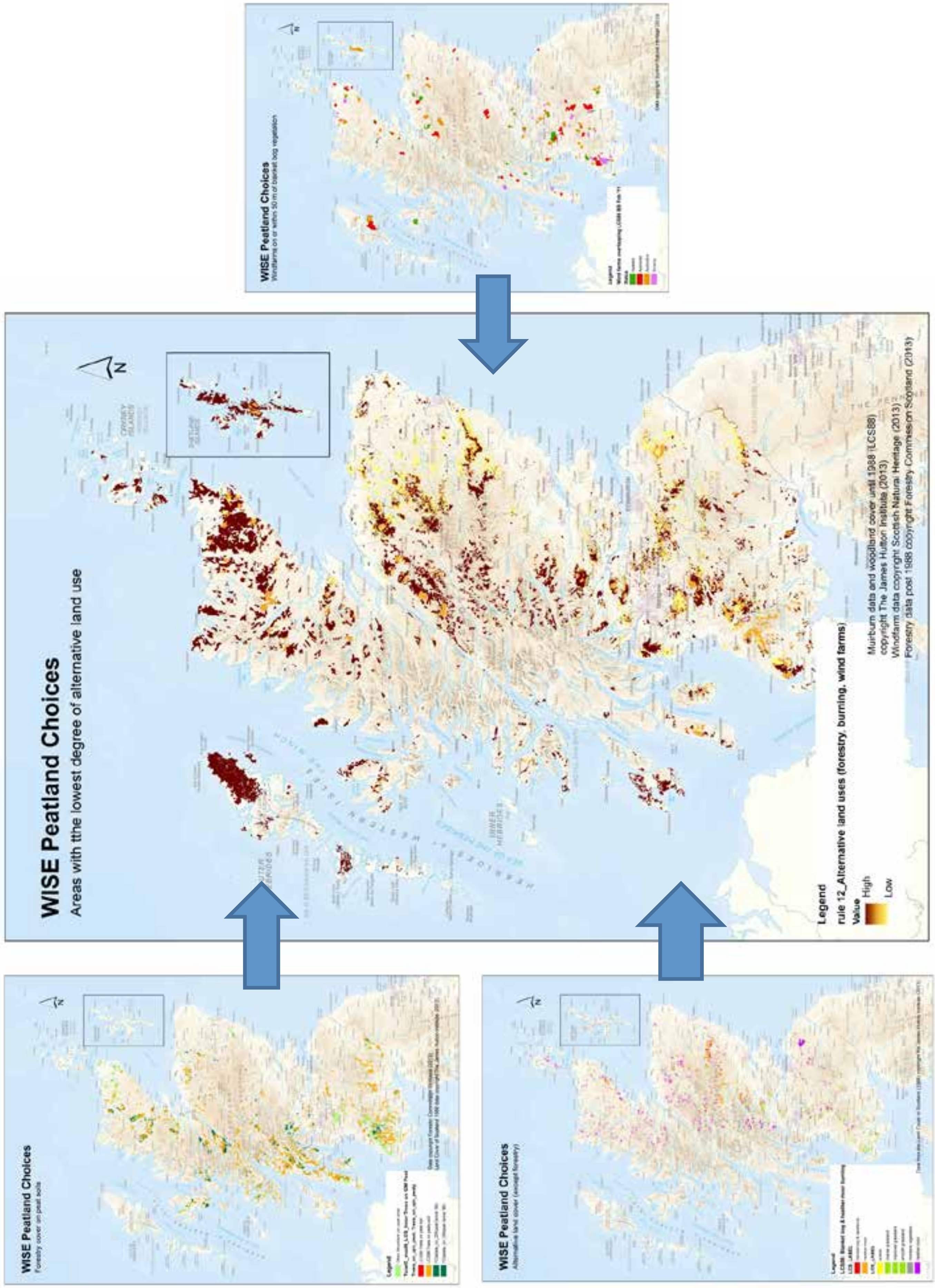


Figure 8: Site selection criterion 12 currently assumes that alternative land uses place such areas into lower categories for restoration or conservation management. For example, areas that have renewable energy development within 50 m and/or alternative vegetation cover, such as rough grassland, on peat soil, are placed in the low categories.

How you can help us to develop a better tool – for your purposes!

We are still testing WISE Peatland Choices and would like your feedback. Please inform us if you:

- can think of additional datasets that would be useful in peatland restoration decision making
- feel that we could present information differently
- spot any errors in the maps (some of the layering of data may cause aberrations, for example where there are uncertainties in the original data layers)

We are also looking for some case studies of potential new restoration projects, for example those at application or pre-application stage under Peatland Action. We would like to work with you in order to test and improve the WISE Peatland Choices tool. Please let us know if you would be interested in working with us, by contacting Rebekka Artz (Rebekka.artz@hutton.ac.uk).

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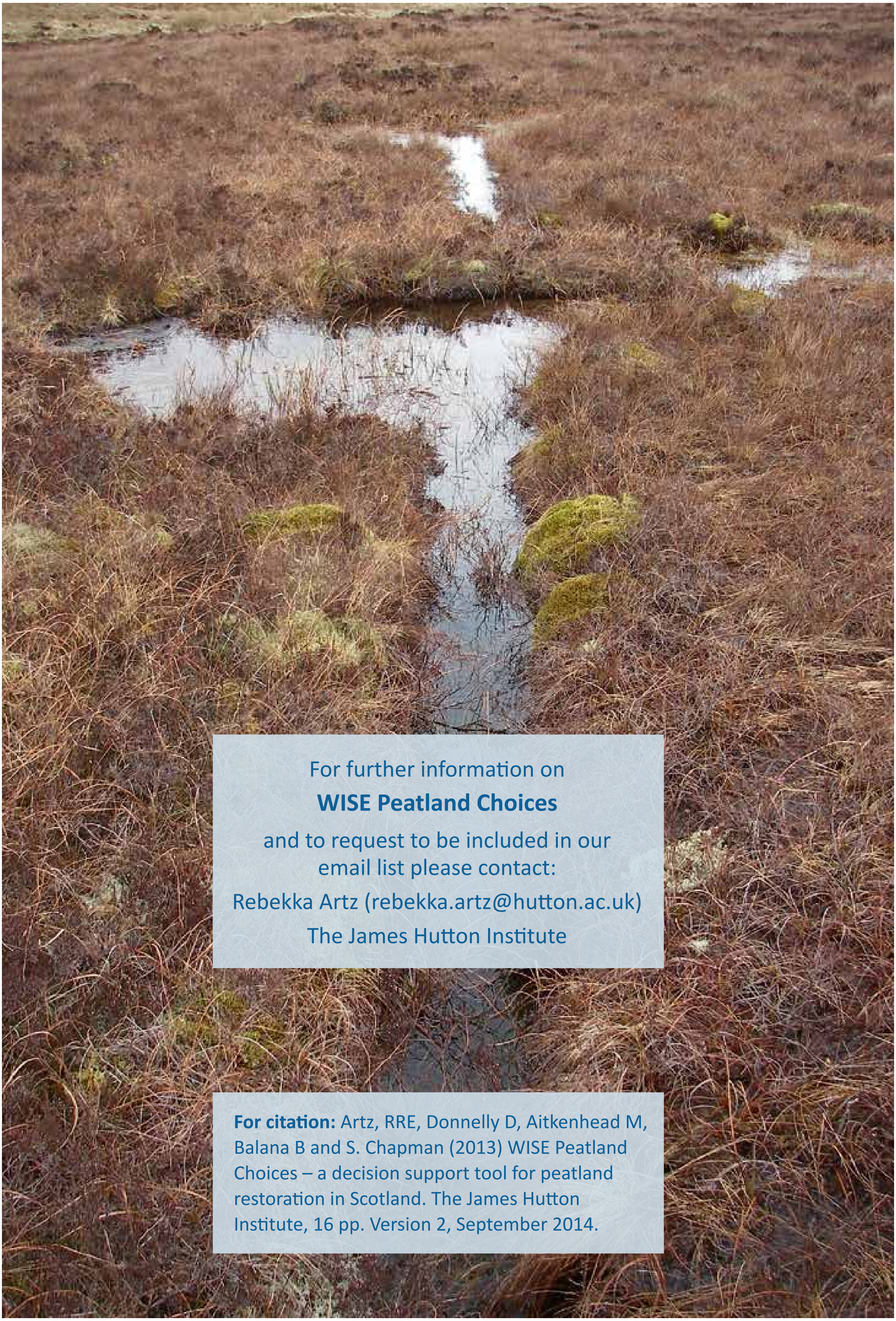
Further developments of WISE

Under our current project, funded by the Scottish Government's ClimateXChange, we are:

- developing a GIS layer of condition across all of the peatland resource, based on remote sensing data
- developing a GIS layer of climate sensitivity, by updating bioclimatic envelope models with more up-to-date climatic projections
- collating cost and spend data of ongoing and completed restoration work in Scotland under SRDP funding streams
- developing a way to calculate the net carbon benefits from restoration

Regeneration at a former peat extraction site



For further information on

WISE Peatland Choices

and to request to be included in our email list please contact:

Rebekka Artz (rebekka.artz@hutton.ac.uk)
The James Hutton Institute

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