Data synthesis for developing Riparian Corridor units

Deliverable D.3b for

Project JHI-D2-2 Achieving Multi-Purpose Nature-Based Solutions

(AiM NBS)

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Contents

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1 Introduction

Work Package 3 of the JHI-D2-2 Achieving Multi-Purpose Nature-Based Solutions (AiM NBS) project aims to holistically assess the role of river corridors and management approaches towards achieving environmental change resilience. We consider transitional riparian zones as dynamic ecohydrological units that deliver vital ecosystem services, focusing on their capacity, influenced by drivers and pressures related to land use and land management and climate change, to increase and maintain organic carbon (C) stores and mediate organic C transfers; regulate water temperatures; and buffer against low flows. Our approach is to use functional classifications of national river corridors that will be used to a) represent river corridor variability at plot to catchment to national scales b) validate against properties (C storage, water storage, transect water quality) and c) link to physico-chemical-ecological-societal functions and vulnerabilities.

In this context, the purpose of this report is to a) propose a typology of river corridor functional units, based on groupings of commonalities in soil hydrological pathways and water movement in the hillslope to floodplain transition, and b) conduct a mapping assessment in the Dee riparian corridor to explore the extent at which these soil groupings reflect respective commonalities related to terrain characteristics and landform and land cover type spatial patterns.

2 Riparian Corridors

2.1 Definitions

For the purpose of this project, a river corridor comprises of the active river channel(s), the floodplain, riparian zone and the underlying hyporheic zone, and the hillslope area that provides the physical space that the river needs to expand and mender to express its energy through the surrounding landscape. River corridor may comprise a narrow strip of riparian vegetation or a wide and complex floodplain (Figure 1). Example of a river corridor includes stream channel, stream banks, floodplains, stream tributaries, trails and roads, wetlands, forest, shrubland, grassland, residential developments, recreation areas such as fishing and picnic areas.

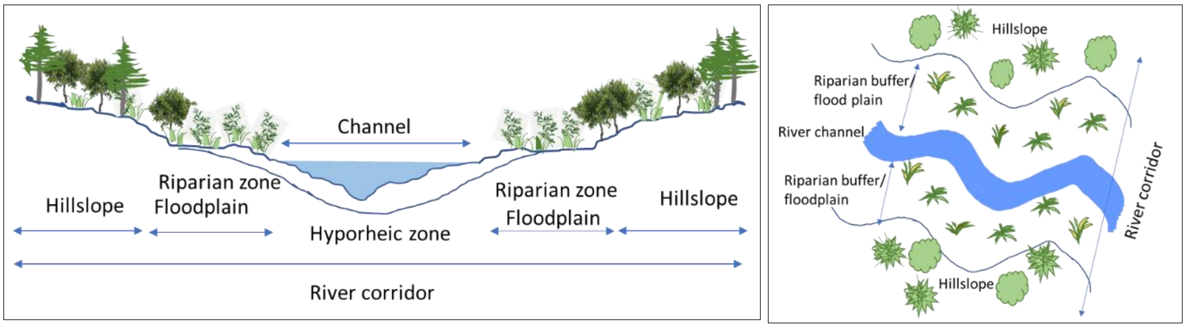

Figure 2.1. Cross section of river corridor (left) and plane view showing meander, buffer and corridor belt (right) (*pers.comm. Samia Richards*).

2.2 Delineation of River Corridors in Scotland

The application of spatial data for delineating riparian zones is mainly based on three conceptual methods (Stutter et al., 2021): a) using a fixed width; b) using a variable width determined by river zone features; and c) using a variable width determined by context of local pressures or required outcomes. The third approach is probably the most difficult to implement and is better suited to catchment or local scale applications, while the second approach is more appropriate for national applications such as these in this project.

Hence, for delineating river corridors in Scotland we explored using the Riparian Zone (RZ) layers generated by the European Environmental Agency (2015) that are available to download as spatial layers from the Copernicus Land Monitoring Service[1]. The RZ layers have been produced by considering river attributes and comprise of a merge of selected rivers (Strahler level 3 to 8) with different buffer sizes as a function of the Strahler level. RZ products comprise of three layers: the Potential RZ, the Observable RZ and the Actual RZ layers.

Spatial Modelling of the Potential RZ, which indicates the disposition to host riparian features is based on the stratification of hydrological and geomorphological parameters derived from input datasets and are weighted differently dependent on their significance and quality. These datasets comprise of the EU-DEM 25m pixel, the Joint Research Centre (JRC) Flood Hazard Risk Maps for 20y/50y/100y/200y/500y return periods (100m) and the Harmonized World Soil Database (HWSD). The resulting membership degree of each input parameter is combined into a single membership degree expressing the likelihood of an area to be part of a Potential RZ, with the Potential RZ extent expressed as the area with ≥ 50% membership degree.

The spatial modelling of the Observable RZ is based on the Copernicus Land Cover/Land Use product and comprises mainly of riparian vegetation but including river features such as riverbanks as well. Finally. the Actual RZ is a combination of the Potential and the Observed RZ and expresses the probability to find riparian zones on the ground and the actual extent of the riparian zone inside the Potential RZ.

Extensive visual inspection of these three RZ layers using satellite imagery in QGIS[2] showed that the Potential RZ layer fitted better the definition of the river corridor used in this project, because it comprises of a continuous riparian zone of variable width, covering the main river systems in Scotland, that encompasses hydrological, geomorphic and land cover features and comprises of both floodplains and adjacent hillslopes (Figure 2.2). The Potential RZ layer was processed in QGIS (i.e., layer was reprojected to OS British Grid and surface water features were removed) and was used to calculate the river corridor extent in Scotland as a total area of 3,676 km^2. This layer excludes riparian zones for upper river reaches (Strahler levels 1 and 2); necessity for inclusion of these zones will be explored at next project stages.

[1] https://land.copernicus.eu/local/riparian-zones
[2] https://www.qgis.org/en/site

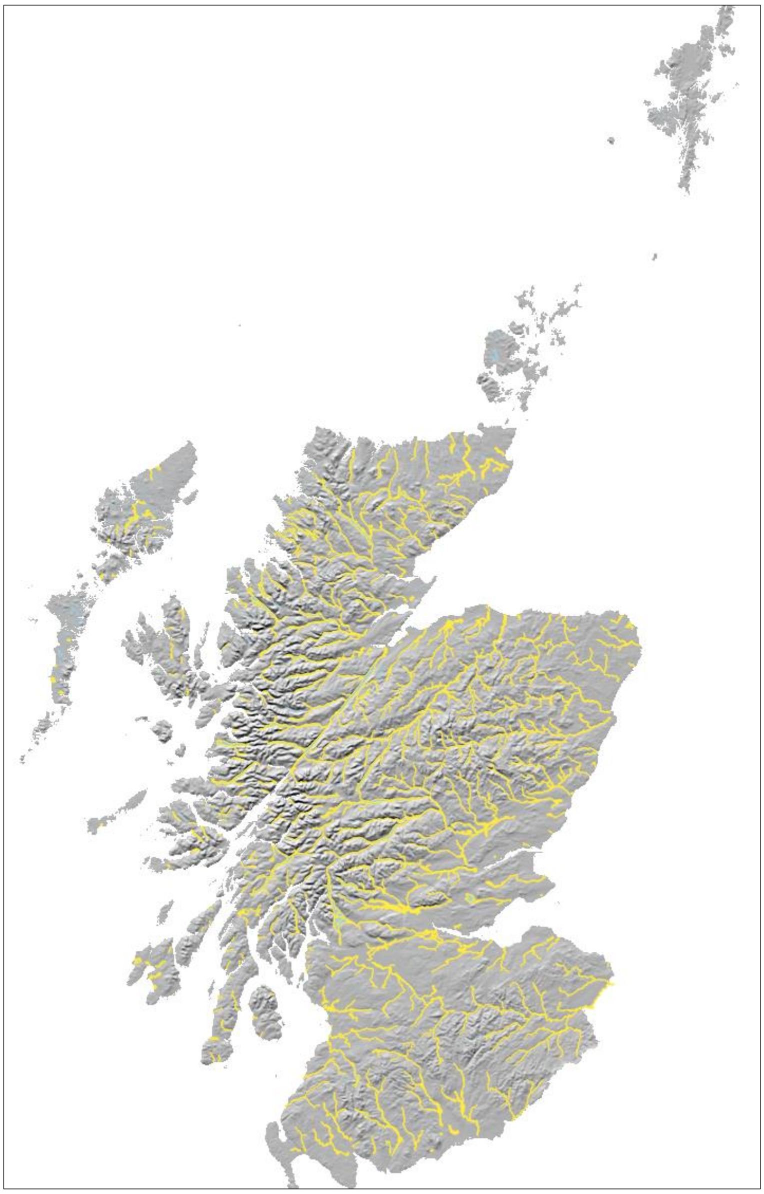

Figure 2.2. Riparian corridor in Scotland based on EEA/Copernicus Potential RZ.

3 Developing Riparian Corridor units

3.1 Overview

Riparian corridor units are defined conceptually as functional groupings of landscape conditions, determined by their inherent soil properties and topographic, geomorphic and land cover characteristics, in relation to their potential in providing river corridor ecosystem services. In particular, developing riparian corridor units enables us to develop a mechanistic understanding of soil, geomorphic and habitat threats affecting climate resilience, water, and habitat quality within river corridors in relation to the riparian functions of (i) increasing and maintaining organic C stores in river corridors and mediating organic C transfers, (ii) regulating water temperatures and (iii) buffering against low flows.

The horizontal and vertical distribution of soils and soil properties determine the pathways and rate of water movement through the soil and substrate and subsequently water and nutrient transfer from land to waters (Lilly et al., 2012), while soil properties dictate to a great extent the type of land use that can develop in a certain area (e.g., capability for agriculture) or are responsible for supporting distinctive wetland vegetation communities. Hence, riparian soils exert profound influence in delivering the three riparian functions stated above, along with other functions such as nutrient transfer and regulation and drought resilience. In this context, building on recent work that looked at soil hydrological pathways for targeted placement of mitigation measures in riparian zones (Stutter et al., 2022), we propose a new typology of riparian soil (hydrological) groupings as basis for developing riparian corridor units that capture the variability of riparian functioning from the hillslope to floodplain transition zone.

This section presents the conceptual framework used to develop the riparian soil groupings (models). It also presents the results of a mapping exercise conducted in the riparian corridor of river Dee, which occupies 135 km^2 of the Dee catchment's 2,083 km^2 (~6.5% cover) (Figure 3.1) to (i) identify the type of spatial data layers that need to be collated for delineating riparian corridor units in the Dee and nationally and (ii) explore variation in terrain characteristics and patterns of landform and habitat types within delineated riparian soil models to assess how well these groupings reflect the main landscape and land use conditions within the Dee riparian corridor.

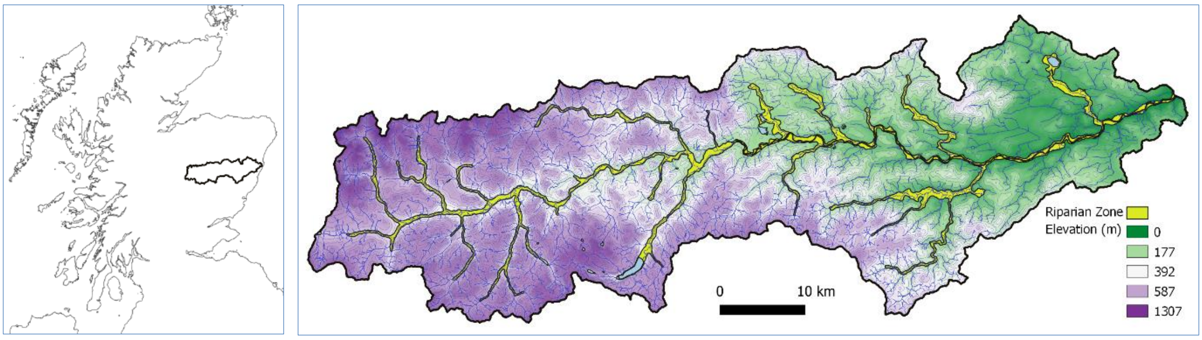

Figure 3.1. Catchment area of river Dee in Aberdeenshire.

3.2 Riparian soil models

The development of riparian soil models as the basis of riparian corridor units is based on the Hydrology of Soil Types (HOST) classification system (Boorman et al., 1995). HOST was developed to predict river flows in ungauged catchments in the UK based on the pathways and rate of water movement through the soil and substrate, and on the spatial distribution of soils within the catchments. HOST was developed using a number of soil morphological attributes systematically recorded from soil profile data held within national soil databases, which are known to represent key features of soil hydrology (Lilly et al., 2012). HOST classifies soils by distinguishing between those soils developed on a permeable parent material with mainly (a) deep groundwater tables or (b) with mainly shallow groundwater tables and those soils (c) developed on slowly permeable parent material which limits infiltration. Based on these three physical settings, 11 HOST response models were defined to account for differences in soil properties, water regimes and flow characteristics (Figure 3.2). These were further subdivided based on whether the dominant flow type was via macropores or micropores and the rate of water movement through the soil and substrate to form 29 different HOST classes with similar hydrologic behaviour. Of these 29, 21 HOST classes are most common in Scotland (Figure 3.2). HOST classes can be mapped by directly linking to available soil spatial datasets and maps.

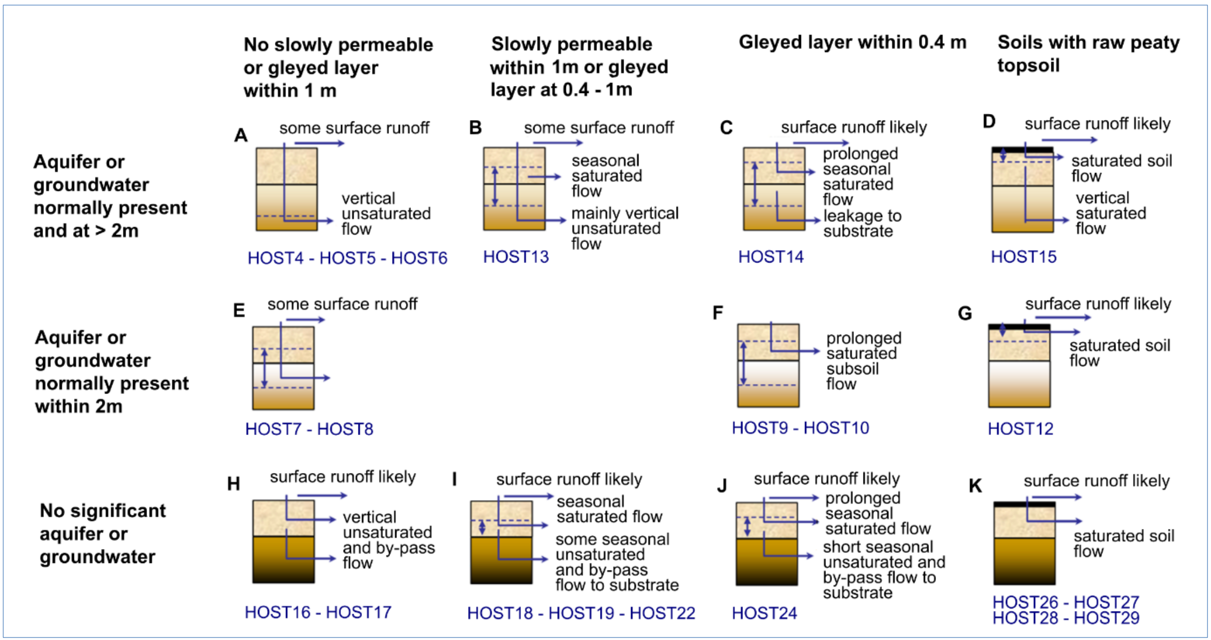

Figure 3.2 HOST conceptual models of water movement and respective HOST classes. Only those HOST classes that are present in Scotland are shown.

A further advantage of using HOST for the development of the riparian corridor units is that the HOST classification takes account of soil-water interactions at a landscape scale and, hence, can be used to distinguish soils that are present on hillslopes or on floodplain areas. This distinction between hillslope vs floodplain areas based on HOST class alone is given in Table 3.1, which also gives a brief description of respective HOST classes.

The set of riparian soils models was developed by translating the HOST response models with regards to flow pathways, inherent soil drainage class and wetness conditions of individual soils. This approach enabled modelling water movement and subsequent pollutant transfer from hillslopes to floodplains via the main identified hydrological and soil hydrological pathways. A set of 21 individual riparian soil groupings were identified and developed (Table 3.2) based on the combination of:

- Seven (7) hillslope models grouped based on inherent soil drainage class from drier to wetter soil conditions and from mineral (Models 1-4) to peaty (Models 5-7) soils.
- Direct connectivity of hillslopes to watercourses / no presence of floodplains (Setting A)).
- Two (2) floodplain settings
    - Setting B): Floodplains comprised of mineral alluvial soils: these can comprise of relatively-free draining and poorly draining soils.
    - Setting C): Floodplains comprised of peaty alluvial soils or basin peat.

Table 3.1 Description of HOST classes for those present on hillslopes (HS) or on floodplains (FP).

HOST class	Description	Landscape Setting
4	Free draining permeable soils on hard but fissured rocks with high permeability	HS
5	Free draining permeable soils in unconsolidated sands or gravels with relatively high permeability	HS
6	Free draining permeable soils in unconsolidated loams with low permeability	HS
7	Free or imperfectly draining permeable soils in unconsolidated sands or gravels with groundwater at less than 2m from the surface	FP
8	Free or imperfectly draining permeable soils in unconsolidated loams with groundwater at less than 2m from the surface	FP
9	Soils seasonally waterlogged by fluctuating groundwater and with relatively slow lateral and horizontal saturated conductivity	FP
10	Soils seasonally waterlogged by fluctuating groundwater and with relatively rapid lateral and horizontal saturated conductivity	FP
12	Undrained lowland peat and peaty soils with shallow or confined groundwater table	FP
13	Soils with slight seasonal waterlogging from fluctuating ground water tables	HS
14	Soils seasonally waterlogged fluctuating ground water tables	HS
15	Permanent wet, peaty topped upland soils	HS
16	Relatively free draining soils over slowly permeable substrates	HS
17	Relatively free draining soils with large storage capacity over hard impermeable rocks	HS
18	Slowly permeable soils with slight seasonal waterlogging over slowly permeable substrates	HS
19	Relatively free draining soils with moderate storage capacity over hard impermeable rocks	HS
22	Relatively free draining soils with low storage capacity over hard impermeable rocks	HS
24	Slowly permeable, seasonally waterlogged soils over slowly permeable substrates	HS
26	Permanently wet, peaty topped upland soils over slowly permeable substrates	HS
27	Permanently wet, peaty topped upland soils over hard impermeable rocks	HS
28	Permanently wet eroded upland blanket peat	HS
29	Permanently wet upland blanket peat	HS

Table 3.2 gives the description of the developed riparian soil models/grouping, and Figure 3.3 provides a graphical illustration of hydrological pathways and water movement in the different hillslope and floodplain settings for the free draining and poorly draining mineral riparian soil models (Models 1 and 4).

Table 3.2 Matrix of riparian soil groupings.

Hillslope Models			River connected to hillslope	Floodplain Settings	
				Mineral alluvial soils	**Peaty alluvium**
No	**Description**	**HOST class**		**HOST7 HOST8 HOST9 HOST10**	**HOST12**
1	Freely draining soil over permeable subsoil & permeable bedrock	HOST4 HOST5 HOST6	1A	1B	1C
2	Freely draining soil over moderately permeable subsoil & slowly permeable bedrock	HOST16 HOST17 HOST19 HOST22	2A	2B	2C
3	Poorly draining soil over permeable subsoil & permeable bedrock	HOST13 HOST14	3A	3B	3C
4	Poorly draining soil over slowly permeable subsoil	HOST18 HOST24	4A	4B	4C
5	Poorly draining peaty surface over permeable subsoil	HOST15	5A	5B	5C
6	Poorly draining peaty surface over permeable subsoil or hard rock	HOST26 HOST27	6A	6B	6C
7	Upland blanket peat	HOST28 HOST29	7A	7B	7C

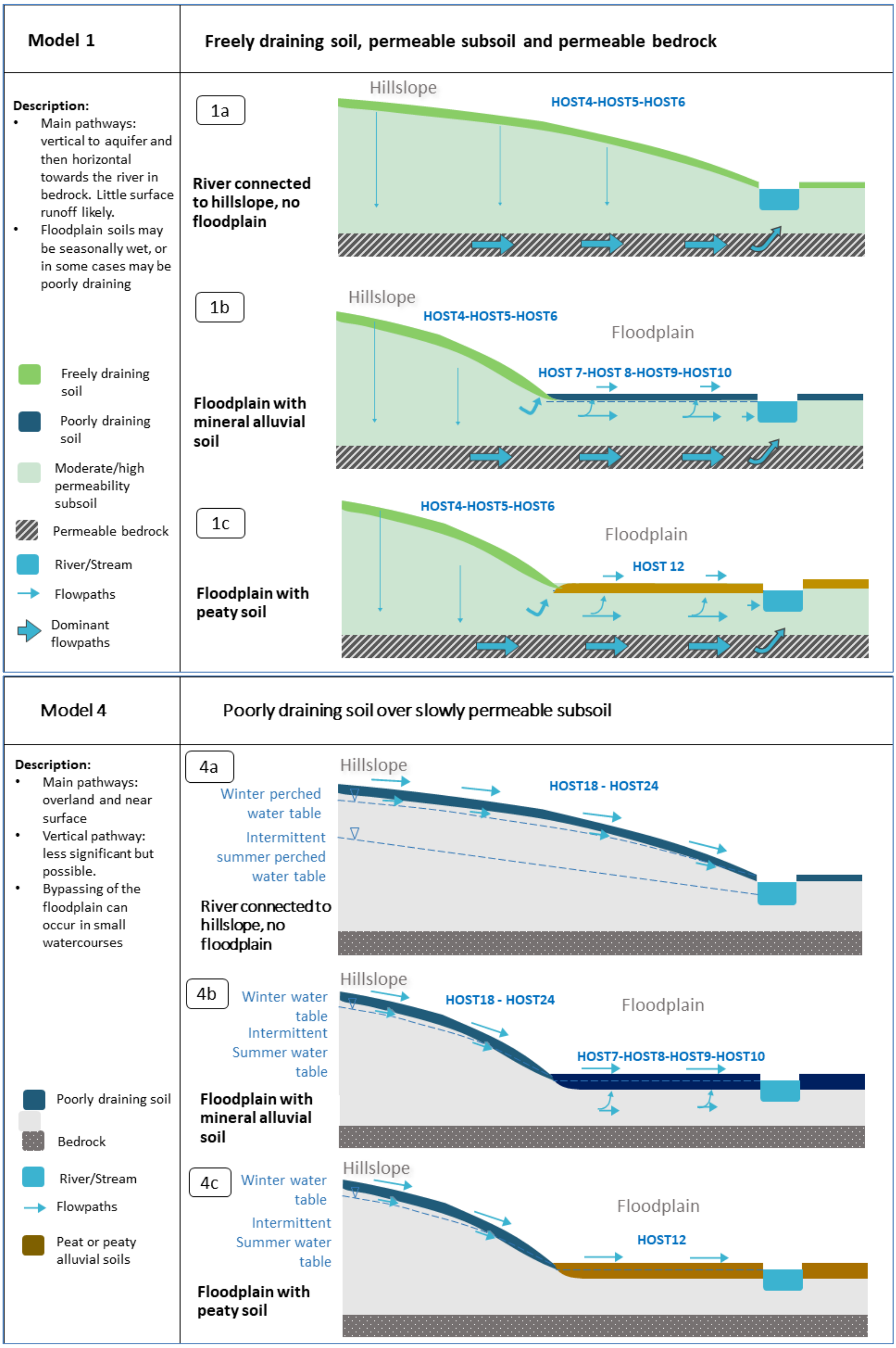

Figure 3.3. Schematic representation of soil hydrological pathways for riparian soil models 1 and 4.

3.3 Mapping assessment

3.3.1 Dataset collation

A number of spatial data layers from different sources was collated and processed in QGIS for characterising terrain, soil, and land cover conditions within the Dee riparian corridor. Data processing comprised of clipping data layers to the extent of the river corridor boundary and harmonising them to 50m grid squares based on the spatial resolution of the gridded OS Terrain 50[3] digital terrain model (DTM). We followed this approach because it enables data integration and synthesis from different sources and attribute population that can be used for exploring relationships or patterns between selected variables.

Figure 3.4 gives an example of the result of the dataset harmonisation and integration process in the form of the attribute table of the generated spatial data layer; rows represent individual 50m grid squares and columns values of individual data layers at the locations of the centroids of each 50m grid squares. Brief description of spatial data layers collated is given below.

Buffered — Features Total: 53852, Filtered: 53852, Selected: 0

	ID	X	Y	SER_CODE	ELEV	HOST	WI	EUNIS	GEOM	SLP
4603	17688	314925	792025	1546	324.399994	12	11.50062	E3 Seasonally wet and wet grasslands	Depression	0.256227712
4604	28706	333725	796225	1546	226.800003	12	9.19785	E3 Seasonally wet and wet grasslands	Valley	3.602715184
4605	17398	314925	791975	1546	323.299988	12	10.314819	E3 Seasonally wet and wet grasslands	Depression	1.077565872
4606	17399	314975	791975	1546	323.399994	12	10.265662	E3 Seasonally wet and wet grasslands	Depression	1.114636384
4607	28696	333225	796225	1546	228.699997	12	10.588661	E3 Seasonally wet and wet grasslands	Valley	0.722445264
4608	17689	314975	792025	1546	324.299988	12	11.298285	E3 Seasonally wet and wet grasslands	Depression	0.331228176
4609	17977	314975	792075	1546	323.700012	12	10.841847	E3 Seasonally wet and wet grasslands	Depression	0.575939392
4610	17992	317125	792075	1546	318.799988	12	9.894351	E3 Seasonally wet and wet grasslands	Depression	2.549786592
4611	28697	333275	796225	1546	229	12	10.852805	F3 Temperate and mediterranean-monta...	Valley	0.53829592
4612	23387	326725	794475	1546	271.5	12	10.2672	F3 Temperate and mediterranean-monta...	Depression	2.8662324
4613	23821	326925	794675	1546	272.600006	12	9.917931	F3 Temperate and mediterranean-monta...	Depression	3.896930144
4614	24265	325525	794875	1546	281.600006	12	10.692052	F3 Temperate and mediterranean-monta...	Valley	1.180927856
4615	23390	326875	794475	1546	272	12	10.357163	F3 Temperate and mediterranean-monta...	Depression	2.249612848
4616	23291	326775	794425	1546	266.799988	12	10.370828	F3 Temperate and mediterranean-monta...	Depression	2.3720544
4617	23708	327025	794625	1546	271.600006	12	10.306072	F3 Temperate and mediterranean-monta...	Depression	2.440580416
4618	24264	325475	794875	1546	282.200012	12	11.73903	F3 Temperate and mediterranean-monta...	Depression	0.364631744
4619	23388	326775	794475	1546	271.600006	12	10.450769	F3 Temperate and mediterranean-monta...	Valley	2.262160672
4620	29152	303375	796325	1546	500.299988	12	8.680977	F4 Temperate shrub heathland	Depression	22.364404976
4621	28664	303375	796225	1546	499.200012	12	8.62237	F4 Temperate shrub heathland	Depression	24.566175664
4622	28915	303375	796275	1546	499.799988	12	8.648236	F4 Temperate shrub heathland	Depression	23.5013868

Show All Features

Figure 3.4 Screenshot of geodatabase containing data layer values for the Dee riparian corridor.

3.3.1.1 Terrain

The OS DTM 50m pixel was used for extracting elevation information and calculating slope, wetness index values and landform types in the river corridor area (Figure 3.5). We calculated the SAGA Wetness Index using the SAGA toolbox[4] in QGIS, which is similar to the Topographic Wetness Index (TWI), but it is based on a modified catchment area calculation that better considers cells situated in

[3] https://beta.ordnancesurvey.co.uk/products/os-terrain-50
[4] https://saga-gis.sourceforge.io/en/index.html

valley floors with a small vertical distance to a channel (Boehner et al., 2002). This provides more realistic soil moisture predictions compared to the standard TWI calculation for flatter areas as those within riparian corridors.

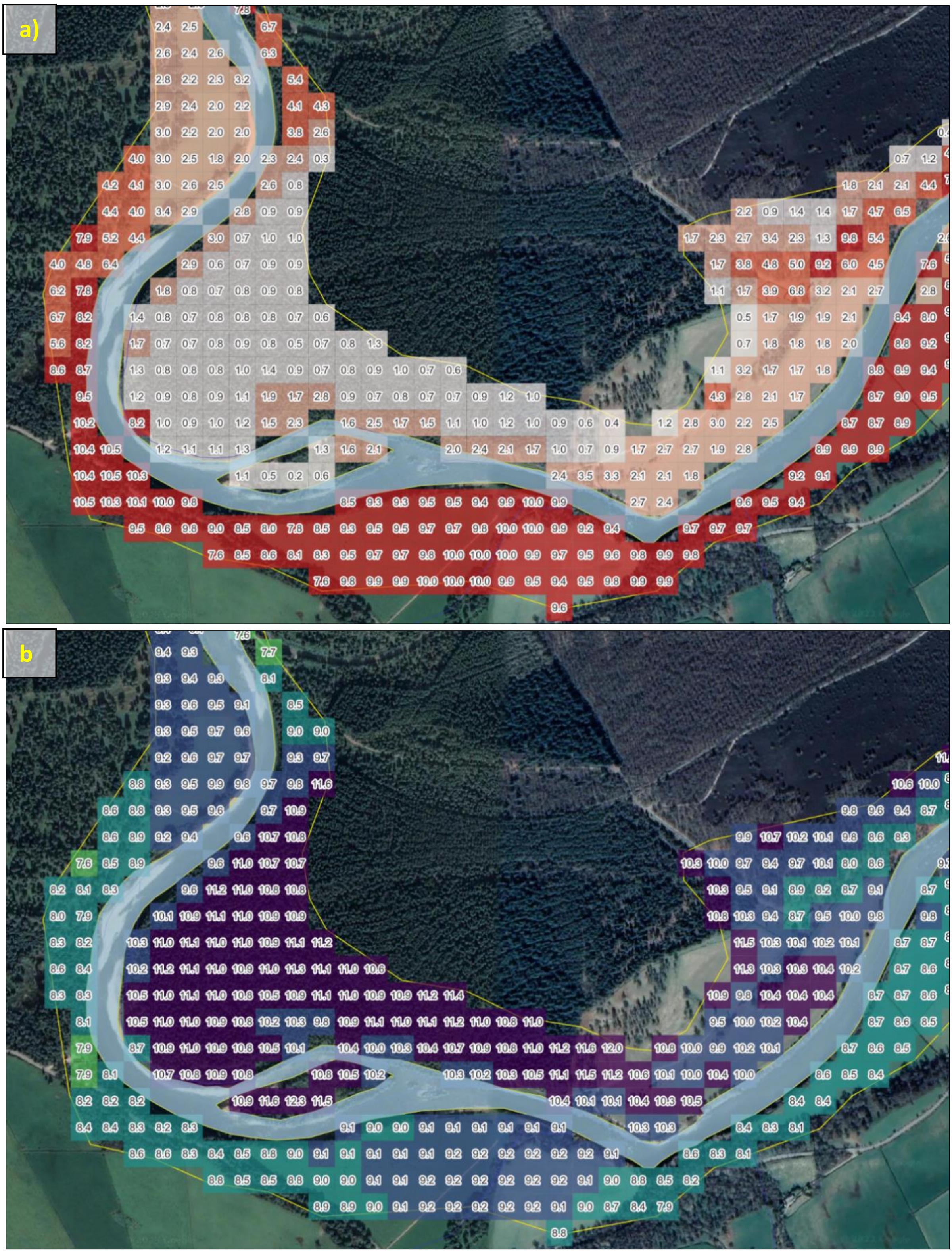

Figure 3.5. Calculated a) topographic slope (in degrees) and b) wetness index at 50m pixel in a lowland section of the Dee riparian corridor.

Different methods exist for calculating landform types from DTMs. Here we calculated geomorphons, a method that builds on concepts from computer vision to accurately classify terrain into discrete landform elements (Jasiewicz and Stepinski, 2013). The geomorphon algorithm classifies each pixel in an elevation raster by assessing surrounding elevation along a line of sight in eight compass directions, and based on the arrangement of higher, lower, or equal elevations surrounding the focal cell, each pixel is classified into one of ten (10) common landform elements (see Figure 3.6). As an application of openness in terrain classification (direct detection), geomorphons are scale- and orientation independent geomorphic features that constitute bare-earth terrain. Geomorphons were calculated using the SAGA GIS toolbox in QGIS.

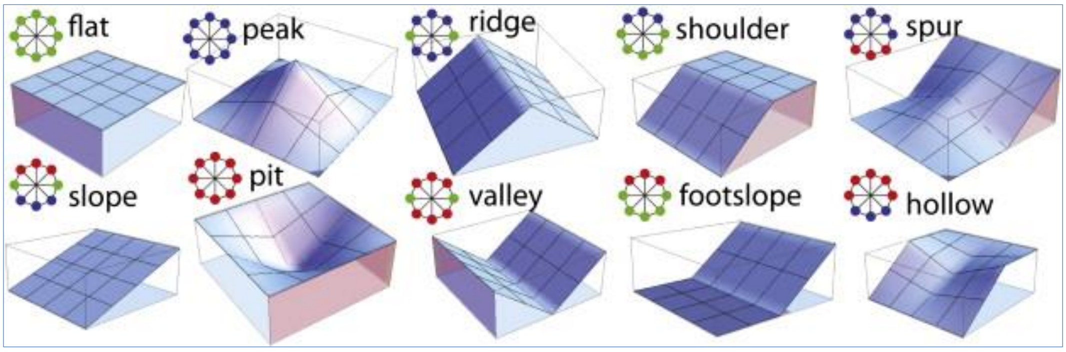

Figure 3.6. The landform types calculated using the geomorphons method.

3.3.1.2 Soils

In Scotland, two main soil map datasets exist; the National Soil Map at 1:250,000 (Soil survey of Scotland Staff, 1981) that provides national coverage, and the Soil Map (partial cover) at 1:25,000 (Soil survey of Scotland Staff, 1970-87) that provides detailed mapping of Scottish soils for around one third of the country's area (covering most of the cultivated land in Scotland and parts of the adjacent uplands. Most soils within the Dee riparian corridor were characterised based on the partial cover map, which provides a fine delineation of riparian zones and detailed mapping of alluvial soils and thus is an appropriate data layers for mapping riparian soil models. However, this map only covers about 2/3 of the Dee's catchment area, mainly the lower and middle sections. Using the National Soil Map cannot be used for characterising soils in the riparian corridor area not mapped by the partial cover soil map because it provides a coarse mapping of riparian zones, and its floodplain map units contain a mixture of different soils whose exact location within the polygon is often unknown. To overcome these limitations, we used a map of soil class (series) at a 50m grid cell resolution that has been produced by disaggregating the same National Soil map units using a predictive soil modelling technique to derive a digital soil map (Gagkas and Lilly, 2019; Gagkas et al., 2022). This map is spatially consistent with the OS DTM 50m pixel used to characterise terrain in the Dee riparian corridor and has been recently used to map wetland soils nationally with good results (Hare et al., 2022).

A variety of soils property information were derived either directly from the soil maps used or by linking to the Scottish Soils Database that can be used to characterise soils in the Dee riparian corridor, such as soil class (series) codes, soil types, soil drainage, soil texture and HOST classes (Figures 3.4 and 3.7).

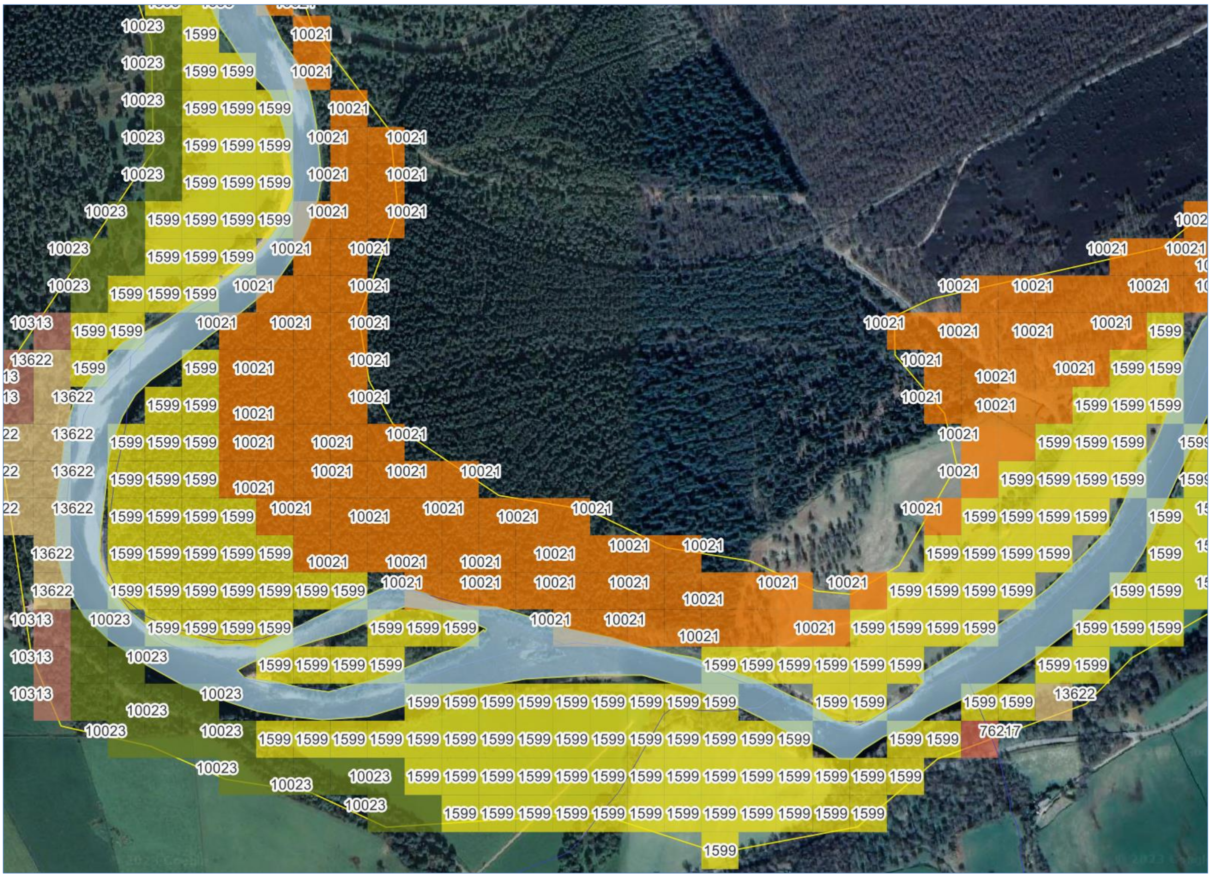

Figure 3.7 Soil class (series) mapping based on the 1:25,000 soil map in a lowland section of the Dee riparian corridor. Main soils shown are for codes 1599 = Mineral alluvial soils, and 10021 = Brown earths. Soil series codes can be used to link to the Scottish Soils Database to extract a variety of soil property information.

3.3.1.3 Land cover

Land cover was characterised within the Dee riparian corridor using the Scotland Habitat and Land cover map (SLAM-MAP) for 2020. SLAM-MAP was produced by Space Intelligence in partnership with NatureScot to provide insight into how Scotland's Natural Capital is changing over time. A workflow was developed that can generate repeatable nationwide habitat maps of 22 habitat/land cover classes at EUNIS Level 2 (L2) (Table 3.3) at 20m pixel resolution. SLAM-MAP products were produced by using collected data samples across Scotland for these 22 types of land cover and analysis of satellite imagery using a cloud-based Artificial Intelligence (AI) platform. Currently, two SLAM-MAP data layers have been produced for the years 2019 and 2020, along with an additional change map showing how the landscape has changed over this 12-month period[5]. Wider patterns of land cover composition within the Dee riparian corridor were explored by aggregating the original EUNIS L2 classes to higher broad habitats (BH), shown in Table 3.3.

[5] https://www.space-intelligence.com/scotland-landcover

Table 3.3. EUNIS L2 habitat types used by SLAM-MAP and respective aggregated higher Broad Habitats (BH)

SLAM-MAP EUNIS L2	**Higher BH**
I1 Arable land and market gardens O Bare field	Arable
D1 Raised and blanket bogs D2 Valley mires, poor fens and transition mires D4 Base-rich fens and calcareous spring mires	Bogs & peatlands
F2 Arctic, alpine and subalpine scrub F3 Temperate and Mediterranean-montane scrub F4 Temperate shrub heathland F9 Riverine and fen scrubs	Shrubland
E1 Dry grasslands E3 Seasonally wet and wet grasslands E4 Alpine and subalpine grasslands E5 Woodland fringes and clearings and tall forb stands	Grasslands
G1 Broadleaved deciduous woodland	Broadleaves
G3 Coniferous woodland	Conifers
G4 Mixed deciduous and coniferous woodland G5 Lines of trees, early-stage woodland and coppice	Mixed woodland
E2 Mesic grassland	Mesic grassland
H2 Screes H3 Cliffs and rock pavements	Cliffs & screes
J Built-up	Built-up
C Surface standing and running waters	Freshwater

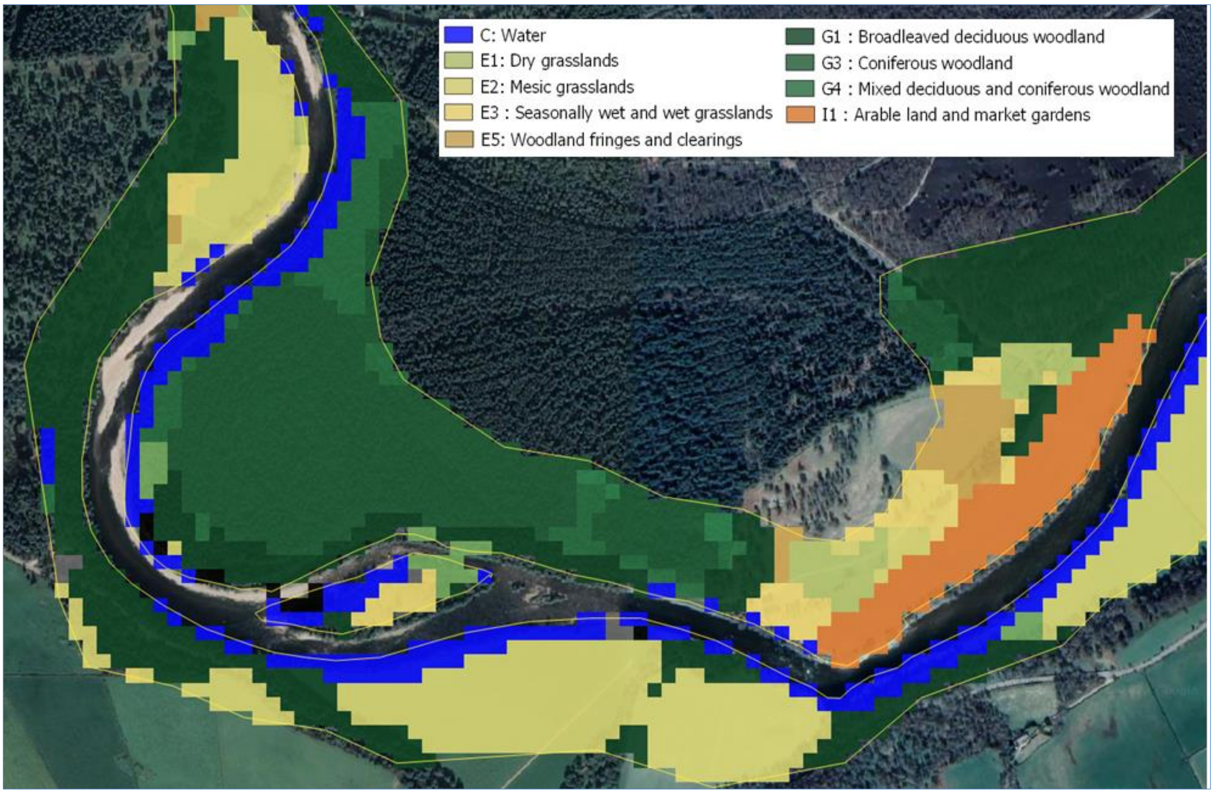

Figure 3.8. Land cover mapping based on EUNIS L2 habitat types provided by SLAM-MAP for 2020 in a lowland section of the Dee riparian corridor.

3.4 Mapping riparian soil models

Riparian soil models were mapped at 50m grid cell resolution using HOST class information derived from the partial cover soil map (Version 10) and the disaggregated soil series map for the Dee riparian corridor area, which comprised of both hillslope and floodplain soils (Table 3.2). Downslope distance to stream, calculated in QGIS using the OS DTM 50m, was used to determine whether the river was connected directly to the hillslope, or a floodplain was present (Table 3.2). We translated the matrix of riparian soil models of Table 3.2 to a set of decision rules using R scripts and used them to classify each 50m grid square within to the Dee riparian corridor into riparian soil models. An example of the result of this process is given in Figure 3.9 that shows mapped riparian soil models in a section of the main river stem with free or relatively free draining hillslope soils and mineral alluvial soils on the floodplain.

Overall, soils belonging to Model 1 cover around 51% of the Dee riparian corridor (6,877 ha), with Model 1B covering 39% (5,250 ha) of the whole riparian corridor (Figure 3.10). These soil models along with Model 1B (13%, 1,683 ha) cover most of the riparian corridor of the main river stem in the middle and lowland sections and comprise of mainly relatively free draining soils derived from fluvioglacial deposits of sands and gravels. On the other hand, the riparian corridor of the upland catchment section and of most upland tributaries is covered by soil models 2A (12%, 1,614 ha) and 5A (10%, 1,293 ha), comprising of relatively free draining, thin upland soils and poorly draining peaty soils, respectively, found on hillslopes connected directly to the river network.

Figure 3.9. Mapping of riparian soil models in a lowland section of the Dee riparian corridor. Labels correspond to model codes given in Table 3.2.

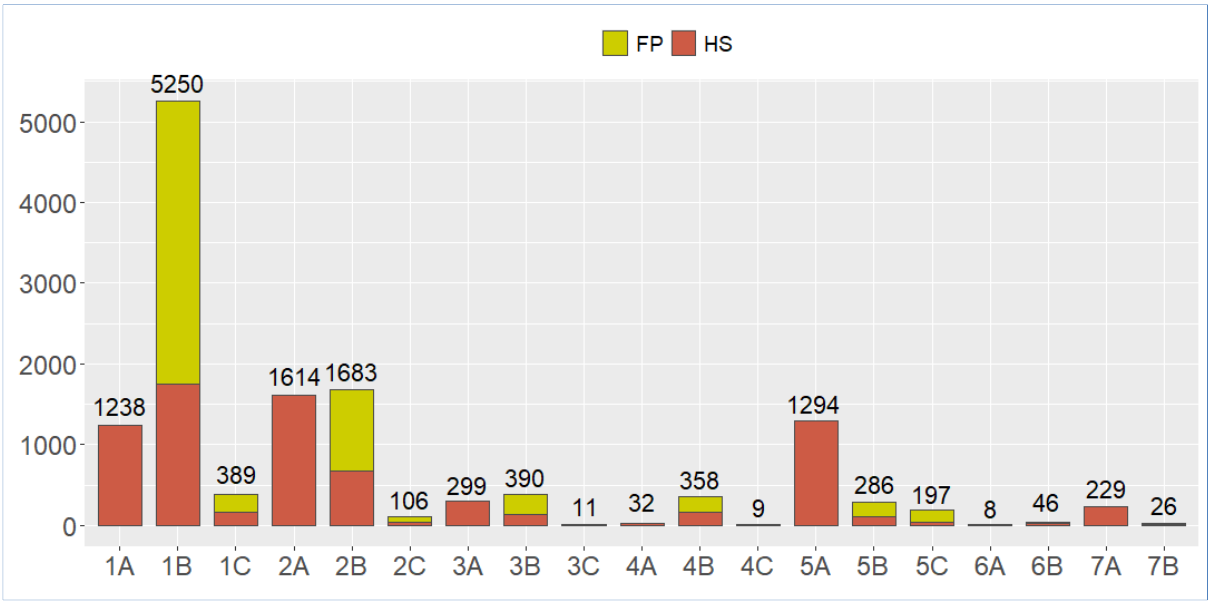

Figure 3.10. Areas (in ha) of riparian soil models, comprosing of both hillslope (HS) and floodplain (FP) soils calculated from mapping of the Dee riparian corridor. Models 1-4 comprise drier to wetter general contexts of mineral hillslope soils and 5-7 similar for organic soils, where A, B and C denote respectively absent, mineral or peaty floodplain presence (see Table 3.2).

3.5 Landscape controls

3.5.1 Terrain characteristics

Figure 3.11 gives the distribution and range of slope and wetness index values for the riparian soil models mapped within the Dee riparian corridor areas. Overall, riparian soil models follow the expected gradients of slope and wetness. Looking at the most dominant (in terms of riparian corridor coverage) riparian soil models 1 and 2, median slope is greater in the soil models where the river is expected to be connected directly to hillslope (1A and 2A) and lower in models with alluvial mineral soils (1B and 2B) and then peaty alluvial soil models (1C and 2C) (Figure 3.11a). This gradient of decreasing slope from hillslope to floodplain is less evident in the peaty soil models, which lie in the more upland section of the riparian corridor.

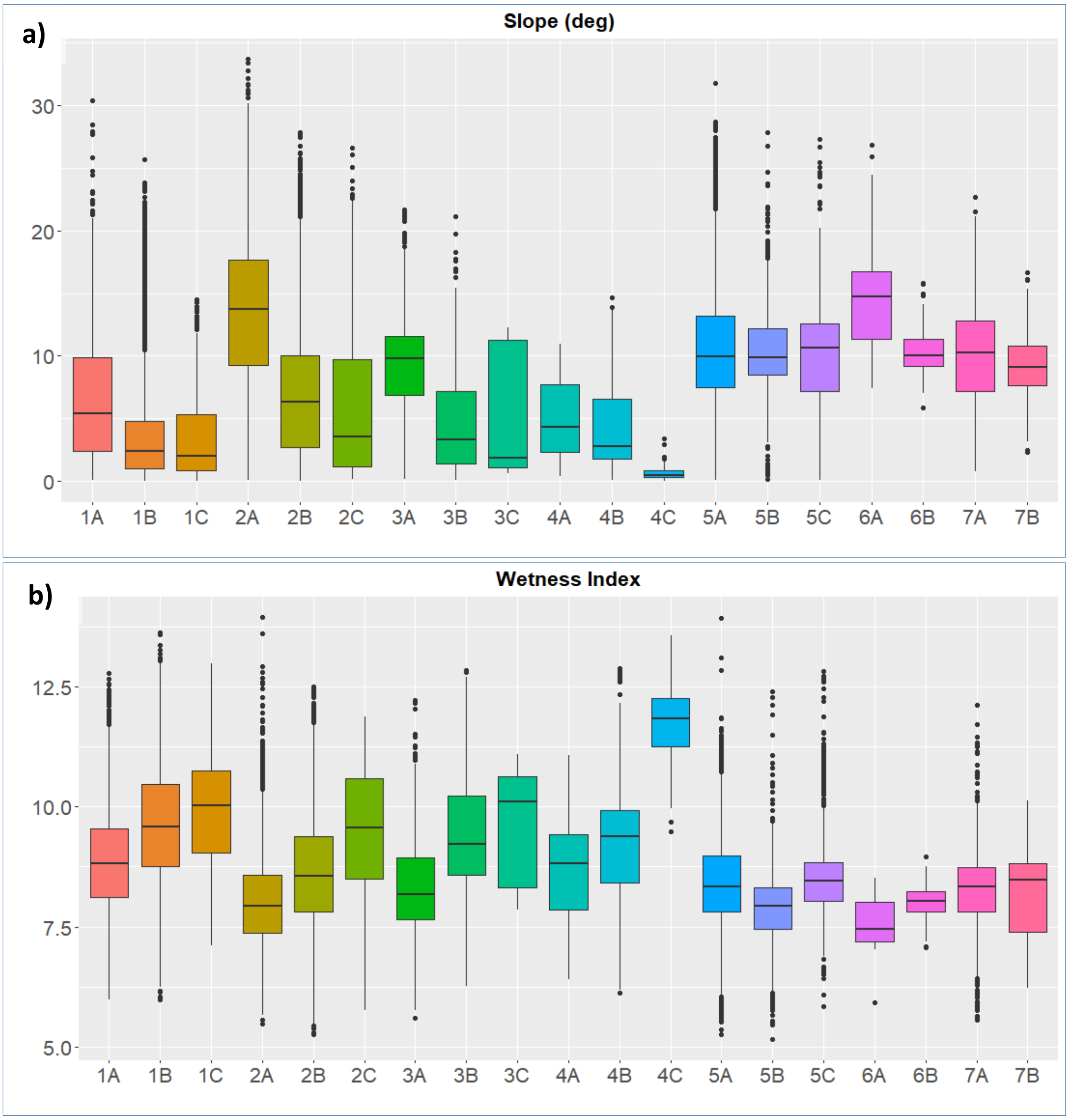

Figure 3.11. Boxplots of slope (in degrees) and modified topographic wetness index for each riparian soil model in the Dee riparian corridor.

Calculated wetness index provides even clearer gradients than slope, as overall there is an increasing gradient of topographic wetness from soil models with no floodplain present, to floodplains with mineral alluvial soils and then to floodplains with peaty alluvial soils (Figure 3.11b). This gradient is evident mainly in the riparian models with mineral hillslope soils and less in the riparian models with peaty soils or peat on the hillslope, which are found in higher altitudes and greater slopes. However, there does not seem to be any difference or gradient between soil models of the same floodplain setting but different hillslope model, with the exception of soil model 4C that has the greatest wetness of all soil models due to the inclusion of a small area (9 ha) of lowland basin peat. This indicates that topographic wetness is appropriate for identifying gradients based on landscape position (i.e., hillslope to floodplain transition) but cannot account for relative differences of wetness related to different soil type composition.

3.5.2 Landform types

Figure 3.12 gives the proportion of landform types calculated using the geomorphon approach within areas mapped as different riparian soil models in the Dee riparian corridor. In most cases, more than 75% of the area of each riparian soil model is characterised as either valleys or depressions. This is the case for the most extensive riparian soil models 1, 2 and 5 that account for 90% of the Dee riparian corridor area. There is an indication that depressions are more frequent in the peaty riparian models, and that other landform types (e.g., slopes and footslopes) are more frequent in the soil models with no floodplain presence. However, these indications are not clear because they are based on relatively small areas. In addition, the accuracy of the landform type characterisation is influenced by the relatively coarse spatial resolution of the DTM used (50m); our analysis in the Dee catchment indicates that a spatial resolution of around 10m provides a good compromise between the granularity of the mapping and the processing effort needed to perform the landform type classification. However, this analysis indicates that overall soils spatial distribution on both hillslopes and floodplains corresponds to expected riparian landform settings, and hence that the HOST-based riparian soil models show good potential for reflecting these landform settings.

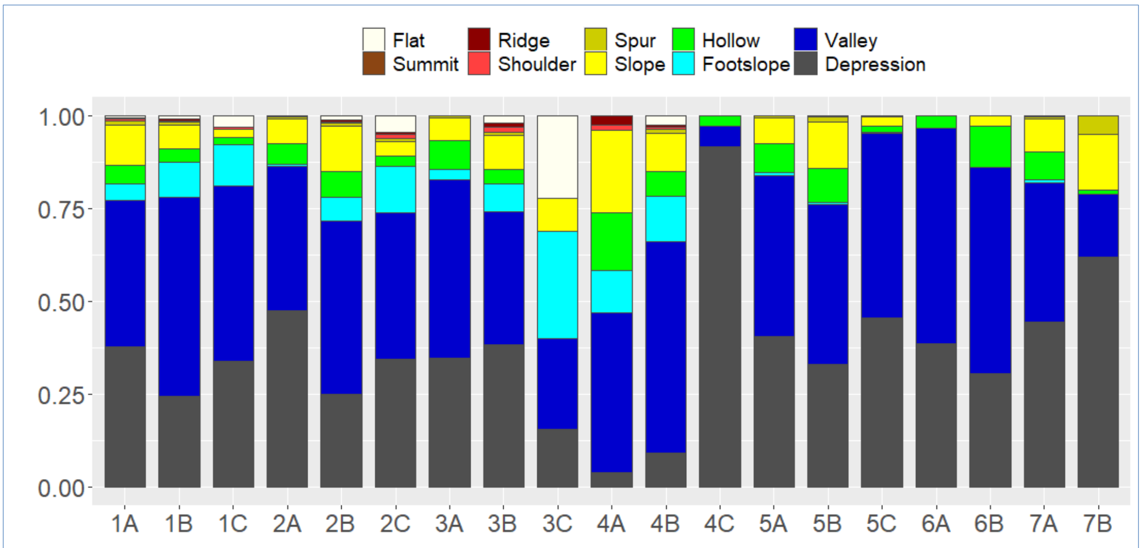

Figure 3.12. Proportions of landform types (“geomorphons”) for each riparian soil model in the Dee riparian corridor.

3.6 Land cover

Figure 3.13 gives the proportion of aggregated EUNIS L2 classes from SLAM-MAP for the different riparian soil models in the Dee riparian corridor. Overall, woodlands (broadleaves, conifers and mixed woodland) and cultivated land (arable and mesic grasslands) tend to be more frequent in the soil models with mineral hillslope soils, while peatlands and shrublands (mostly heather moorland) are more frequent in the soil models with either peaty soils or peat on the hillslope. This pattern of land cover composition is to be expected because it follows the typical land transition from cultivated lowlands to seminatural uplands. Seminatural grassland (usually wet grassland) and heather moorlands are also quite frequent in the peaty floodplain setting of the extensive 1 and 2 riparian soil models (1C and 2C), covering around 45%-55% of their area, which reflects the expected presence of wetland vegetation communities in these areas of wetter soils (Figure 3.13).

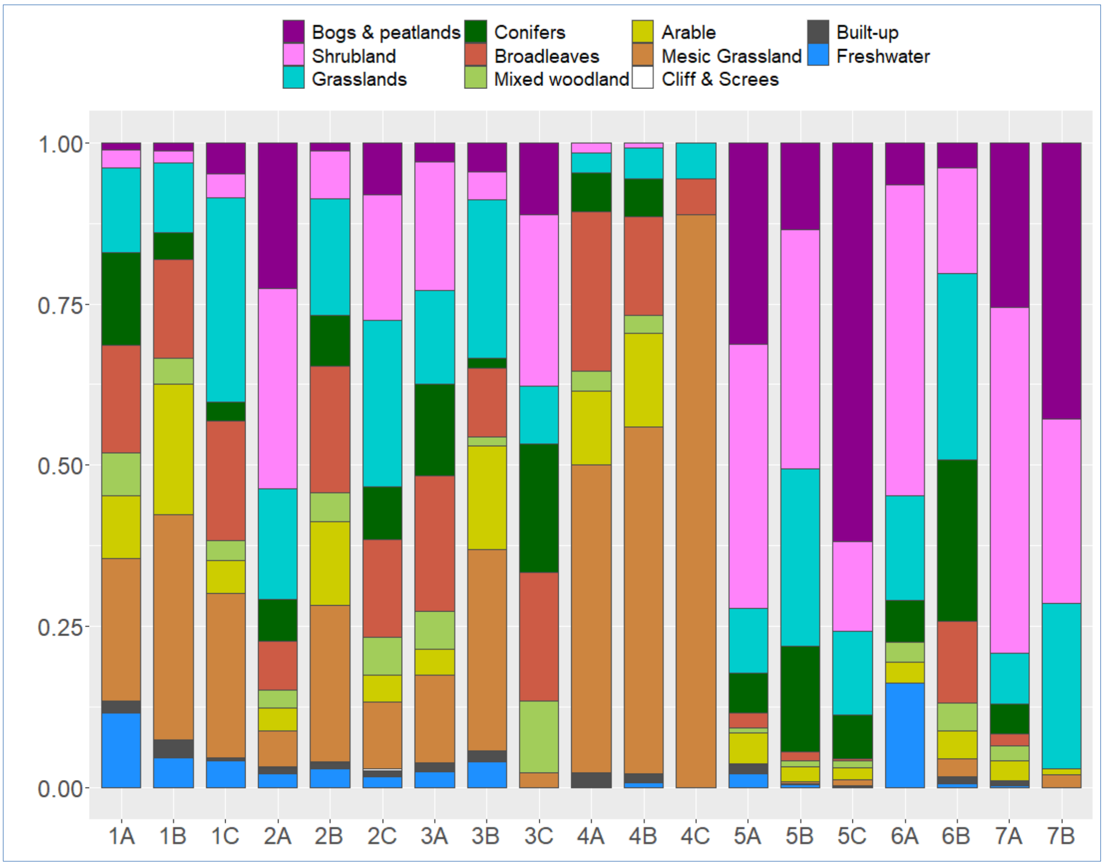

Figure 3.13. Aggregated EUNIS L2 classes ("Broad Habitats") for each riparian soil model in the Dee riparian corridor.

Around 80% of the area of riparian soil model 2A, which comprises mainly of upland soils with thin organic topsoils belonging to class HOST 22, is covered by either peatlands, moorlands or seminatural grasslands, while the remaining area is occupied by soils belonging to HOST class 17 that are found at lower altitudes in the middle and lower sections of the Dee riparian corridor where agriculture and forestry are the most frequent land uses. Finally, most of the area of Model 4, which comprises of the wettest mineral hillslope soils, is covered by mesic grasslands, most likely used for livestock grazing, indicating that these wet soils are quite likely to have been artificially drained.

4 Conclusions & Next Steps

The results of the analysis presented in this report indicate that riparian soil models, developed using HOST conceptual models of soil hydrological pathways, can provide the basis for a typology of riparian corridor units that is appropriate for assessing the capacity of riparian corridors to provide key ecosystem functions. These riparian soil models were shown to be able to capture key terrain and landform characteristics and reflect expected gradients of wetness and patterns of landform types and land cover within the Dee riparian corridor. Moreover, this analysis indicates that the Potential RZ layer is appropriate for delineating the river corridor, as defined for the purposes of this project, at national scale because it captures the hillslope to floodplain transition of the main river systems in Scotland.

Building from this analysis, next steps planned for Year 2 include:

- Map riparian soil models in the riparian corridor of river Forth to assess whether similar soils – landscape – land cover relationships and patterns exist as in the Dee.
- Select indicators from the DPSIR framework (from D.3a) that relate to the provision of river corridor ecosystem services (focus on C storage/transformations/exports, habitats, flow regulation) and identify respective spatial and numerical datasets.
- Liaise with JHI-D5-2 project (Climate change impacts on Natural Capital) to integrate drivers and pressures arising from changes in climatic patterns (e.g., projections of climatic water deficits) in the DSPIR framework, to enable assessments of climate change impacts on riparian corridor functioning.

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