Natural Capital Strategy for Derbyshire

Final report

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Chapter 1: Introduction to Derbyshire's Natural Capital Strategy

Natural capital can be defined as the stocks of natural assets which include geology, soil, air, water and all living things. Our environment is our life support system sustaining and providing our food, fuel, building materials, fresh air, clean water; and as such is fundamental to the functioning and stability of our economy. It is from this natural capital that humans derive a wide range of services, often called ecosystem services, which make human life possible and enjoyable.

Our environment functions as a dynamic system. The land, water and biodiversity it supports are all interconnected; changes in land use such as housing developments not only affect the local environment, but can have implications for the functioning of the environment at a wider landscape scale, and implications for the local and national economy.

The effects of climate change, declines in biodiversity, and increasing population pressure, together with growing scientific understanding of how our environmental systems function, have shown that the earth's resources are finite and need to be carefully managed; they are integral to decision making, and integral to the future health and stability of our economy.

The level of ecosystem services provided by an area of land depends heavily on the land cover or habitat present in that area, and how resilient those habitats are in the face of the many pressures they face, such as pollution, invasive non-native species, and climate change. Natural habitats form the most resilient ecosystems, and provide a wide range of ecosystem services. Resilient habitats adapt to pressures and demands, either by resisting, recovering or adapting to external pressures, whilst retaining their ability to deliver the same level of ecosystem services, now and into the future.

Resilient ecosystems:

- preserve and regenerate soil
- control floods
- mitigate droughts
- pollinate crops
- store carbon
- operate the hydrological cycle
- fix nitrogen
- recycle nutrients
- filter pollutants
- assimilate waste
- maintain a genetic library

It is important to understand how ecosystem services are being delivered in an area, as they underpin our well-being, our prosperity, health, culture and identity. Although they

are often hidden from view, they can be spatially modelled and mapped, and valued in monetary terms by way of a natural capital account, allowing us to realise the true value of nature and the environment.

Our environment is important not only at the local scale, but at the broad landscape scale also. Landscapes have evolved over time as a result of both natural and cultural processes, and these different combinations of natural and human factors can be used to describe the landscape character of an area. The landscape character of Derbyshire is distinct, recognisable and has consistent patterns of elements, such as hedgerows, heath and arable land, in the landscape. It is these patterns that give each locality its 'sense of place', making one landscape different from another.

The Natural Capital Strategy for Derbyshire describes the current status of the natural assets in the county using the best available data. The strategy identifies where our natural capital is resilient and performing well in supporting our population. It identifies opportunities to adjust land management to increase the benefits we get from nature in Derbyshire;, this will allow us to understand how and where to invest in maintaining and enhancing natural capital in our landscape, whilst maintaining its distinct landscape character. The rationale of the strategy is shown in Figure 1.

Figure 1: Rationale for the Natural Capital Strategy for Derbyshire

Derbyshire's Natural Capital Strategy comprises:

- a natural capital baseline assessment with:
    - baseline habitat and ecological network maps
    - ecosystem service stock maps
    - baseline landscape character and cultural heritage assessment
- natural capital baseline accounts
- a monitoring plan for updating the natural capital accounts and habitat map
- analysis of the predicted impacts of climate change on natural capital of the county;
- proposed land management actions to maintain and enhance natural capital that align with landscape character
- identification of funding mechanisms to attract investment for natural capital projects
- this report, which includes conclusions, recommendations and technical appendices

The work has been completed by Environment Systems Limited together with eftec Limited and SLR Consulting Limited, with input from key stakeholders in the county. It covers the geographical county of Derbyshire (Figure 2), including Derby City and the area of the Peak District National Park (PDNP), shown in green, that falls within the county.

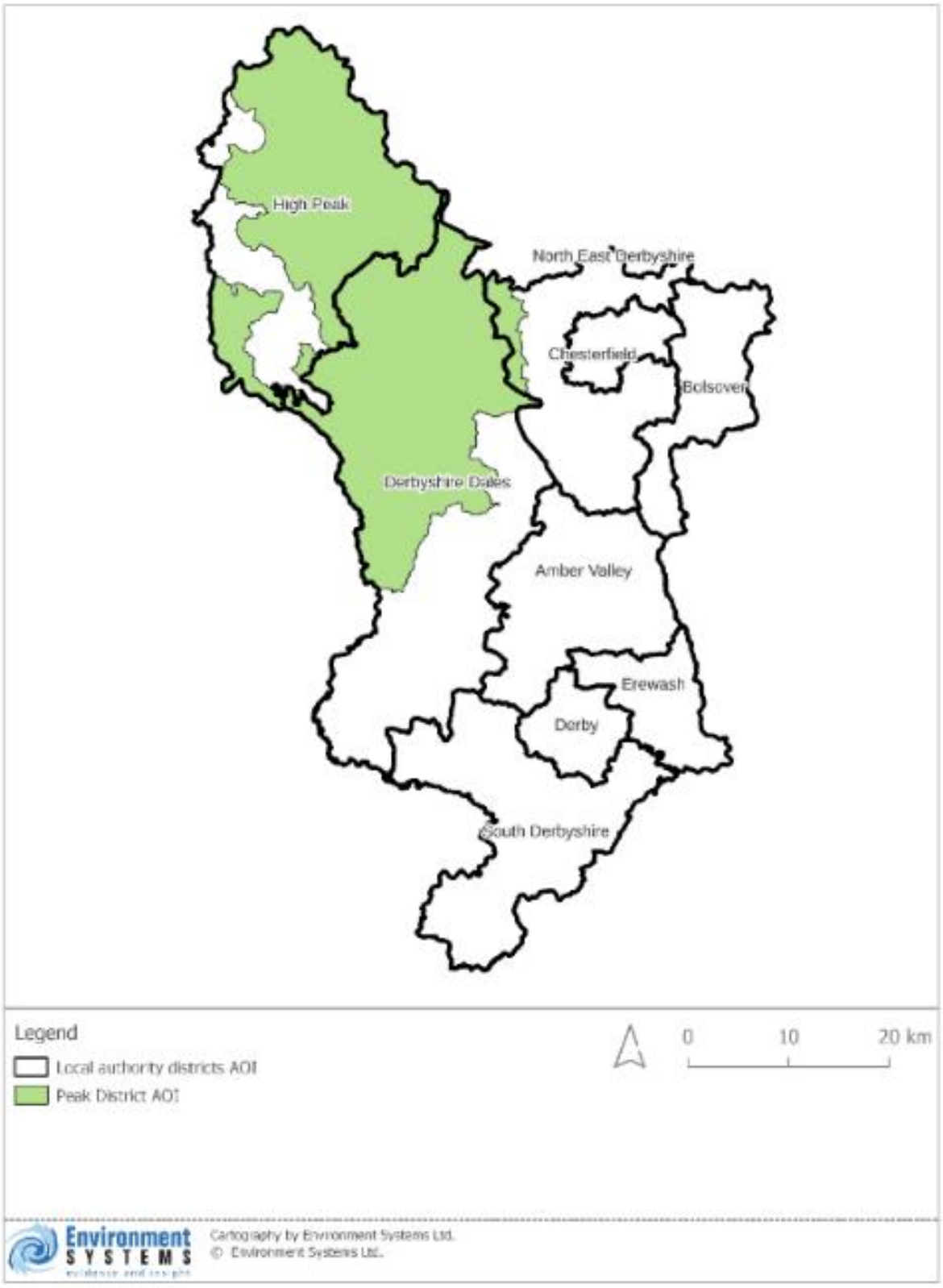

Figure 2: Area covered by the Derbyshire Natural Capital Strategy, showing Local Administrative Districts

Chapter 2: Natural Capital Baseline Assessment: Mapping for Nature Recovery

Introduction

Natural capital

Natural capital is "the stock of renewable and non-renewable natural resources (e.g. plants, animals, air, water, soils, minerals) that combine to yield a flow of benefits to people"[1].

Understanding where semi-natural habitats are located is of key importance, as these places are high in biodiversity, support nature recovery and provide multiple other ecosystem services. For example, understanding how farmed land relates to the urban landscape is key to understanding how rural areas currently help mitigate problems such as flooding, poor water quality and carbon loss. Conversely, understanding where semi-natural habitats are not present, but could be restored, will help mitigate and prevent such problems.

For natural capital accounting it is important to distinguish between the natural capital stocks and the flows of benefits they provide; projecting benefits into the future and linking them to the extent and condition of assets. The intention is to ensure that decisions prioritise maintaining the assets to sustain a range of benefits, and not to maximise one of the benefits at the expense of others, or the natural capital asset itself.

Nature Recovery Network (NRN)

The Nature Recovery Network (NRN) is a major commitment in the Government's 25 Year Environment Plan that brings together partners, legislation and funding to restore and enhance the natural environment. It seeks a national joined-up network of marine, water and terrestrial habitats where nature and people can thrive. More than a map, it is an active, adaptive spatial plan that identifies the best opportunities to deliver nature's recovery. The NRN helps deal with the challenges of biodiversity loss, climate change and human wellbeing, and establishing the NRN will:

- enhance sites designated for nature conservation and other wildlife-rich places - newly created and restored wildlife-rich habitats, corridors and stepping stones will help wildlife populations to grow and move
- improve the landscape's resilience to climate change, providing natural solutions to sequester or store carbon and manage flood risk, and sustaining vital ecosystems such as improved soil, clean water and clean air
- reinforce the natural, geological and cultural diversity of our landscapes, and protect our historic natural environment

[1] Natural Capital Protocol https://naturalcapitalcoalition.org/natural-capital-protocol/

- enable us to enjoy and connect with nature where we live, work and play - benefiting our health and wellbeing

Local Nature Recovery Strategies

To deliver the NRN there is a requirement for mapping and data and this involves Local Nature Recovery Strategies (LNRS) to effectively target action and investment in nature. LNRS are a new mandatory system of spatial strategies for nature established by the Environment Act 2021. They are designed as tools to encourage more coordinated practical and focused action and investment in nature and will link to funding streams, policy and statutory duties that will incentivise the restoration and creation of habitats and help deliver the NRN through collaboration and partnership working.

Mapping for the Local Nature Recovery Strategy

The mapping of habitats, ecological networks and opportunities for biodiversity in Derbyshire provide the evidence base for the county natural capital strategy, and provides the baseline for the LNRS.

Creating a habitat map of Derbyshire

In order to map and quantify the natural capital assets and provide data to inform the natural capital baseline accounts, a habitat map is needed for the whole of Derbyshire. This habitat map can be maintained as a 'living map': an excellent resource to build upon and keep updating as new survey data becomes available, and restoration projects are established.

Choice of classification system for the habitat map

Many counties have data from a variety of habitat and land use surveys, conducted over many years, and that use differing classification systems. A single classification system was needed for a countywide analysis. To facilitate this, the construction of the habitat map used the UK Habitat Classification (UKHab) as a land classification system. In addition, other data from several sources was used. The UKHab is a framework that enables data from differing habitat classifications to be brought together and translated to a single system. By combining data from multiple sources, the mapping provides a more accurate and complete estimate of the coverage of land and habitat types to include in the Asset Register.

The relevant top tier UKHab classification used includes cropland, grassland, heathland and shrub, rivers and lakes, sparsely vegetated land, urban, wetland and woodland. A full overview of the habitat classifications used in this account is provided in Appendix 1.

UKHab is a nested system, which means that habitat analysis can be disaggregated if higher detail is required. The use of UKHab also facilitates links to datasets with more or fewer categories, including those used in other parts of the region (e.g., mapping of natural capital in the DCC area), at a national scale (e.g., the Broad Habitats used by the Natural Capital Committee), and to other assessment frameworks (e.g., the Defra biodiversity metric).

Creating the habitat map of Derbyshire

A full list of datasets used to produce the habitat map is provided in Appendix 2; the key input datasets are:

- Amenity and urban greenspace data (Chesterfield, Derby)
- Ordnance Survey MasterMap
- Derbyshire Wildlife Trust habitat data (e.g. open mosaic habitats (OMH), ponds, lowland lakes)
- Natural England - Priority Habitat Inventory data
- Peak District National Park Authority (PDNPA) - Priority Habitat data
- National Trust - Phase 1 habitat data
- Defra - Annex 1 habitat data
- Other habitat inventories: traditional orchards, National Forest Inventory, Ancient Woodland Inventory
- Rural Payments Agency – CROME (Crop Map of England)
- Earth observation (EO) imagery: LiDAR, Sentinel-1 and Sentinel-2 data

An extensive consultation exercise was undertaken to review the habitat map and receive stakeholder feedback to ensure that as much detail as possible was captured for both urban and rural areas. This was compiled through the design and build of a private website where stakeholders could log in to mark corrections and upload photos, maps and other data.

The input habitat datasets utilised a range of classification systems with differing survey dates which were each translated into UKHab notation at Level 2 classification. These were then summarised to derive an overarching Level 1 classification (see Appendix 3) with fewer classes.

The habitat map was generated by combining all available existing habitat data. However, once combined, there were still gaps in coverage. To address this, UKHab Level 1 habitats were mapped for these locations using Sentinel-2 satellite imagery (from 2021).

The datasets were then merged to form a seamless habitat dataset for Derbyshire. This was done in a way that gave priority to certain datasets, so the final version of the habitat map utilises the most up to date information for each area (Figure 3). Where there were data conflicts, a judgement was made of which dataset should be used depending on the land category and data quality assessment.

Air photo analysis was used to quality assure the resulting outputs, concentrating on classes with less certainty. For example, areas identified as improved, intensely managed grassland in the urban areas, were checked and reclassified as playing fields or other green space as appropriate.

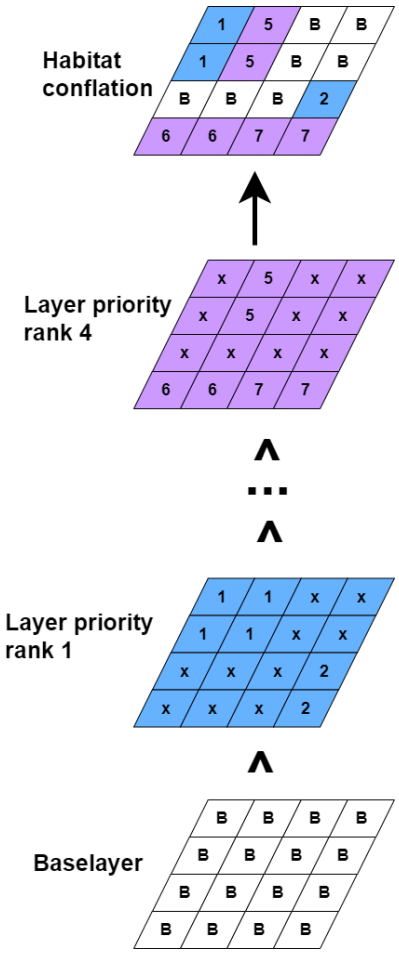

Figure 3: Merging data to create the habitat map

No existing datasets mapping hedgerows were available to the project. Hedgerows are important habitats that have a profound influence on ecosystem service delivery in Derbyshire, and as such an inability to factor the presence (and absence) of hedgerows into the analyses would be a significant limitation. Hedgerows, which support biodiversity, help intercept water, contribute to carbon storage and abatement and, in the correct places, can have a significant effect on water quality and flood management.

In the absence of existing data, a hedgerow map was created using the available EO datasets. LiDAR, which records the height of features in the landscape, was available for some areas outside the uplands and was used to map hedgerows. In the uplands, in the absence of LiDAR data, a combination of satellite image classification, followed by aerial imagery processing (which helped exclude walls and tracks) was also used to classify and map hedgerows. The mapping of hedgerows in the uplands is therefore less accurate than the lowland areas mapped using LiDAR.

In some areas there are very dense networks of hedgerows as illustrated in Figure 4.

Figure 4: Extract of habitat map showing hedgerow and woodland classes

The habitat map of Derbyshire

The Level 1 habitat map classification is shown in Figure 5. In this map it can be seen that heath (purple) and wetland (pink) dominate the upland environments in northern parts of the county. Woodlands (dark green) are located on the sides of steep linear valleys in the uplands, and typically alongside water bodies and rivers (blue) in the lower lying areas. There also some larger blocks of woodlands and parklands, for example in the larger estates. Arable land (orange) is located more to the east and south of the county, and the eastern areas are more urbanised. Hedgerows are a feature of the agricultural land in southern and eastern areas. In the county-scale map hedgerows and stone walls are coloued mid-green, although a larger-scale map is needed to fully identify these narrow features (e.g Figure 4).

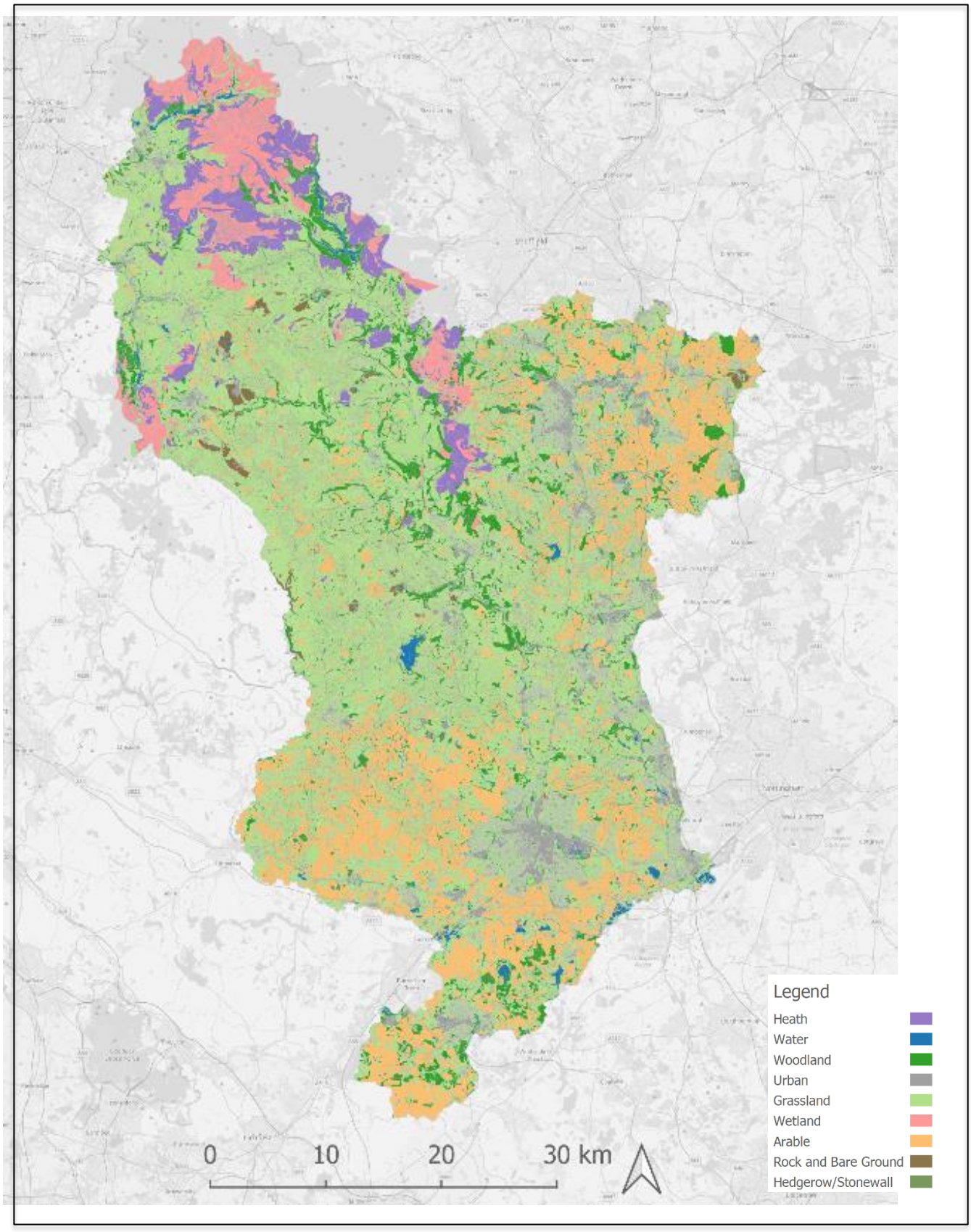

Figure 5: Habitat map showing Level 1 classification

Baseline ecological networks

Ecological networks describe how well individual habitat patches are connected across the landscape. The closer patches of habitats are together, the better they are able to share resources such as pollinators, and seeds. Where habitats are close enough to share these resources, an ecological network is formed. These networks are significant as they increase the resilience of the habitats within them. For example, a woodland patch that is damaged by a storm will have a better chance of regenerating to its former level of biodiversity if it lies within a network of other woodlands, as animals and seeds will be able to disperse from neighbouring patches to recolonise the damaged area. Conversely, habitat patches that are isolated will be less able to regenerate to the same habitat type, or level of diversity. Networks are important as restoring habitats within the overall network generally protects the existing resource, whilst also allowing a more robust habitat to form which provides better ecosystem services overall.

Ecological networks were mapped for four habitat types: woodland, wetland, heathland and grassland. Connectivity was modelled using a cost-distance approach, using the comprehensive Derbyshire habitat map.

In the cost-distance approach larger blocks of habitats are recognised as being more resilient and able to sustain viable populations of species, and therefore are classed as 'core habitats'. Smaller habitat areas are classed as stepping stones. An animal might use the small isolated area of habitat (stepping stone) to pass through or forage in, but the stepping stone is too small to provide all of the resources the animal needs to make its permanent home there; for this, an area of core habitat is needed.

All habitats and land cover types in the habitat map were considered in terms of how easy or difficult it would be for a typical grassland / heathland / wetland / woodland species to move through and forage within; each habitat type is assigned a movement cost. Core habitats were assigned a movement cost of 0, meaning that the associated species can easily exist in these patches. The cost value increases for habitats that are more difficult for species to traverse, with intensively managed agricultural land or urban areas normally having the highest cost values.

Woodland ecological network

The woodland network is shown in Figure 6 and includes ancient woodlands, broadleaved woodlands and mixed plantation woodlands. Core woodland habitat is located predominately in central and north-eastern areas of Derbyshire. There is generally high connectivity of woodlands throughout Derbyshire except in areas that are managed intensively for agriculture; a very strong woodland network follows the Derwent and Wye valleys, from the upper catchments to the valley bottom. Hedgerows form a very important part of the woodland network in the Needwood & South Derbyshire Claylands region, and south of Chesterfield, and are particularly important for connecting the many smaller woodland core habitat patches. There is a high abundance of small, highly fragmented woodland patches in the Trent Valley Washlands region, and northern Melbourne Parklands, where hedgerows are less common; in these areas the woodland network is not functioning well. There are large areas of core woodland habitat in the

Mease/Sense Lowlands region, that are relatively poorly connected at present; this area lies within the National Forest boundary.

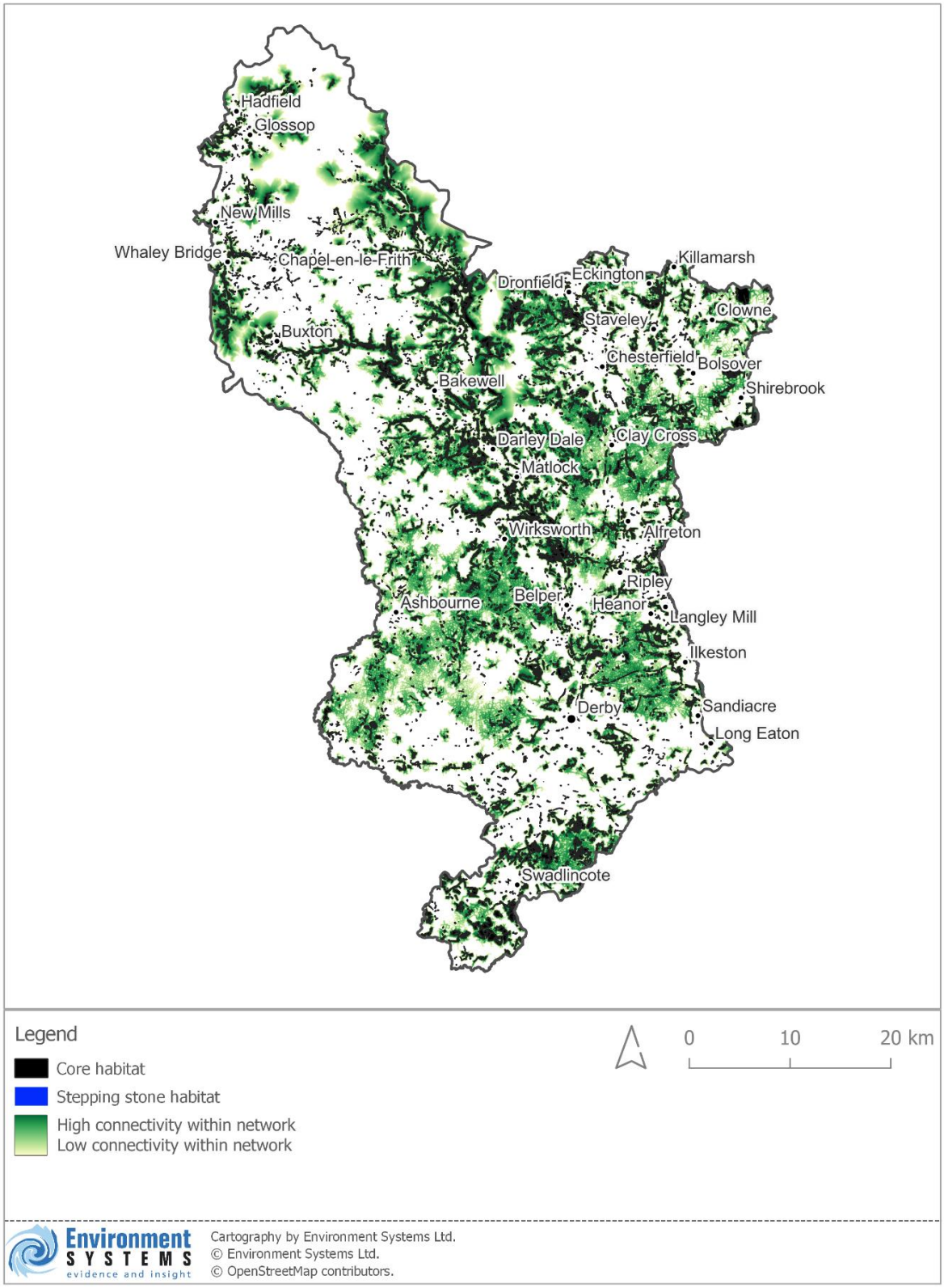

Figure 6: Woodland network

Heath ecological network

Heath is more difficult to re-establish than woodland as the heather forms a relationship with mycorrhizal fungi in the soil which helps heather germinate and grow. Heath networks therefore need an existing heath very closely associated with them or propagules with soil will need to be transported from a donor site. The heath network in Derbyshire is associated with the uplands and is mostly located within the Peak District National Park and the upland parts of the Peak Fringe & Lower Derwent region (Figure 7).

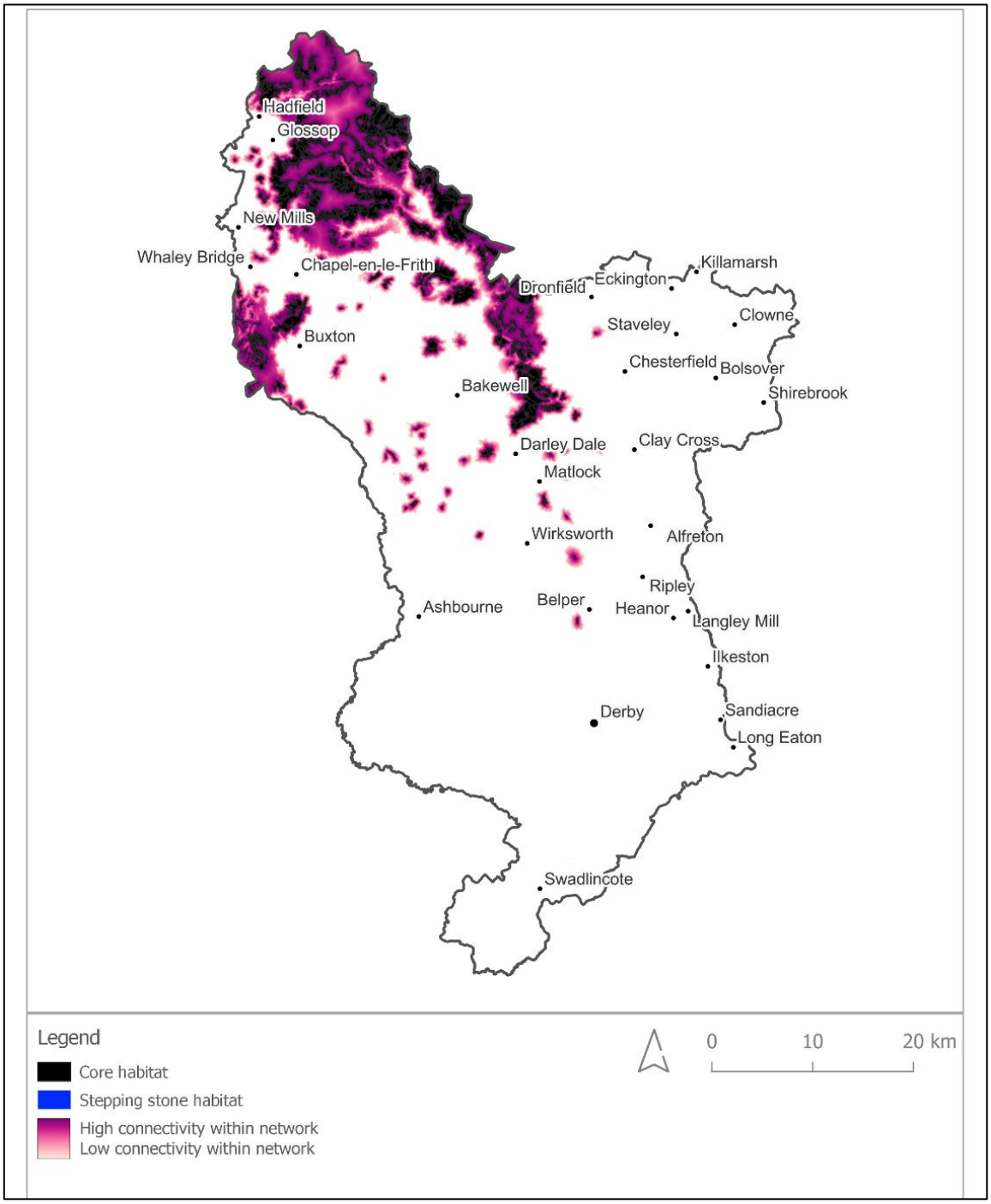

Figure 7: Heath network

Wetland ecological network

The wetland network is determined by the rivers and lakes, as well as occurring on extensive areas of blanket bog in the uplands of the Peak District National Park, and the upland parts of the Peak Fringe & Lower Derwent region; areas that also feature strongly in the heath network (Figure 7).

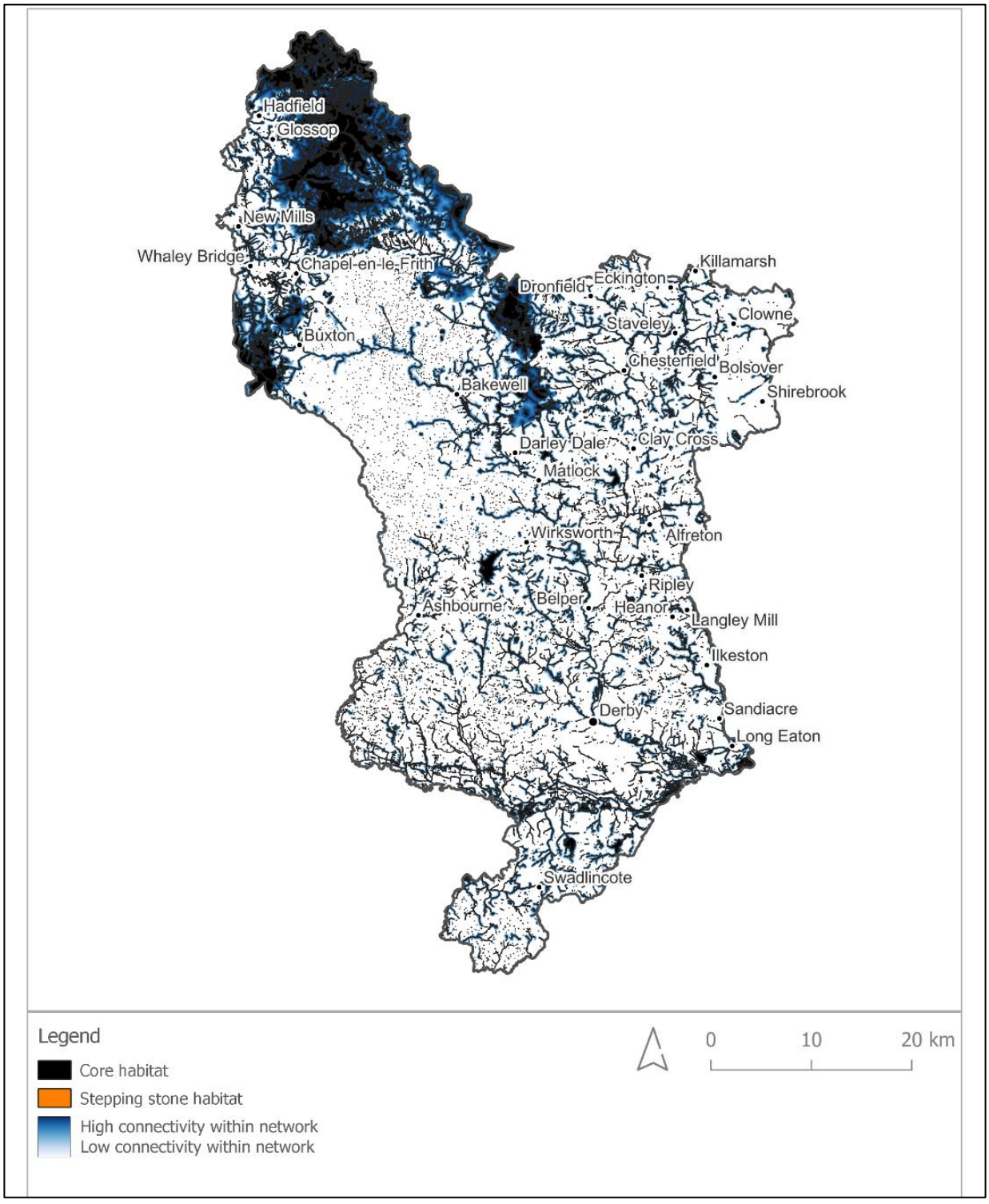

Figure 8: Wetland network

Species-rich grassland ecological network

There are several types of natural grassland in Derbyshire; the limestone grassland located on the White Peak, is of particular importance, but neutral grassland and hay meadows are also frequently found throughout Derbyshire (Figure 9). There is a large number of highly fragmented grassland habitat patches within the Needwood & South Derbyshire Claylands, and Peak Fringe & Lower Derwent regions; the grassland network is not currently working well in these areas, and these core habitat patches are likely to be less resilient/more vulnerable to pressures as a result.

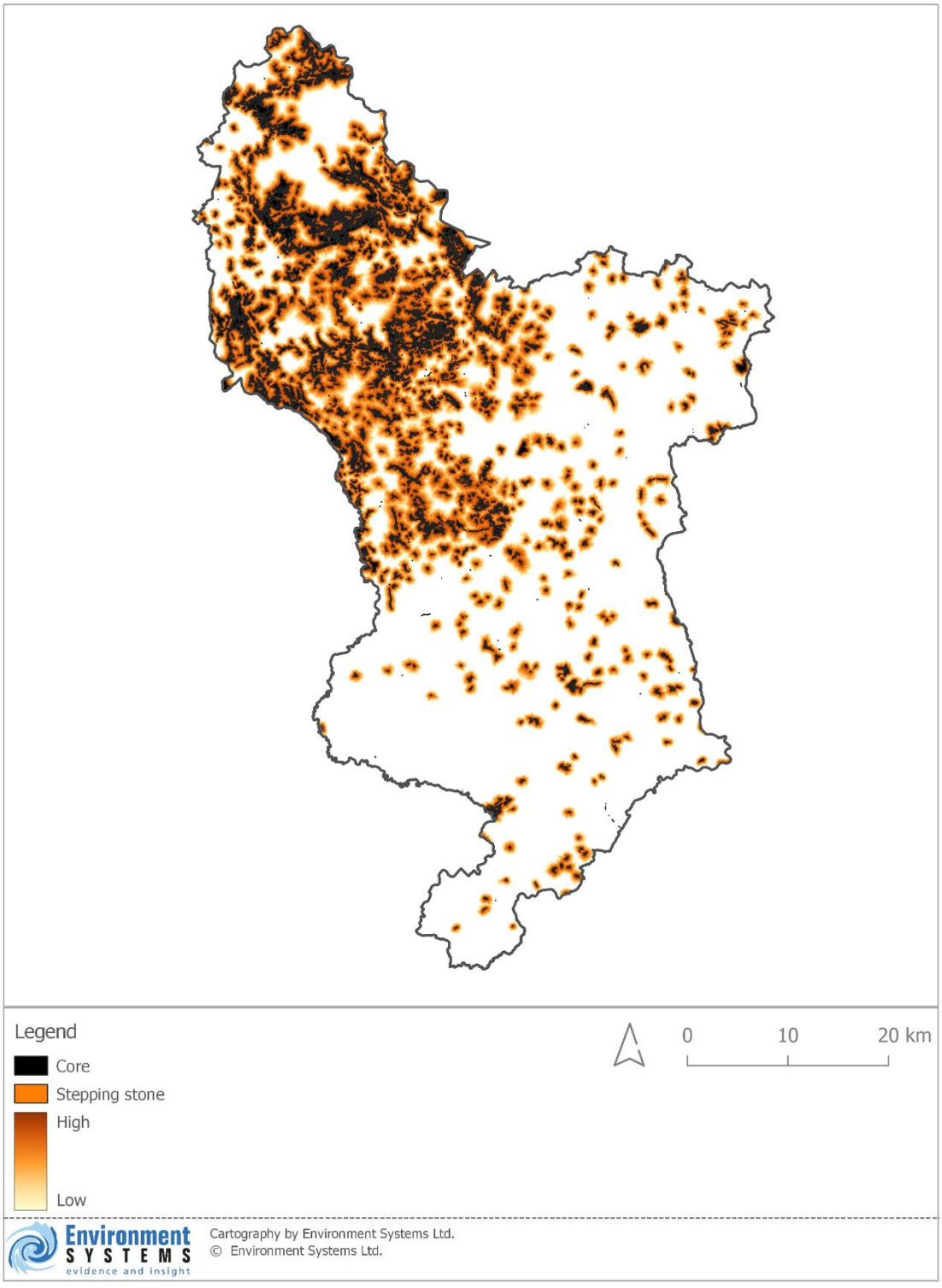

Figure 9: Natural grassland network

Opportunities for biodiversity restoration

The success of habitat restoration projects depends on the selection of appropriate sites, and the ecological networks form an important part of this decision-making process; restoration areas located within an existing ecological network will serve to enhance the resilience of the existing network and core habitat patches, while also increasing the chances of success at the restoration site, as a site located within an ecological network will benefit from species dispersal from the surrounding areas. Therefore, ecological networks will be a key component of the overall natural capital strategy.

Habitat Condition

It is important to understand the condition of habitats as this affects the delivery of ecosystem services, and what kind of opportunities exist for nature recovery. The natural capital asset register (Chapter 2: Natural Capital Baseline Assessment: Mapping for Nature Recovery) incorporates data on current habitat condition; both the extent and condition of habitat assets form the basis of the benefits assessment, which combine these data with unit value and other context data.

The Derbyshire habitat map provides information on habitat extent, and this directly feeds into the natural capital asset register. The habitat map also provides information on current habitat condition (for example the location of priority habitats, and areas of degraded habitats), that is incorporated into the asset register. Additional datasets were sourced to further describe habitat condition in the asset register.

Examples of datasets representing indicators of condition, that were utilised in this work include; land use types (habitat map), recreational land (parks), open access land, and statutory and local site designations such as Sites of Special Scientific Interest (SSSI), Ancient Woodland, Country Parks, Local Nature Reserves and National Nature Reserves; and existing monitoring and condition data (e.g. SSSI condition monitoring data, Water Framework Directive status, and flood zone areas).

Habitat condition is not a static attribute, and regular monitoring is required to maintain an accurate picture of biodiversity and wider ecosystem service analyses, and for natural capital accounting. Habitat condition is influenced by soil and vegetation management practices both locally and in the wider catchment, as well as pollution, the spread of invasive non-native species, and climatic conditions. Climate change is a significant emerging threat to habitat condition due to range shifts in ecological niches, and the frequency and magnitude of extreme events such as drought, flooding and storms[2].

Summary

A habitat map has been created for the whole of Derbyshire to inform the natural capital baseline accounts and is the foundation for ecosystem service analysis, the identification of opportunities and the formulation of natural capital strategy. The maps of ecological networks are key environmental information for modelling opportunities to enhance biodiversity and inform the LNRS. A new dataset of hedgerows has been specifically created to support the natural capital strategy. The coverage

[2] UK Climate Change Risk Assessment 2022. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1047003/climate-change-risk-assessment-2022.pdf

and level of detail that these maps provide gives Derbyshire County Council a particularly good start on designing local nature recovery projects.

Derbyshire currently has a very strong woodland network following the Derwent and Wye valleys, with large blocks of well-connected core habitats. Where hedgerows occur these greatly enhance woodland connectivity, and are particularly important for connecting the numerous smaller core habitat patches. The National Forest provides an opportunity to improve connectivity of large blocks of core woodland habitat that are currently poorly-connected in the Mease/Sense Lowlands region.

Mapping existing ecological networks is fundamental step before targeting habitat restoration and creation activities. Much greater biodiversity resilience can be created by focusing activity on sites that are within the existing networks. Habitat restoration can still be undertaken outside the existing networks, but the habitats and species they support are likely to be less resilient to pressures and disturbances. This means they will not serve to protect and enhance the existing biodiversity assets and therefore, in purely biodiversity terms they may be considered to represent a lower return on investment.

However, habitat restoration outside the ecological networks may be valuable in terms of increasing the delivery of other ecosystem services; for example, a site may not enhance the local biodiversity resilience a great deal but could lead to great improvements in the level of surface water runoff regulation, and therefore be considered a viable, value-for-money project. For this reason, a broad view must be taken, to consider the full range of ecosystem services that could be enhanced by taking action in a specific location, and to consider who/what would benefit. This is addressed in Chapter 5: Natural Capital Baseline Assessment - landscape character

Chapter 3: Spatial Distribution of Ecosystem Services, Risks and Opportunities

Ecosystem services

Derbyshires' land and the water deliver many different ecosystem services, from providing food, minerals and timber through to supporting wellbeing and other cultural services. Ecosystem services can be valued; measuring and reporting these values facilitates production of natural capital accounts (Chapter 4: The Natural Capital Accounts).

The 25-Year Environment Plan for England outlines a future where the net gain approach is expanded to include wider natural capital benefits when planning development activities or changes to land management. So rather than require only a biodiversity net gain, the projects should also result in a gain for features such as carbon capture, water regulation and control of water pollution. This is being termed environmental net gain. The key ecosystem services in Derbyshire were considered to allow the natural capital strategy for Derbyshire to report the complete set of relevant environmental net gain indicators, when considering opportunities for enhancing the environment and risks.

A crucial output of the ecosystem service analysis is the spatial data and maps identifying where in the county ecosystem service provision is strong or, conversely, weak. When the value of the land is mapped in this way, decision-makers have a more complete picture of the current value of the environment in terms of the wide range of ecosystem services it provides, and how land management decisions will impact on these. The maps and data are part of the evidence base that inform the Natural Capital Strategy, helping to identify what needs to be protected, and where enhancements can be made. The ecosystem services of most importance were chosen in a workshop held with key stakeholders from the county. Nine ecosystem services were considered key for the county and these have been grouped according to the main type of ecosystem service delivered:

Provisioning services

- Agricultural production

Supporting services

- Biodiversity

Regulating services

- Water regulation (Natural Flood Management)
- Water quality regulation
- Carbon storage (the total amount of carbon contained in vegetation and soil)
- Carbon sequestration (the amount of carbon being removed from the atmospheree and stored in anotherr form that cannot immediately be released)

Cultural services

- Recreation
- Tourism
- Contribution of agriculture to landscape character

The spatial distribution of these services has been mapped using SENCE (Spatial Evidence for Natural Capital Evaluation), an established natural capital tool developed by Environment Systems. SENCE is a modelling process that provides place-based information on natural capital and identifies:

- the stock of ecosystems services that the land is currently delivering
- where environmental risks or issues are located
- the most advantageous locations for changing land management to enhance ecosystem services.

SENCE uses a rule-based approach to map and combine individual environmental variables of the ecosystem service in question. This provides a stepped approach to building a representation of the whole, or part of, a complex ecosystem interaction.

Factors that influence ecosystem services

The main factors that influence the spatial distribution of the Natural Capital and the delivery of ecosystem services in Derbyshire are:

- **The habitat type:** Habitat type is the main driver for the delivery of biodiversity and other ecosystem services. For example, broadleaved woodlands intercept rainfall, absorbing the energy of the rain, and slowing surface runoff; which means the rainfall infiltrates into the ground more easily. The tree roots are deep; they carry water, and often also organic matter rich in carbon, down into the soil profile to be stored. In contrast, an arable field with emerging crops has much bare ground, the crop does not intercept rainfall as effectively as woodland and the plant roots are shallower. The reduced ability of the crop to intercept rainfall and help it get into the soil, leads to the rain running off the land surface potentially picking up pollutants and transferring them to watercourses, as well as potentially speeding up flood events.
- **Habitat management and condition**: The condition of habitats and their management also plays an important part in the delivery of ecosystem services, for example drained, actively eroding upland blanket bogs will not be effective at storing water and will be losing greenhouse gasses to the atmosphere, whereas an intact blanket bog will store water contributing to natural flood management and will also sequester carbon.
- **Soil type:** The soil type and condition are also important. In terms of carbon storage, organic soils store more carbon than mineral soils. Clay and silt rich mineral soils hold more carbon than sandy mineral soils. It is not possible in a county wide strategic survey to represent individual site soil conditions, but good soil management will always enhance ecosystem services.
- **Landform:** Slope will affect the role of habitats in certain ecosystem service delivery, for example on steep slopes the water will flow over the surface more rapidly, potentially carrying soil particles and causing soil erosion.
- **Hydrology:** Land close to rivers will be more impacted by river levels and flooding events, and have more influence on water quality than those areas more remote from rivers and channels. There is less opportunity for pollutants to be filtered by vegetation or soil in land that is closest to rivers.

The SENCE rule base is built around a series of key factors which interact together in different ways for the ecosystem service under consideration. As an example, the key factors can be used to describe how the biophysical properties of a parcel of land can be applied, as shown in Figure 10. By understanding these characteristics, it is possible to infer the functions that each parcel of land provides and therefore identify the societal benefits and dis-benefits.

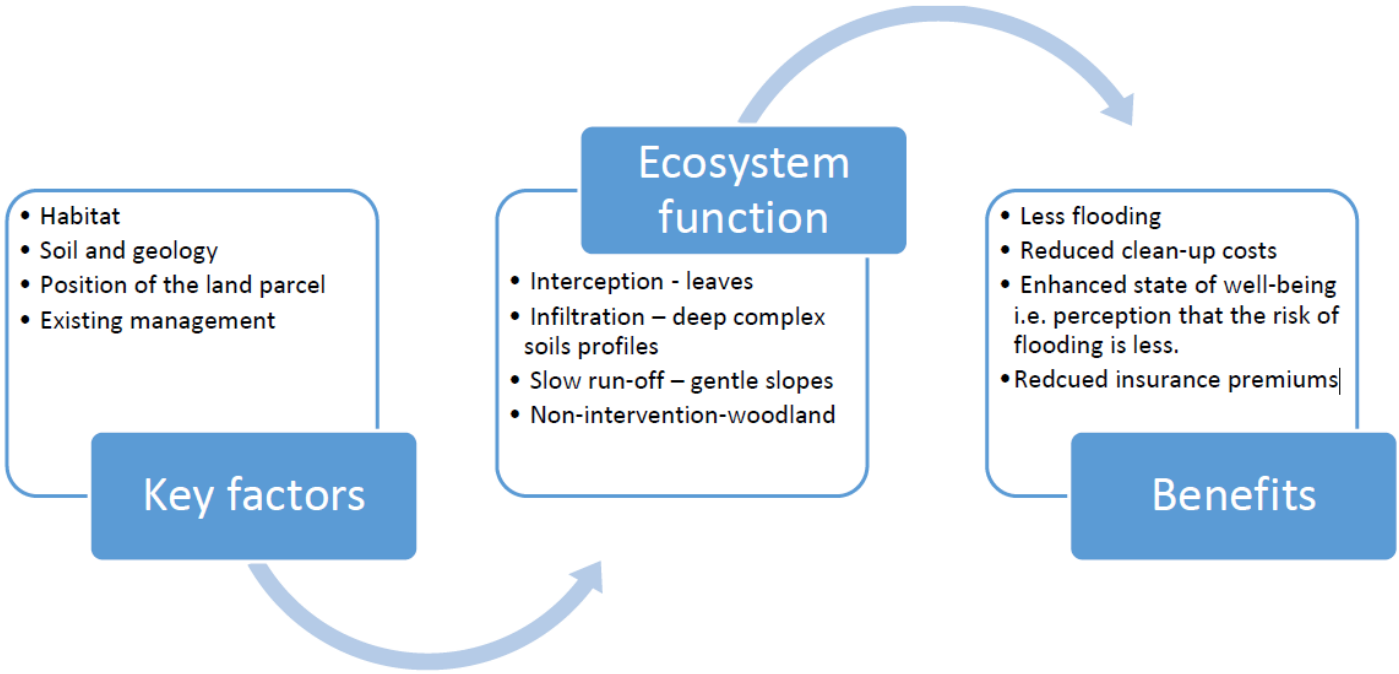

Figure 10: Identification of living systems, their management and the flow of ecosystem service for detention time of overland flow

Additional spatial datasets were sourced for modelling the ecosystem services and these are listed in Appendix 4. Information on the methodology used to produce each ecosystem service map is provided in Appendix 5.

Nature-based solutions

The best way to enhance ecosystem services and address risks and issues is to restore native habitats and species in locations that would naturally support their biophysical requirements. This is known as nature-based solutions. The existing land cover and soil types are the features of primary importance when considering where the opportunities to restore natural habitats. For example, habitats which have the requirement for a nutrient poor soil environment such as native woodland, or species-rich acid grassland, cannot be established well on land that is currently under arable land management, which has a higher pH and nutrient loading, without drastic action to ameliorate the soil environment. If the land is currently an old improved ley for permanent grazing pasture, with a lower pH and nutrient load then the woodland is likely to establish more quickly and is more likely to support the full range of species associated with the native habitats; this will enable a functioning ecosystem to form quickly. In addition, if the restoration area is within the ecological network for woodland, then there are likely to be features such as seeds and pollinators which will move into the woodland and increase the genetic diversity and in turn, its resilience.

The topography and hydrology of areas are also significant in prioritising the optimum areas to develop nature-based solutions. Some species prefer shadier locations, other sunnier ones, some will thrive on exposed ridges, while others prefer sheltered, wet hollows. Wetland creation must consider aspects such as soil drainage, slope and hydrological connectivity; attempting to establish a natural wetland on a naturally freely draining site would face many challenges.

Climate change

Climate change is an important emerging risk to all ecosystem services due to its impact on the underlying key factors of habitat, soil and land management. However, spatially mapping climate change impacts on ecisystem services at the county scale is difficult because the level of risk varies according to local site resilience, which itself is dependent on multiple contributing factors that are difficult to quantify.

As a general rule of thumb, habitats that are currently in favourable condition, are connected through a strong ecological network, and are surrounded by a range of topographic niches, are considered to be more resilient to the impacts of climate change than habitats that are currently in poor condition and more fragmented, with limited opportunities for species migration as the climate changes. A freshwater habitat may become stressed due to reduced summer water levels as a result of climate change; the level of stress and the ability of the habitat to recover will depend on its starting condition and the frequency and magnitude of the stress events that occur. A habitat that is already stressed by pollution levels and invasive non-native species is likely to be less able to recover than a habitat that is in a better starting condition.

The complexity and local variability of these interactions means that climate change has not been considered as a standalone risk factor in the ecosystem service modelling. However, actions to enhance the condition and local resilience of habitats will also enhance climate change resilience.

The predicted trends in climate change in Derbyshire are discussed on Chapter 8: The impacts of climate change.

Irreplaceable habitats

Some species-rich priority habitats within Derbyshire contain native species that are irreplaceable, because these habitats cannot be reconstructed in a different place. In these cases, the particular combination of soil, geology and hydrology is very closely attuned to the habitat that has developed over centuries at that place. An example is the calcareous grassland Priority Habitat. Irreplaceable habitats are defined as:

> *"habitat that cannot be recreated within a specified timeframe because it would be technically very difficult or impossible to recreate taking into account their age, uniqueness, species diversity, rarity and environmental or historical context. These habitats are also likely to be particularly vulnerable to threats such as degradation, fragmentation or loss. In the UK, there is no definitive list of irreplaceable habitats … the full range of factors affecting irreplaceability should be taken into account when determining the status of a particular habitat."*[3]

Natural England is in the process of developing a more comprehensive definition for 'irreplaceable habitats' together with a 'high level' list of habitat types that are considered likely to fall within the revised definition in England. Natural England will retain control of the list and definition and may provide additional evidence and guidance to define irreplaceable habitats and to make additions or deletions to the list.

[3] British Standard BS8683:2021 – Process for Designing and Implementing Biodiversity Net Gain – Specification (BSI, 2021)

Conceptually, individual stands of habitat need to be assessed to determine whether they are irreplaceable or not due to the variation that is likely to occur within particular stands of Priority Habitat. In order to assist practitioners and stakeholders with identifying irreplaceable habitats, Natural England is regularly reviewing its habitat inventories[4]. The national inventories of priority habitats provide a reasonable starting point for identification of irreplaceable habitats, however considerable work is required to maintain and update these inventories. There should be a clear mechanism to add to, and subtract from, the inventories to correct errors, with a right to appeal that is transparent for all stakeholders involved.

Irreplaceable habitats are vulnerable to misidentification by ecologists and degradation through management changes. Therefore, all irreplaceable habitat stands (or those potential to be irreplaceable) should be subject to independent verification as part of any development-related process to ensure that they have been correctly identified.
Work to update the inventories should be undertaken soon, as there is a substantial risk that stands of habitat that are not on the current lists will be subject to poor management or deliberate degradation to render them less likely to meet irreplaceable habitats thresholds.

Outputs and analysis: ecosystem services – stock, opportunity and risk

Agricultural production

The stock of the most highly productive agricultural areas is located in the Southern Magnesian Limestone and in valley bottom areas, particularly in the catchments of the Melbourne Parklands, and Mease/Sense Lowlands (Figure 11 & f
Figure 12). Productivity is highest where the soil and topography are most suited to agriculture. This is defined as the 'Best and Most Versatile (BMV) land measured using the Agricultural Land Classification (BMV is ALC Grades 1, 2 and 3a).

Risk to agricultural production is currently driven by new market forces which are taking the ALC BMV land out of production. This is an issue as this land supports the widest range of crops and losing this land may affect food security. As well as affecting agricultural production these market driven changes will affect the landscape character; particularly in those areas where agriculture plays a significant role in the landscape character.

Maps have been produced to show high quality agricultural land that may be targeted for woodland for carbon schemes and making a distinction of whether the areas are within or outside of the woodland network (Chapter 2: Natural Capital Baseline Assessment: Mapping for Nature Recovery). The highest concentration of risk is in the south of the county. Areas which may be suited for solar (Figure 14) or wind energy generation (Figure 15 and Figure 16) have also been mapped and have similar locations. Areas have been classified as a higher risk of a loss of agricultural production if there are deemed to be fewer constraints to establishing renewable energy projects. Risks to a loss of

[4] Priority Habitat inventories are published by NE and are regularly updated. Current dataset (09/08/2022) is available here: https://www.data.gov.uk/dataset/4b6ddab7-6c0f-4407-946e-d6499f19fcde/priority-habitat-inventory-england

agricultural production have been based on assessments from the Derbyshire Spatial Energy Strategy[5].

The risk maps consider all scales of renerable energy generation (micro to very large), and identify areas where applications for renewable energy are most likely to be lodged and approved. The maps do not identify the level of risk to productivity associated with each scale of generation; therefore it has not been possible to classify the level of risk to agricultural production according to generation scale (for example, small wind schemes would lead to lower impacts on productivity than larger schemes).

Where point data mapping the location of existing energy generation proposals were available, these were included only for schemes proposing significant scales of development (>1MV; medium to very large schemes). It is important to note that while the Spatial Energy Strategy considered agricultural land quality and landscape character sensitivities in its assessment of site suitability for energy generation, it did not consider grid connection costs; therefore the mapped areas are likely to be an overestimation of what is currently technically feasible in terms of energy generation, or planned improvements to grid connections.

Key points and recommendations for nature-based action: Agricultural Production

- **Change management practices** to increase resilience to climate change; for example, altering the types of crop grown and cropping cycles.
- **Agroforestry:** integration of trees and shrubs into crop and animal farming systems to create a range of environmental, economic, and social benefits, including climate change adaptation by way of providing shelter from extreme temperatures, benefiting animal welfare.
- **Embrace regenerative agriculture:** supported by innovative technologies this approach reduces the use of water and other inputs. Through preventing land degradation and deforestation, this approach also protects and improves soil, biodiversity, climate resilience and water resources, while making farming more productive and profitable in the face of climate change.
- **Renewable Energy:** changing land use to support renewable energy generation can support income generation and provide other environmental benefits.

[5] Scene Connect (2022) Derbyshire Spatial Energy Study. Evidence base for policy makers. Derbyshire County Council

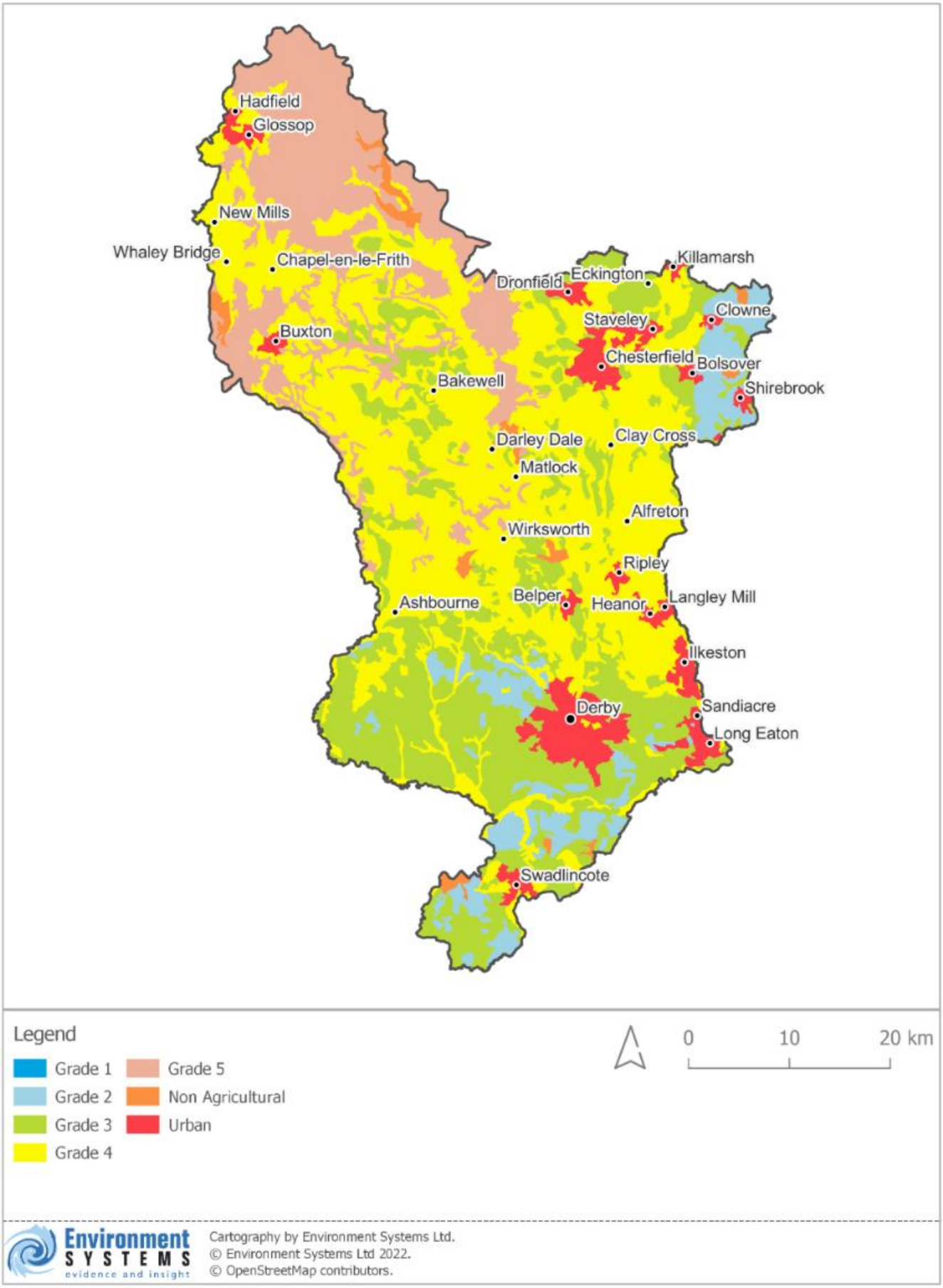

Figure 11: Agricultural Land Classification

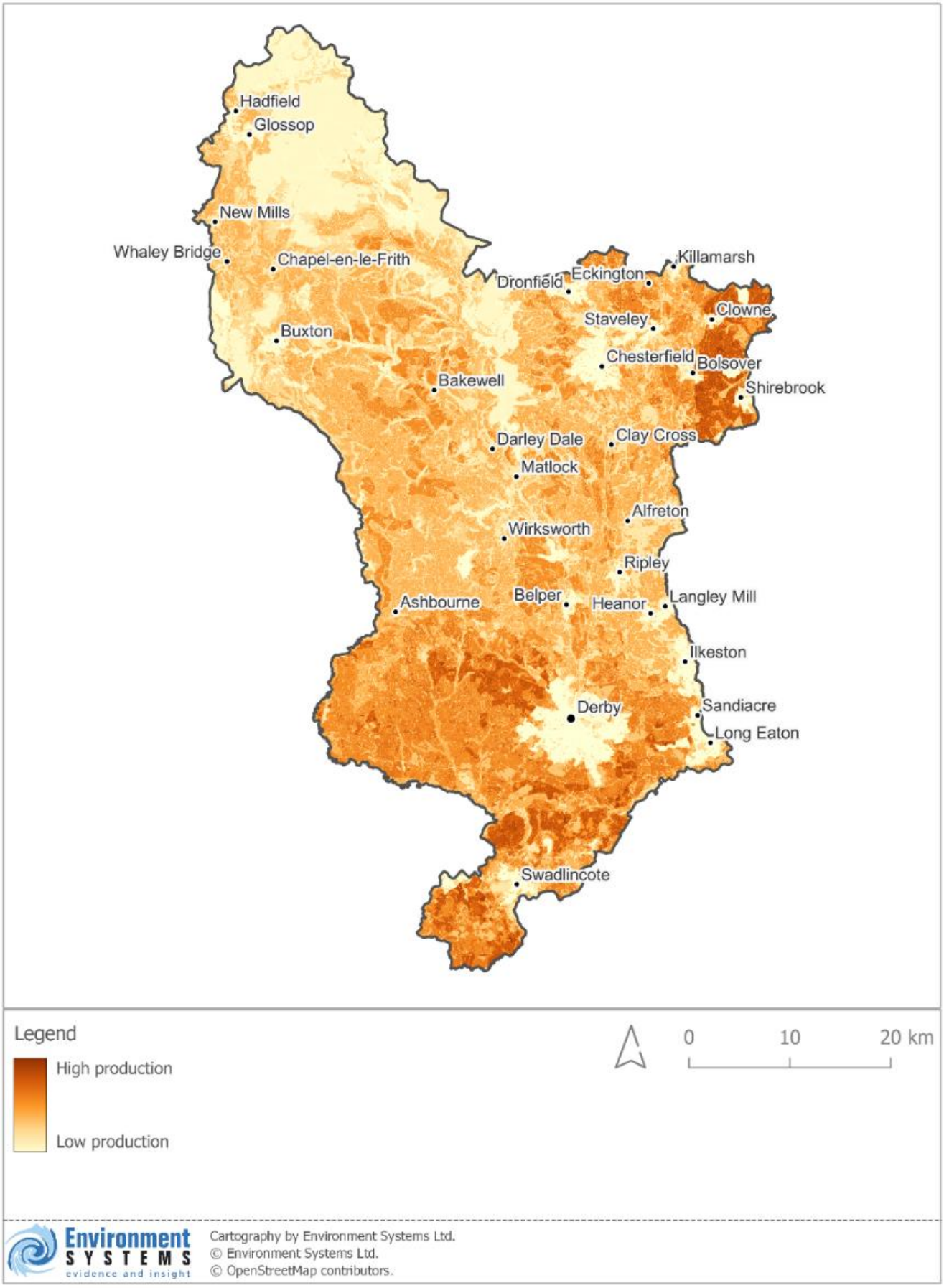

Figure 12: Agricultural production: current provision (stock)

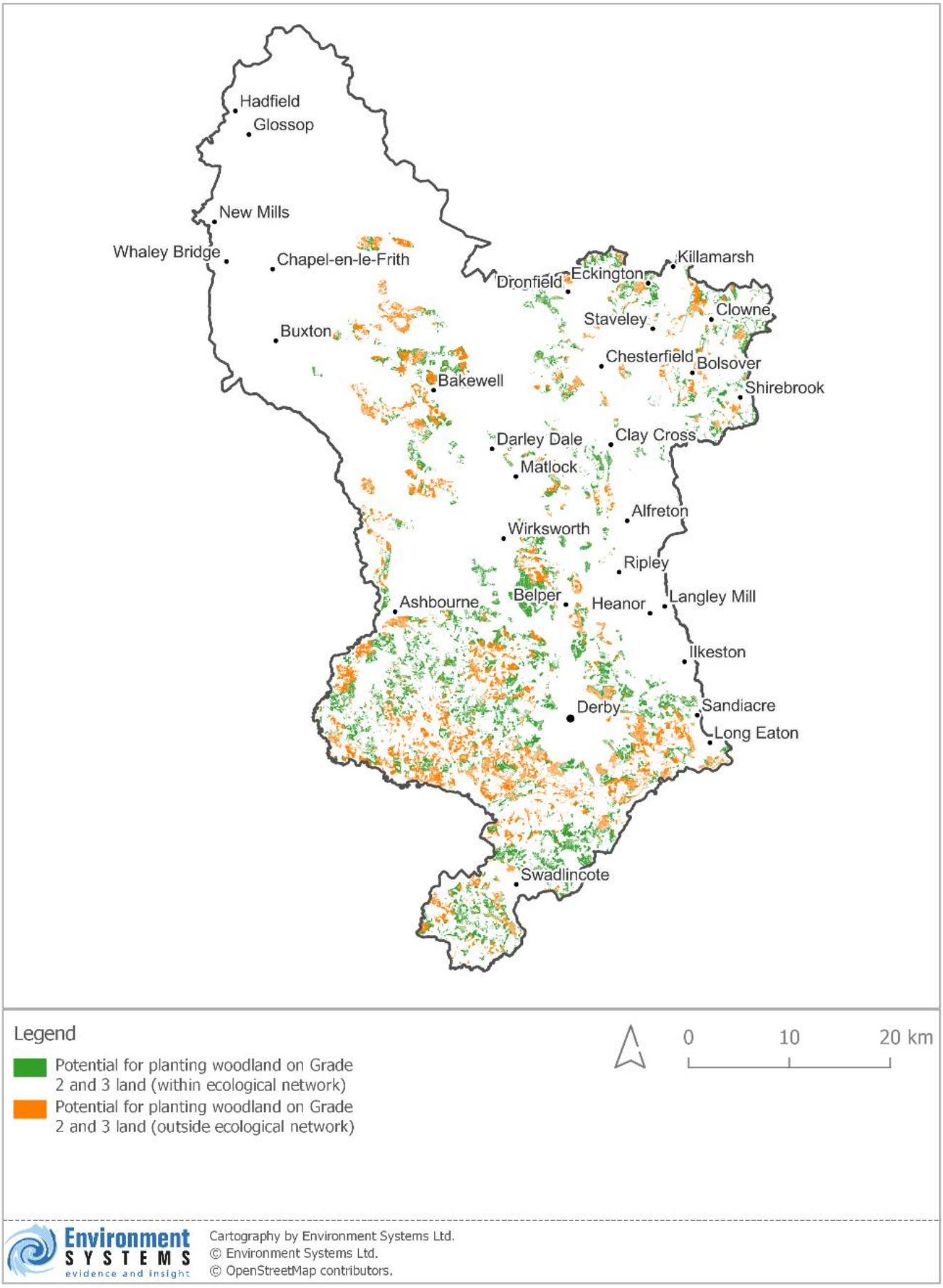

Figure 13: Risks to agricultural production: potential conflicts with woodland objectives

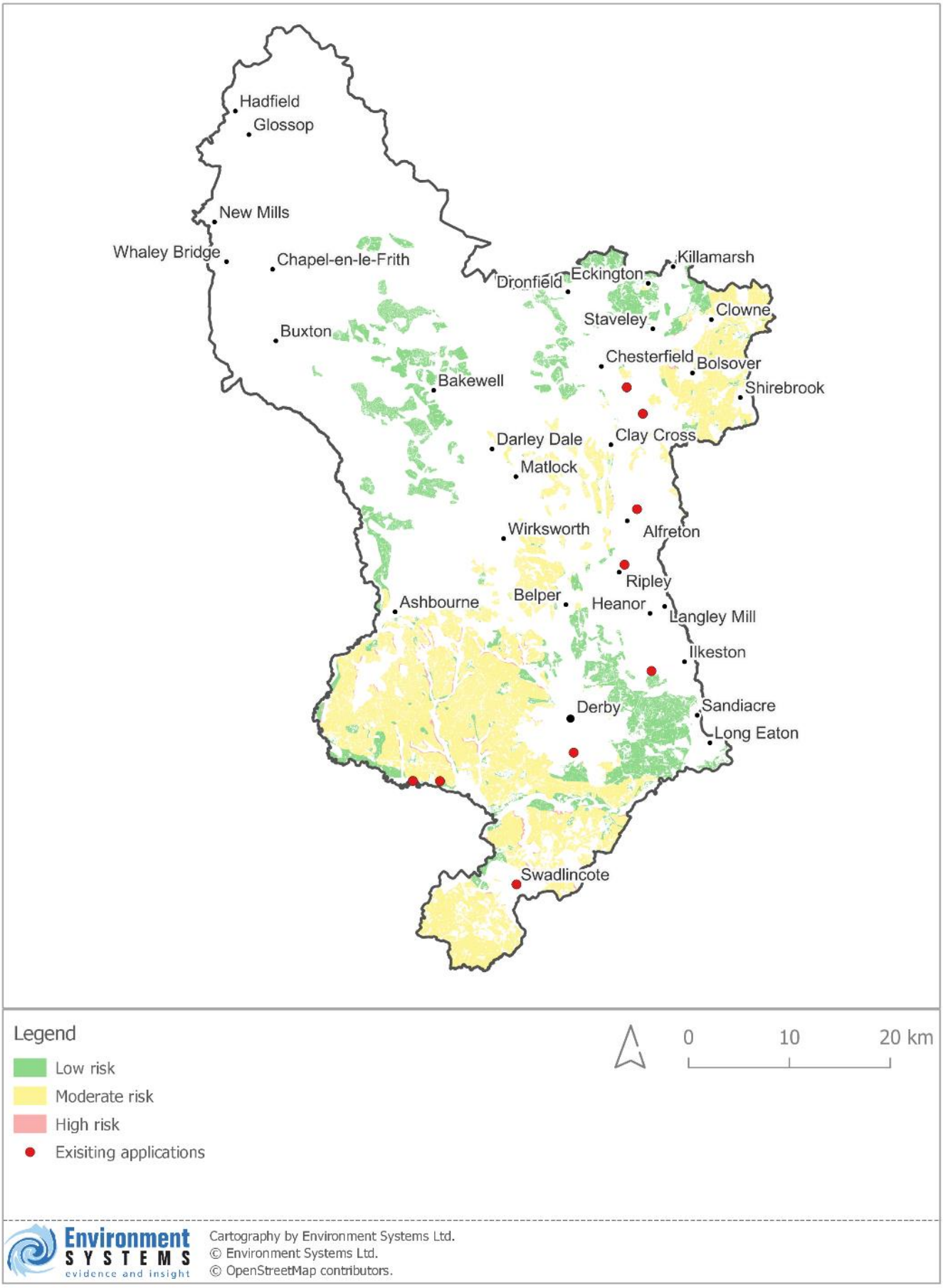

Figure 14: Risks to agricultural production: ground-mounted solar PV

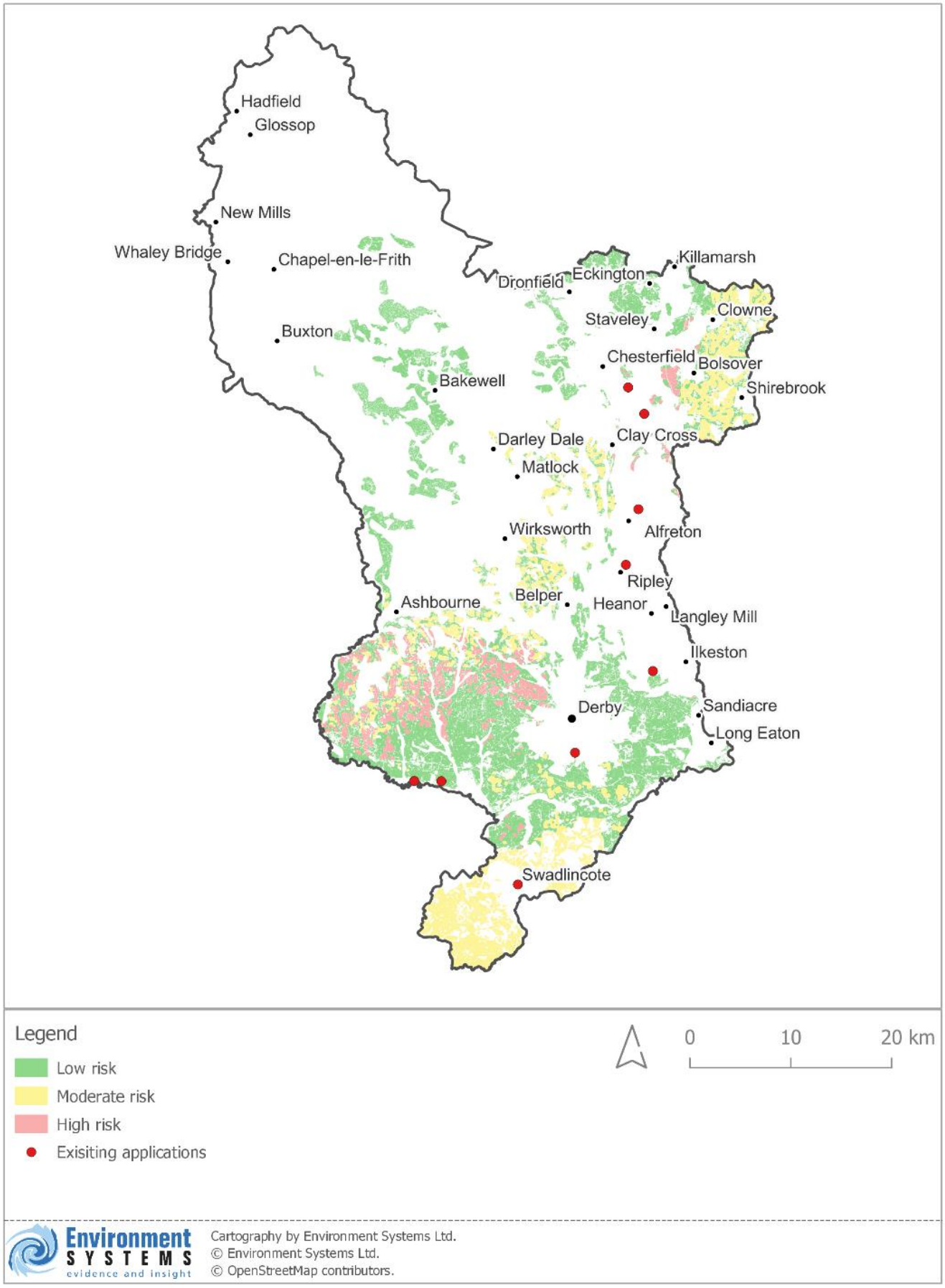

Figure 15: Risks to agricultural production: small wind generation

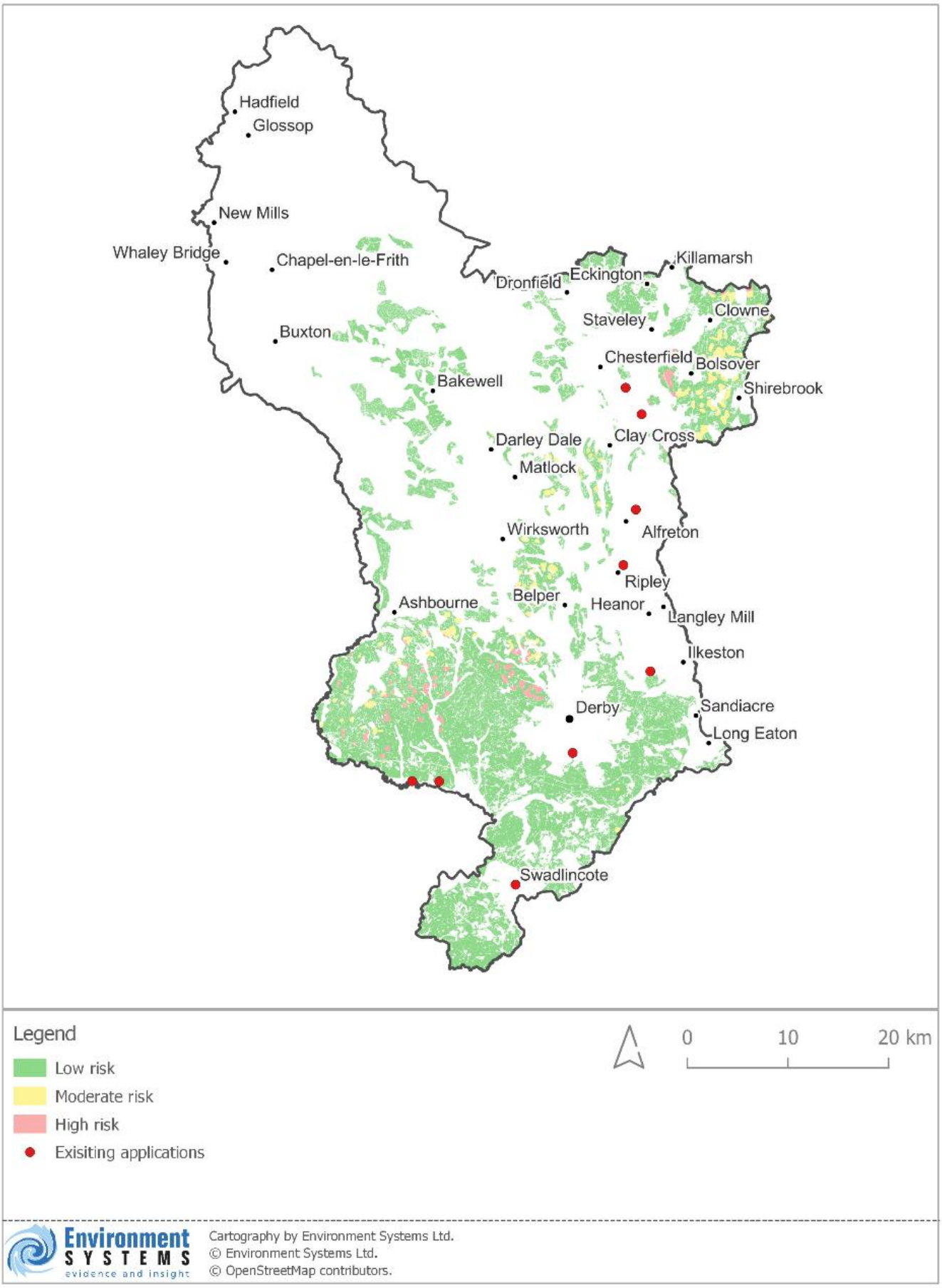

Figure 16: Risks to agricultural production: large wind generation

Biodiversity and irreplaceable Habitats

Very significant areas of biodiversity stock, known as biodiversity hotspots, are located in the northern areas of the Peak District National Park (Figure 17 and Figure 18), which also support the most important heath (Figure 21) and wetland ecological networks in Derbyshire (Figure 23). Other biodiversity hotspot areas that are outside of the National Park are found in White Peak, the Peak Fringe. Lower Derwent, Melbourne Parklands and Southern Magnesian Limestone areas (Figure 18).

There are opportunities for creating new areas of grassland, heath, wetland and woodland habitat (Figures 19-26) which will strengthen the ecological networks in Derbyshire. A comparison has been made between these ecological network maps and the more strategic scale Natural England Nature Recovery Networks (NRNs) which are based on less comprehensive and detailed data. This is informative to the Derbyshire natural capital strategy because where the NRNs coincide, the delivery of natural capital projects will meet both local and national priorities. For example, Figure 19 shows all opportunities throughout Derbyshire for creating species-rich grassland habitat, while Figure 20 solely shows those opportunities that coincide with the Natural England grassland NRNs. Opportunities that coincide with the NRNs will be particularly effective at supporting national biodiversity objectives, but opportunity areas outside the Natural England NRNs maps could be very important at a local scale, and may also provide significant co-benefits in terms of other ecosystem services.

There is widespread opportunity for creating both grassland (Figure 19) and woodland (Figure 25) across Derbyshire, with concentrations of opportunity for grassland creation within the existing grassland network in the Peak District National Park and the Peak Fringe and Lower Derwent. Opportunities for woodland creation lie along the river valleys and other lower lying areas of the county. Through development of the National Forest there is an opportunity to enhance connectivity of large areas of core woodland habitat that are currently relatively isolated, and enhance their resilience.

Opportunities for heath creation are located in the Peak District National Park, as well as in the more southern areas of Derbyshire from the Needwood and South Derbyshire Claylands to the Mease/Sense Lowlands (Figure 21). Opportunities for creating wetland are concentrated in the Trent Valley Washlands (Figure 23). Heath shows a very large potential opportunity space outside the existing ecological network, but these 'outside of network' areas should be treated with caution; due to its exacting mycorrhizal requirements, it is very difficult to establish heath unless it borders, or is in close proximity to, existing heath. An exception to this is areas of coniferous plantation that may have been planted on heath; such areas could revert quickly back to heath habitat.

Key points and recommendations for nature-based action: Biodiversity

- **Maintain and enhance existing biodiversity hotspots:** prioritise areas containing significant stock of irreplaceable habitat; including The Peak District National Park, White Peak, and Derwent valley.
- **Increase the connectivity of existing habitats**: prioritise ecological restoration activities within the ecological networks, to promote nature recovery and increase habitat resilience to pressures including climate change.
- **Consider the size of the habitat:** the size of a habitat patch is important in selecting sites for restoration and habitat creation. For example a woodland site <2ha is considered vulnerable, while a much smaller patch of Calaminarian grassland could be considered resilient.
- **Consider the existing ecology of the site:** habitat restoration is most successful when the soil conditions of the restoration site are similar to those associated with the native habitat. For certain habitats such as heathland, soil mycorrhizal associations are so important that the restoration site will need to either be adjacent to the existing habitat, or an element of soil translocation from a donor site would be needed to improve the success rate of habitat establishment. Coniferous plantations on former heath sites may retain the soil conditions needed for heath establishment, making good candidates for heath restoration.
- **Consider ecosystem multi-benefits:** habitat restoration to support biodiversity can also provide other valuable ecosystem services such as flood management, benefits to agriculture and carbon storage. Consideration of multi-benefit areas can help in the prioritisation of restoration sites.
- **Ensure appropriate mitigation actions are taken by developers**: 'Bespoke compensation' should be required to mitigate the damages potentially caused mitigation of development projects that lead to losses of irreplaceable habitats
- **Establish long-term management agreements:** Habitat restoration and creation projects should be accompanied by a secured agreement for long-term management to ensure success and sustainability

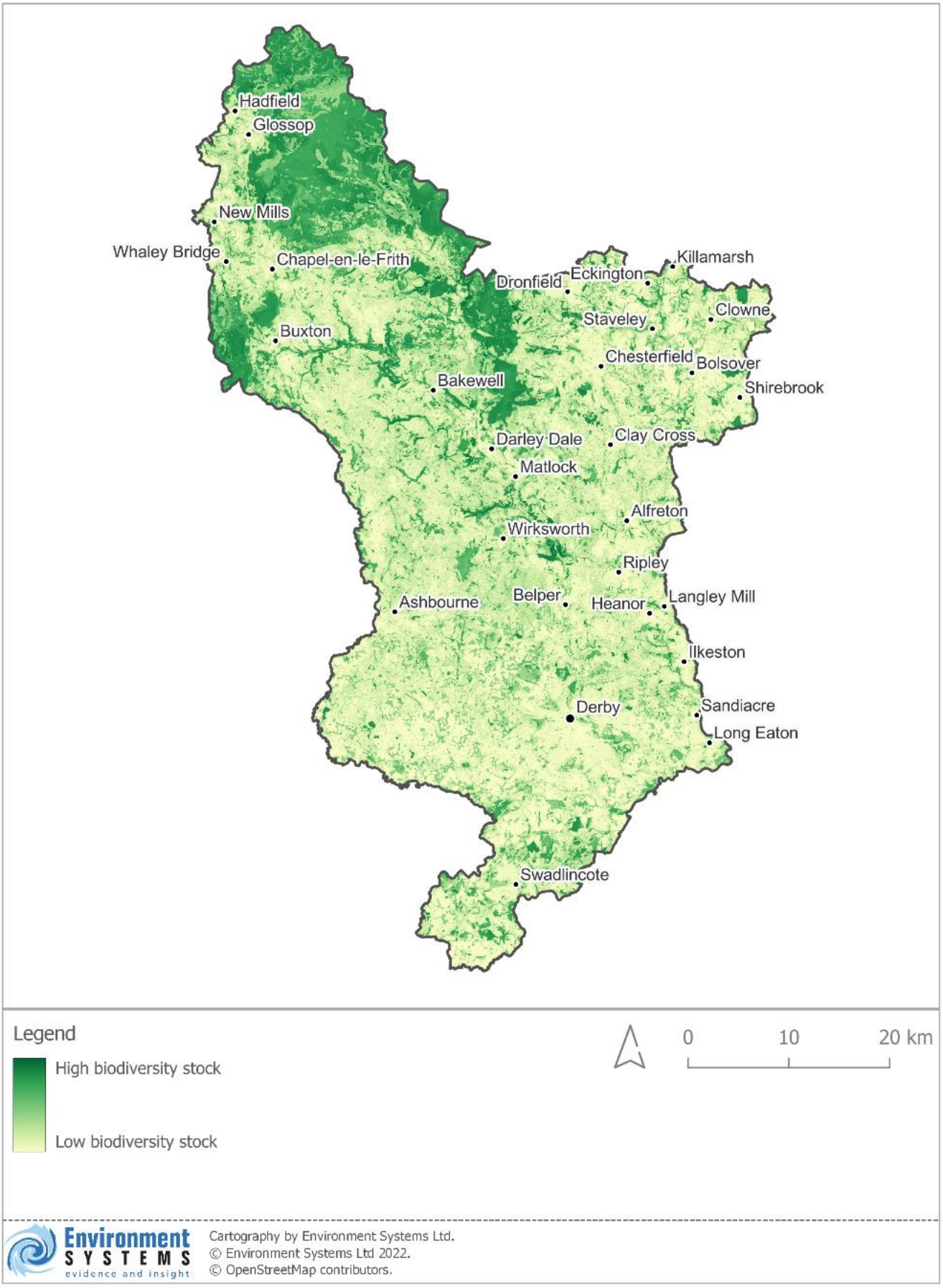

Figure 17: Biodiversity: current provision (stock)

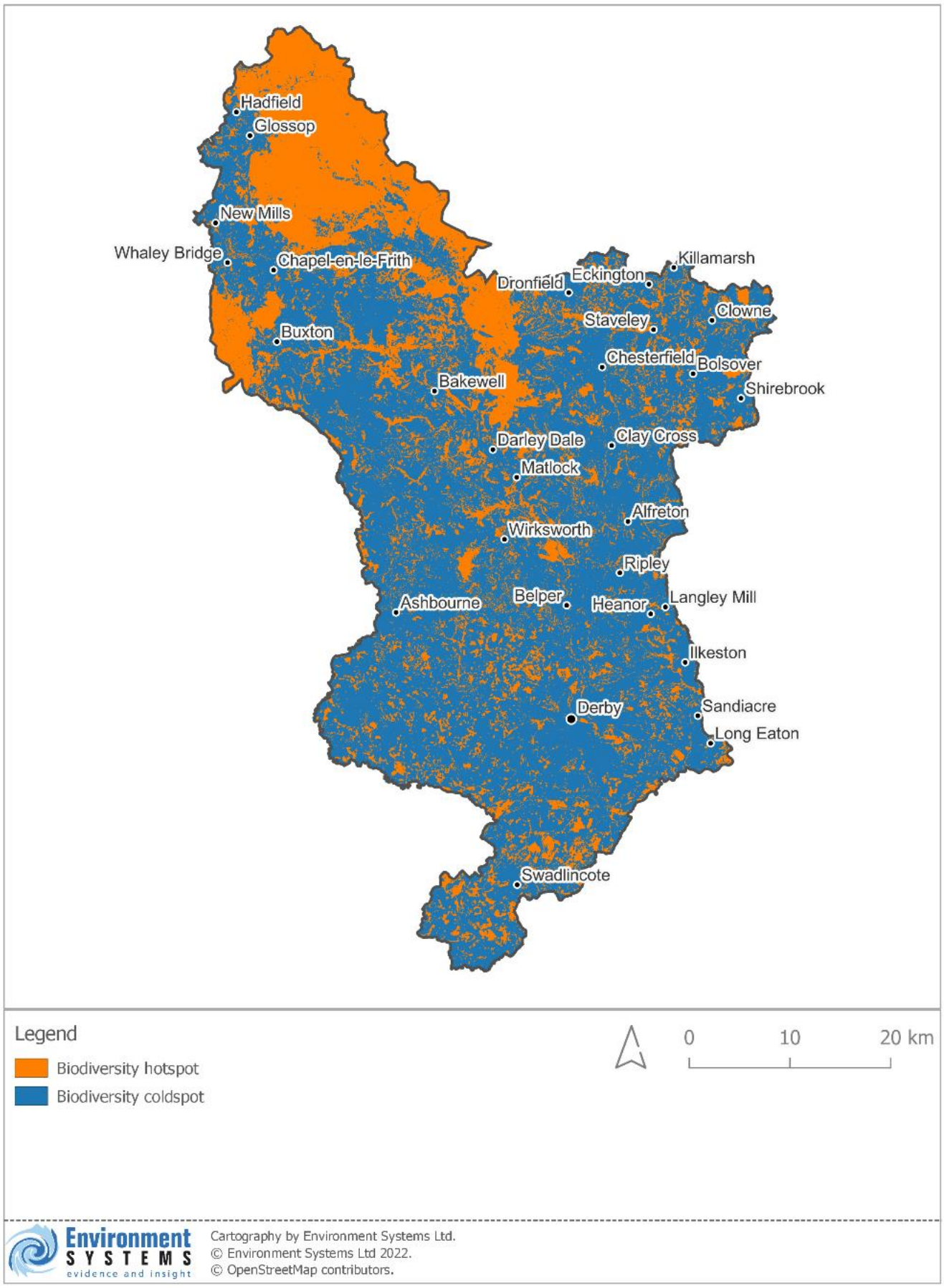

Figure 18: Biodiversity hotspots / coldspots

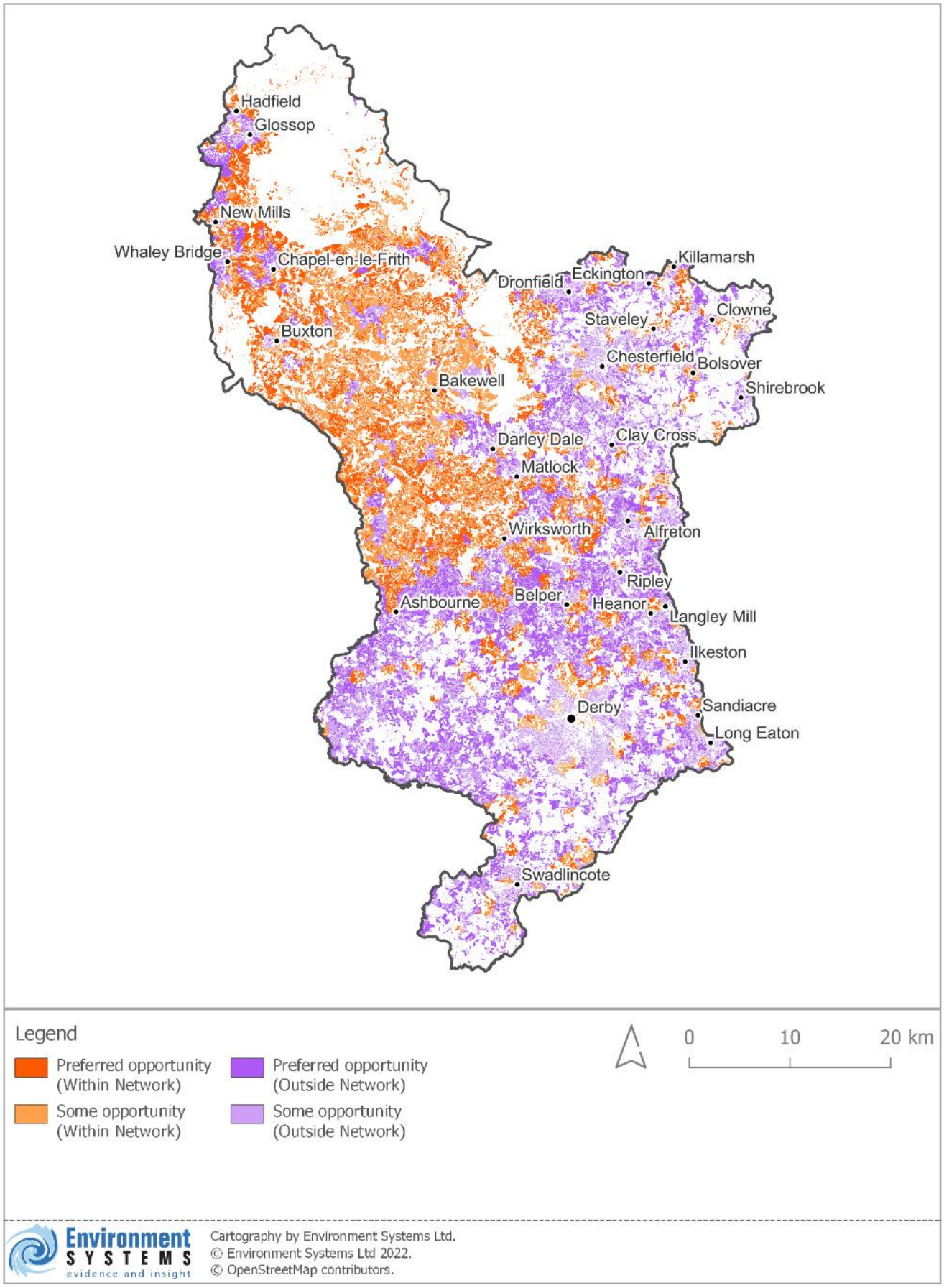

Figure 19: Opportunities for establishing species-rich grassland

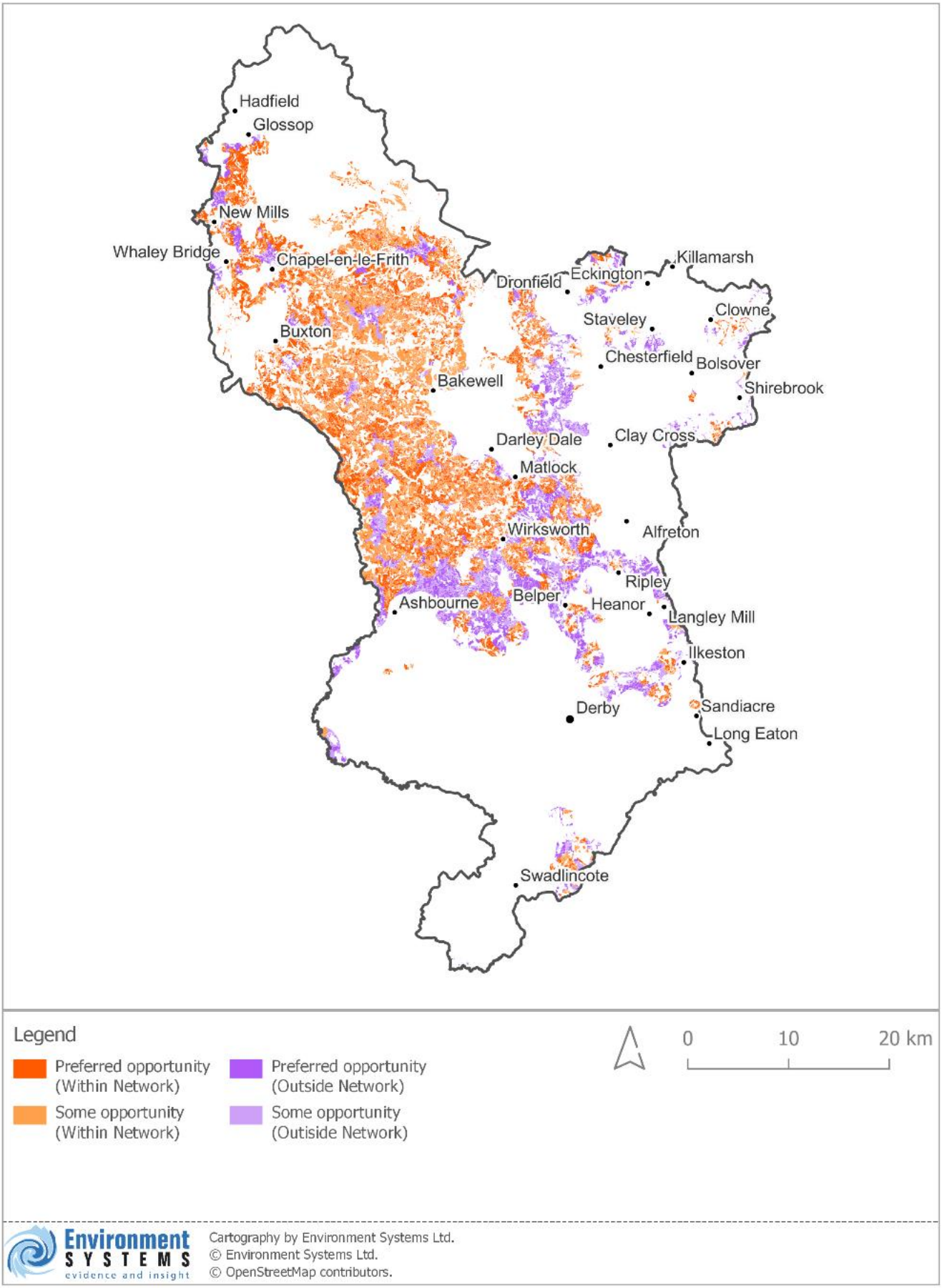

Figure 20: Opportunities for establishing species-rich grassland in relation to Natural England national grassland NRNs

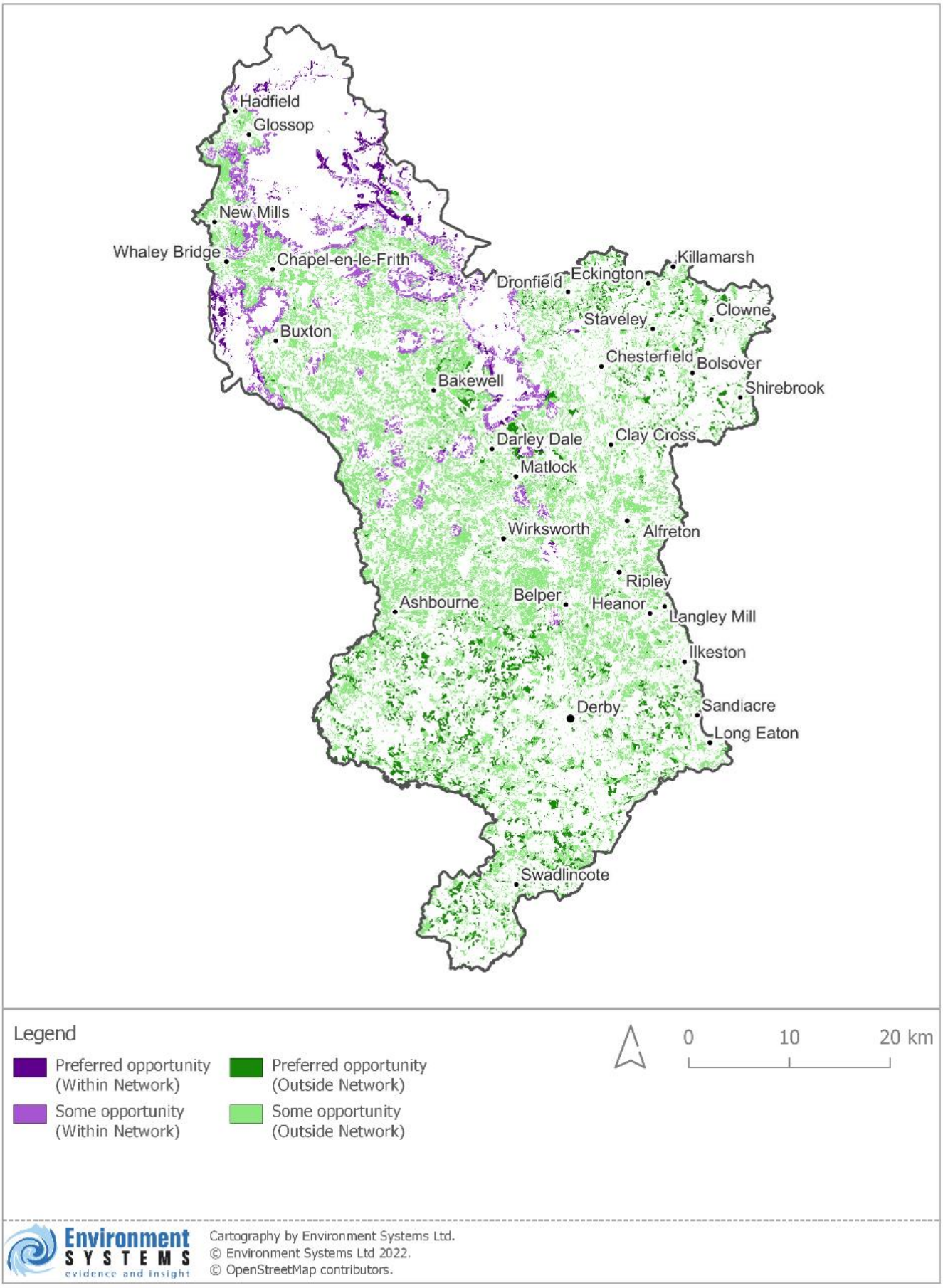

Figure 21: Opportunities for establishing heath

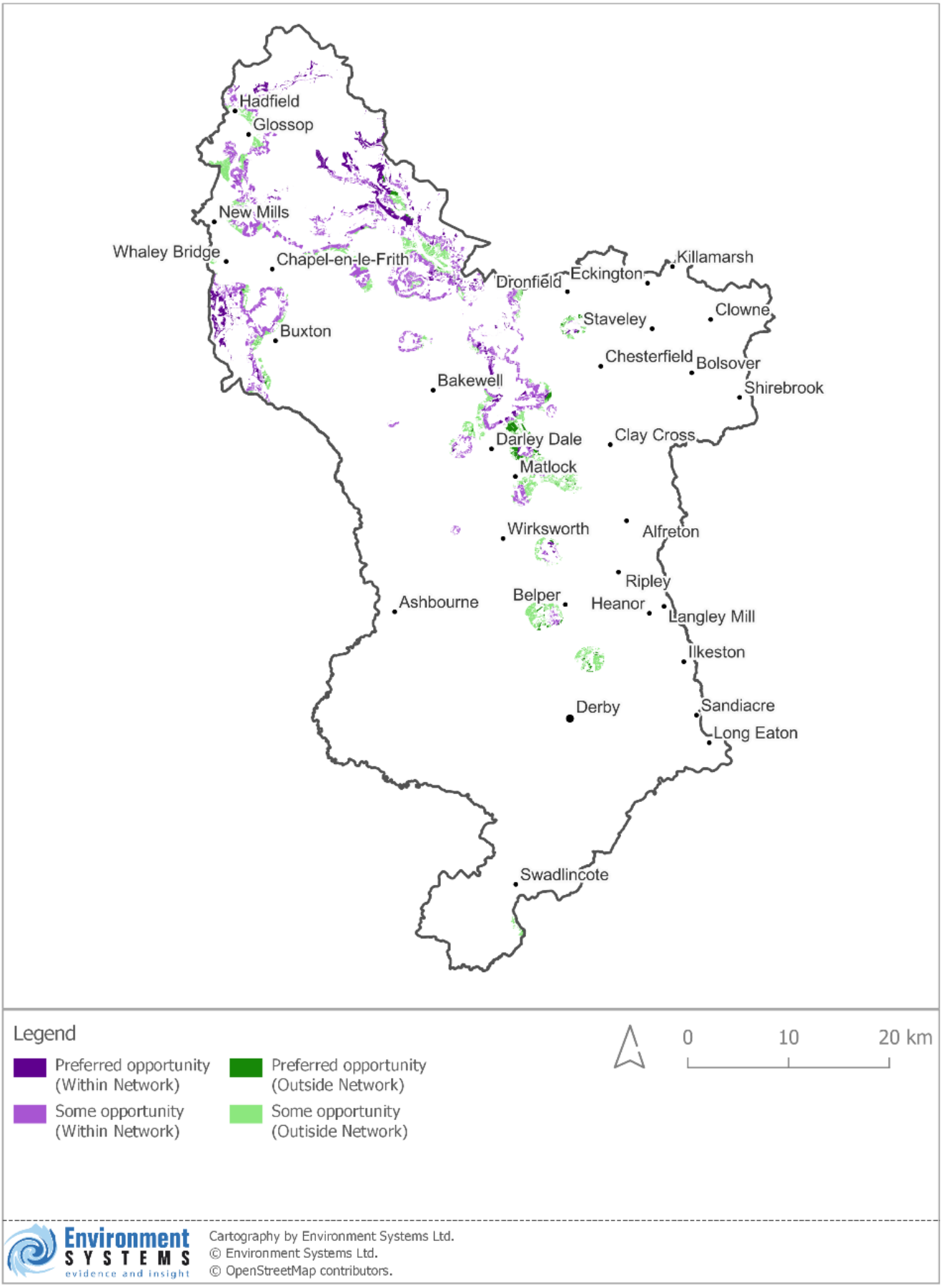

Figure 22: Opportunities for establishing heath in relation to Natural England national heathland NRNs

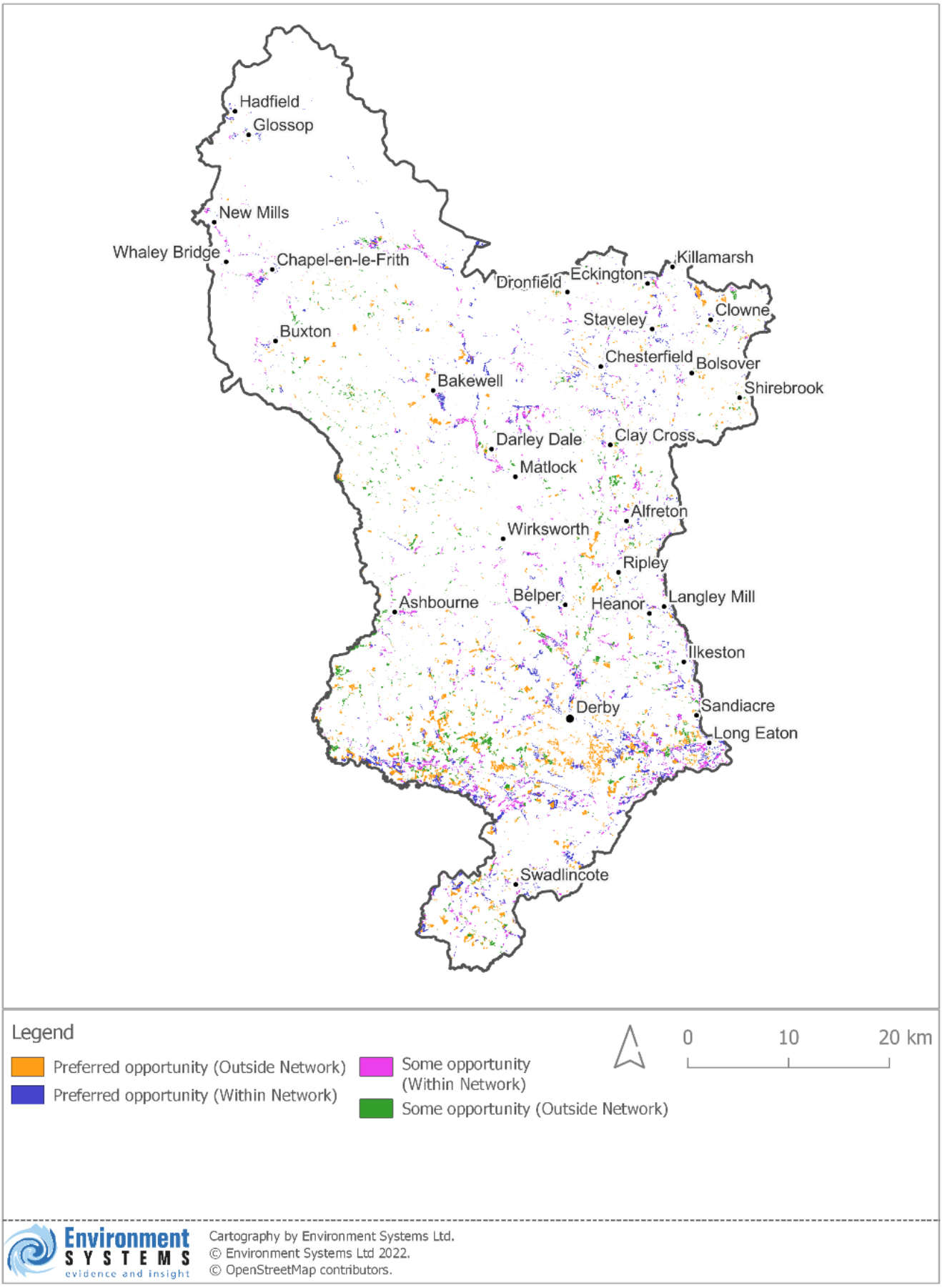

Figure 23: Opportunities for establishing wetland

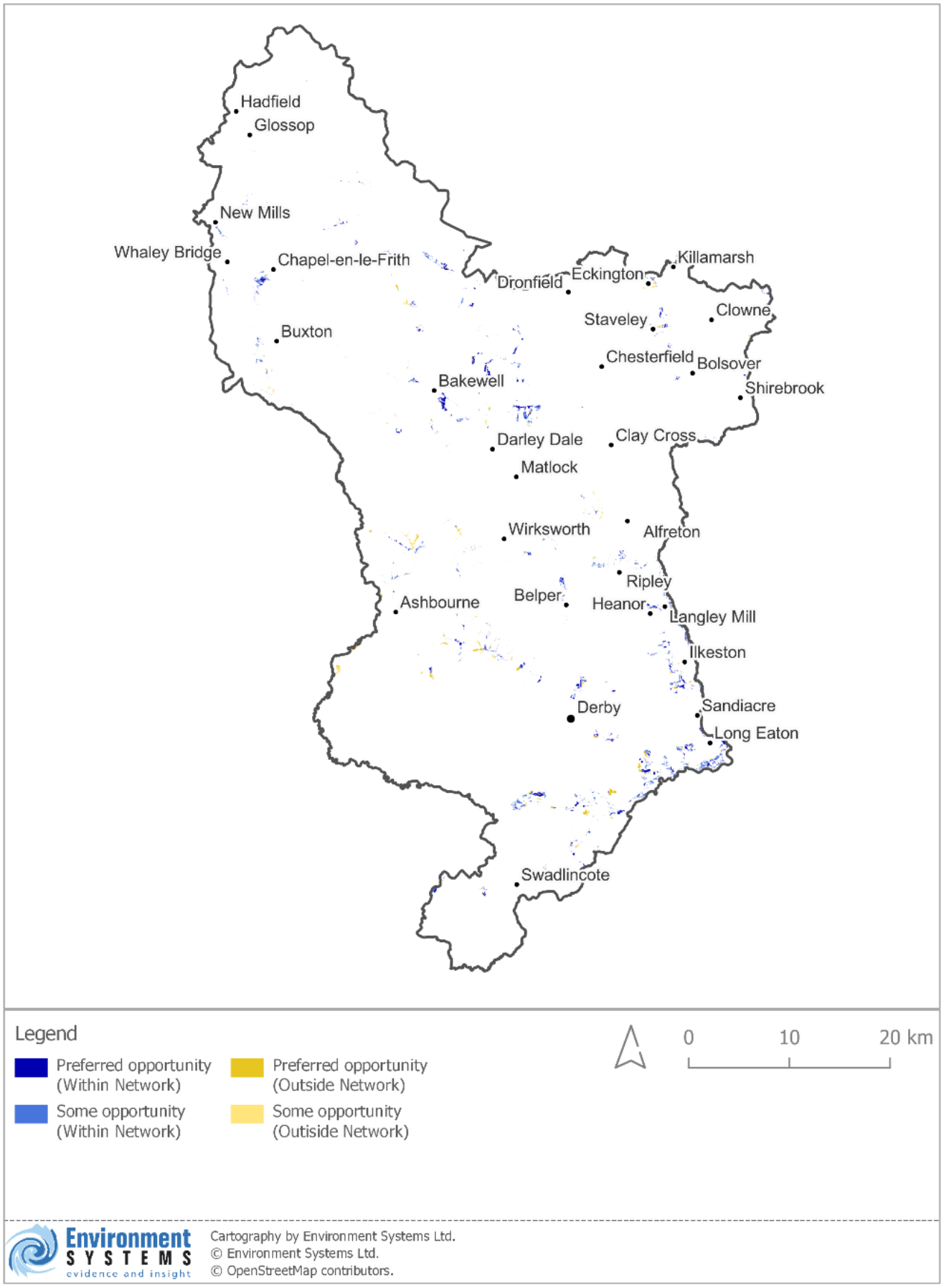

Figure 24: Opportunities for establishing wetland in relation to Natural England national wetland NRNs

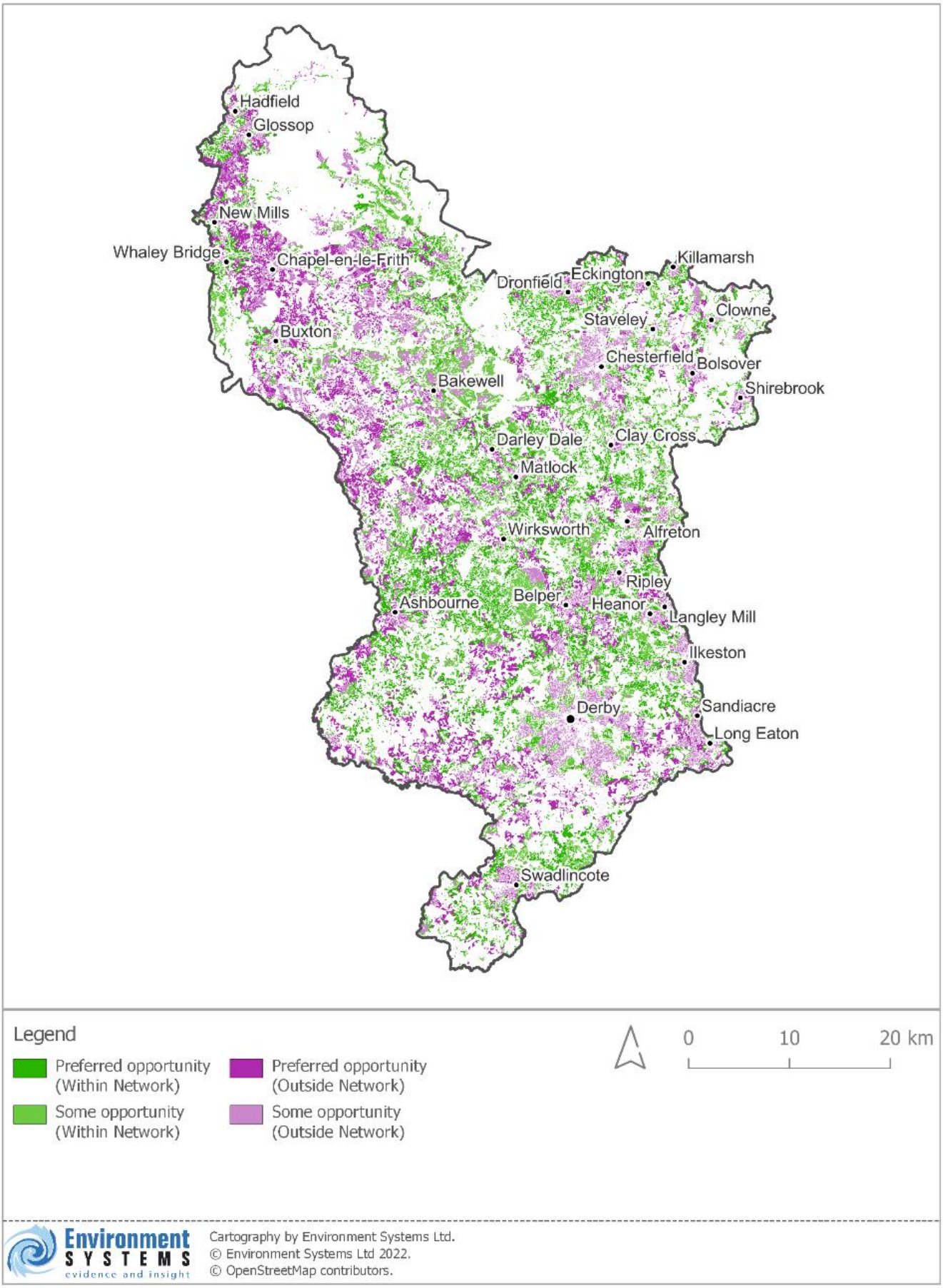

Figure 25: Opportunities for establishing woodland

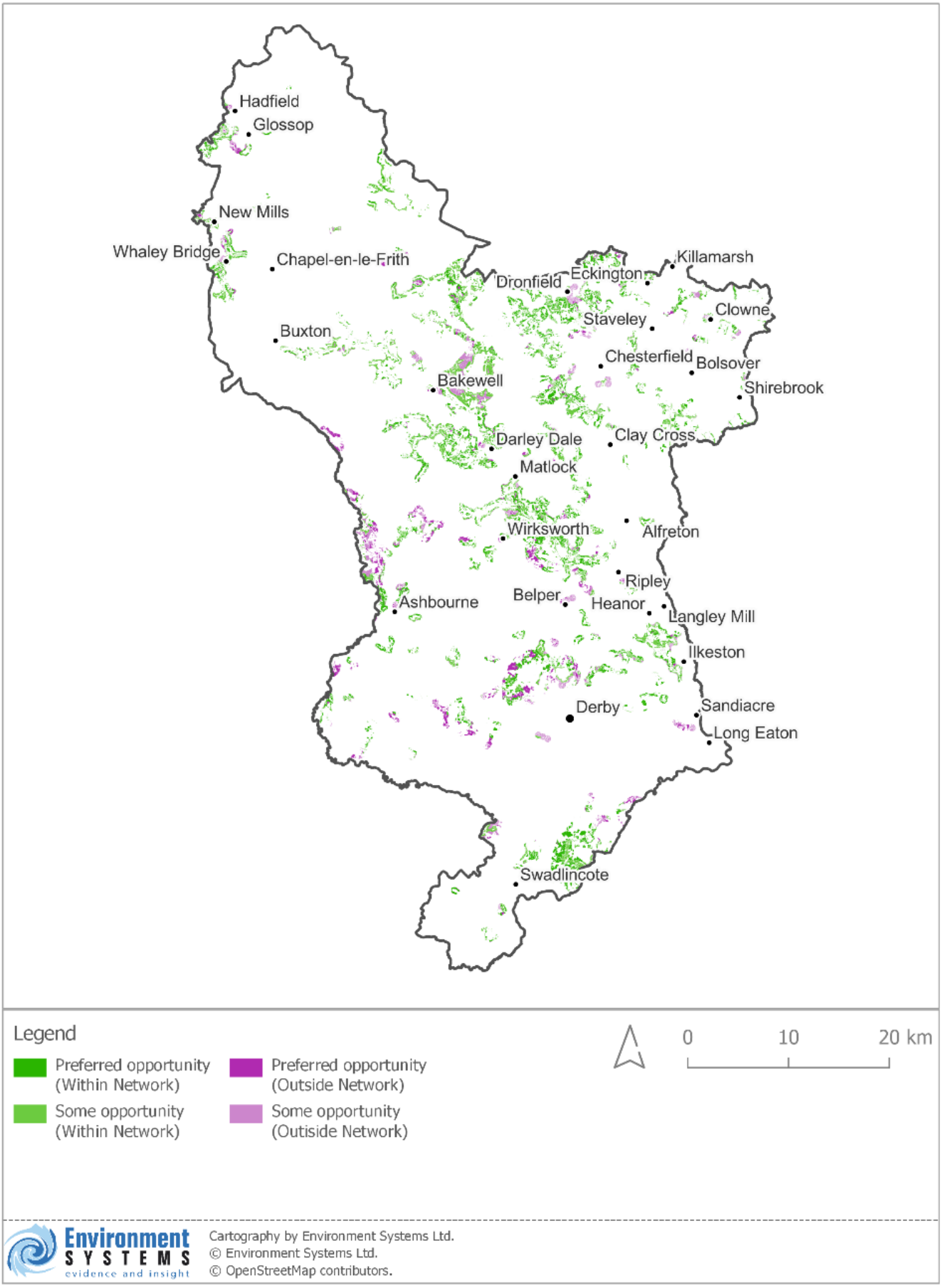

Figure 26: Opportunities for establishing woodland in relation to Natural England national woodland NRNs

Risks to biodiversity have been mapped where native habitats experience pressures from the surrounding land use (Figure 27), as follows:

- Native woodlands less than 2ha in extent, where the surrounding land is under more intensive agricultural use; the risk of fertilisers and herbicide sprays affecting the vegetation in these small woodlands is much higher than for larger woodlands. In this situation, the agricultural management of crops can create unfavourable conditions for some specialist native woodland species and, therefore, poses a risk to the biodiversity these smaller woodlands host.
- Other habitats adjacent to intensive agricultural land are also affected by the same type of risk if they also contain specialist species.
- Where public access is present to woodland, grassland, heath or wetland, there is a risk to species including from disturbance to wildlife, increased pollution (e.g. phosphorus from dog excrement) and littering; this is a particular issue in the Peak District National Park.
- Some Sites of Special Scientific Interest (SSSIs) are recorded as being in 'poor' or 'declining' condition which demonstrates that there is currently a risk to the biodiversity they are designated to support.
- Water bodies with a current 'poor-quality' status.

Development risk: areas that have been identified within local development plans as areas targeted for housing or employment development. The distribution of irreplaceable habitats is shown in Figure 28. These habitats are predominately located within the Peak District National Park and the Peak Fringe and Lower Derwent, and mainly comprise heath, blanket bog and calcareous grasslands.

Local planning policy as determined by Local Authorities, National Park Authorities, City Councils and Natural Capital Strategies must ensure rigorous protection of these habitats. A significant and largely unquantified proportion of irreplaceable habitats occur outside the designated sites network in Derbyshire, and therefore outside protected designated sites, such as National Nature Reserves, SSSIs, Local Nature Reserves and Local Wildlife Sites. Planning authorities should adhere to the protections already granted to designated sites but also ensure through the Natural Capital Strategy and LNRS that the undesignated irreplaceable habitats are not comprised. These unprotected important habitats are often small patches that have been fragmented and degraded by human activity, making them key targets for restoration, as they are stepping stones that can be included in plans for the expansion of existing ecological networks.

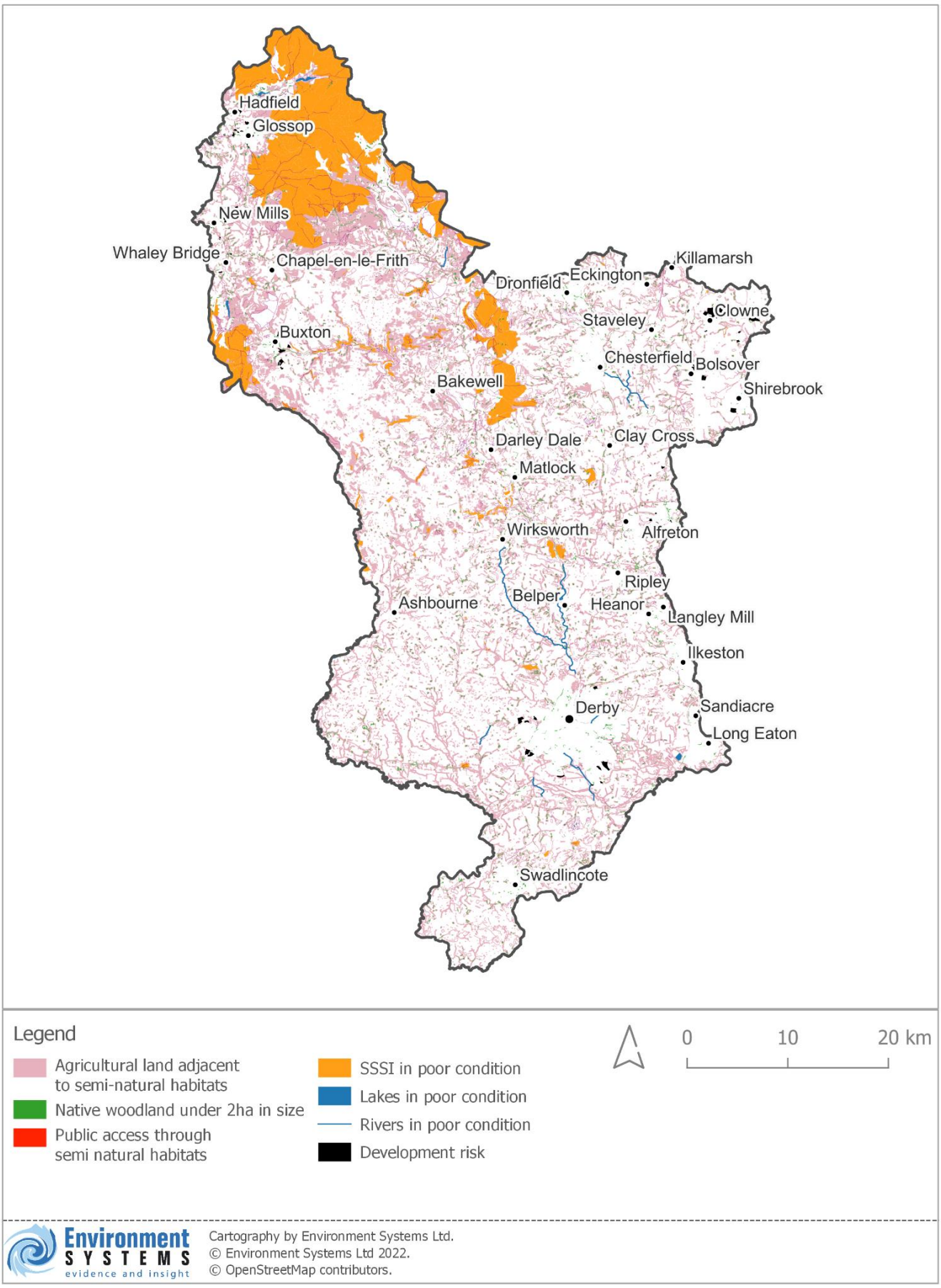

Figure 27: Risks to biodiversity

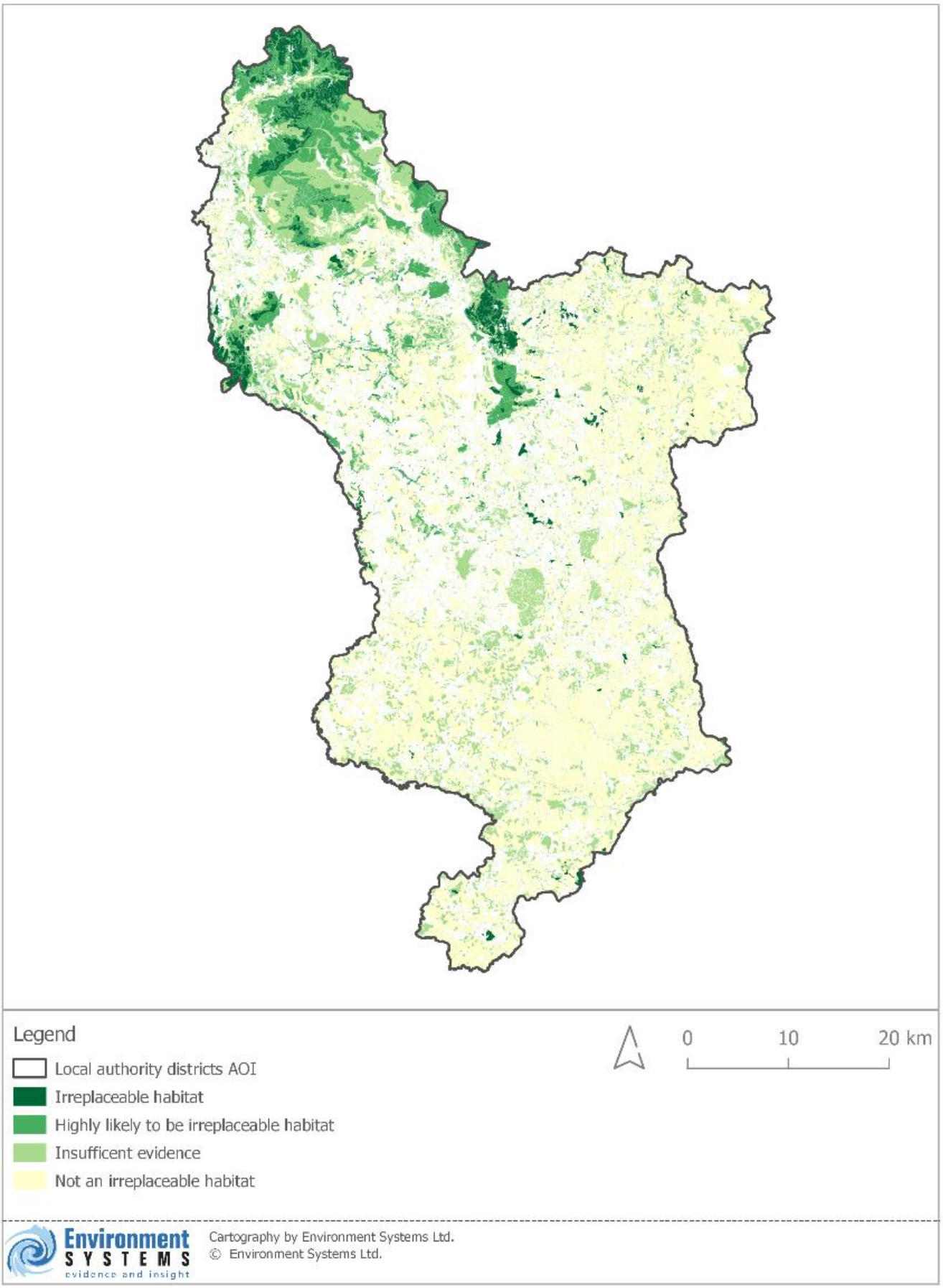

Figure 28: Distribution of irreplaceable habitats

It is a core principle of Biodiversity Net Gain (BNG) that irreplaceable habitats are avoided by proposed development. Figure 29 illustrates a proposed flowchart for the consideration of irreplaceable habitats in the development planning process and for BNG projects.

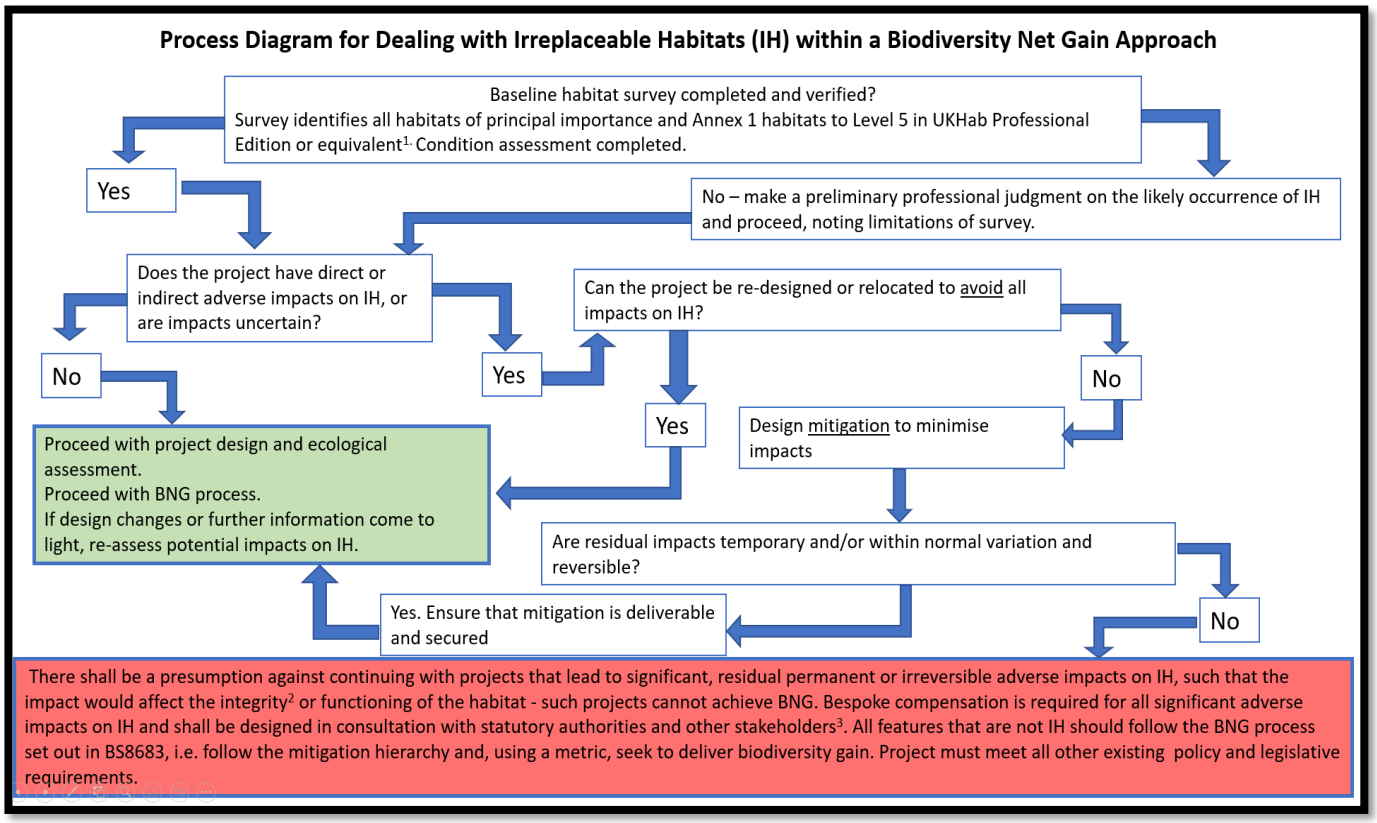

Figure 29: Process Diagram for Dealing with Irreplaceable Habitats in Development Planning and BNG Projects

Figure 29 identifies that 'bespoke compensation' is required for projects that lead to losses of irreplaceable habitats. Currently, there is no national guidance on what form this compensation should take. One approach may be to provide a hierarchy of suitable measures, for example:

1. Compensate for losses of irreplaceable habitats through a habitat translocation, where this is technically feasible and subject to existing guidance[6];
2. Restore existing equivalent habitats, i.e. habitats that are the same type as those being impacted, and secure their long-term management;
3. Create new habitat to enhance network connectivity and buffering to existing equivalent habitats already under appropriate management;

The approach to compensation for irreplaceable habitats must be clearly defined and agreed with relevant stakeholders. Where appropriate, compensation should be quantified using standard and repeatable methods. As a minimum, the quantum of compensatory habitat required should be significantly above the baseline biodiversity units + 10% to account for the relevant risk multipliers and habitat type should be the closest approximation to the habitat type lost as practicable.

[6] https://cieem.net/resource/habitat-translocation-a-best-practice-guide/

A national list of irreplaceable habitats is yet to be published by Natural England. In the absence of a national list a provisional list of habitats of high irreplaceability that are known to occur in Derbyshire has been identified for the Natural Capital Strategy, as follows:

- Ancient woodland
- Wood pasture and parkland
- Ancient and Veteran Trees
- Long-established woodland
- Blanket bog
- Lowland hay meadows and pastures
- Traditional Orchards
- Purple moor grass and rush pasture
- Lowland and upland fens
- Reedbeds
- Inland rock and scree
- Calaminarian grassland

This list should be interpreted with caution and reviewed as soon as the forthcoming Natural England definition and national list is available. The location of these habitats in Derbyshire, their characteristics and how each habitat is mapped in the Natural Capital Strategy is described in Table 1: Irreplaceable habitats in Derbyshire. It is expected that local authorities can build upon this list to ensure it is adequate in the local context.

Table 1: Irreplaceable habitats in Derbyshire

Habitat Name	Habitat Type (UKHab[7] typology)	Description and likely occurrence in Derbyshire
Ancient woodland	All woodland (w) ecosystems identified with Secondary code 33	Current definition of Ancient Woodland is any woodland (including plantations) that has been continuously wooded since 1600AD[8]. Known Ancient Woodlands >2ha are documented on the Ancient Woodland Inventory, although many smaller woods will not be included. In Derbyshire, the majority of recorded ancient woodlands are small and fragmented. Larger fragments remain in the ashwoods of the limestone dales of the White Peak, e.g. Millers Dale, Cressbrook Dale and Lathkill Dale and the Derwent Valley around Matlock and the oak and birch woods on the steeper slopes of the gritstone edges in the Eastern Moors.
Wood pasture and parkland	Habitat features identified with Secondary code 20	Wood-pasture and parkland are mosaic habitats valued for their ancient and veteran trees and are typically characterised by open grown trees in an extensive grazed landscape.

[7] Butcher, B., Carey, P., Edmonds, R., Norton, L. and Treweek, J. (2020). The *UK Habitat Classification Version 1.1* at http://www.ukhab.org/

[8] Ancient woodland, ancient trees and veteran trees: advice for making planning decisions - GOV.UK (www.gov.uk)

Habitat Name	Habitat Type (UKHab[7] typology)	Description and likely occurrence in Derbyshire
		Some sites have origins from Royal Hunting Forests. Anderson (2021)[9] records 3 Royal Forests partially in Derbyshire: The High Peak, Malbanc Frith and Macclesfield Forest, although there are only remnants of wood-pasture habitat retained along the Snake Pass road recorded on the current inventory. Most parklands in Derbyshire are associated with the country estates, including Chatsworth, Haddon Hall, Longshaw, Kedleston and numerous smaller estates. Wiltshire and Woore (2009)[10] provides a useful reference source of other medieval parks of Derbyshire.
Ancient and Veteran Trees	Point features identified with Secondary code 49	Many ancient and veteran trees fall within other ancient habitats, e.g. woodland and parkland. Open grown trees are poorly recorded, but the Woodland Trust has a publicly accessible database[11]. NB – all ancient trees are also veterans, but the terms are not strictly interchangeable.
Long-established woodland	Potentially including all woodland (w) ecosystem types	Long-established woodland is a stand of habitat that has a recorded history of being continuously wooded* >100years. There is no systematic inventory of these woodlands and many have no protection from development pressures. The First Edition Ordnance Survey maps are a useful resource to indicate the presence of long-established woodlands in Derbyshire. *woodland management, including coppice, felling and replanting or felling and regeneration is acceptable and areas of woodland open space and habitats that occur as part of woodland succession, e.g. native scrub, may also count.
Blanket Bog	Degraded blanket bog (UKHab f1a6) and Active Blanket Bog (UKHab f1a5 Annex 1 H7130)	Large blocks of blanket bog, a UKBAP Habitat of Principal Importance and the majority are also an Annex 1 Habitat under the Habitats Directive are present within Derbyshire. The vast majority of blanket bog in Derbyshire has been degraded by a combination of fire, including managed burns, wild fire and arson; drainage, cutting for fuel, over-grazing, air pollution and recreational pressures (Anderson, 2021). There are 3 major areas of blanket bog within Derbyshire: The Dark Peak, including Edale Head and Kinder Scout National Nature Reserve and part of South Pennines Moors Special Area of Conservation. (SAC) The Dark Peak, including the open moors and moorland fringe of Coombs Moss and the Upper Goyt Valley (including part of the Goyt Valley SSSI) to the west of Buxton

[9]Anderson, P (2021) Peak District – A Survey of British Natural History. New Naturalist Library
[10] Wiltshire M. and Woore, S. (2009) Medieval Parks of Derbyshire. Landmark Collectors Library
[11] Ancient Tree Inventory - Woodland Trust

Habitat Name	Habitat Type (UKHab[7] typology)	Description and likely occurrence in Derbyshire
		The Eastern Gritstone Moors, including Big Moor above the Gritstone Edges of Froggatt and Curbar, which include part of the Eastern Peak District Moors SSSI.
Lowland hay meadows and pastures	May include all priority grassland types: g1a lowland dry acid grassland, g2a lowland calcareous grassland and g3a lowland meadows	Grasslands with a long history of continuous management are likely to have high irreplaceability where they meet the following criteria: 1) Presence of designated species or habitats, rare or scarce plants, fungi or invertebrates; 2) Characteristic and appropriately managed areas with evidence of long establishment (>100 years); 3) Presence of characteristic topography, aspect, geology and soils. This includes grassland on all soil types (acid, calcareous and neutral), which are widely distributed throughout Derbyshire. Natural England has published grassland priority habitat inventories[12], although field data should be used to confirm the presence and status of any grasslands outside of the designated sites network. Calcareous grasslands are typically largest in area and are restricted to the limestone dales in the north and west of the county. Acid grasslands are typically smaller and associated with the Gritstone Dark Peak. Neutral grasslands are widespread, but typically in small patches.
Traditional Orchards	Complex habitat features identified with Secondary code 21	Traditional orchards comprise open-grown fruit and nut trees typically including specimens which are >50years old and have veteran features. Typically planted in herbaceous ground layer, this habitat may have fallen out of regular management, leading to encroachment with tall herbs and scrub. Habitat includes traditional orchards within curtilage of domestic properties. Habitat patches are typically very small (typically <1000m^2) and isolated patches, associated with traditional villages and farmsteads throughout the county.
Purple moor grass and rush pasture	UKHab f2b	This grass and rush-dominated wetland community is associated with poorly drained soils on valley sides and spring-lines, especially on calcareous and clay soils. Good examples of this uncommon and difficult to identify community are typically herb-rich and are sometimes confused with considerably more widespread species-poor acidic communities such as Yorkshire fog – soft rush pastures (UKHab g3c8) and many purple moor-grass dominated communities that have arisen through inappropriate management of other bog and fen communities. Very rare in Derbyshire, probably covering <50ha in total, the largest known patch is within Goyt Valley SSSI.
Lowland and upland fens	Lowland fens (f2a) and Upland flushes,	Derbyshire straddles the upland/lowland boundary of the UK and this complicates the differentiation between these two closely allied priority habitat types. The upland moorland of

[12] Priority Habitat Inventory (England) - data.gov.uk

Habitat Name	Habitat Type (UKHab[7] typology)	Description and likely occurrence in Derbyshire
	fens and swamps (f2c)	Kinder and the Dark Peak SSSI, Derwent and the Eastern Moors support a mosaic of blanket bog, wet heath and upland flush communities, with the latter largely associated with streamlines and cloughs[13]. Lowland fens are uncommon and largely confined to river valleys, notably along Bretton Clough near Abney and in the Erewash valley on the border with Nottinghamshire.
Reedbeds	UKHab f2e	Reedbeds are an uncommon habitat in Derbyshire and almost all are a result of the restoration of former mineral workings. Reedbeds in restored mineral working are not irreplaceable.
Inland rock and scree	UKHab s1a	Inland rock and scree and their natural vegetation communities, derived from natural and semi-natural outcrops (as opposed to quarried outcrops) are likely to be irreplaceable. There is no national habitat inventory for this habitat type currently. Natural limestone outcrops (UKHab s1a), base-rich screes (UKHab s1a6) and crevice vegetation (UKHab s1a7), particularly within the Derbyshire Dales NNR, but occurring throughout the dales of the White Peak support fragments of this habitat. It is notably difficult to map these habitats as they occur on steep slopes and so the area shown on two-dimensional spatial projections significantly under-estimates the area of the habitat across the county.
Calaminarian grassland	UKHab u1c	This is a very uncommon and rare habitat within Derbyshire, although the county is a stronghold nationally. This habitat is only associated with the former workings of historic metalliferous surface mining, in particular the lead rakes of the White Peak. Good examples, such as Tideslow Rake SSSI, are protected, but much of this habitat has been subject to grazing pressure and intensification which has led to loss and degradation. It is estimated that only 14ha of Calaminarian grassland remains in the Peak District, with an upper estimate of 41ha[14]. Mapping the current extent, condition and potential for restoration and buffering (through new habitat creation of species-rich grasslands) for this critical habitat resource within the county should be a conservation priority.

[13] a steep-sided ravine
[14] Anderson, P (2021) Peak District, New Naturalist Library.

Surface water regulation (Natural Flood Management)

Surface water regulation is an important ecosystem service with respect to climate change, due to the trend for increased frequency and severity of flood events. Enhancing surface water regulation can reduce peak flows when carried out at scale, in the right locations.

Figure 30 shows the existing level (stock) of Natural Flood Management (NFM) provision. The uplands of the Peak District National Park provide the highest provision for NFM due to the high occurrence of peaty soils that absorb and retain water. Other areas that have a high capacity to reduce flooding are those with shallow gradients and areas that are wooded.

Knowledge of the areas that flood can help us understand where nature-based solution can be targeted to help mitigate flood peaks by slowing the time it takes water to reach rivers during high rainfall events. The position of land in a water catchment is an important consideration; interventions targeted within headwater zones (i.e. upstream) have greatest impact, but can be physically challenging to achieve due to accessibility issues. Interventions in the valley bottoms are least effective at slowing the flow of water through a catchment, but can still be important locally. Figure 31 shows the hydrological catchment zones for Derbyshire from headwaters to valley bottoms.

Hydrological connectivity is an important consideration when targeting interventions to enhance NFM. The existing channel network for Derbyshire, showing rivers and major streams, is shown in Figure 32. From this network and the surrounding topography the hydrological connectivity has been derived. Hydrological connectivity is shown in Figure 33; in areas with high connectivity more of the surface water is funnelled by the topography to join the channel network, which then carries it downstream and these areas are more prone erosion, pollution and pluvial flooding.

Two maps for NFM opportunities have been produced; one showing all possible locations where interventions could be located (Figure 34 and Figure 35) and one showing a range of targeted interventions, which are the locations that have the highest hydrological connectivity, and as such would have the greatest impact on reducing the flow of water into the channel network (Figure 32).

Key points and recommendations for nature-based action: NFM

- **Restoration of peatland** within the Peak District National Park will enhance water holding capacity in the peat, thereby mitigating downstream flooding. It will also alleviate the impact of drought on the surrounding areas, and store carbon.

- **Plant riparian woodlands** along rivers where there is no existing adjacent semi-natural vegetation. This flood management solution will be particularly beneficial in reducing flood risk in the Trent Valley Washlands, and the mid and lower section of the river Derwent.

- **Create and restore floodplains** in the lower reaches of the catchment where the floodplain is larger. Flood mitigation can be enhanced by establishing sacrificial flood areas upstream of major settlements. An example of this is the lower reaches of the River Rother near Chesterfield, where washlands have been created upstream of the town to contain flood water.

- **Enhance integrity of river channels,** particularly the river Derwent, to slow the speed of water and increase its water holding capacity.

- **Creation of wet woodlands and fen** adjacent to rivers to absorb flood waters.

- **Enhance soil infiltration** through the management of existing species-rich pastures, planting deep rooted grasses in agricultural ley grassland, and/or establishing species rich meadows. These actions will have most impact when they are carried out in the higher catchment zones, and on the areas with greater hydrological conductivity.

- **Plant new hedges** or restore older hedges and field margins across slopes. This will help slow the movement of water and mitigate flooding particularly when implemented in the mid-reach catchment zone.

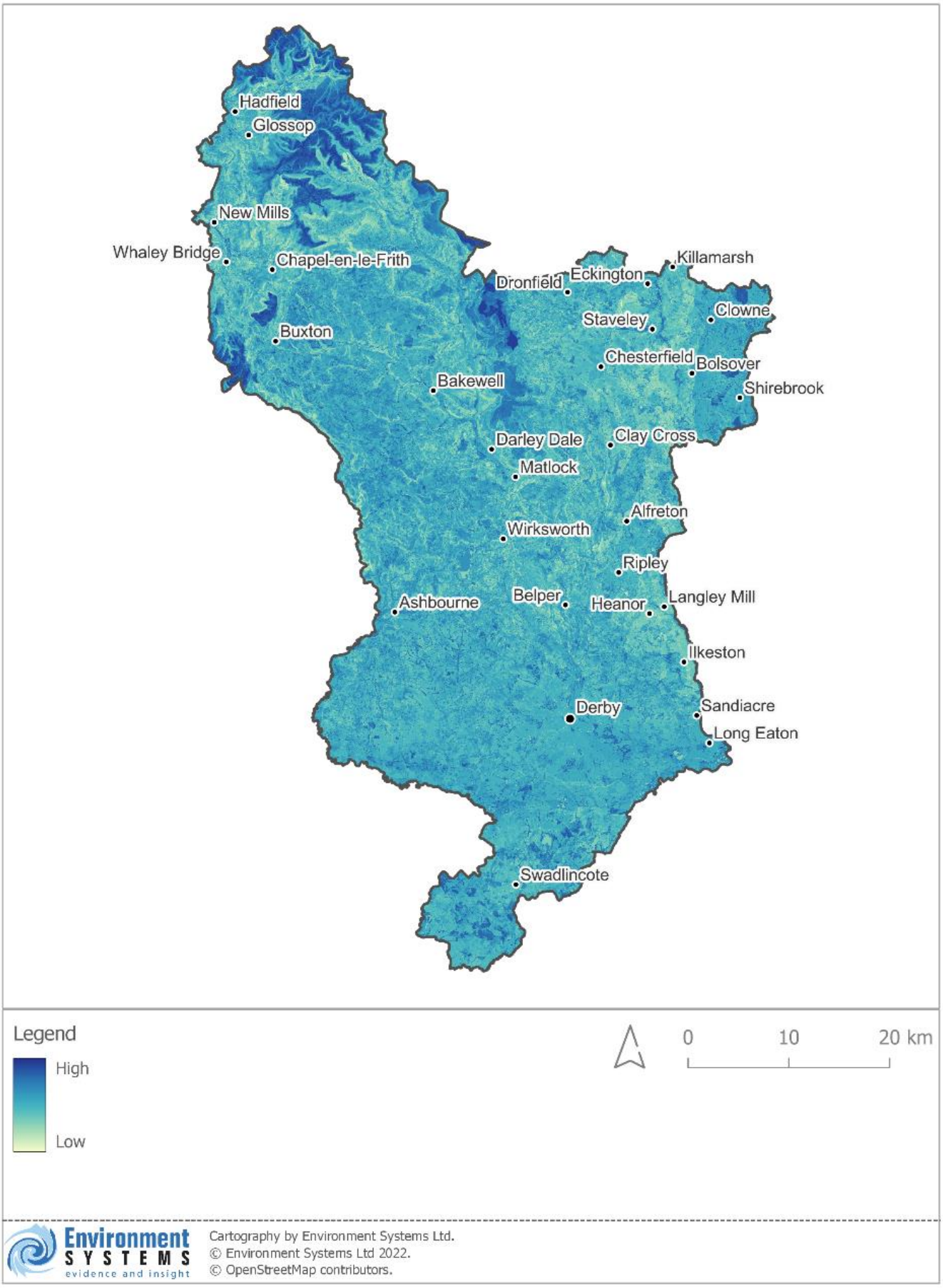

Figure 30: Natural Flood Management: current provision (stock)

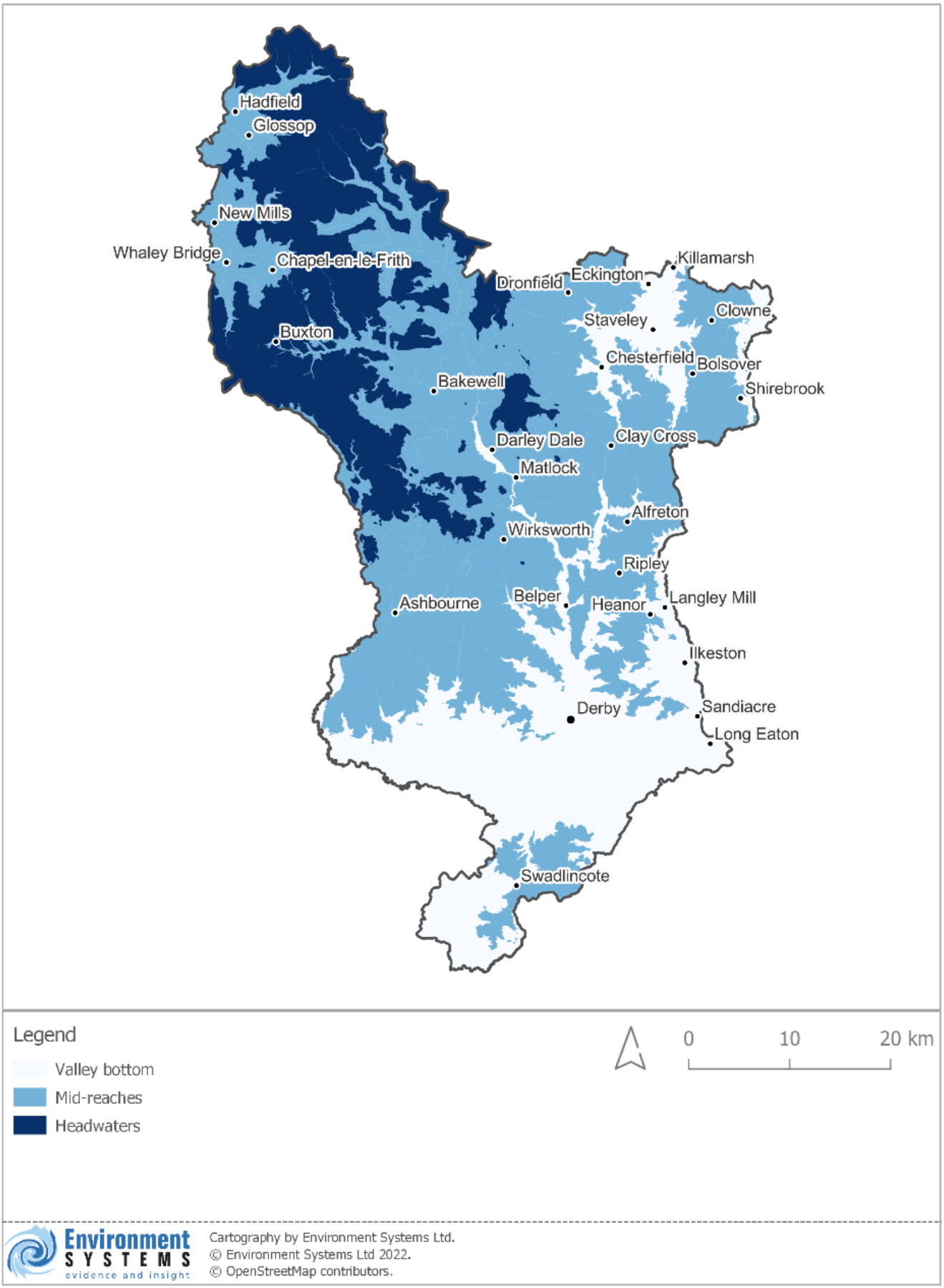

Figure 31: Hydrological catchment zones

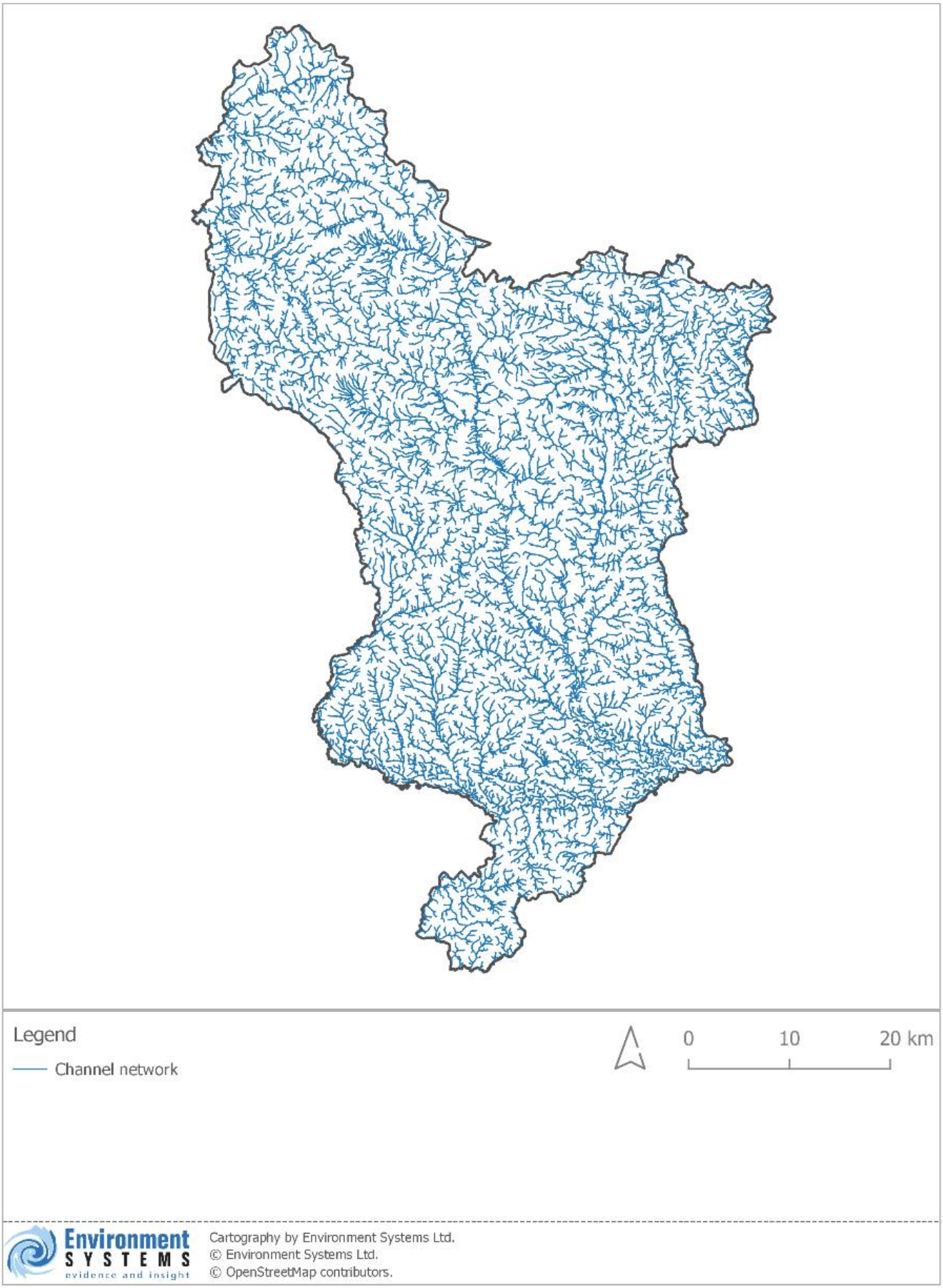

Figure 32: Channel Network

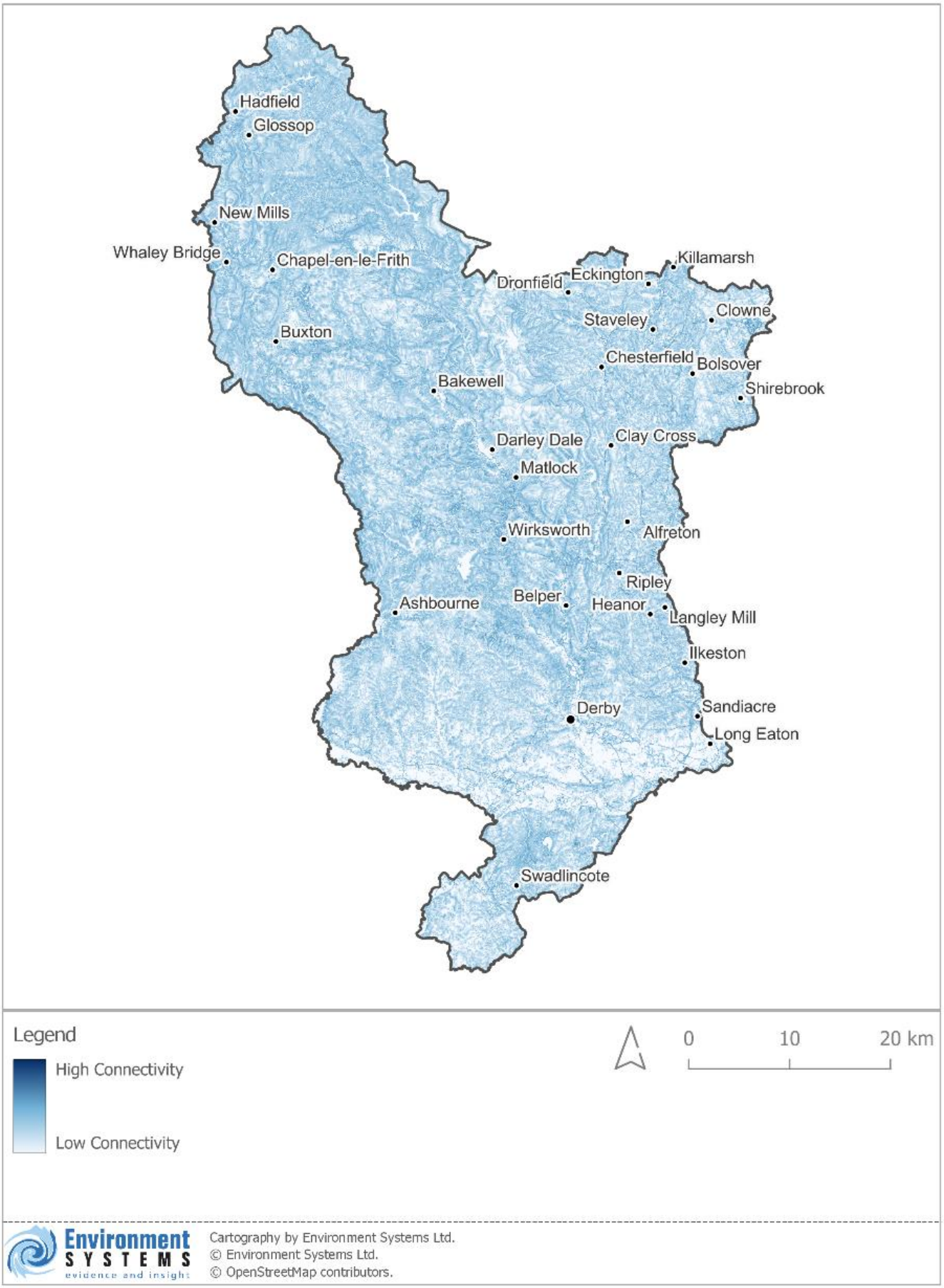

Figure 33: Hydrological connectivity

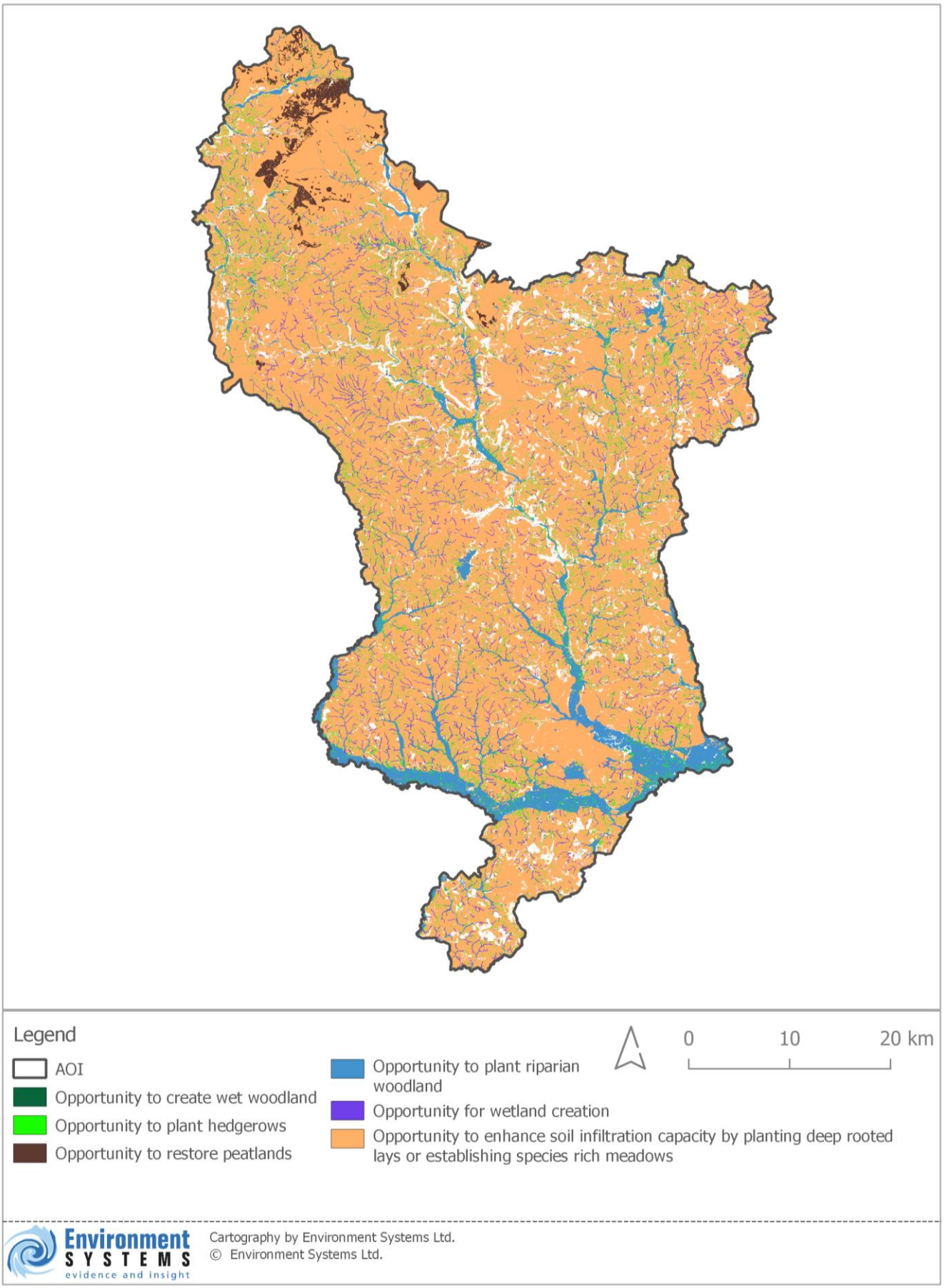

Figure 34: Natural Flood Management: all NFM opportunities

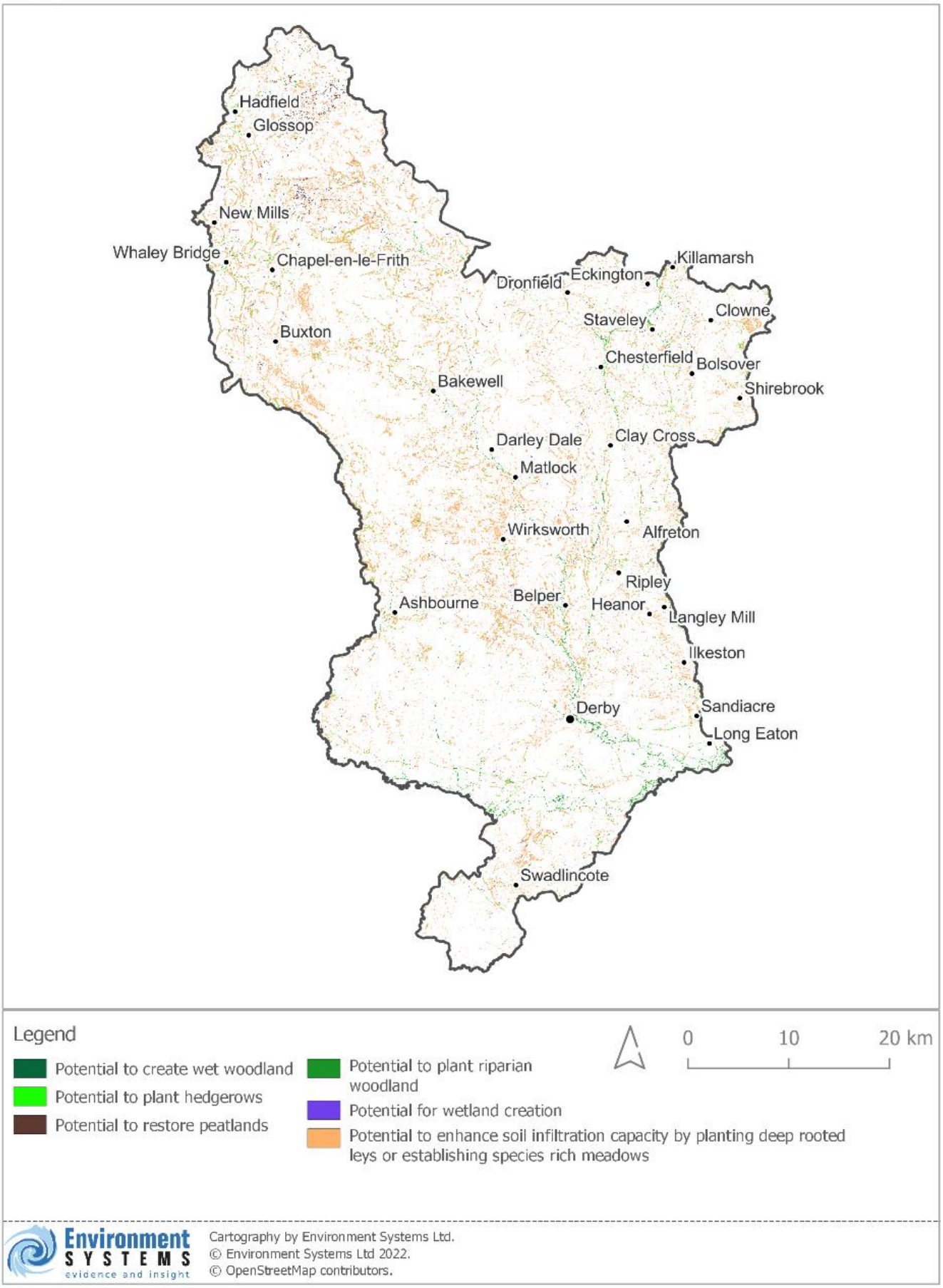

Figure 35: Natural Flood Management: targeted opportunities

Water quality regulation

Slope, soil type, vegetation cover and land management practice all have an impact on maintaining water quality. Figure 36 shows the existing level (stock) of water quality regulation in Derbyshire. Peat habitats located within the Peak District National Park have a high existing provision for maintaining water quality. In contrast, the intensively managed agricultural land in the Trent Valley Washlands currently have the lowest existing provision for maintaining water quality.

The degraded peat within the Peak District National Park is a risk to water quality in the wider catchment (Figure 37). However, the most widespread risk to water quality within Derbyshire that can be tacked by NBS is the potential for agricultural run-off into watercourses, or places where there are livestock directly adjacent to streams and rivers and channels of fast water movement; in this situation run-off can pick up pollutants which then enter the watercourses. This risk is greatest in areas with high levels of agricultural production such as Southern Magnesian Limestone and in the valley bottom areas of the main river catchments, particularly the Trent Valley washlands, the Melbourne Parklands and Mease/Sense Lowlands.

Opportunities for nature-based solutions that will improve water quality throughout the catchment are shown in Figure 38. These land management actions can have a significant, positive impact on water quality.

Key points and recommendations for nature-based action:
Water Quality

- **Restoration of peatland:** peatlands act as a water filter removing dirt, debris and pollutants from water before they flow into waterways.
- **Establish within-field headlands** throughout Derbyshire's agricultural lands to reduce sediment and pollutant run-off.
- **Enhance the woodland network** throughout Derbyshire to reduce soil erosion and pollutant run-off.
- **Improve bankside vegetation:** riparian tree buffers and riverside meadows intercept and immobilise sediment and pollutants before they reach watercourses.
- **Plant new hedgerows or rows of trees** across slopes or adjacent to watercourses, to reduce the sediment and pollutant load reaching watercourses.
- **Prevent erosion and pollution of the River Wye:** this river has specific management needs, as due to the porosity of the underlying limestone it is common for this river to dry up during the summer. Preventing erosion, and pollution of the river bed from animal grazing or visitor pressure, are particularly important during dry periods. Fencing, and establishing more bank-side vegetation along the river bed is recommended.
- **Planting of vegetation around disused mining sites:** bankside vegetation adjacent to mining sites can alleviate heavy metal pollution.

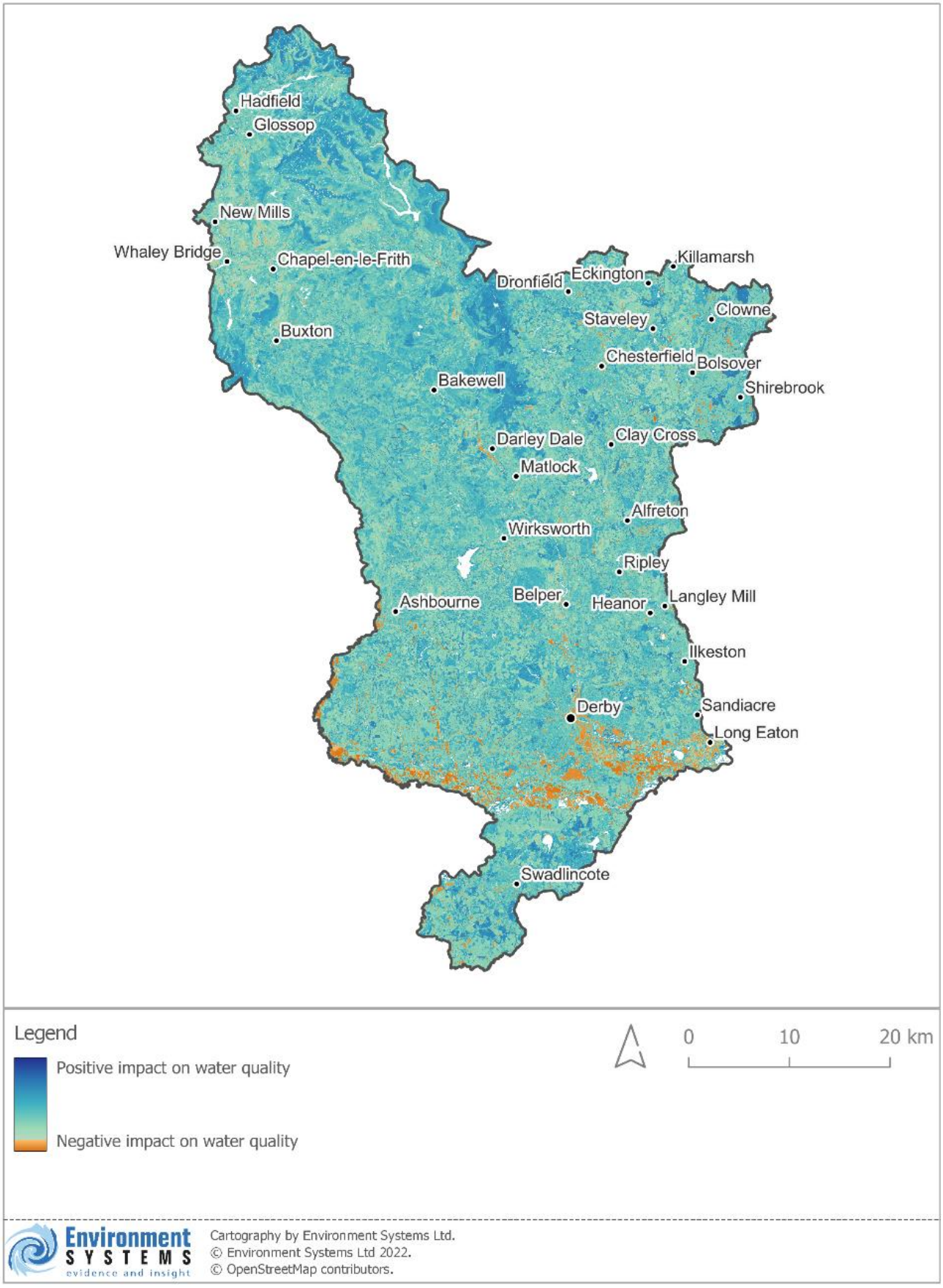

Figure 36: Water quality regulation: current provision (stock)

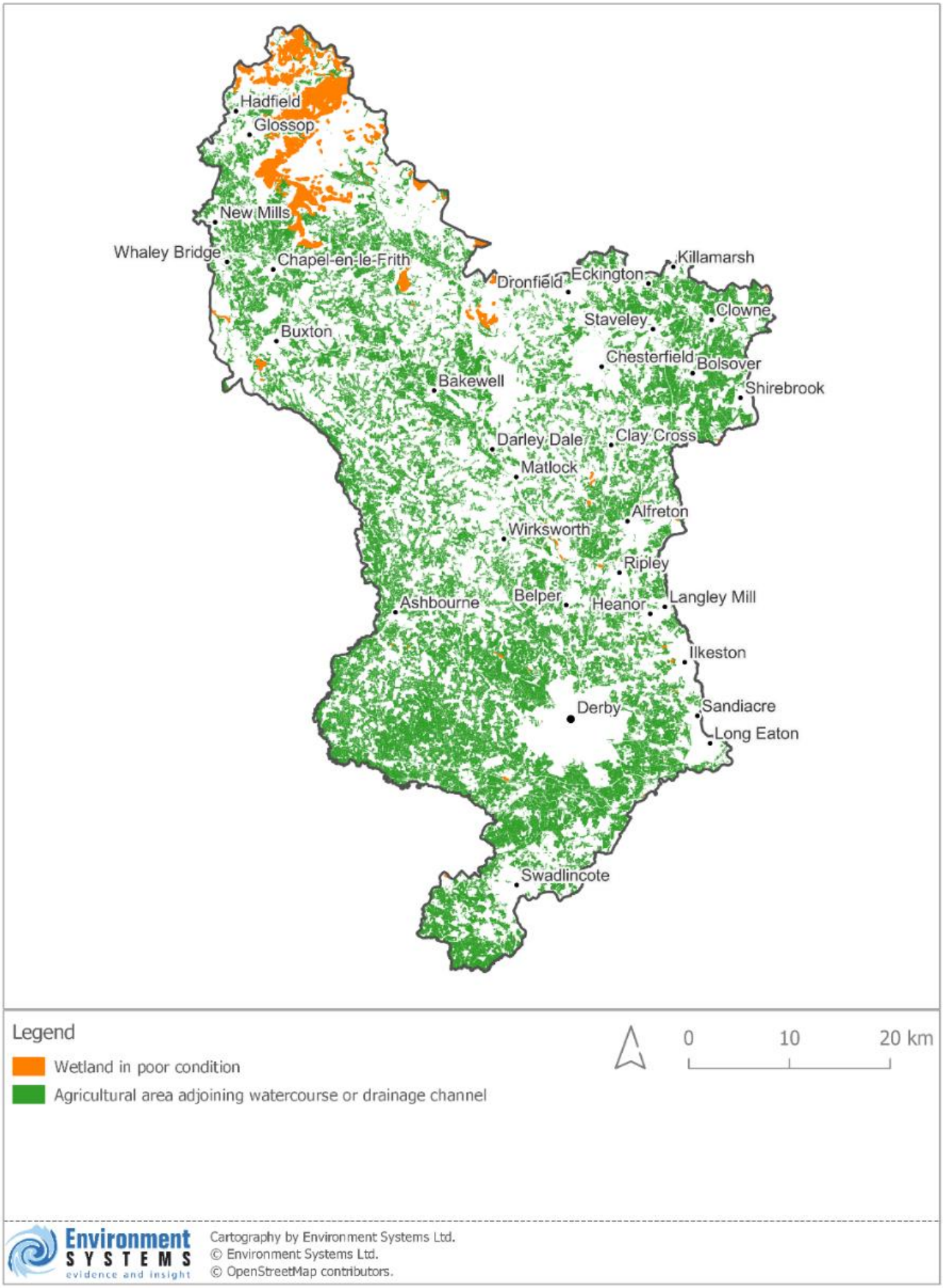

Figure 37: Water quality regulation: risk areas

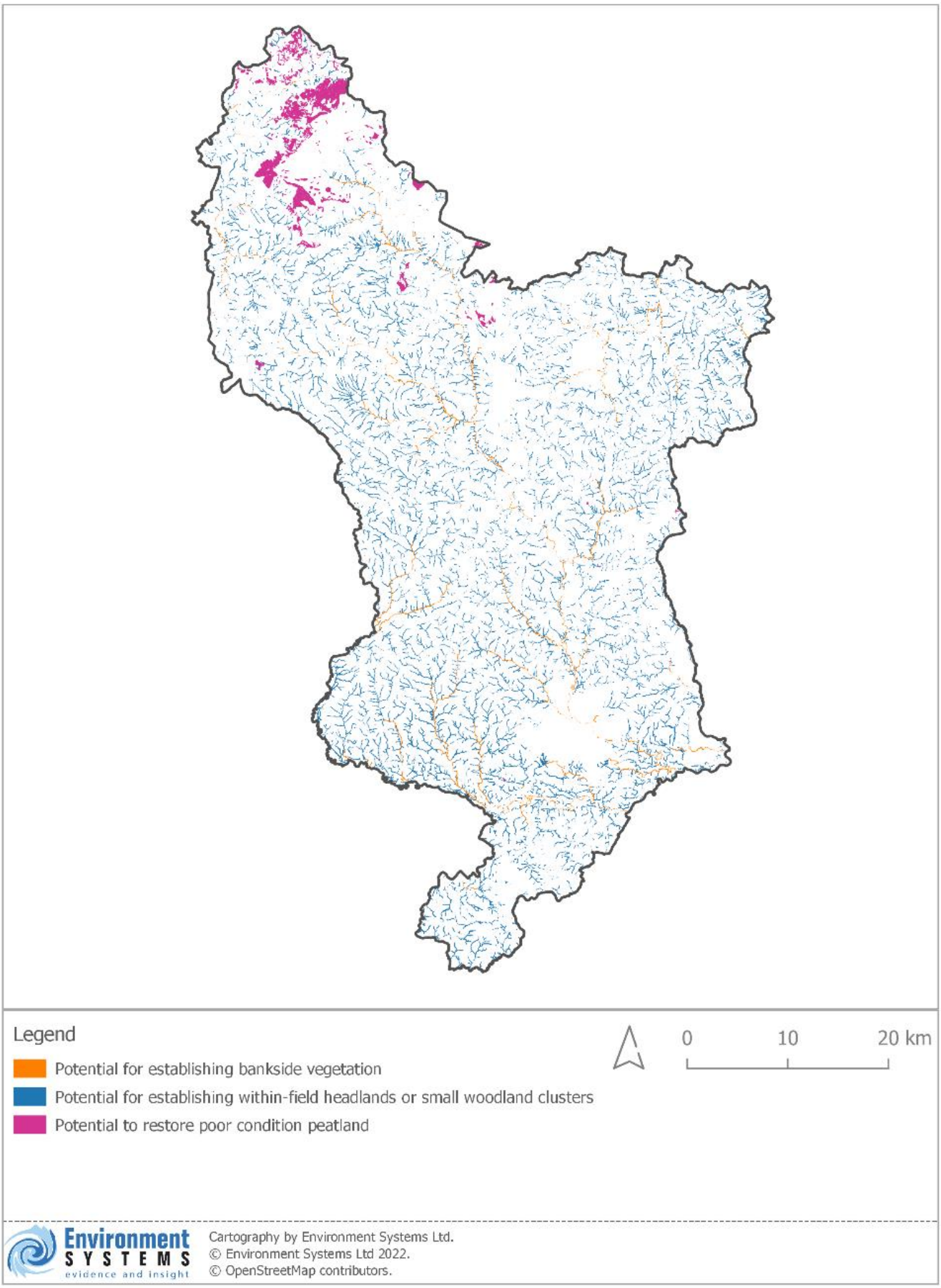

Figure 38: Water quality regulation: areas where nature-based solutions will improve water quality

Carbon storage and sequestration

Areas with the greatest area of carbon storage (stock) are located within the Peak District National Park, the Peak Fringe and Lower Derwent and areas south of the Mease/Sense lowlands (Figure 39) where there is bog on deep peat.

Figure 40 shows the current likely status of natural carbon sequestration, the process by which carbon dioxide is removed from the atmosphere and held in vegetation or the soil. The map also shows areas where there is likely to be a loss of carbon occurring.

There is widespread risk to carbon sequestration throughout Derbyshire due to the extent of degraded peat and agricultural land that is not under regenerative management.

In general, areas with the highest levels of carbon stock also deliver carbon sequestration. Woodlands provide the highest levels of sequestration and intact bog on deep peat the highest carbon storage. There are notable exceptions though; carbon emissions are occurring on degraded peat in the Peak District National Park.

Land of high agricultural quality throughout Derbyshire has also been identified as a potential carbon emission source rather than emission sink (Figure 41). However, land management practices have a significant role to play in maintaining carbon in arable and intensive grassland systems, for example regenerative agriculture and organic farm systems can sequester carbon. As no information is available on management practices, the map should be interpreted as showing the potential for risk of carbon loss.

There is also widespread opportunity to enhance carbon storage and sequestration (known as carbon abatement). The highest benefits to sequestration can be achieved through bog and heath restoration within the Peak District National Park and the conversion of low productivity grasslands to native woodland, particularly in the Peak Fringe and Lower Derwent (Figure 42).

Key points and recommendations for nature-based action: Carbon storage and sequestration

- **Restore peatlands:** when in poor condition peatlands emit a large amount of greenhouse gases to the atmosphere every year. Restoring peatland and making sure it is sufficiently wet all year round will have the biggest impact on the carbon budget of the county.
- **Establishment of new wetlands:** particularly wet woodlands and fens. This will enhance soil carbon, as well as providing other benefits for water management and biodiversity.
- **Regenerative agriculture** is effective at enhancing soil carbon while retaining agricultural production. Measures taken to increase soil carbon will also increase the resilience of agricultural land to the impacts of climate change.
- **Establishment of deep-rooted leys** across agricultural lands will increase soil structure and stability and crop resilience to drought, as well as increasing the overall carbon storage potential.
- **Mange ancient woodlands:** coppicing / pollarding of individual trees will maintain the ecosystem in a state of carbon sequestration rather than it reaching an equilibrium.
- **Planting new trees** will always enhance carbon sequestration; the planting of native species should be encouraged as native species will better support overall biodiversity.
- **Commercial woodlands:** where a forest operation is sought, trees should be destined for the wood rather than paper market. In order to make a positive impact on carbon sequestration, trees should be in place for at least 40 years prior to harvest.
- **Willow coppice for biofuel** can be a useful carbon market, to enhance the soil carbon while still preserving woodland habitats.
- **Planting shelterbelts, green barns and hedgerows** can all bring carbon sequestration benefits to farms while also benefiting animal welfare.

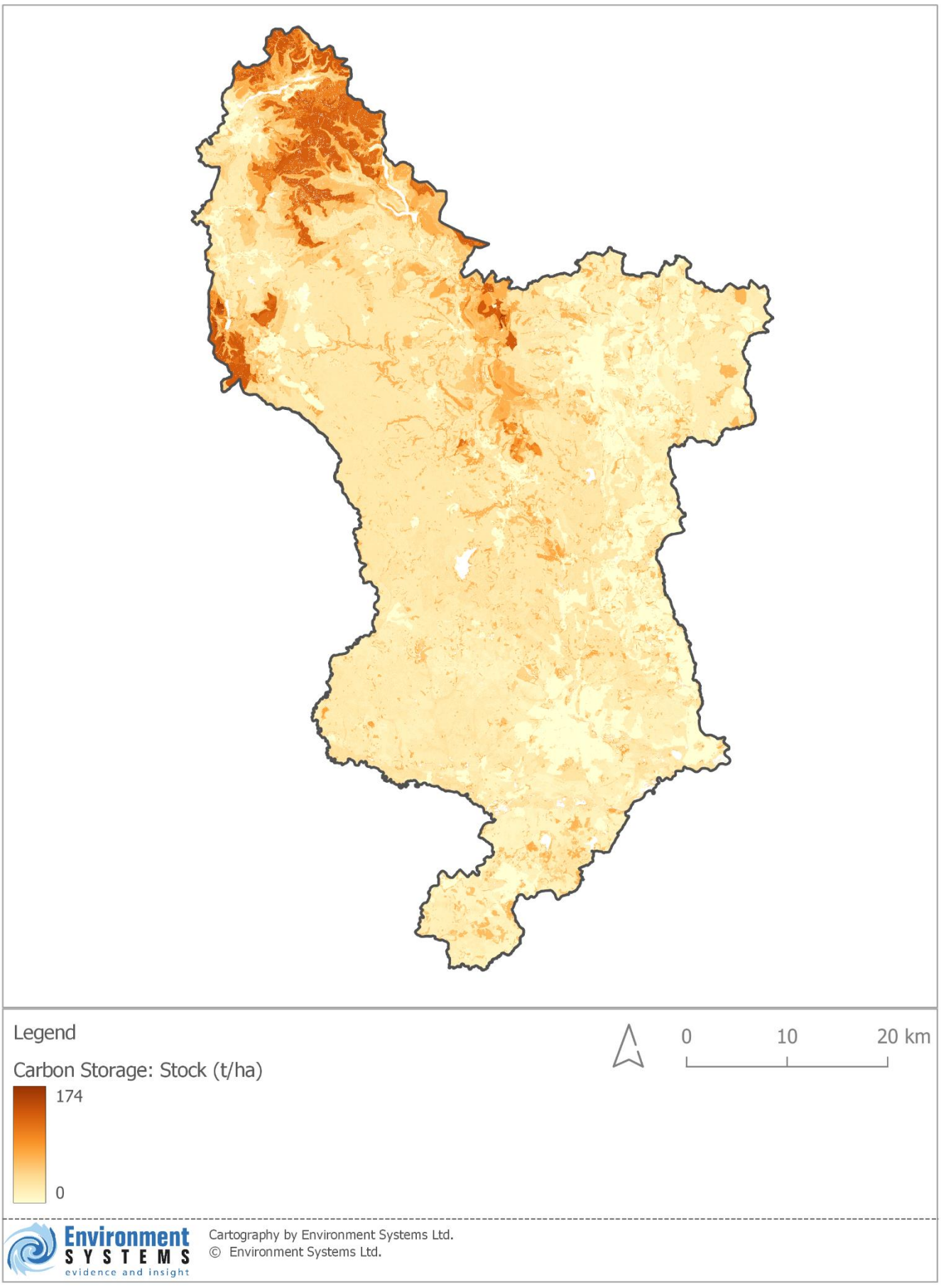

Figure 39: Current carbon storage (stock)

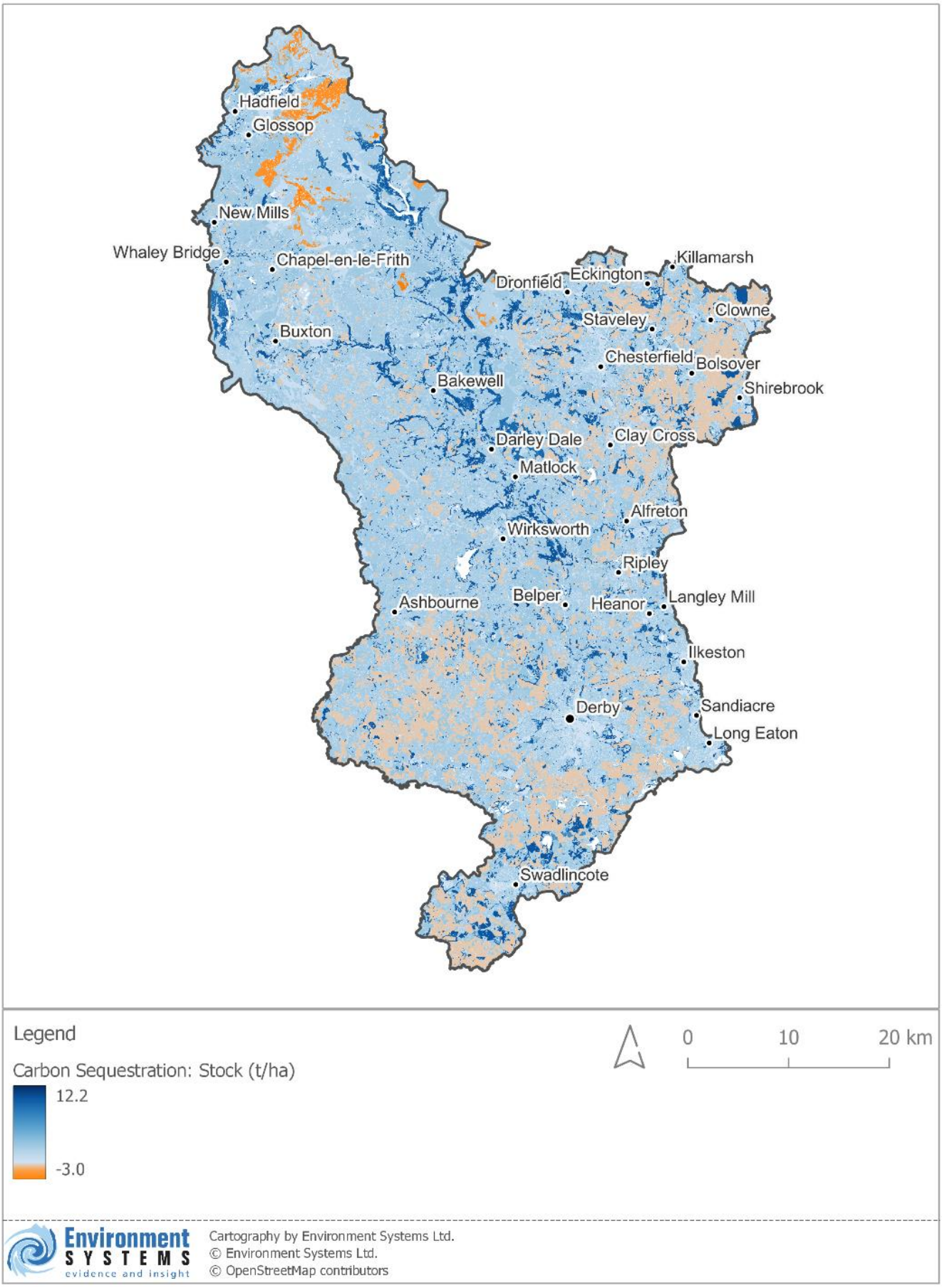

Figure 40: Current carbon sequestration (stock)

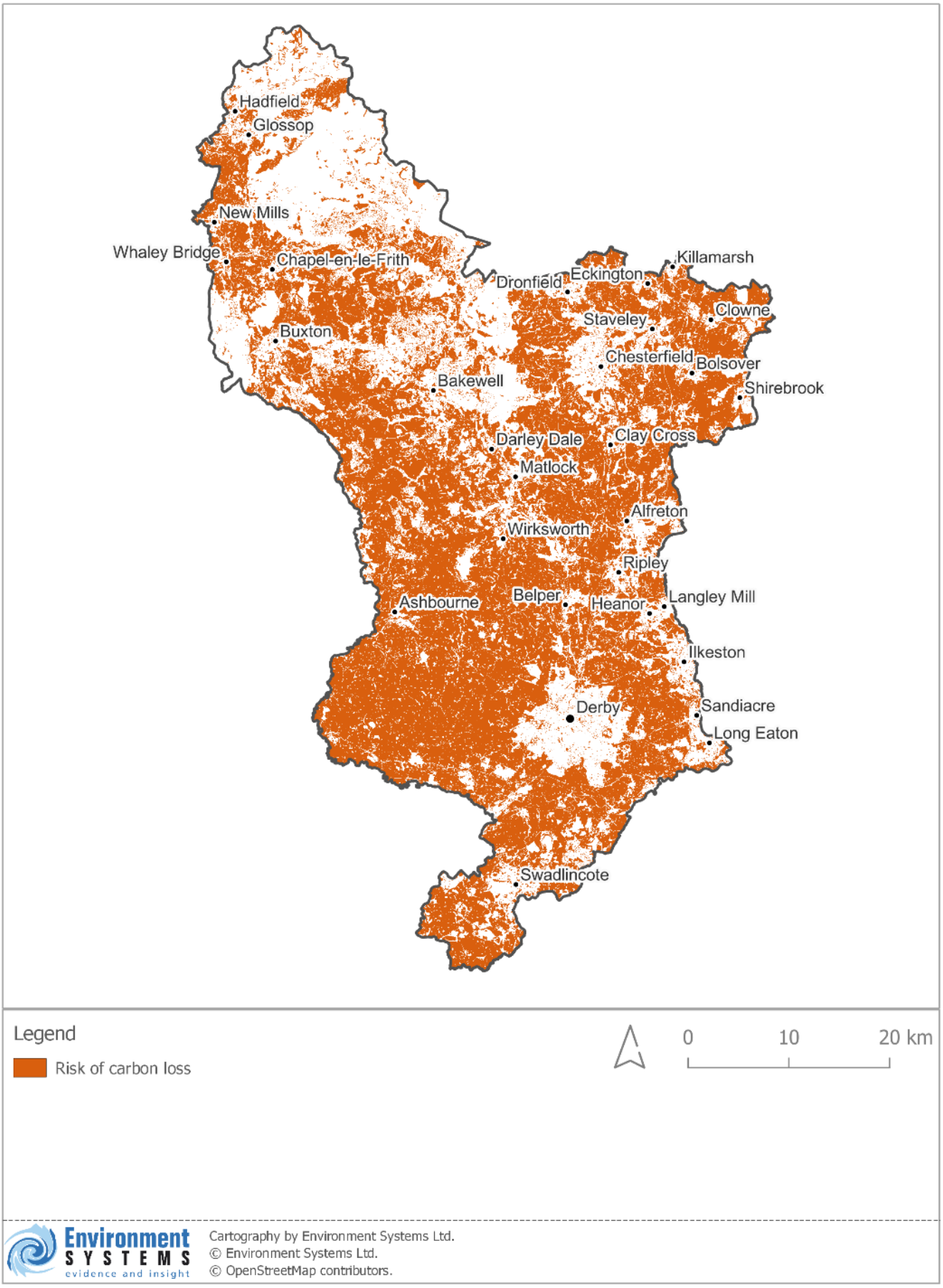

Figure 41: Carbon sequestration risks

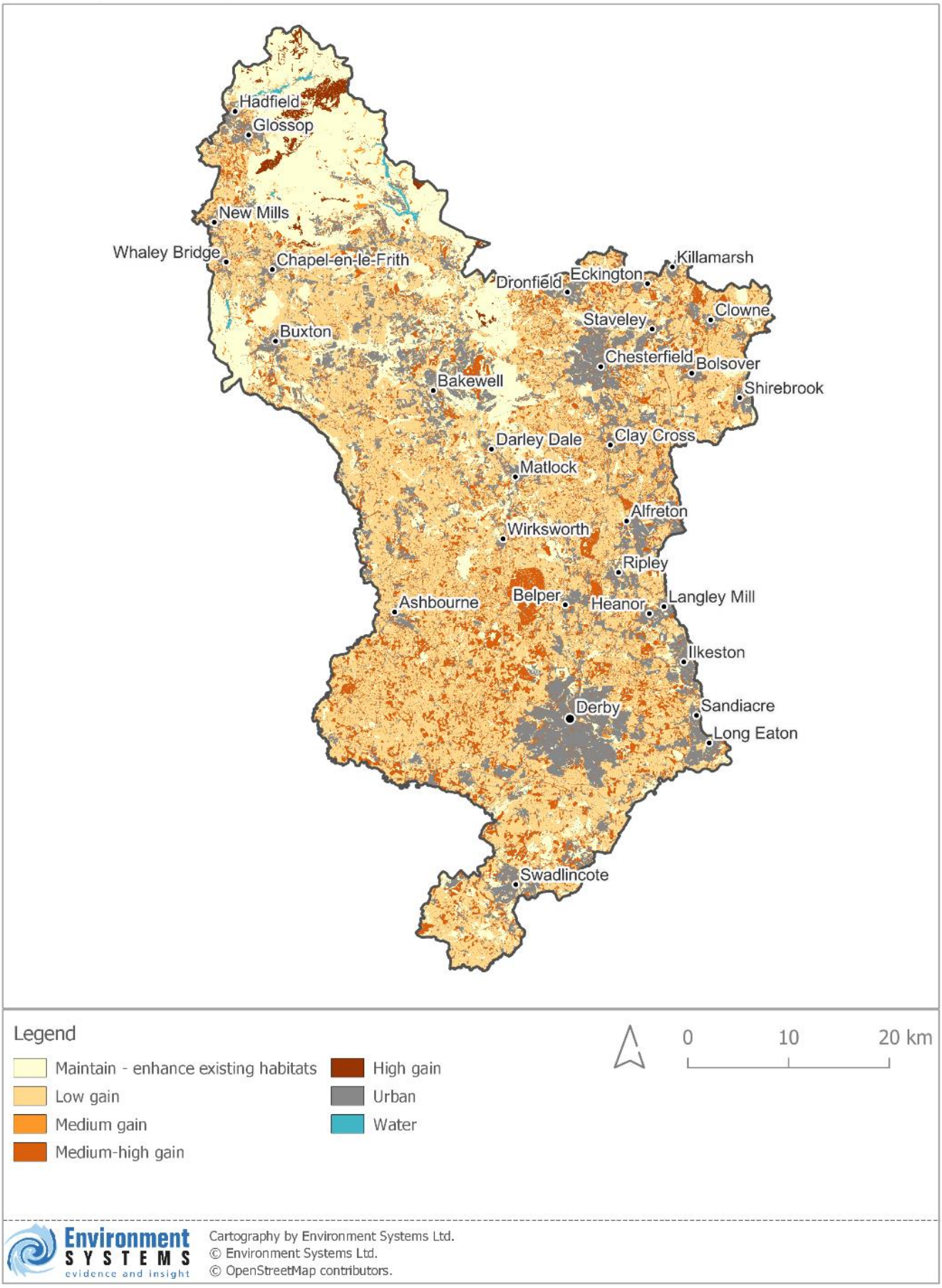

Figure 42: Carbon abatement opportunities: relative gain in carbon storage/sequestration

Recreation

For the purpose of this study recreation was considered as places where local people choose to visit in their spare time, including facilities such as parks, sports pitches and other relatively local greenspaces, as opposed to places that are considered more as a tourism destination, which have been considered as a separate theme in this study. However, there is cross-over between the two, as local people may choose to visit a major tourist honeypot, and tourists may also make use of smaller, more local assets and facilities during the course of their stay.

The input datasets considered in the recreation analysis are shown in Figure 43. These datasets were analysed by ORVal in order to assign the respective visitor numbers and monetary value of each input feature, based on the underlying data from the habitat map. This method for assigning the relative value of the recreational features was chosen in order to maintain parity with the methodology used to produce the baseline Natural Capital Accounts, which also used ORVal for calculating recreational value.

Figure 44 displays the relative value of recreational areas in terms of visitor numbers. The highest visitor numbers are found within the Peak District National Park, where the most extensive recreational spaces are located. In Derby City, Chesterfield, and within the National Forest area there are high visitor numbers in much less extensive recreational areas.

Recreation risk has been mapped by showing residential areas that do not currently have sufficient access to greenspace, based on the ANGSt framework. ANGSt considers how far people have to travel from their homes to access a greenspace area, as well as how large the individual greenspaces are. For the purpose of this study areas of risk have been identified as areas where the current distribution of greenspaces does not meet the ANGSt standard, which states that everyone should have access to all of the following accessible greenspaces meeting the following criteria:

- A 2ha site within 300 m of home (Figure 45)
- A 20 ha site within 2km of home (Figure 46)
- A 100 ha site within 5km of home (Figure 47)
- A 500 ha site within 10km of home (Figure 48)

When using these risk maps, consideration should be given to the fact that recreational assets outside the Derbyshire boundary were not accounted for; the risk areas identified reflect the level of access to accessible greenspace within the county of Derbyshire only, and some areas marked as being at-risk may in fact have access to assets and facilities located outside of the county.

The risk maps identify a disparity in the level of greenspace access between western and eastern Chesterfield. They also reveal large risk areas within Derby City despite the high density of input features considered by the study; this is because although there are a large

number of recreation features included in the modelling, many of these are small and do not meet the ANGSt minimum size standards.

Key points and recommendations for nature-based action: Recreation

- **Chesterfield** is relatively well-served in terms of access to smaller areas of greenspace, although opportunities should be sought to increase access in to greenspace in the east of the town.
- **Derby City** has low levels of accessible greenspace when assessed using ANGSt size criteris; opportunities could be sought to increase the accessibility of existing restricted-access sites (for example private sports clubs), in addition to establishing new accessible greenspace areas via habitat creation schemes, in order to create multi-functional greenspaces that provide recreation, biodiversity, and other ecosystem service benefits.
- **Many rural toens and villages have poor access to greenspace:** in spite of being situated within the countryside, or with the National Park itself. In such areas the surrounding greenspaces may not be accessible due to access restrictions relating to land ownership (e.g. farmland) or infrastructure (e.g. footpath, road and pavement network). Schemes that enhance access to greenspace in these areas should be considered.

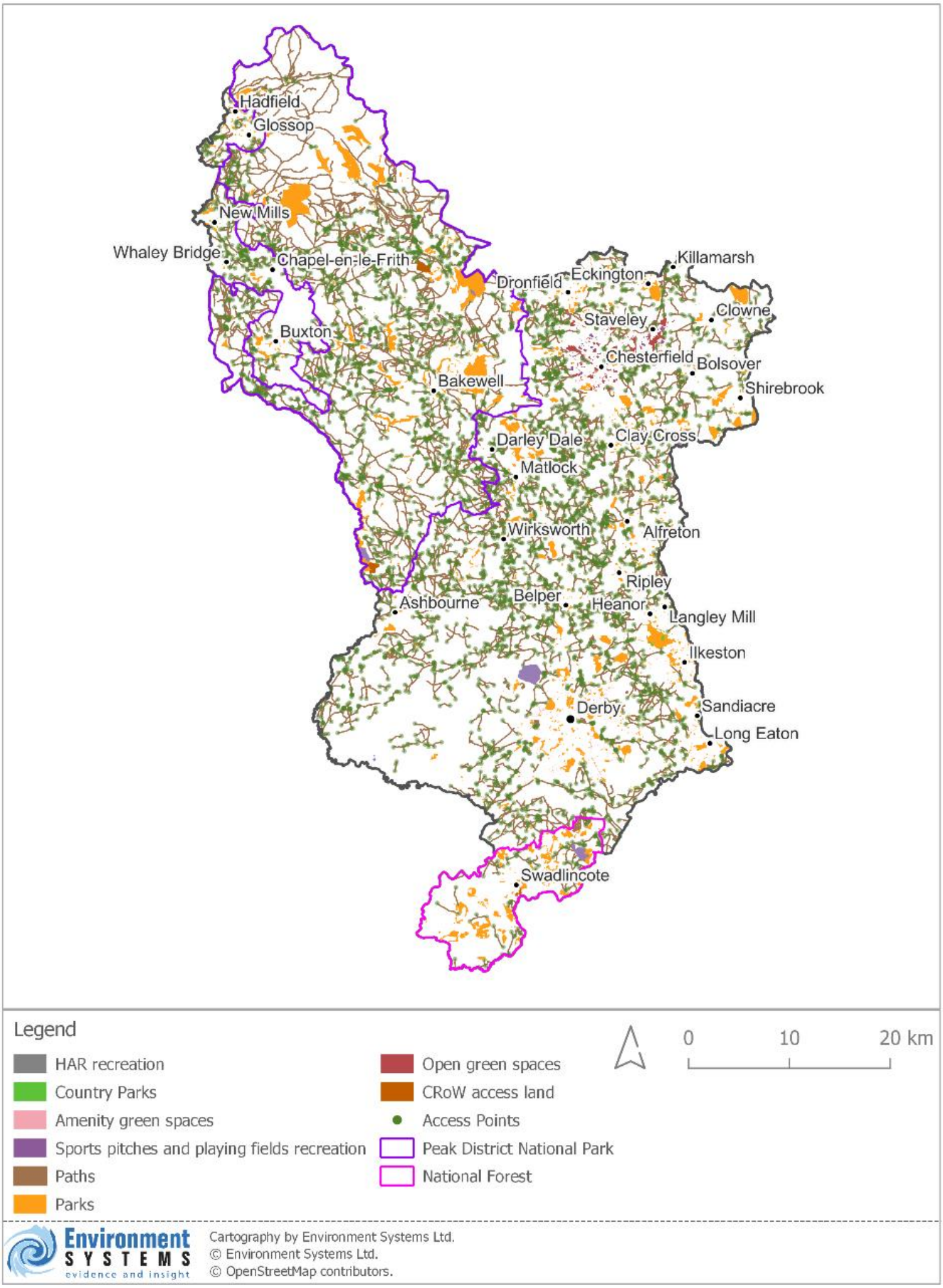

Figure 43: Areas of high importance for recreation: input datasets

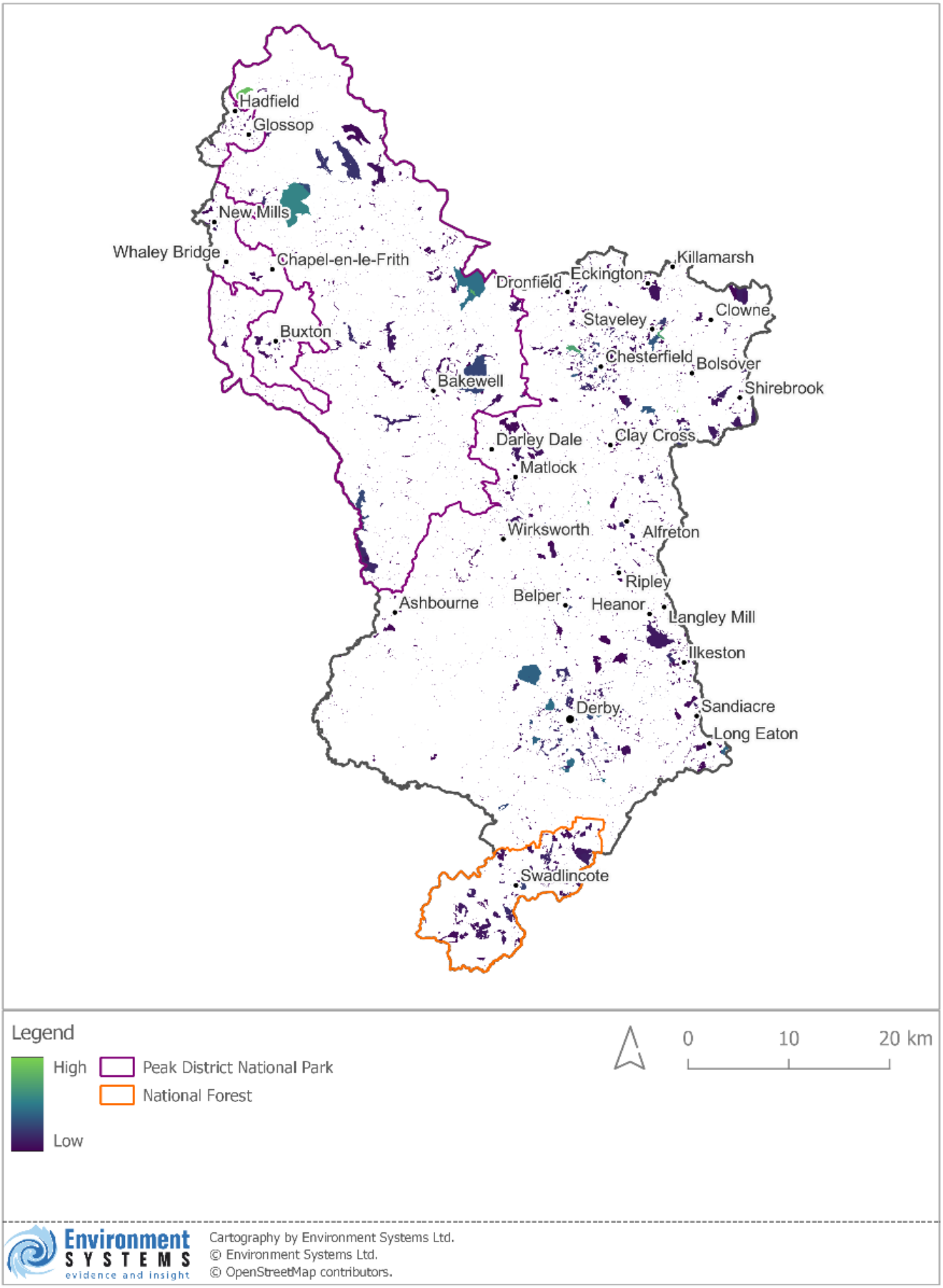

Figure 44: Areas of high importance for recreation in terms of visitor numbers

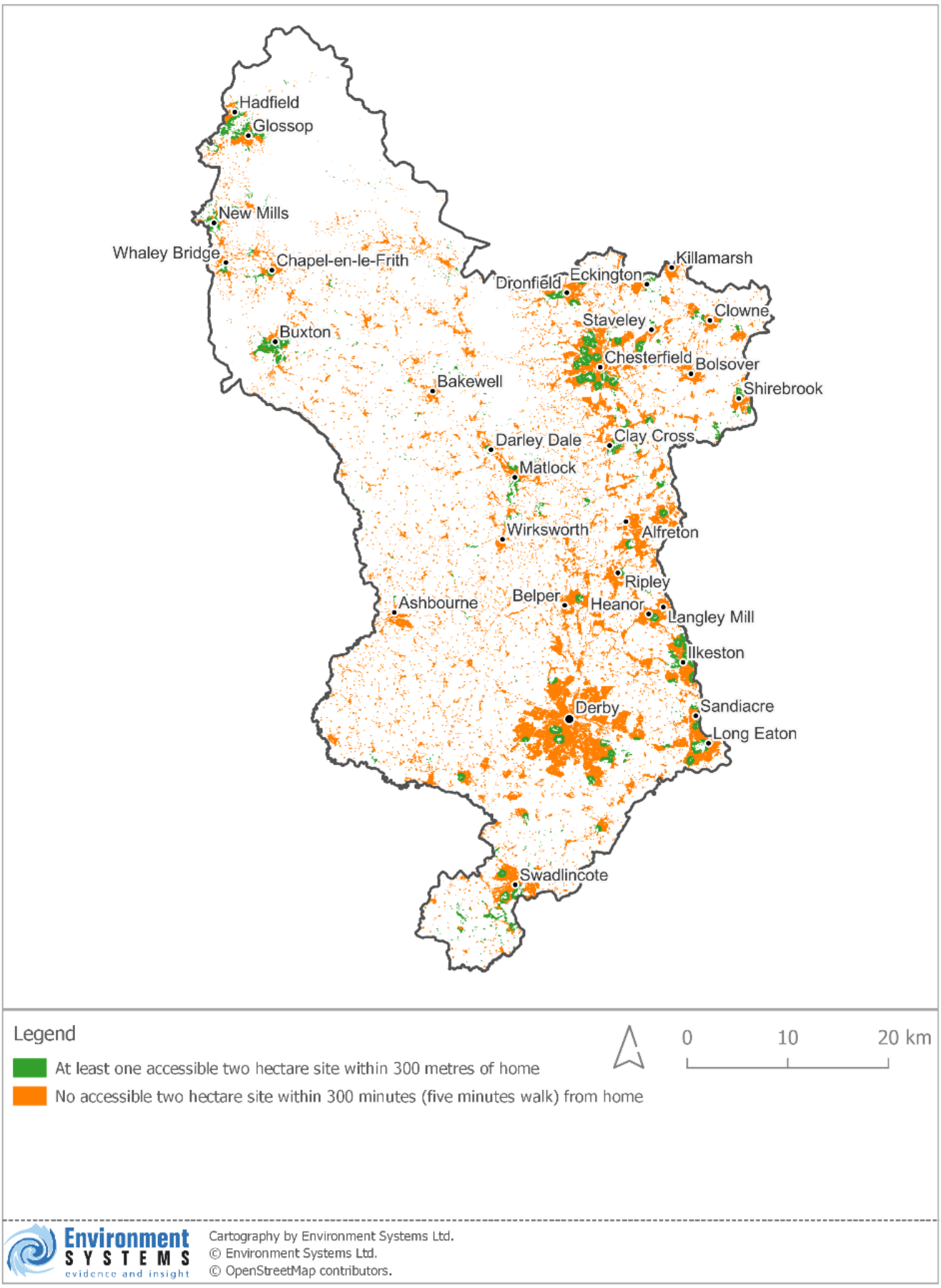

Figure 45: Recreation risks: urban areas with and without access to a 2ha recreational site

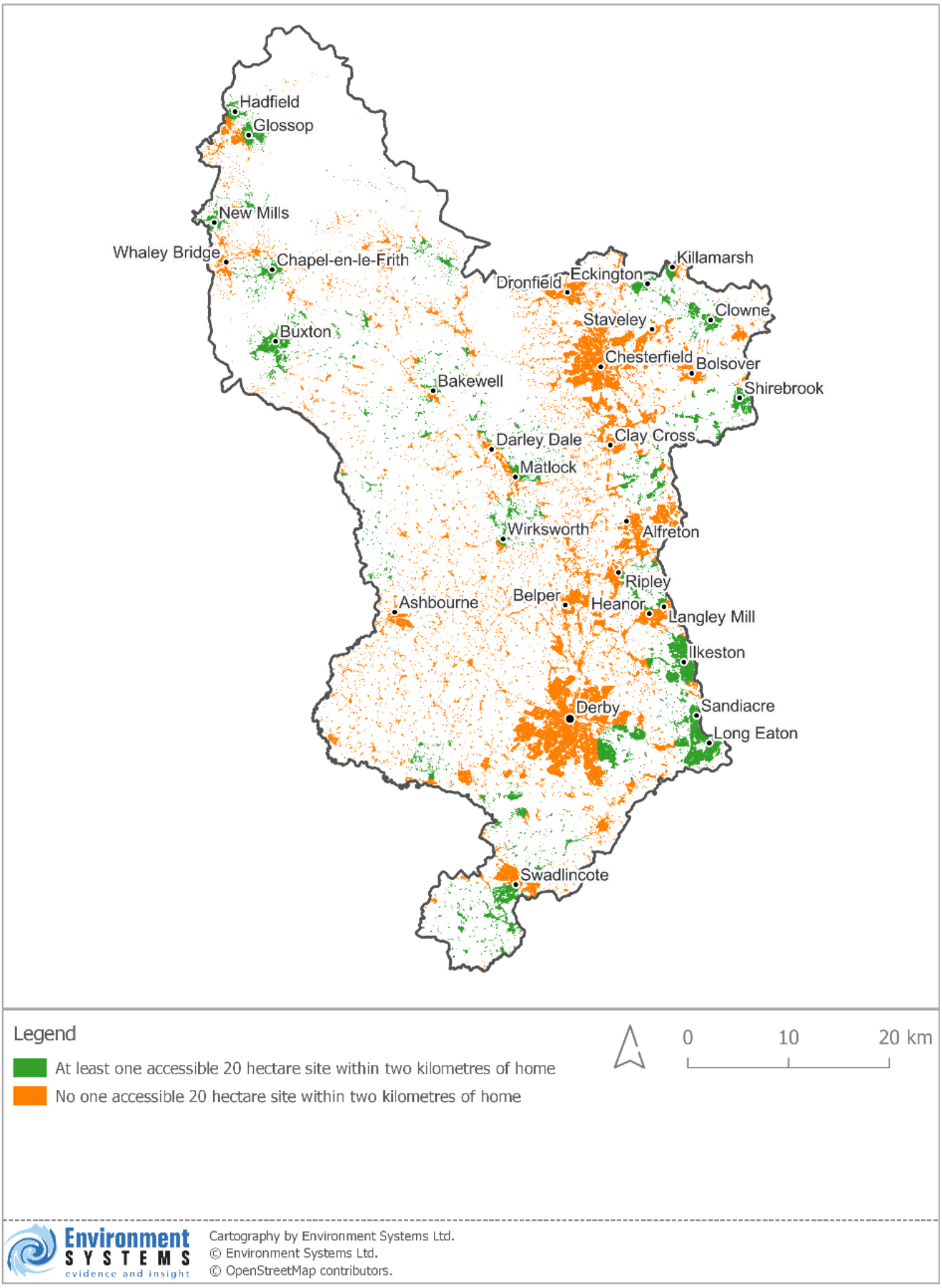

Figure 46: Recreation risks: urban areas with and without access to a 20ha recreational site

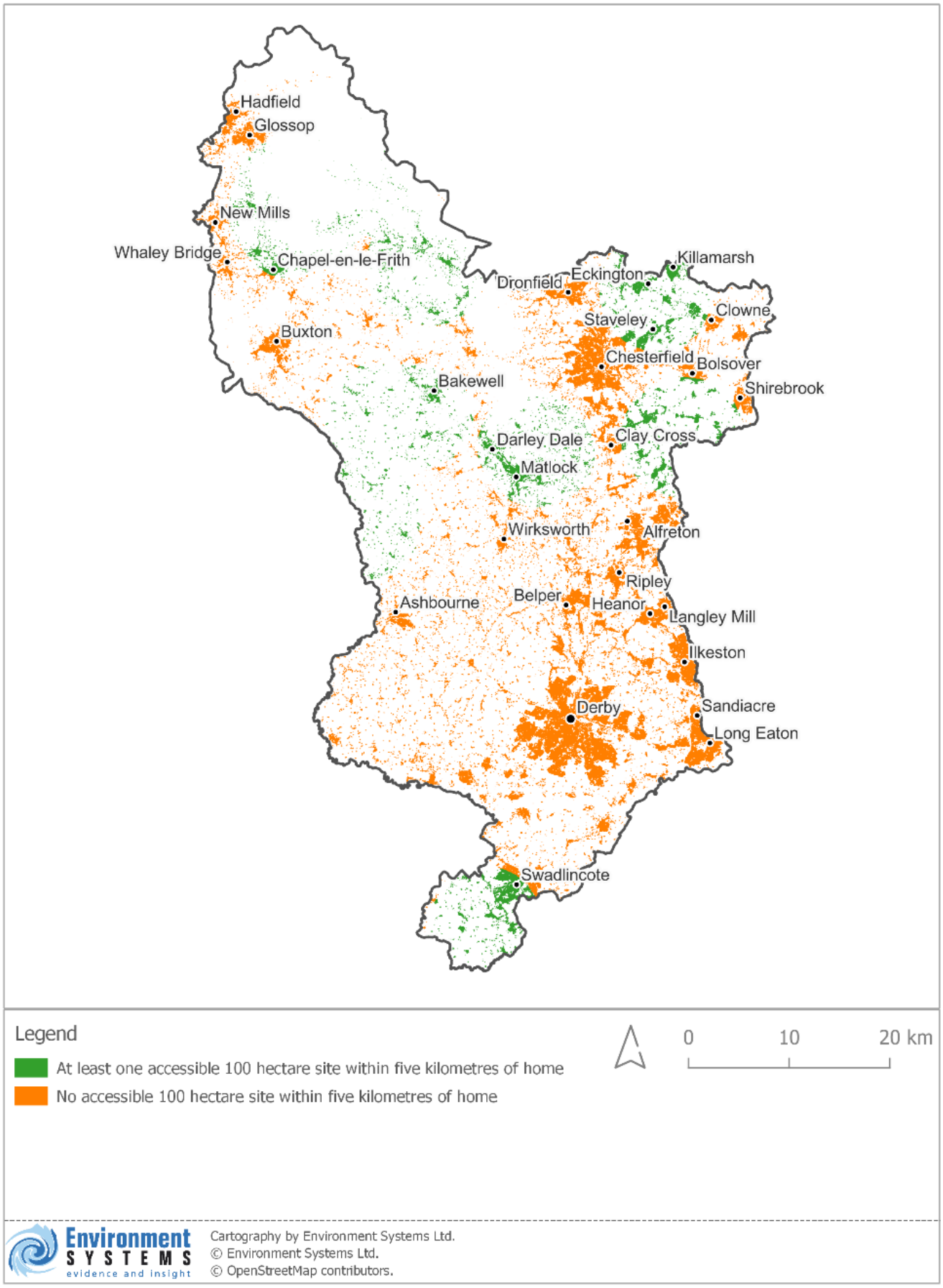

Figure 47: Recreation risks: urban areas with and without access to a 100ha recreational site

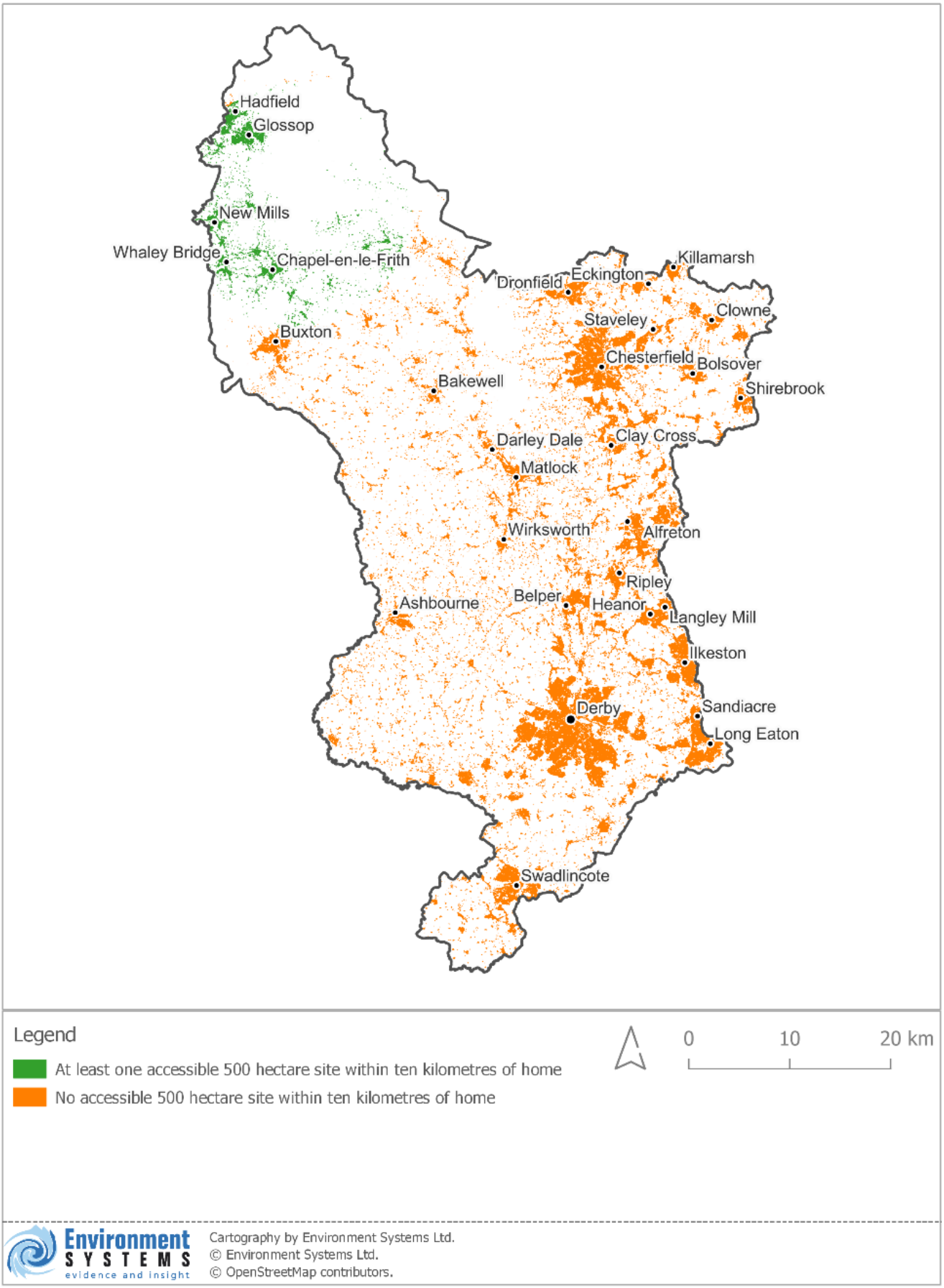

Figure 48: Recreation risks: urban areas with and without access to a 500ha recreational site

Tourism

The input datasets used to identify areas of importance for tourism are shown in Figure 49, and the relative value of individual features is shown in Figure 50. Clusters of sites important for tourism are shown in Figure 51 and it can be seen that a high density of important sites occurs within the Peak District National Park. This map also shows the significance of the National Forest, and Chesterfield, a town which is richly dense in small-footprint tourism assets, such as listed buildings. The Derwent Valley is also identified as a region of high tourism value.

Key points and recommendations for nature-based action: Tourism

- **Peak District National Park,** via its extensive path network, is an important tourist destination but this popularity can create problems for example through peat erosion. Peat restoration, particularly on Kinder Scout, is a high priority in order to protect these vulnerable soils and the carbon they store, and preserve enjoyment of the landscape for generations to come.

- **The National Forest region** is important for providing a high density of tourism destinations in southern Derbyshire, offering potential to alleviate excessive tourism pressure in other parts of the county. Numerous cycling routes and forest trails are located in the region; woodland and heathland restoration could be designed to complement the creation of new paths.

- **The Trent Valley** region currently provides relatively low levels of tourism value, but partnership working under the Transforming the Trent Valley project[15] creates opportunities for tourism to be significantly enhanced in this area.

- **A number of stately homes and historic sites** are important sites for tourism in Derbyshire, including Hardwick Hall, Chatsworth House, Bolsover Castle and Calke Abbey. This presents opportunities to work with large-scale landowners such as National Trust and English Heritage, to co-ordinate action for nature recovery in line with the Natural Capital Strategy, on a landscape scale; the existing landscape partnership between the National Trust, RSPB, The Wildlife Trusts and Woodland Trust is one such example.

- **Reservoirs** such as Carsington Water and Ladybower are important locations for watersport tourism and trail walking; actions to protect and enhance water quality would benefit these areas. Working with landowners such as Severn Trent Water, new habitat resoration schemes could be realised in the surrounding areas that extend the existing options for public access, while also benefitting nature recovery and other ecosystem services.

- **The Derwent Valley** is a significant area for tourism, and the riverine and native woodland habitats are an important part of this, which should be protected and enhanced. Upstream actions to mitigate flood risk would benefit this area.

[15] Transforming the Trent Valley: https://www.thetrentvalley.org.uk/

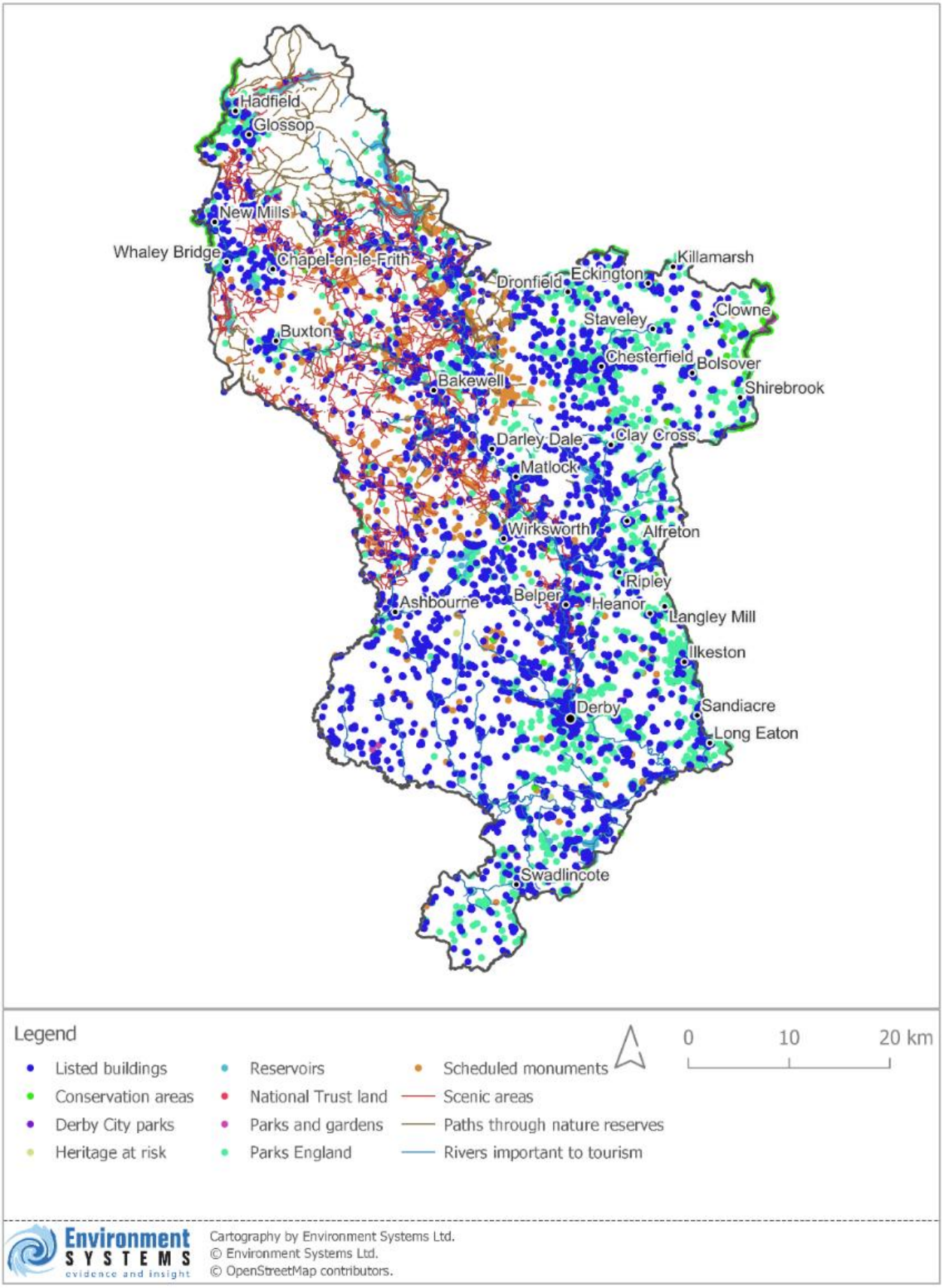

Figure 49: Areas of high importance for tourism: input datasets

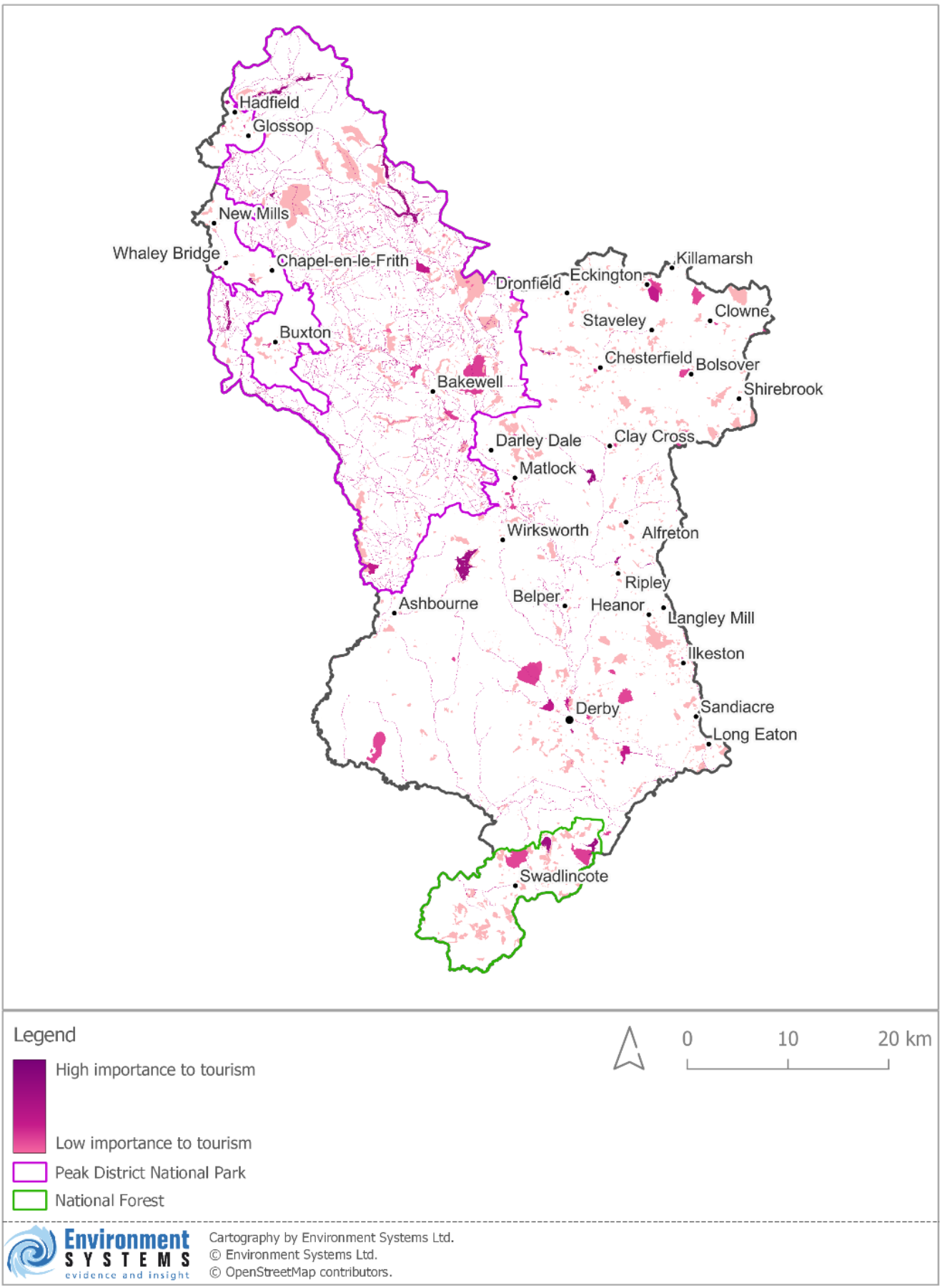

Figure 50: Areas of high importance to tourism: current stock

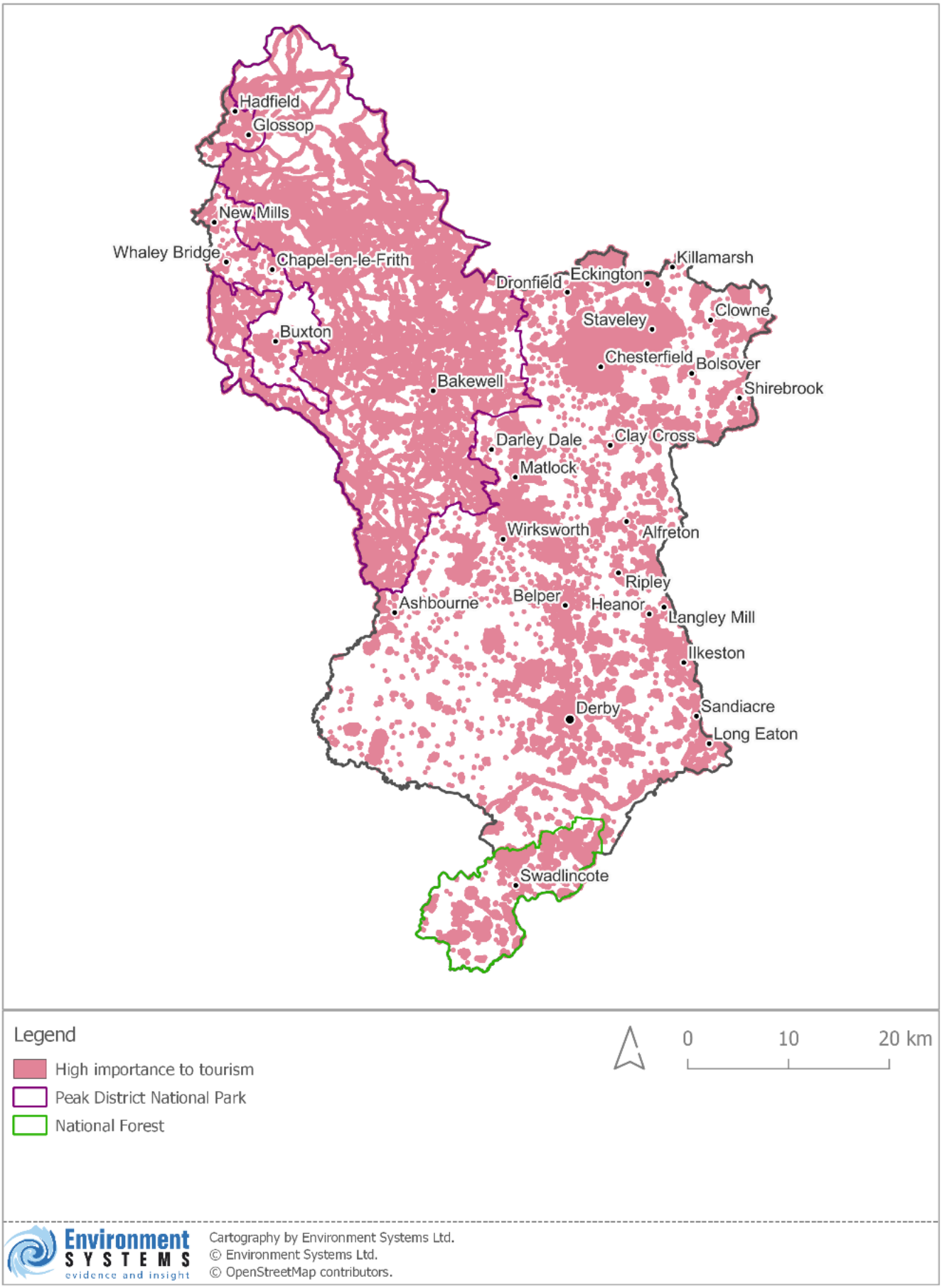

Figure 51: Clustered tourism sites; groupings of sites of high importance for tourism

Contribution of agriculture to landscape character

Agriculture is an important component of Derbyshire's landscape character; centuries of agricultural enclosure and land management practices have crafted the distinctive landscapes people value today. Figure 52 displays the relative contribution of the agricultural areas of Derbyshire, in terms of the current level of visual intactness of the area, and the presence of important cultural and historic assets on agricultural land.

An emerging risk to the existing agricultural aspect of landscape character is the drive for woodland planting for climate change mitigation. Figure 53 identifies areas where the visual intactness of the agricultural landscape may be particularly at risk, due to the presence of woodland opportunities within the ecological network; the highest risk to landscape character from woodland establishment is concentrated within the White Peak and the border separating the Peak District National Park and the Peak Fringe and Lower Derwent. This does not necessarily mean that woodland planting could not be considered in these places, but that sensitivity should be given to the size and location of any planting, and how the landscape character can be maintained. In some places the agricultural component of landscape character may be judged to be more significant than others, but the cumulative impact of woodland planting should be considered, in addition to the impact of individual planting sites.

Another risk to the agricultural aspect of landscape character could come from renewable energy generation; Figure 54 identifies places where the landscape character could be significantly degraded by solar and wind developments. The highest risk to landscape character from the development of renewable energy is concentrated within the areas of Southern Magnesian Limestone, Peak Fringe and Lower Derwent and the Needwood and South Derbyshire Claylands, Melbourne Parklands and the Mease/Sense Lowlands.

Key points and recommendations for nature-based action: Contribution of agriculture to landscape character

- **Changes in agricultural practices,** driven by market forces, are changing the landscape character of agricultural areas. Agricultural areas are a particularly important component of the landscape in parts of Derbyshire Peak Fringe and Coalfield Estatelands, and parts of South West Peak. The baseline landscape character assessment and associated habitat priorities analysis (Chapter 5) and cultural historic assessment (Chapter 6) provide insights into the areas where agriculture is a key component of the landscape.

- **Extensive woodland planting** could significantly alter the contribution of agriculture to landscape character, particularly where the chosen tree species do not reflect the local native species mix. Derbyshire County Council's woodland planting strategy identifies the relative scale and type of woodlands suitable for each landscape character area; when considering new planting schemes, the cumulative impacts of existing and proposed plantations on landscape character should be considered.

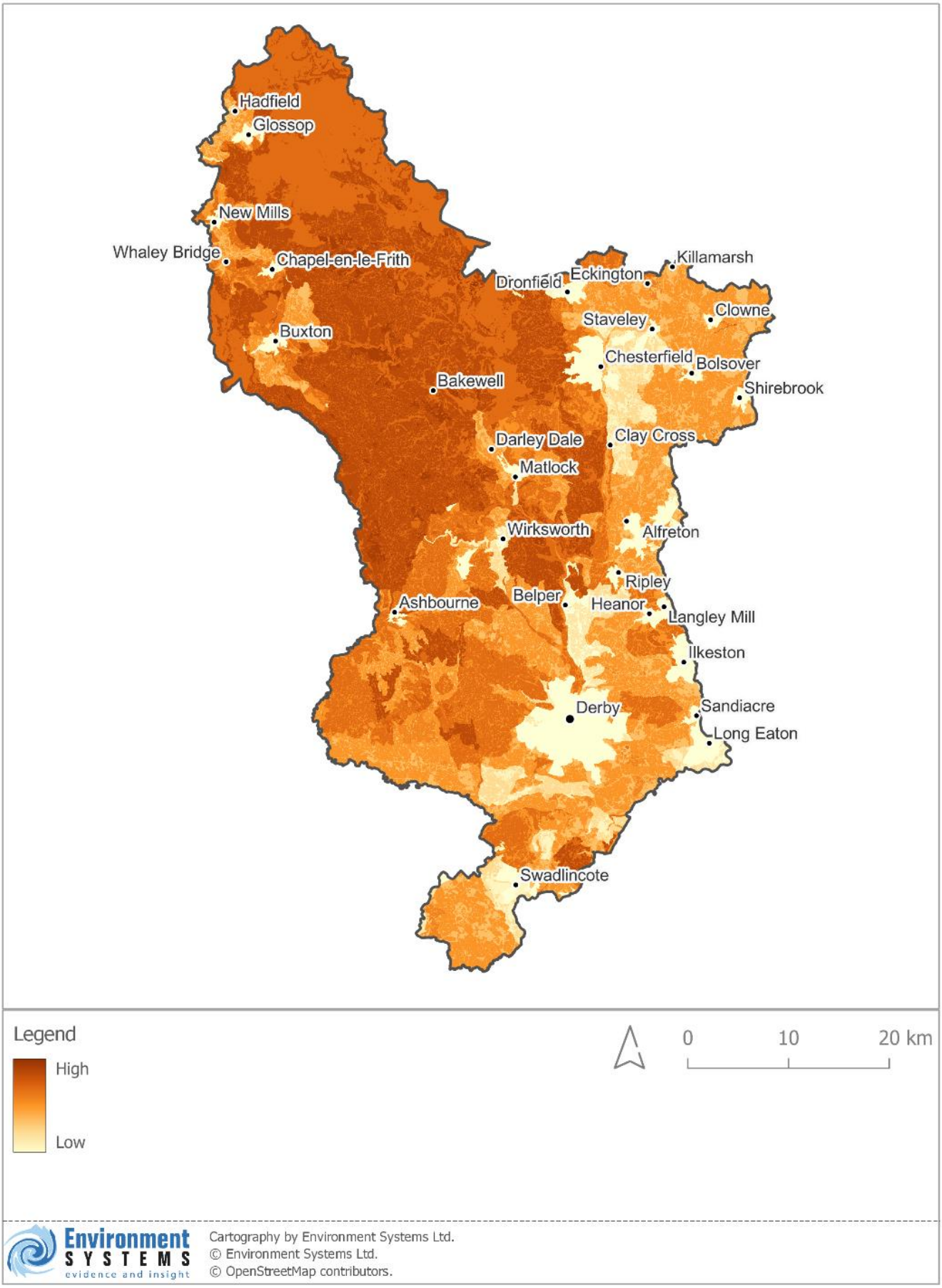

Figure 52: Relative contribution of agriculture to landscape character

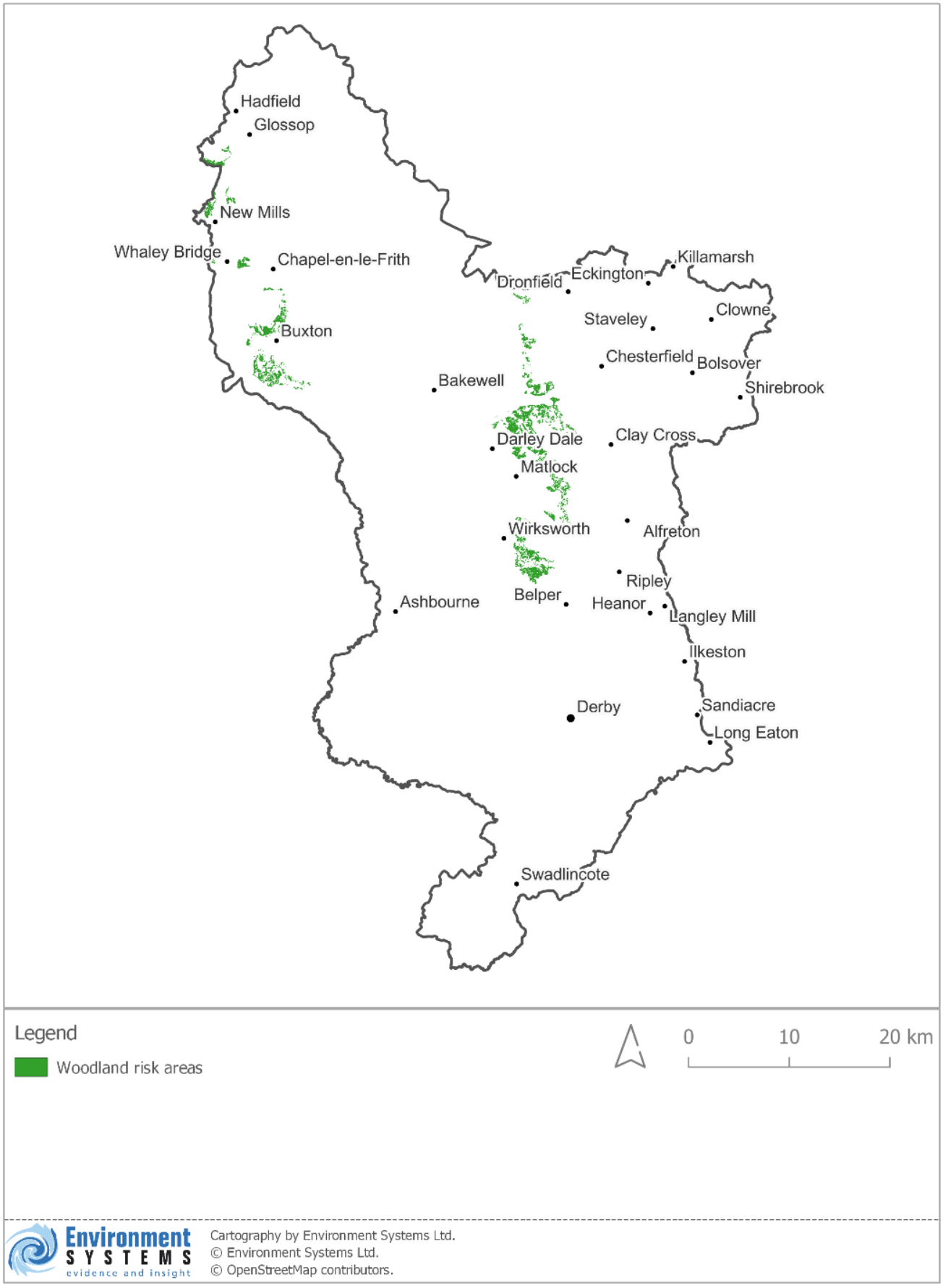

Figure 53: Potential risks to landscape character from woodland planting within the ecological network

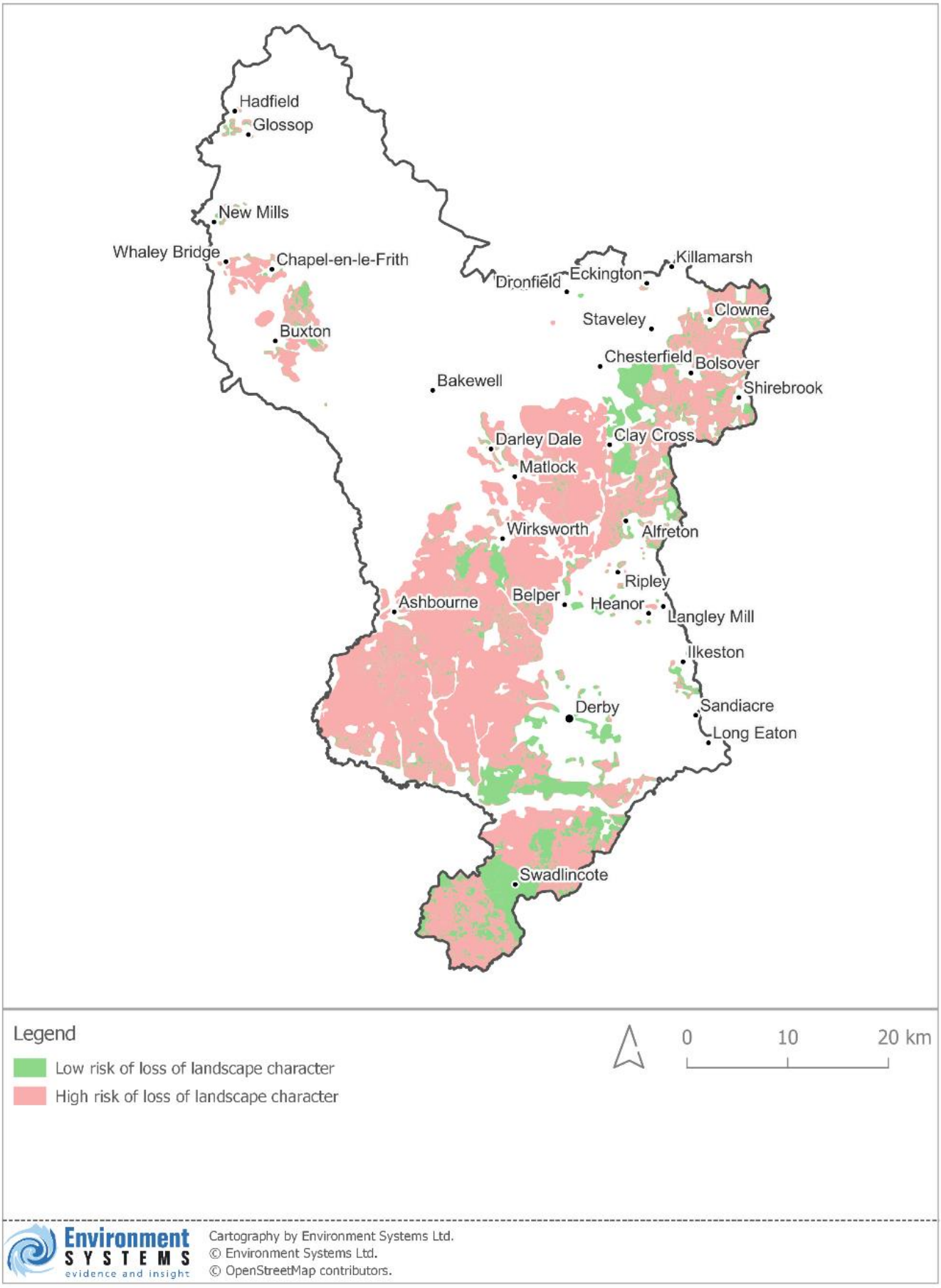

Figure 54: Potential risks to landscape character from solar and wind renewable energy projects Provision of multiple ecosystem service benefits for effective targeting of land management action

In a world of conflicting land use pressures, limited financial resources, and limited time in which to achieve our goals, effective means of targeting land management action are needed in order to maximise the level of benefits realised from nature-based solutions. When considering sites for habitat restoration the full range of priority ecosystem service themes should be considered to address related questions such as:

- Where are the most effective sites for enhancing biodiversity?
- Do any of these align with areas identified as a priority for Natural Flood Management or water quality regulation?
- Do the proposed actions secure or enhance existing carbon stocks?
- Are there opportunities for creating habitats that can address the needs of residents that currently have poor access to greenspace?

Examples of places where there are opportunities to deliver multiple ecosystem service opportunities including for biodiversity and to improve water quality regulation are shown in Figure 55 and for Natural Flood Management in Figure 56. In both cases, the multi-benefits can be met by a land management actions that are appropriate to the particular habitat type. For example, an opportunity for both biodiversity and water quality regulation would be the creation of riparian (grassland / woodland) buffer strips alongside rivers.

These maps identify that there are extensive areas where water quality regulation opportunities can be realised in the Peak District National Park and in west Derbyshire through enhancing the grassland and heathland ecological networks by restoring heath and species-rich grassland. In eastern and southern Derbyshire, water quality benefits can be achieved by targeted woodland planting initiatives (making consideration to landscape character sensitivities) which also strengthen the existing woodland network and development of the National Forest.

In terms of delivering Natural Flood Management (NFM) opportunities, there is a lot of scope for enhancing the grassland ecological network in the upland and mid-reach areas of river catchments. There are significant opportunities for enhancing the wetland network in the lowland valley areas to benefit NFM. It is notable that there were few opportunities for woodland creation that would meet the dual benefits of enhancing NFM and improving the woodland network connectivity; this is a reflection of the current distribution of the woodland network, and the extent of land clearance for agriculture. It highlights the fact that most of the areas with high hydrological connectivity in Derbyshire are currently unwooded.

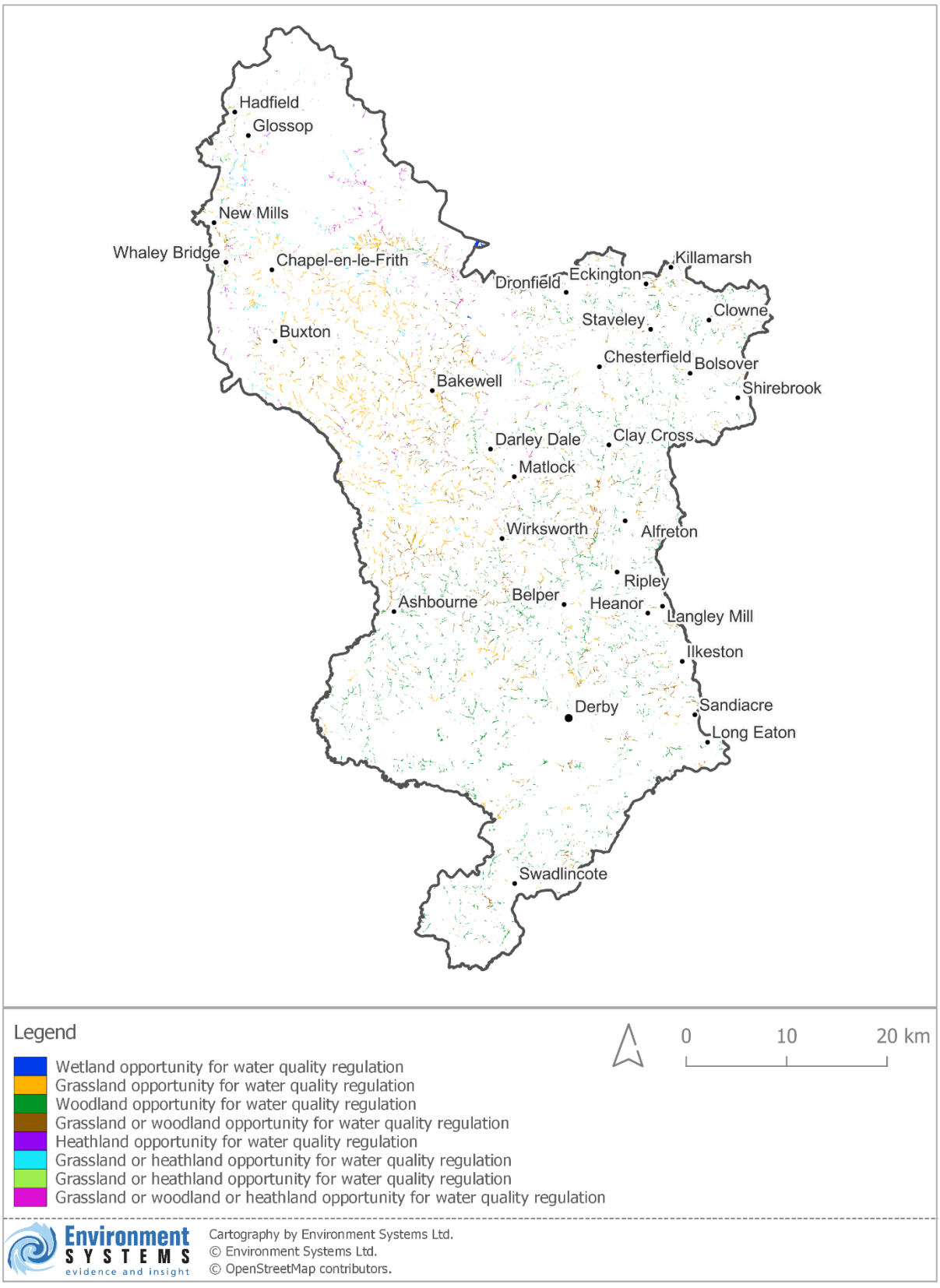

Figure 55: Biodiversity and water quality regulation multi-benefits

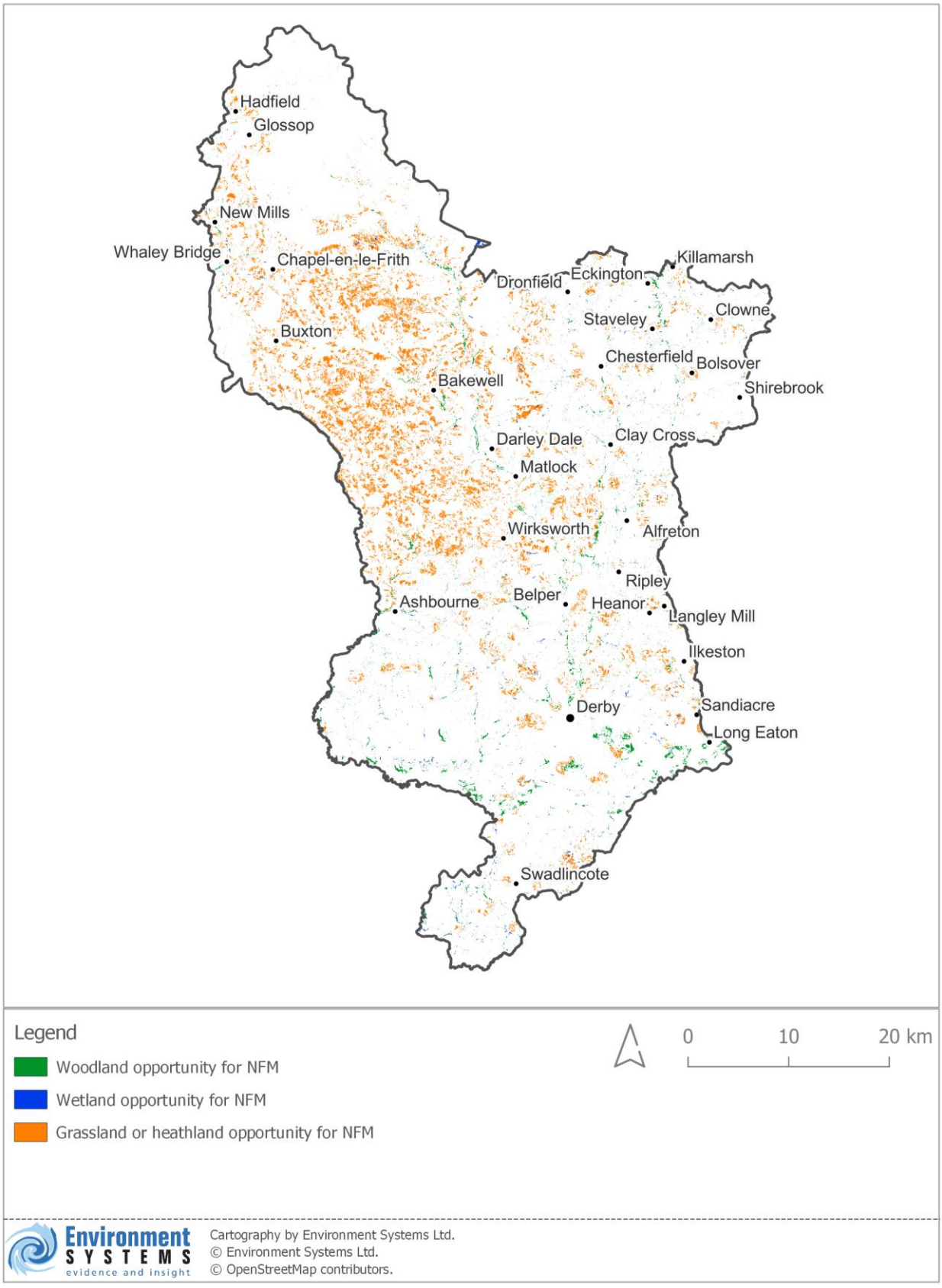

Figure 56: Biodiversity and Natural Flood Management multi-benefits

Chapter 4: The Natural Capital Accounts

Natural Capital Accounting

Natural Capital is "the stock of renewable and non-renewable natural resources (e.g., plants, animals, air, water, soils, minerals) that combine to yield a flow of benefits to people"[16].

A natural capital approach can be defined as distinguishing between the natural capital stocks and the flows of benefits they provide; projecting benefits into the future and linking them to the extent and condition of assets. The intention is to ensure that decisions prioritise maintaining the assets to sustain a range of benefits, and not to maximise one of the benefits at the expense of others or the natural capital asset itself.

This approach is reflected in the structure of natural capital accounts, shown in Figure 57. The accounts link together different types of physical and monetary assets and flow data. This study has developed natural capital accounts to understand the extent, condition and benefits of Natural Capital in Derbyshire. The results for Derbyshire as a whole are reported in this chapter, and sub-accounts for local government boundaries, landscape character areas and the Peak District National Park of Derbyshire are reported in Appendix 6.

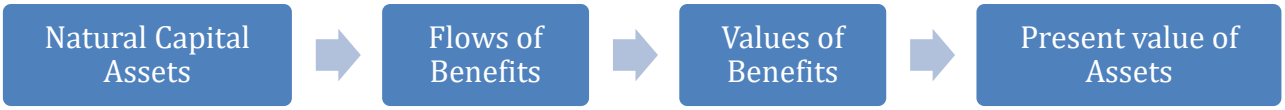

Figure 57: The structure of natural capital accounts

Accounting differs from one-off assessments by generating systematic and consistent evidence, enabling repeated updates. Accounting offers comparability across space and time, bringing rigour to the presentation of data on natural capital assets, the services they provide, the benefits and hence the value of those services, and the distribution of those benefits across society and into the future.

The approach to developing the Derbyshire baseline natural capital accounts is based on the Corporate Natural Capital Account (CNCA) framework for the Natural Capital Committee in 2015[17]. This framework is also the basis of BSI:8632 on Natural Capital Accounting for Organizations[18]. Natural capital accounting involves producing a natural capital balance sheet and a natural capital income statement mirroring traditional

[16] Source: Natural Capital Protocol *https://naturalcapitalcoalition.org/natural-capital-protocol/*
[17] eftec, RSPB and PWC (2015) Developing Corporate Natural Capital Accounts for the Natural Capital Committee. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/516968/ncc-research-cnca-final-report.pdf
[18] Available at: *https://shop.bsigroup.com/products/natural-capital-accounting-for-organizations-specification?pid=000000000030401243*

financial accounting. The intention is to present information to decision makers in a format they are familiar with so that the organisation's impacts and dependencies on natural capital are considered more explicitly and in conjunction with other forms of capital.

The **natural capital balance sheet** has two parts:

1. Asset Values (of the benefits natural capital produces for business and the wider society)
2. Liabilities (of spending to maintain natural capital).

This project considers the asset values. It was not possible to consider liabilities within this project's resources. The report presents a Natural Capital Asset Register, Physical Flows Accounts and Monetary Flow Accounts, which come together to form a **Natural Capital Asset Account**.

The natural capital balance sheet and its supporting schedules answer five key questions, those which the Natural Capital Asset Account can address are the first three of these (shown in bold):

- **What assets do we own and/or manage?**
- **What benefits do they provide and to whom?**
- **What are these benefits worth?**
- **What does it cost to maintain the assets?**
- **How do costs compare to benefits over time?**

Three supporting schedules hold the information gathered for the Derbyshire account:

- **Natural Capital Asset Register** – which records the stock of natural capital assets in terms of their extent, condition and spatial configuration (e.g. size and status of designated sites). These indicators help determine the health of natural capital assets and their capacity to provide benefits[19].
- **Physical Flow Accounts** – which quantify the benefits that the assets deliver in physical terms. Changes in the quantity / quality of the assets and their benefit provision over time are also shown.
- **Monetary Value Accounts** – which estimate the economic value of the benefits in monetary terms and discounts the projected future flow of these benefits to provide the present value for the assets. This uses data from actual markets and other (non-market) values. The value of the benefit should be the net of the cost of producing the benefit.

The monetary flow and cost accounts distinguish private values to business from external values to the rest of society. Where understanding and evidence allow, calculation of

[19] The natural capital asset register is also the basis for scoping the natural capital risk register, and for a materiality assessment to determine the content of the flow and liabilities accounts.

asset values can take account of expected changes to future costs and benefits of management, and external factors such as population growth or climate change.

This part of the project was executed through three main tasks:

Task 1 - Data collection: established data requirements, including discussions with Derbyshire County Council, Peak District National Park Authority and Derby City Council to identify relevant stakeholders to contact for data inputs to help produce the account. eftec developed a data collection spreadsheet to gather this data.

Task 2 – Support to build the natural capital accounts: The development of the asset register was undertaken by project lead partners Environment Systems. Data was provided on both the extent and condition of natural capital assets with the County level and sub-regional level. eftec used this data to complete the calculation processes for quantifying benefits and expressing the values in monetary terms.

Task 3 – Review of results: initial draft results were presented to stakeholders on the 8th June 2022, the results have since been updated are summarised in this report.

The natural capital approach and overall method for producing natural capital accounts for Derbyshire are described in Chapter 2. A more specific description of the methods used to evaluate the benefits included in the accounts is provided in Appendix 7. The distribution of benefits between private benefits to business sectors and benefits to wider society, is also noted in the reporting.

Scope of the account

The scoping stage defined the spatial and temporal boundary of the account, the data sources available and the types of benefits from natural capital covered; these are summarised in

Table 2. The list of potential benefits to assess reflects the list of individual benefits included in Defra's (2020) 'Enabling a Natural Capital Approach' (ENCA), shown in Table 3.

Table 2: Natural Capital Asset Account parameters

Parameter	Description
Spatial	The spatial boundary for the account is Derbyshire county– the results have been broken down into the eight district and borough councils within Derbyshire, Derby City and the Peak District National Park (see Appendix 6).
Temporal	The baseline year for the analysis is 2021 and all values are reported in 2021 prices using HM Treasury (2022b) GDP deflators. The results are provided in annual terms and present value over a 60-year time period for both catchments, as recommended by the HM Treasury (2022a) Green Book. A discount rate of 3.5% is applied in the present value calculations for all benefits. Where possible, future values take into account expected trends in the quantity and/or value of the benefit. Where this information is not available, renewable benefits are assumed to be constant over time.
Data sources	National and regional datasets are the initial source for evidence and assumptions, with local level information sources drawn on where feasible. Sources used are in line with Defra's Enabling a Natural Capital Approach (ENCA) guidance (Defra, 2020).

Table 3: Potential benefits to assess

- Agricultural output
- Fishing (commercial)
- Timber
- Water supply
- Renewable energy
- Minerals
- Carbon sequestration
- Air quality regulation
- Flood risk management
- Noise reduction
- Temperature regulation
- Recreation
- Physical health
- Mental health
- Education
- Volunteering
- Amenity
- Biodiversity
- Soil
- Water quality
- Landscape
- Non-use values

Materiality assessment

A materiality[20] assessment is used to determine which of the benefits listed above should be included in the account, given the natural capital assets in scope. All the individual benefits in Defra's ENCA guidance (2020), listed above, were considered for inclusion in

[20] This is defined in the Natural Capital Protocol as "an impact or dependency on natural capital is material if considering it, as part of the set of information used for decision making, has the potential to alter that decision" (p. 43, Capitals Coalition, 2016).

the account[21]. The assessment has been undertaken using a service-asset attribute matrix which aims to show:

- Which ecosystem services are material for each asset within the Derbyshire account boundary;
- Of these material ecosystem services, which benefits have been assessed and how; and
- Which have not been possible to measure in biophysical units or value in monetary terms and why.

The materiality assessment for the Derbyshire account is shown in Table 4.

The following benefits are considered material but have not been measured in these accounts:

- **Flood risk management** – It is difficult to quantify the benefit provision without more detailed modelling (e.g. identifying flood risk areas and natural capital assets providing flood risk benefits)
- **Mental health benefits of engagement with nature** – Following current ENCA guidance (Defra, 2020a), only physical health benefits are valued in this report as there is currently insufficient evidence to value mental health benefits in general terms. While the evidence for mental health benefits from green space is strong, it is context dependent and not readily quantifiable for the purposes of accounting and policy analysis.

[21] Defra's ENCA (2020) also reflects 'bundled' benefits which include amenity, soil, landscape and non-use values. These are not considered for this account to avoid double-counting with the individual benefits already included (e.g., recreation).

Table 4. Materiality assessment, 2021

Private & Public Benefits **At September, 2022**	**Natural Capital Assets**						
	Arable	Freshwater	Grassland	Mountain, moorland and heath	Woodland	Urban	Other
Agricultural output	●		●				
Fishing (commercial)							
Timber					●		
Water supply		●	●	●	●		
Renewable energy	○	●	○	○			●
Minerals							●
Carbon sequestration	●		●	●	●		
Air quality regulation					●		
Flood risk management	○	○	○	○	○	○	○
Noise reduction						○	
Temperature regulation						○	
Recreation	●	●	●	●	●	●	●
Physical health	●	●	●	●	●	●	●
Mental health	○	○	○	○	○	○	○
Tourism	●	●	●	●	●	●	●
Education[1]	●	●	●	●	●	●	●
Volunteering	●	●	●	●	●	●	●
Water quality		●					
Biodiversity	◖	◖	◖	◖	◖	◖	◖

Legend

Material service provision	
No material service provision	
Benefit estimated in quantitative and monetary terms	●
Benefit estimated in non-monetary terms	◖
Not assessed	○

[1]Education estimates only reflects South Derbyshire and volunteering only reflects Lowland Derbyshire due to data limitations in the other areas.

Outputs

Asset Register

Figure 58 and Table 5 summarise the asset extent account for Derbyshire by UK broad habitat.

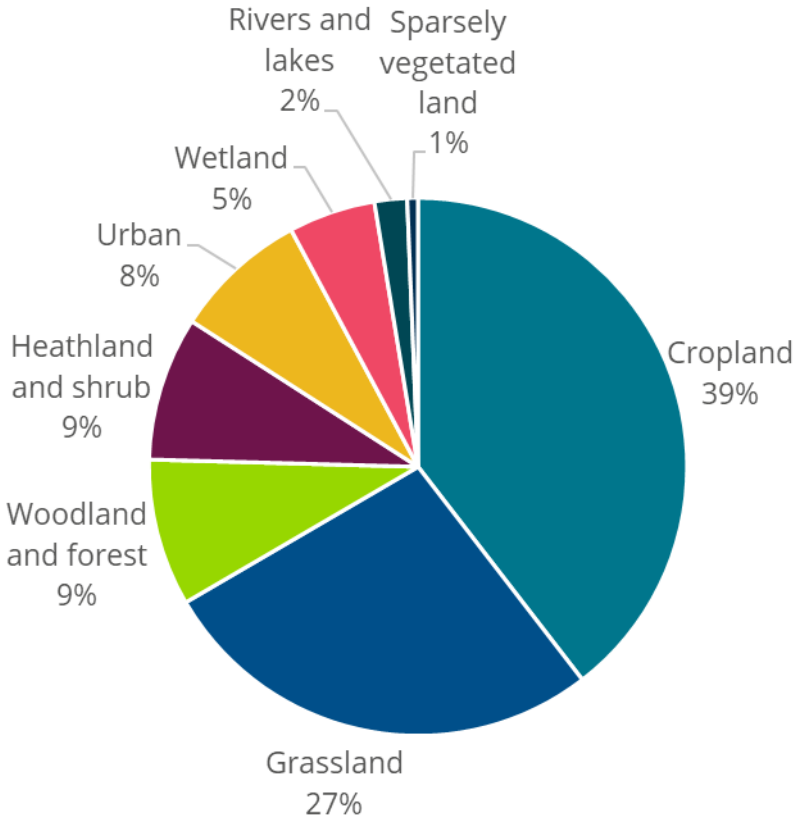

Figure 58. Asset extent Derbyshire, 2021 (produced at September 2022)

Table 5 Asset extent Derbyshire (ha), 2021 (produced at September 2022)

Habitat	Area (ha)
Cropland	104,000
Grassland	71,200
Woodland and forest	23,300
Heathland and shrub	22,800
Urban	21,200
Wetland	13,700
Rivers and lakes	5,200
Sparsely vegetated land	1,700
Total	263,100

Data reflecting the condition of natural capital assets is shown in Table 6 which presents the coverage of terrestrial designations, flood risk zones and habitat connectivity within

Derbyshire, and Table 7 which shows the condition data on the water environment including Water Framework Directive status.

Table 6 Terrestrial designations in Derbyshire, 2021 (produced in September 2022)

Indicator		
Designated SSSIs	**Area (hectares)**	**% of total SSSI area**
Favourable condition	4,600	16%
Unfavourable recovering condition	23,000	81%
Unfavourable declining condition	270	1%
Unfavourable no change	520	2%
Part destroyed	1	0.004%
Destroyed	5	0.02%
Total	28,330	100%
Other designated areas	**Areas (hectares)**	**% of total area**
Country Parks	1,600	1%
Local Nature Reserves	670	0.3%
National Nature Reserves	1,800	1%
Special Areas of Conservation	27,000	10%
Special Protection Areas	25,000	10%
Ancient Woodland	7,700	3%
Green Belt	240	0.1%
Parks and Gardens	3,000	1%
Flood risk	**Areas (hectares)**	
Flood zone 2	19,000	
Flood zone 3	15,000	
Accessibility		
Area of greenspace (ha)	14,000	
Length of footpaths (m)	3,800,000	
Habitat connectivity	**Areas (hectares)**	**% of total habitat area**
Grassland		
Core network	12,000	5%
Stepping stone	200	0.1%
Remaining network	110,000	42%
Outside network	140,000	54%
Heathland		
Core network	11,000	5%
Stepping stone	50	0.02%
Remaining network	42,000	18%
Outside network	180,000	77%
Wetland		
Core network	15,000	6%
Stepping stone	1,100	0.4%
Remaining network	90,000	34%
Outside network	160,000	60%
Woodland		
Core network	14,000	5%
Stepping stone	4,600	2%
Remaining network	130,000	48%
Outside network	120,000	45%

Source: Day, B. H., and G. Smith (2018), Habitat Asset Register, Natural England data

Table 7. Water Framework Directive waterbodies in Derbyshire, 2021 (produced at September 2022)

Water Framework Directive status[22]		
Rivers	Length (kilometres)	% of total length
High	320	45%
Good	250	35%
Moderate	87	12%
Poor	51	7%
Total	708	100%
Lakes	Area (hectares)	% of total area
High	1,500	18%
Good	3,000	35%
Moderate	3,700	44%
Poor	300	4%
Total	8,500	100%

Source: *Day, B. H., and G. Smith (2018)*

Physical and Monetary Flow Account

The estimated annual physical and monetary values for each benefit are summarised in Table 9. The physical and monetary estimates in Table 9 are given a confidence rating, which is described in **Error! Not a valid bookmark self-reference.**.

Table 8. Assessing data quality

Level of confidence	Symbol	Description
Low	L	Evidence is partial and significant assumptions are made so that the data provides only order of magnitude estimates of value to inform decisions and spending choices.
Medium	M	Science-based assumptions and published data are used but there is some uncertainty in combining them, resulting in reasonable confidence in using the data to guide decisions and spending choices.
High	H	Evidence is peer reviewed or based on published guidance so there is good confidence in using the data to support specific decisions and spending choices.
No colour	●	Not valued

The accounts identify a wide range of benefits from the natural capital within Derbyshire. Table 9 shows significant values for provisioning (e.g. water supply and minerals), regulating (e.g. air quality regulation) and cultural (e.g. recreation) services, as well as significant physical health benefits in relation to physical activity. Overall, there is medium to high confidence for most benefits, except for the

[22] *Source: Environmental Agency (2021) Catchment Data Explorer. Available at: https://environment.data.gov.uk/catchment-planning/*

estimated tourism expenditure, education and volunteering attributed to nature, which are low confidence.

The total annual net value of ecosystem benefits and services produced within Derbyshire is £2.6 billion in 2021 prices. Key benefit values include carbon sequestration by habitats (£2 billion, 77% of total benefits), mineral production (£298 million, 11% of total benefits) and recreation (£181 million, 7% of total benefits). The carbon sequestration benefits provided by habitats outweigh the GHG emissions produced by habitats (-£95 million) and livestock (-£249 million). Note that wherever red values in parentheses appear, this indicates that the value is negative and represents negative environmental impacts.

Table 9. Derbyshire Physical and Monetary Flow Account (annual values , 2021

At September, 2022	Physical flow (unit/yr)			Monetary value (£m/yr)		
	Indicator	**2021**	**Confidence**	**Valuation metric**	**2021**	**Confidence**
Agricultural output	Arable crop production (tonnes/yr)	241,979	H	Gross margin of arable crop production	24	H
	Livestock production (heads/yr)	460,488	H	Gross margin of livestock production	72	H
Timber	Volume of softwood removals (m3/yr)	25,402	M	Value of softwood removals	1	M
Water supply	Surface water abstraction for public water supply (m3/yr)	534,967,247	H	Resource rent value of surface water abstractions for public water supply	123	M
	Groundwater abstraction for public and private water supply, spray irrigation, agriculture and fish farming (m3/yr)	4,053,711	H	Ecosystem provision value of groundwater for public and private drinking water and agriculture benefits	9	M
Renewable energy	Electricity generated by renewable sources (MWh/yr)	85,895	M	Resource rent value of renewable energy	1	M
Minerals	Volume of minerals extracted (tonnes/yr)	22,557,750	H	Ex-works value of mineral production	298	M
Carbon sequestration	CO2e sequestered in habitats (tCO2e/yr)	8,028,901	M	Value of CO2e sequestered in habitats	1,966	M
	CO2e emitted by habitats (tCO2e/yr)	(387,305)	M	Value of CO2e emitted by habitats	(95)	M
	CO2e emitted by livestock (tCO2e/yr)	(1,017,527)	M	Value of CO2e emitted by livestock	(249)	M
Air quality regulation	PM2.5 removal by woodland (kg/yr)	158,226	H	Value of PM2.5 removal by woodland	20	H
Recreation	Adult recreation visits (under 3 hours) (visits/year)	49,708,989	M	Adult recreation welfare value (under 3 hours)	181	M
Physical health	Number of active visits (no. active visits/yr)	25,600,129	M	Avoided treatment medical costs	86	M
Tourism	Domestic day visits and overnight trips attributed to NC (visits/yr)	4,082,960	L	Domestic tourism expenditure attributed to natural capital	105	L
Education	Number of volunteer days (days/yr)	27,817	L	Value of volunteer days	1	L
Volunteering	Number of education visits (visits/yr)	5,110	L	Value of educational visits	0.02	L
Water quality	Length of WFD rivers (km)	702	H	Welfare of avoiding deterioration in rivers	9	M
	Area of WFD lakes (km2)	8,598	H	Welfare of avoiding deterioration in lakes	62	M
				Total value	**2,619**	M
Key non-monetised benefits						
Biodiversity	Total SSSI area (ha)	30,000	H		Not valued	•
Other material unquantified benefits						
Flood risk management						
Mental health						

Natural Capital Asset Account

Table 10 shows the benefits than can be provided by natural capital in Derbyshire if current annual benefits and quantified trends continue over 60 years. Overall, Derbyshire's natural capital assets have an asset value of £87 billion in present value terms. Within the account climate change is considered as a known but mostly unquantified trend.

Table 10 also reflects the distribution of benefits to businesses and wider society. Most of these benefits accrue to wider society through air quality regulation, carbon sequestration, water quality, recreation and physical health, equating to around £73 billion in present value terms. A further £14 billion accrues to businesses through agriculture, timber, water supply, renewable energy and minerals. In general, there is high to moderate confidence in both the Physical and Monetary Flow Account estimates, with present value estimates having greater uncertainty due to assumptions on future trends. Key gaps and uncertainties for the Derbyshire accounting boundary include:

- Partial estimates of the education and volunteering benefits throughout the Derbyshire, as data for each district and borough council was limited.
- There is insufficient data to represent some expected future changes (such as climate change risks) in the account, therefore the values may change due to costs and/or impacts of climate change or other trends. These future costs will partly depend on the actions taken to mitigate and adapt to climate change.
- The non-monetised and unquantified benefits listed in Table 10 are expected to be material. Further work could include undertaking a baseline biodiversity assessment for the region; however, this is expected to require support from other stakeholders.
- The maintenance costs associated with natural capital and their distribution (e.g., tree thinning, greenspace maintenance) should be included in order to understand the relationship over time between spending on assets and the benefits they provide.

Table 10. Derbyshire Natural Capital Asset Account, £m PV60, 2021

	Valuation metric	Value to businesses	Value to the rest of society	Total
Asset values (monetised)				
Agricultural output	Gross margin of cereal crop production	619	-	619
	Gross margin of livestock production	2,029	-	2,092
Timber	Value of softwood removals	22	-	22
Water supply	Resource rent value of Surface water abstractions for public water supply	3,226	-	3,226
	Ecosystem provision value of groundwater for public/private drinking water/agriculture benefits	235	-	235
Renewable energy	Resource rent value of renewable energy	37	-	37
Minerals	Ex-works value of mineral production	7,481	-	7,481
Carbon sequestration	Value of CO2e sequestered in habitats	-	72,066	72,066
	Value of CO2e emitted by habitats	-	(3,476)	(3,476)
	Value of CO2e emitted by livestock	-	(9,133)	(9,133)
Air quality regulation	Value of PM2.5 removal by woodland	-	532	532
Recreation	Adult recreation welfare value (under 3 hours)	-	4,736	4,742
Physical health	Avoided treatment medical costs	-	3,481	3,482
Tourism	Domestic tourism expenditure attributed to NC	-	2,744	2,744
Education	Value of volunteer days	-	18	18
Volunteering	Value of educational visits	-	0.5	0.5
Water quality	Welfare of avoiding deterioration in rivers	-	224	224
	Welfare of avoiding deterioration in lakes	-	1,631	1,631
Total gross asset value		13,691	72,824	86,515
Asset values (non-monetised)				
Biodiversity	Total SSSI area: 30,000 hectares			
Other material unquantified benefits				
Flood risk management				
Mental health				

Breakdown of results within Derbyshire

Sub-boundary accounts have been developed for the administrative areas and National Character Areas that fall within Derbyshire County, as well as for the Peak District National Park. Appendix 6 contains the reporting results for each sub-boundary area.

The sub boundary accounts are a sub-division of the Derbyshire account, applying the same methods where possible. The methodology for the benefit calculations is set out in Appendix 7.

Summary

Through working with Derbyshire County Council, Peak District National Park Authority, Derby City Council and stakeholders a Natural Capital Asset Account has been developed for the Derbyshire, the nine administrative areas, ten National Character Areas and the Peak District National Park. It provides an understanding of the overall scale and significance of benefits provided by

natural capital assets. It aligns with the Green Book (HM Treasury, 2022a) and Defra's Enabling the Natural Capital Accounting approach (ENCA) methods.

The account has been developed with a good coverage of data, including extensive habitat mapping (see Section 3) using the UKHab classification, and the measurement and valuation of 13 different benefits. The account provides a good baseline; however, it isn't able to capture everything in monetary terms due to data and methodological constraints.

The account can be used in different ways. Firstly, it provides data that can be used to make a business case to central government for support and funding to invest in natural capital. Secondly, it gives a consistent evidence base for different groups and decision-makers to refer to. For example, Biodiversity Net Gain, environmental land management schemes (ELMS[23]; where participating landowners receive payments for managing land in support of environmental objectives such as sustainable farming and nature recovery) design, and other policies can work from connected data. However, good communication is required to ensure the data is used properly.

Thirdly, the accounting structure also allows for comparison of the sub-regions using a consistent approach and data. Finally, while the account provides useful information to help manage natural capital it should be noted the positive values do not mean that the natural capital assets are being managed sustainably. To assess this, more understanding of future trends (e.g. climate change) and estimations of maintenance costs would need to be factored in.

[23] https://www.gov.uk/government/publications/environmental-land-management-schemes-overview

Chapter 5: Natural Capital Baseline Assessment - landscape character

Baseline landscape character

This chapter comprises a natural capital baseline assessment which includes comment on baseline landscape character. The baseline landscape character details:

- The key characteristics of Derbyshire's landscape
- The landscape character attributes
- Land management actions to maintain and enhance landscape character

It provides an objective account and high-level review of possible management actions from a landscape perspective with all information extracted from existing written published data and publicly available spatial datasets.

The key characteristics of Derbyshire's landscape

The baseline landscape character starts at the national level and includes consideration of existing published assessments such as the National Character Area (NCA) profiles prepared by Natural England. The NCA's identify ecosystem services within each broad character area.

The Landscape Character Baseline assessment reviewed the five major NCAs within the county (highlighted bold below) and a further five NCAs that make a significant contribution to the landscape of the county. The following NCAs have been included within the Landscape Character Baseline Figure 59:

- NCA 30: Southern Magnesian Limestone;
- NCA 38: **Nottinghamshire, Derbyshire and Yorkshire Coalfield;**
- NCA 50: **Derbyshire Peak Fringe & Lower Derwent;**
- NCA 51: **Dark Peak;**
- NCA 52: **White Peak**;
- NCA 68: **Needwood and South Derbyshire Claylands;**
- NCA 69: Trent Valley Washlands;
- NCA 70: Melbourne Parklands;
- NCA 71: Leicestershire & South Derbyshire Coalfield; and
- NCA 72: Mease/ Sence Lowlands.

The findings of the NCA mapping have been compared with existing local character assessments prepared by both DCC[24] and the Peak District National Park

[24] The Landscape Character of Derbyshire, 2014

(PDNP)[25]. Each LCT within the 10 NCA's has also been reviewed to give a finer grain of detail to this document.

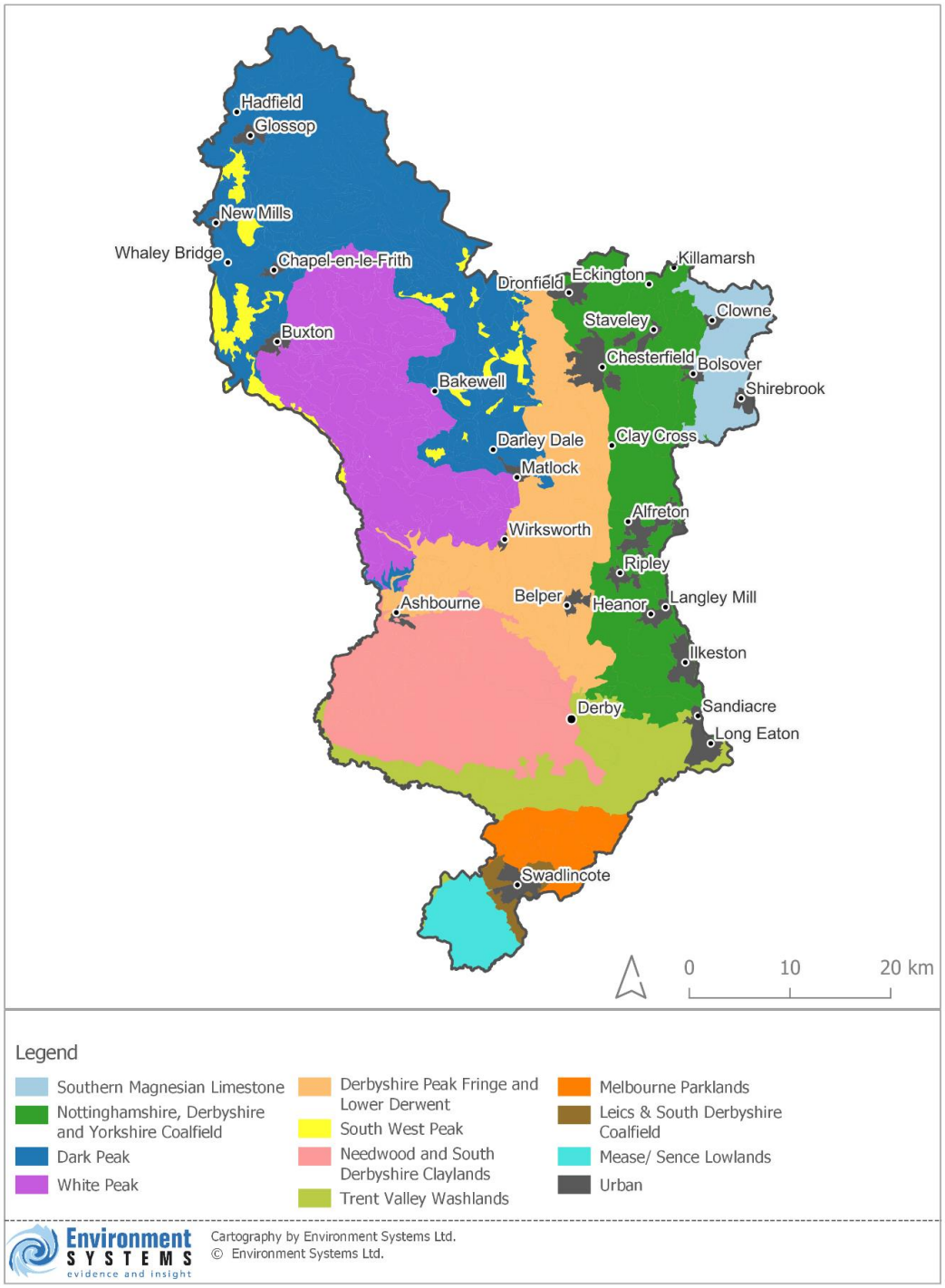

Figure 59: Natural England's National Character Areas in Derbyshire, with interpretation of boundaries across the Derby City urban area

[25] The Landscape Strategy and Action Plan for the Peak District National Park, 2009

The key characteristics of each NCA are described in Appendix 8. An example for NCA 30: Southern Magnesian Limestone follows:

- Underlying limestone creates an elevated ridge with smoothly rolling landform; river valleys cut through the ridge, in places following dramatic gorges. There are also some dry valleys.
- Fertile, intensively farmed arable land, with large fields bounded by clipped hawthorn hedges, creating a generally large-scale, open landscape.
- Semi-natural habitats, strongly associated with underlying limestone geology, include lowland calcareous grassland and limestone scrub on the free draining upland and gorges with wetland habitats associated with localised springs and watercourses, but all tend to be small and fragmented.
- Large number of abbeys, country houses and estates with designed gardens and parklands, woodlands, plantations and game coverts.
- Long views over lowlands to the east and west, and most prominent in the south;
- Woodlands combining with open arable land to create a wooded farmland landscape in places, where traditionally coppiced woodlands support dormouse populations.
- Unifying influence of creamy white Magnesian Limestone used as a building material and often combined with red pantile roofing.
- Localised industrial influences, especially in the Aire and Don valleys, and in the south and along the fringe of the Coal Measures to the west, with former mines and spoil heaps (many now restored), power lines, settlements, industry and transport routes. Bramham Park is one of a number of large country houses that have designed gardens and parklands.
- Influenced by the transport corridor of the A1 which is apparent in an otherwise undisturbed rural countryside.
- Archaeological evidence, with some notable prehistoric sites, reflects the longstanding importance of the area for occupation and transport.
- A comparison of the NCA profiles has been made with existing and more detailed local character assessments prepared by:
- Derbyshire County Council: The Landscape Character of Derbyshire (2014); and,
- The Peak District National Park: The Landscape Strategy and Action Plan for the Peak District National Park (2009).
- Consideration of these additional character assessments allowed a more detailed and Derbyshire-specific assessment to be carried out.
- Each NCA comprises landscape character types (LCT) as shown Figure 60 and Figure 61, and these have also been reviewed using the more detailed local character assessments to provide more contextual detail.

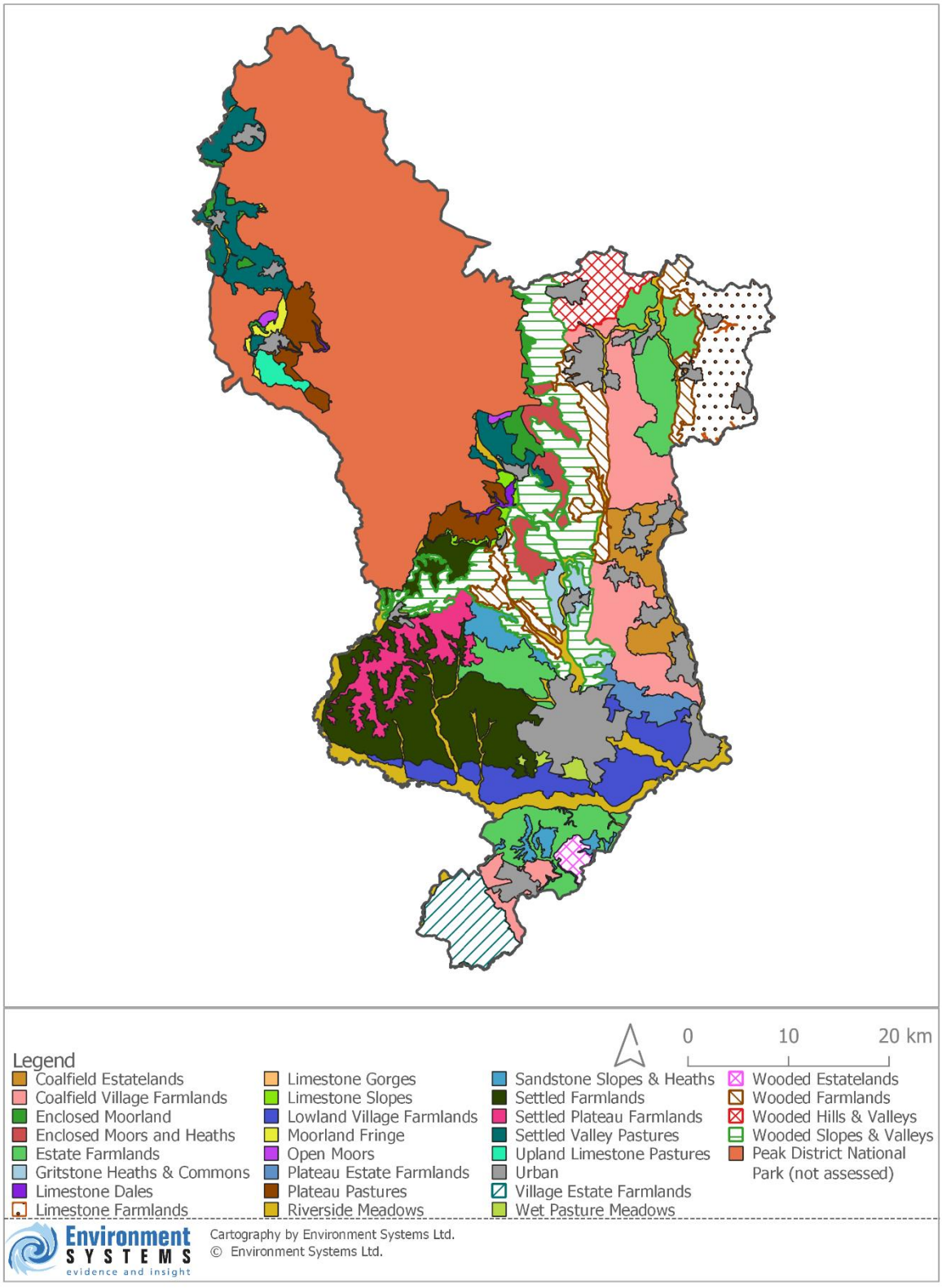

Figure 60: Landscape Character Types within Derbyshire (outside of PDNP, including an interpretation of NCA boundaries within Derby City

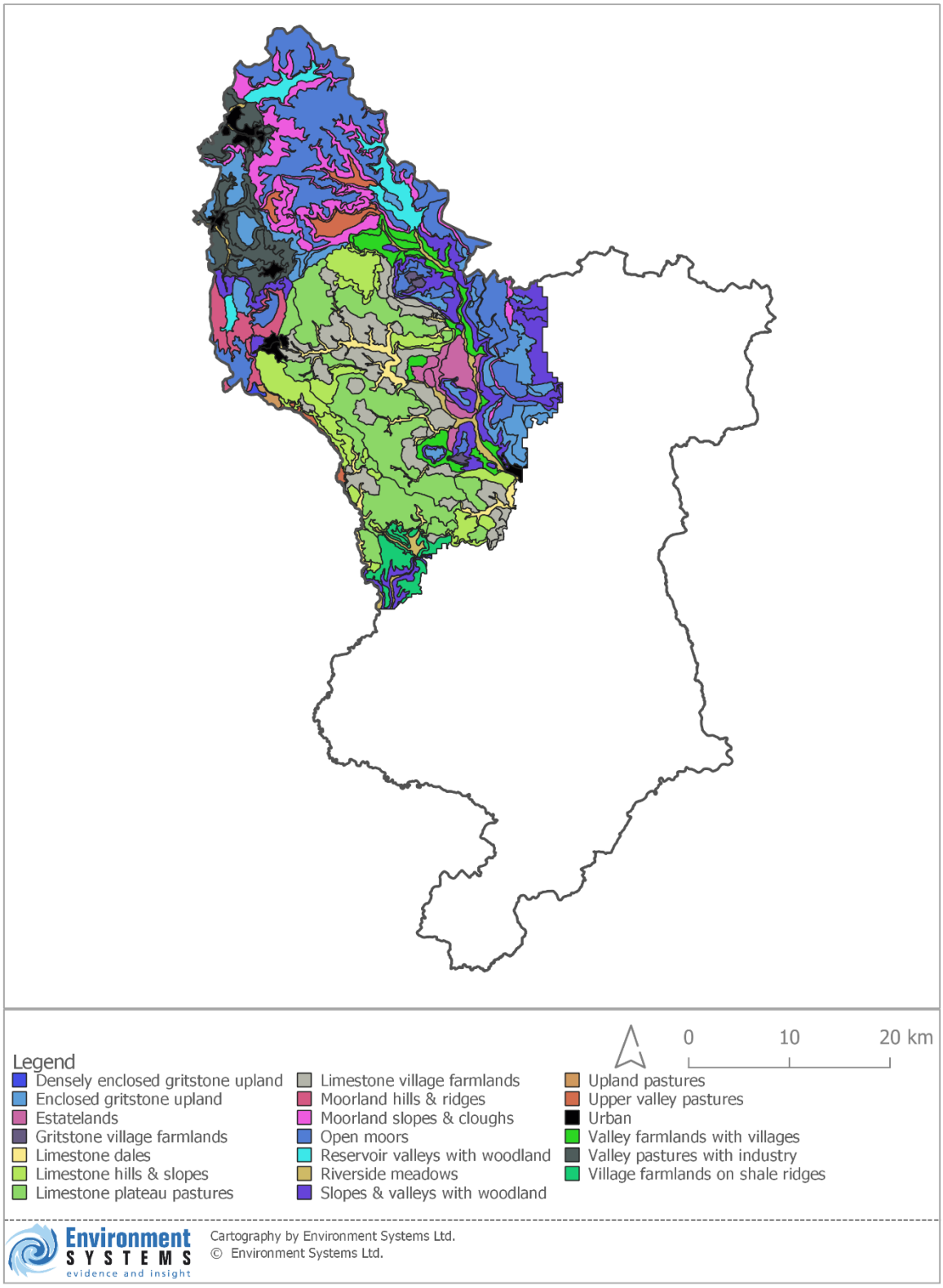

Figure 61: Landscape Character Types in Peak District National Park

An example for the LCT Limestone farmlands within NCA 30: Southern Magnesian Limestone follows:

A gently rolling, agricultural landscape, characterised by large scale open farmland, estate woodlands and limestone villages.

Key Characteristics:

- Gently rolling limestone plateau
- Fertile soils supporting productive arable farmland
- Large and medium estate woodlands
- Amenity trees around small rural villages and isolated farmsteads
- Large regular fields bounded by hedgerows
- Straight roads with uniform width verges
- Nucleated settlement pattern
- Historic buildings constructed of limestone with red clay pantile roofs
- Panoramic views across lowland to the west
- Long distance views over plateau often ending in a wooded skyline

Distinctive Local Characteristics:

- Long distance views are characteristic, due to the gentle relief, lack of hedgerow trees and large arable fields;
- Large and medium estate woodlands including areas of ancient woodland; and Hardwick Hall and Bolsover Castle.

The landscape character attributes

The distinctive elements and features of each LCT have been identified and listed for each LCT (Appendix 8).

Limestone Farmlands	Current Landscape Character Attributes
Land Use	Arable
Main Habitat Type	Farmland
Other Habitat Type	Woodland
Woodland Character	Occasional large plantations
Woodland Vision	Occasional large plantations
Woodland Type	Ash, oak, elm with hazel
Hedgerow Trees	Insignificant
Watercourse	None
Amenity Trees	Localised around settlement
Boundary Type	Thorn hedgerows
Settlement Character	Villages and sparsely scattered farmsteads
Traditional Materials	Limestone with red clay pantile roof
Cultural Interests	Hardwick Hall, Bolsover Castle, Green Lanes

Using landscape character to inform decision making

The distinctive elements and features of each LCT have been identified and appropriate land management actions for future habitat conservation, enhancement, or creation were identified for eight broad habitat types (Grassland; Woodland and forest; Heathland and shrub; Wetland; Sparsely vegetated land; Urban; Cropland; Rivers and lakes) within each LCT-NCA region.

Maps have been produced which identify areas where each broad habitat is of high interest for conservation, restoration or creation, divided into three levels of significance:

- Principal Habitat – habitat is a prominent and key characteristic of the area
- Secondary Habitat – habitat is a variable and local characteristic of the area
- Locally Significant – habitat is unusual, often a minor characteristic of the area

For the purpose of mapping, an interpretation of NCA/LCT boundaries within the 'urban' region of Derby City was provided by Derbyshire County Council, in order to carry out a case study of applying landscap character-based recommendations to an urban area.

The unofficial interpretative dataset of LCT boundaries within Derby City has been incorporated into the analysis in order to provide context for the City of Derby urban area within this baseline study. However, no analysis of this data has been carried out in relation to the setting of management actions, although it can be inferred that they would be similar to the wider LCT as documented in the baseline study.

Combining the PDNP LCTs with wider Derbyshire LCTs creates a total of 47 unique LCTs within Derbyshire. The LCTs for Derbyshire (excluding PDNP) are illustrated in Figure 60, while the LCTs for PDNP are shown in Figure 61.

Using the management action recommendations in the baseline landscape character assessment, with modifications applied in consultation with Derbyshire County Council and PDNPA, each broad habitat type was assigned a principal habitat priority classification (principal, secondary, or locally significant habitat as defined above), for each LCT.

A greater level of detail was applied to the characterisation of the favoured Heathland & shrub habitat type in many LCT regions, and also for some Wetland areas, In order to improve the targeting of management actions for these broad habitat types. In these cases the following sub-categories were assogned to the principal habitat priority class, identifying the preferred habitat sub-type in the region; heather/moorland, thorn-dominated scrub, or hedgerows. The resulting maps are shown in Figure 62-Figure 69.

Where LCT regions are not shown to have a particular habitat as a principal habitat priority, it means that the region either does not contain notable examples of the specified habitat type, or expanding the habitat type is not a priority because this would be detrimental to the landscape character. Alternatively, it could be because it would be preferable to invest in expanding and restoring the habitat type in other LCTs.

The habitat priorities for each LCT have been defined by recent work undertaken by Derbyshire County Council; this includes an interpretation of the NCA/ LCT boundaries within the Derby City 'urban' NCA region, based on local landscape and geological characteristics, in order to allow habitat priorities and management recommendations to be mapped within this urban area, as a case study. Due to the unofficial nature of the NCA/LCT boundaries applied to the Derby City region, these areas are shown as partially transparent within the maps.

Other urban areas have not been included in the analysis of priority land management actions, due to the unavaiability of boundary data defining the different LCTs within these zones; however, should such data become available in the future the same methodology could be applied.

A large-scale map of Grassland habitat principal habitat priority areas within the Derby City area is shown in Figure 70. A full suite of large-scale maps of habitat priorities for Derby City can be found in Appendix 10.

A detailed breakdown of the habitat-specific land management priorities for each LCT is shown in Figure 71-Figure 75; these management actions have been drawn from the Baseline Landscape Character Assessment (Appendix 8), with amendments applied to heathland and wetland areas where sub-categorisation of the habitat had been undertaken. The habitat priorities and management actions are listed in tabular format in Appendix 9.

The proposed land management actions have been reviewed by an expert panel with local knowledge to provide additional input on appropriate management action.

Locations where grassland nature-based solutions (NBS) support the LCT are shown in Figure 71. Locations where heathland and wetland restoration / NBS support the LCT are shown in Figure 72 and Figure 73, respectively. Locations where woodland NBS support the LCT are shown in Figure 74.

A large-scale map of locations in Derby City where grassland NBS support the applied LCT boundaries is shown in

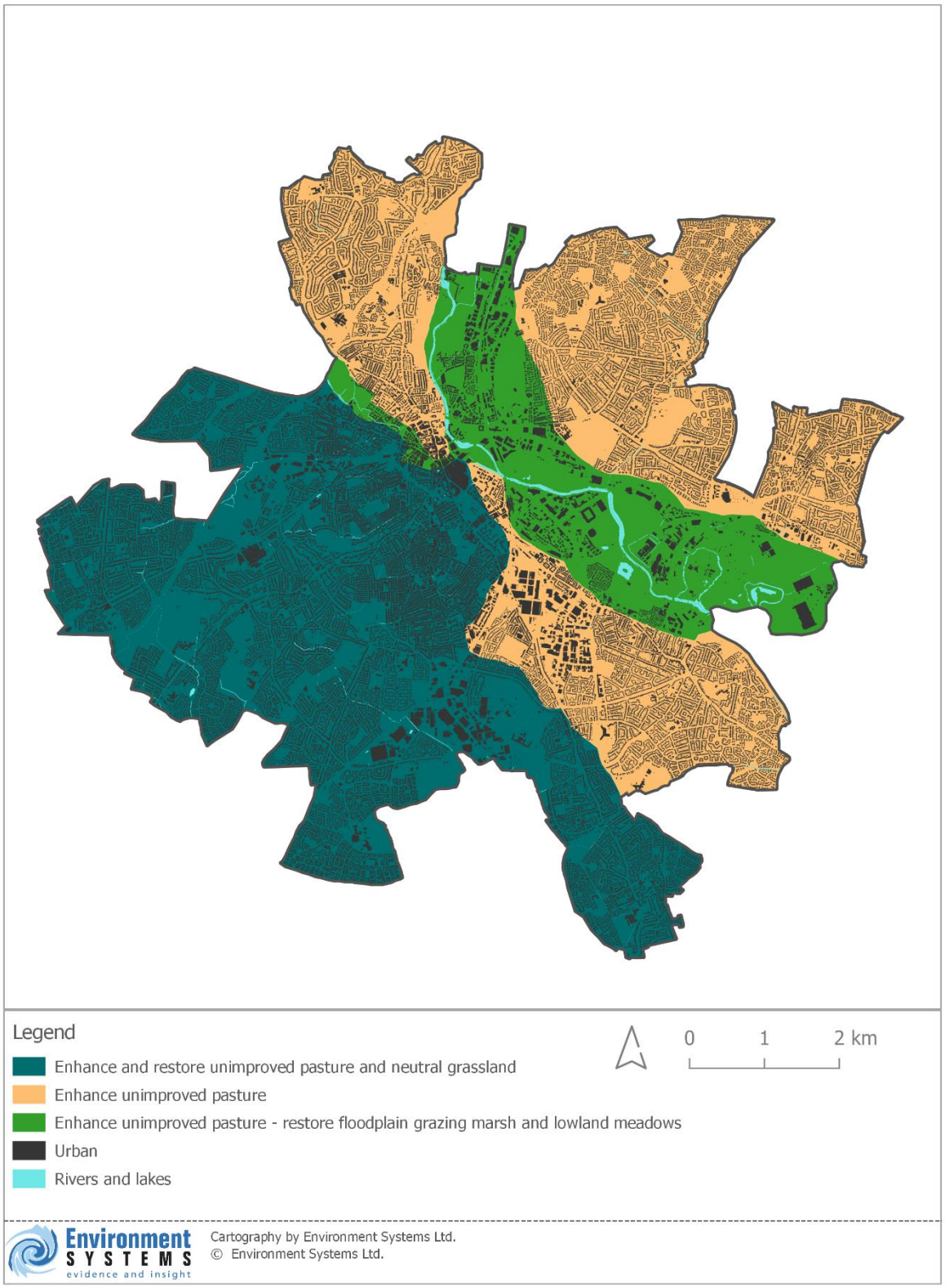

Figure 76. A full suite of large-scale maps of NBS actions for Derby City is provided in Appendix 10. These maps should be viewed as a guide to be followed by more detailed investigation of site suitability prior to land management decisions being taken, due to the unique opportunities and constraints to NBS solutions within the urban environment; an analysis of which was outside the scope of this work.

Key findings: preferred habitat actions within LCT regions

- Grassland action is a priority in most LCTs in Derbyshire
- Woodland acrion is desired across most LCTs in Derbyshire, but is preferred in the east, in the Derwent valley, and in the southern tip (National Forest area) of the county.
- Heathland action is a priority in the majority of LCTs, with the exception of areas within White Peak, where the habitat is of more localised significance. It is a preferred habitat in Needwood & South Derbyshire Claylands, and Peak Fringe & Lower Derwent.
- A balance will need to be struck between heath enhancement/expansion and grassland or woodland expansion to work towards a sustainable habitat matrix.
- Restoration and enhancement of existing semi-natural grasslands, and floodplain grazing marsh, is a priority for many LCTs.
- Hedgerow planting is a priority for many LCTs, as is riparian/floodplain woodland planting, and restoration of ancient woodland sites.
- River restoration, and enhancement of the natural continuity of river corridors, is a priority in most LCTs.
- Wetlands are a priority for many LCTs, with the areas dominated by limestone geology being a notable exception. Priority actions focus on enhancing existing wet meadows and marshes, and restoration of upland and lowland bog habitats.
- Cropland priorities focus on improving the ecological value of intensive farmlands, and conserving and enhancing the mixed farm landscape where it is still present.
- The land management recommendations are a guide, and should be field-checked in prior to action being taken at the specific site level.

A future pathway for defining more targeted recommendations for Derby City (and other urban areas) should incorporate a Townscape Assessment, and consideration of management actions such as street trees, grass verge cutting regime, green roofs and walls, SuDS, and garden wilding.

Landscape character considerations influence decision-making on the prioritisation of natural capital opportunities. The rules used for modelling ecosystem service stock, risk and opportunities maps reflect this. For example:

- hedgerow planting and woodland creation is not appropriate for the White Peak and other areas in Derbyshire where the policy vision developed by Derbyshire County Council in landscape character spatial data is to maintain an open/unwooded landscape character.

- there are limited opportunities for wetland creation in some places characterised by limestone geology (e.g. the Southern Magnesian Limestone character type).

The final decisions on what types of management action should be taken where must combine the outputs of the ecosystem service opportunity mapping with the outputs of the baseline landscape character assessment; in many places it would be biophysically possible to undertake multiple habitat restoration options; for example planting riparian buffer strips of either woodland or species-rich grassland composition; the final decision on which habitat type, land use and matrix of habitats are most suitable for a particular location will be influenced by the landscape character considerations, as well as whether the area lies within a particular ecological network.

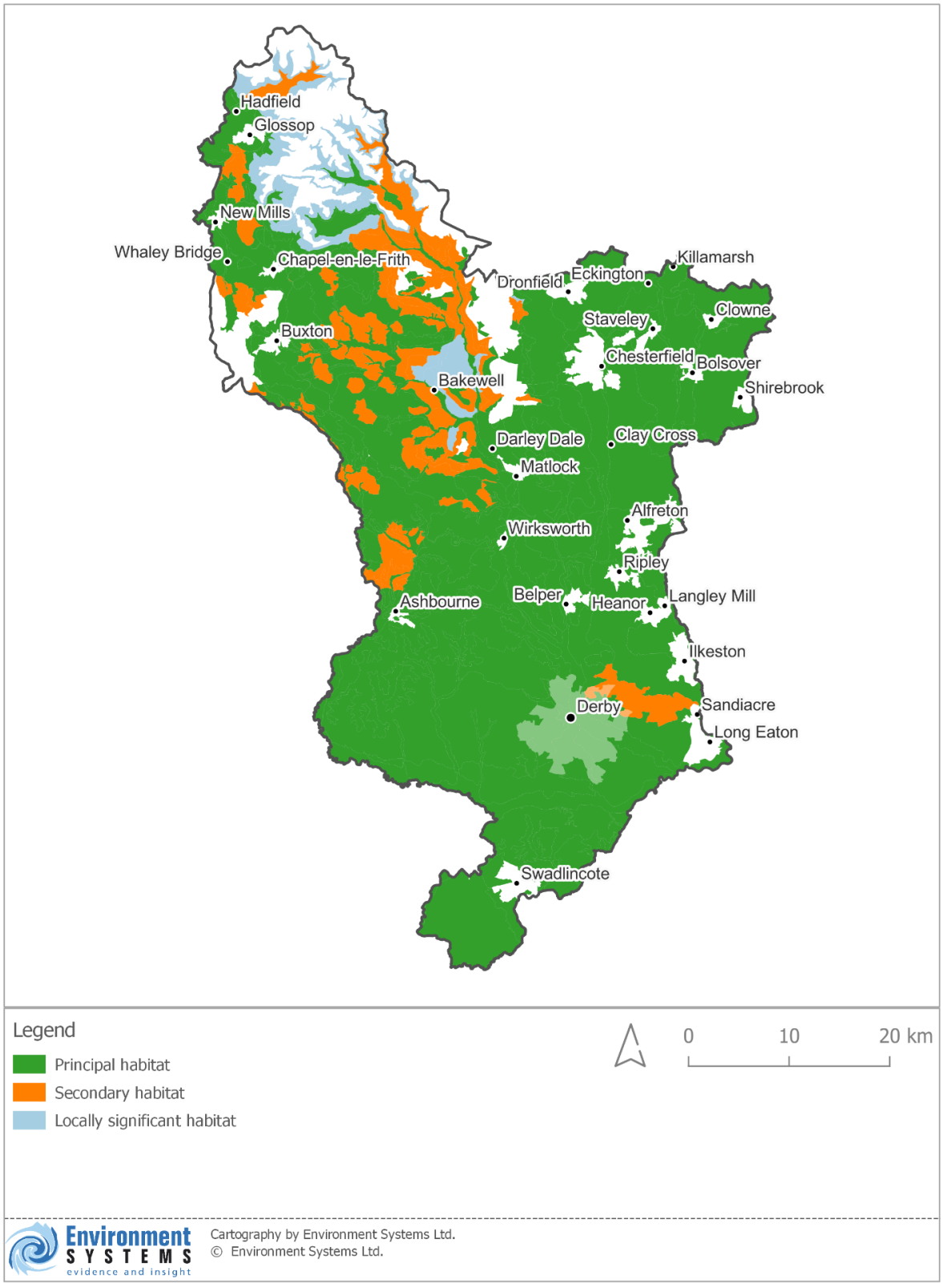

Figure 62: Landscape Character Types where the Grassland broad habitat type is a priority for conservation, restoration or habitat creation (interpreted boundary areas mapped as partially transparent)

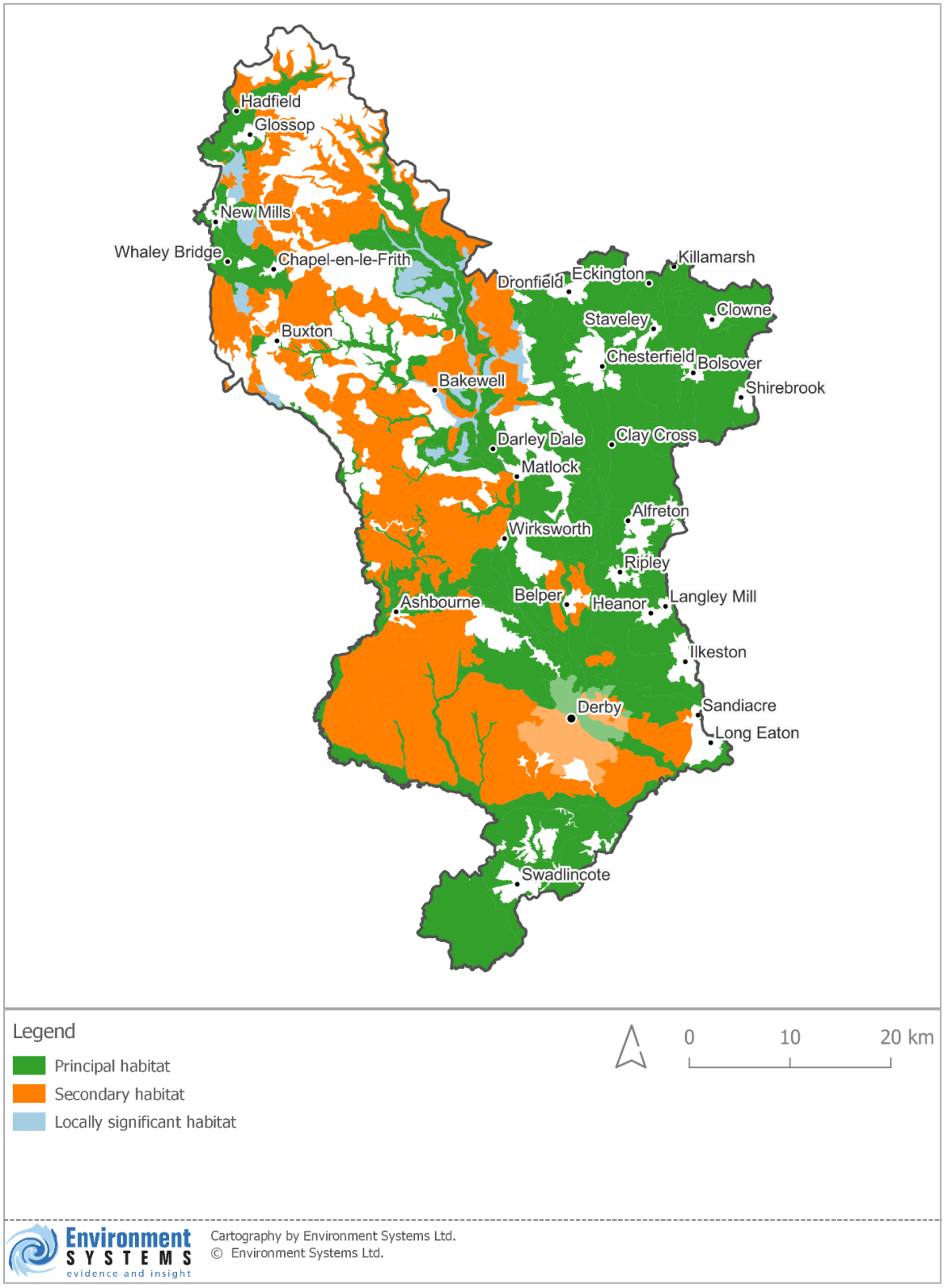

Figure 63: Landscape Character Types where the Woodland & Forest broad habitat type is a priority for conservation, restoration or habitat creation (interpreted boundary areas mapped as partially transparent)

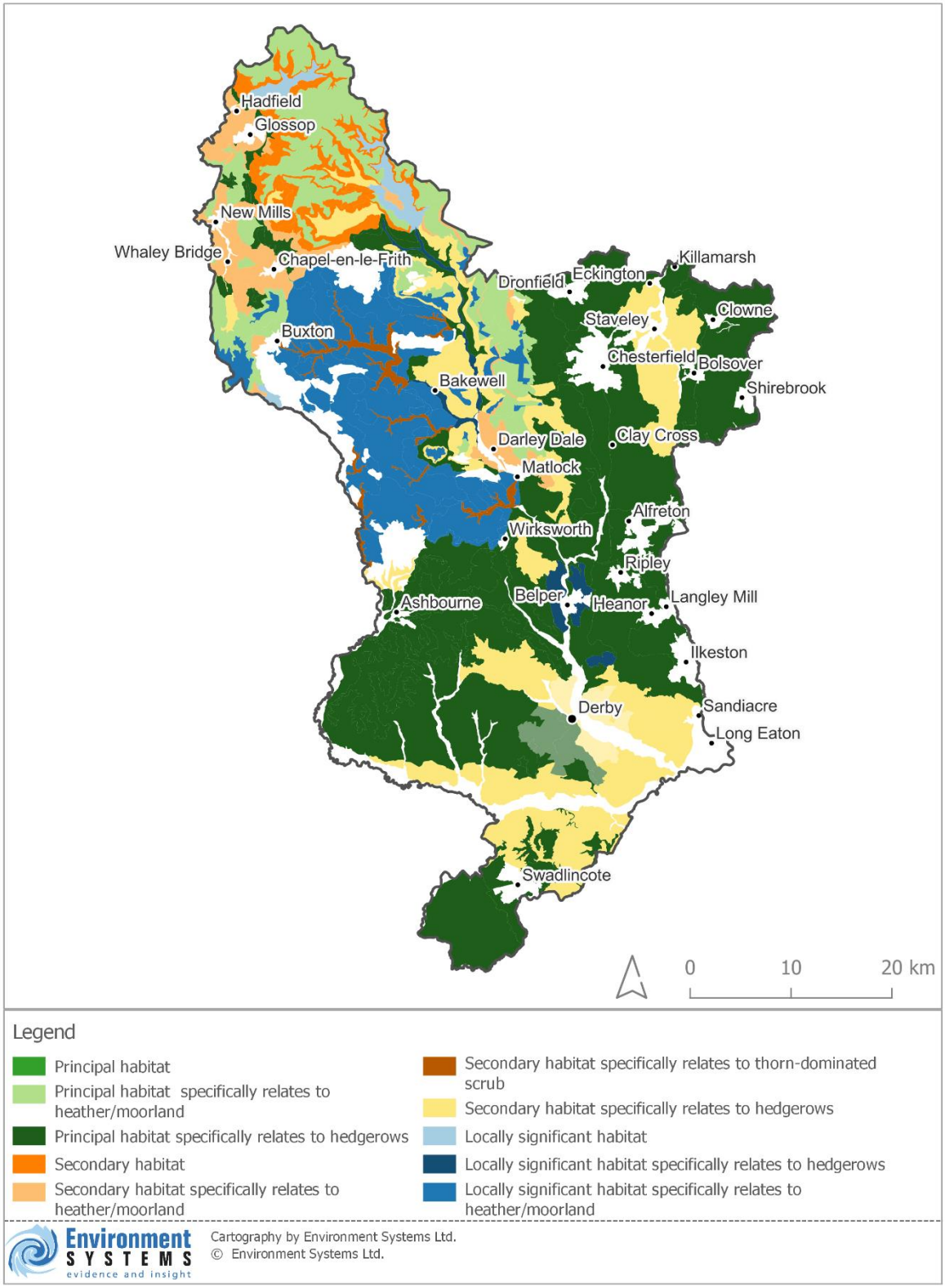

Figure 64: Landscape Character Types where the Heathland & Shrub broad habitat type is a priority for conservation, restoration or habitat creation (interpreted boundary areas mapped as partially transparent)

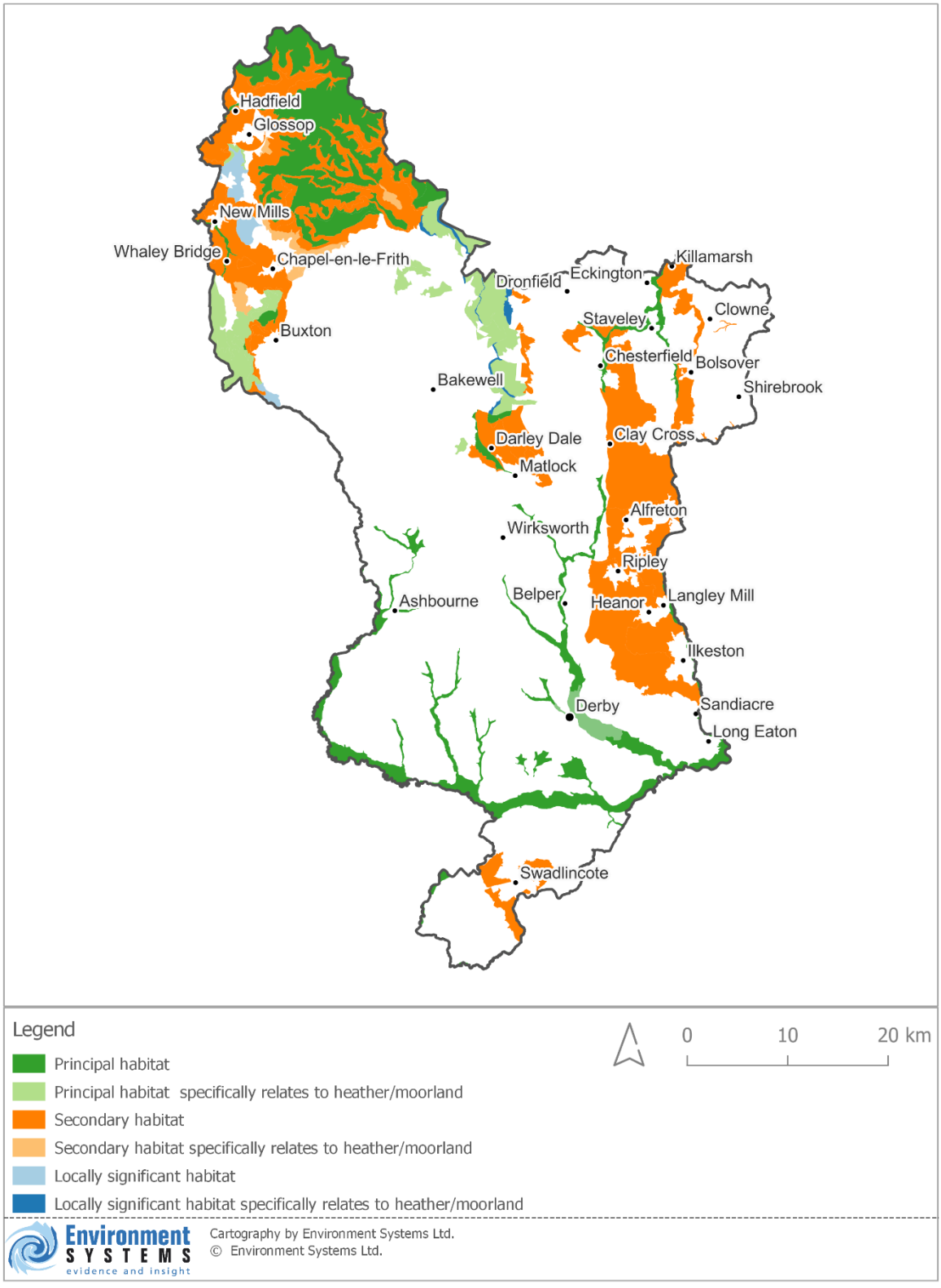

Figure 65: Landscape Character Types where the Wetland broad habitat type is a priority for conservation, restoration or habitat creation (interpreted boundary areas mapped as partially transparent)

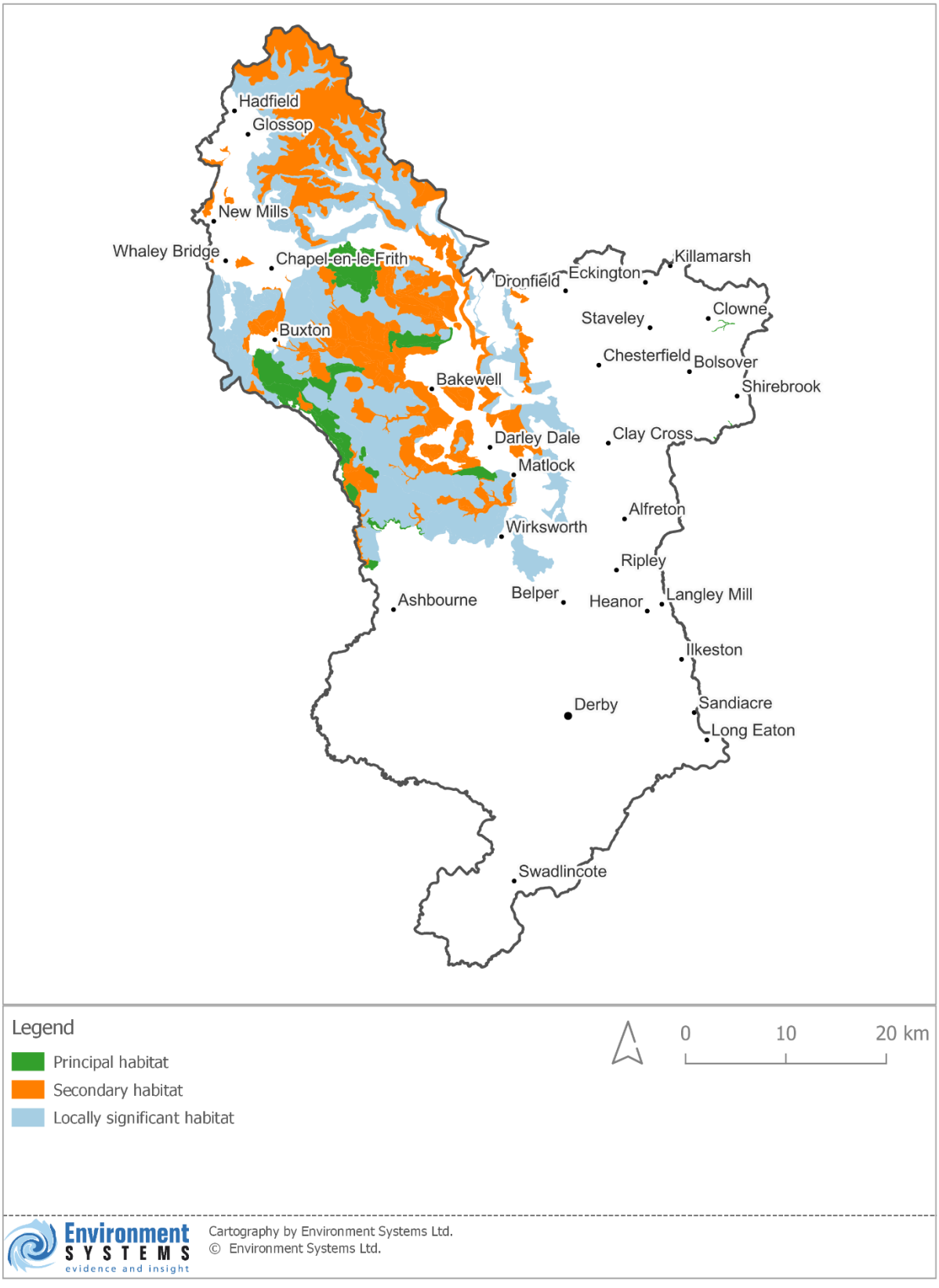

Figure 66: Landscape Character Types where the Sparsely vegetated land broad habitat type is a priority for conservation, restoration or habitat creation (interpreted boundary areas mapped as partially transparent)

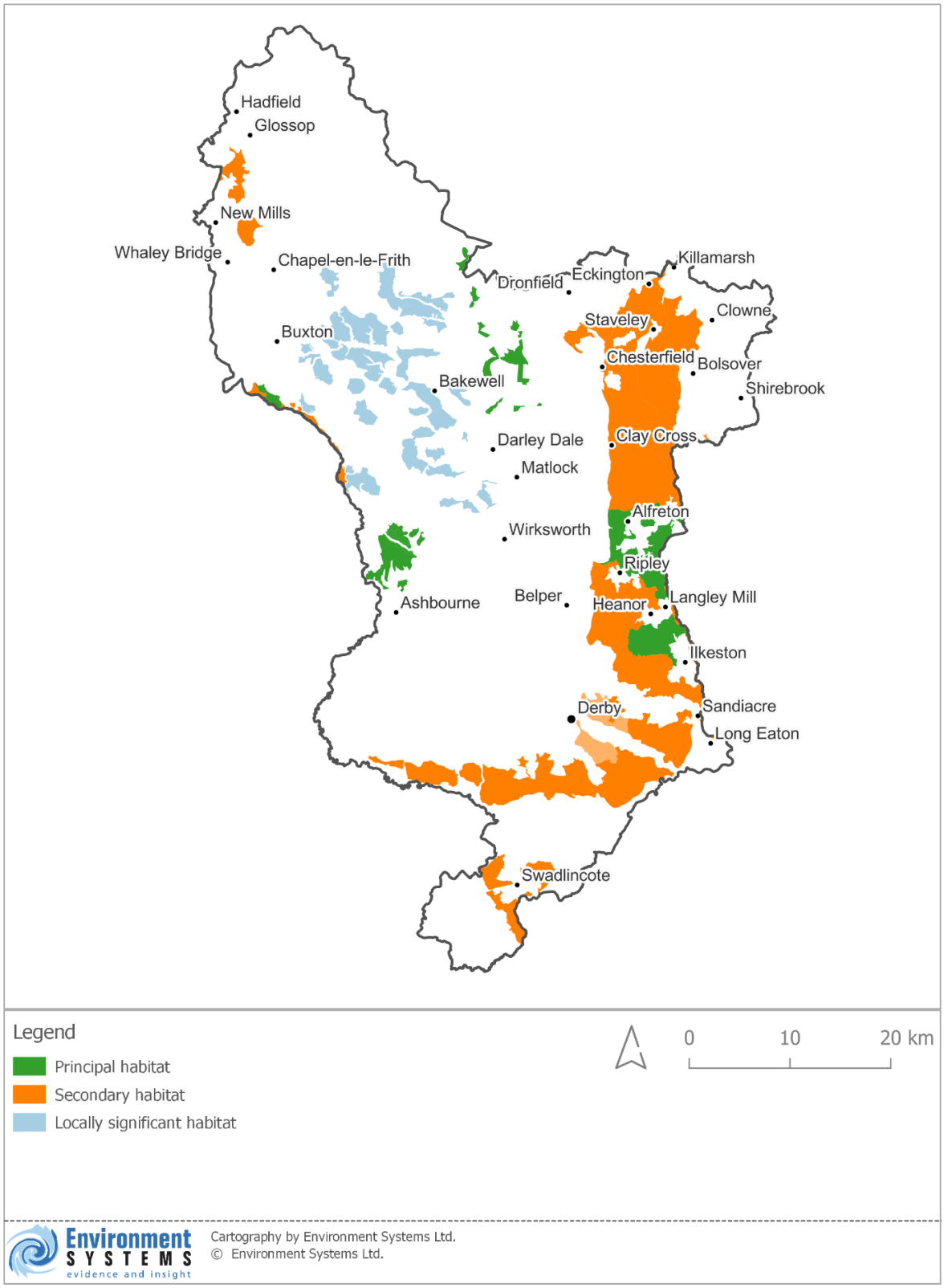

Figure 67: Landscape Character Types where the Urban broad habitat type is a priority for conservation, restoration or habitat creation (interpreted boundary areas mapped as partially transparent)

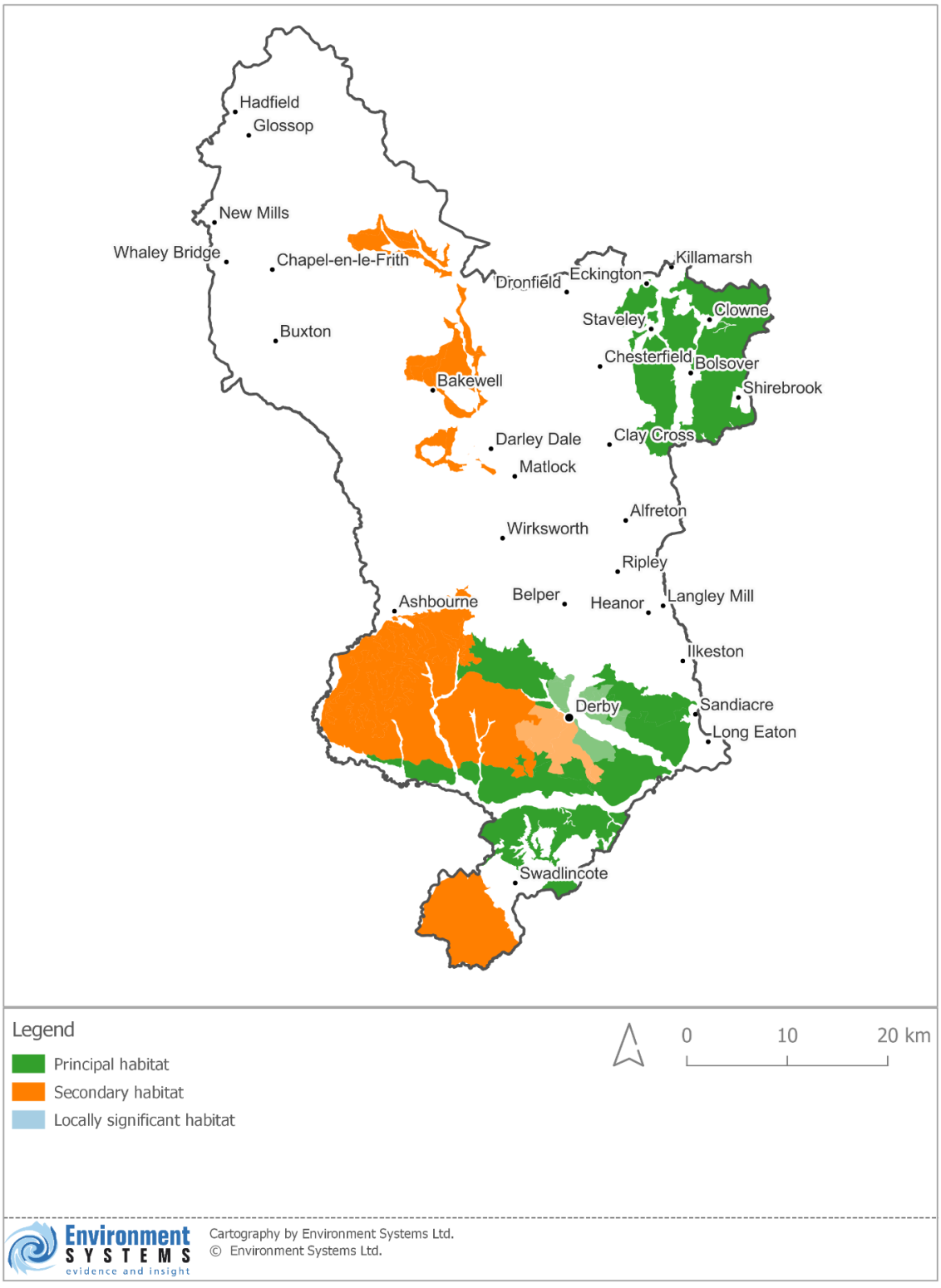

Figure 68: Landscape Character Types where the Cropland broad habitat type is a priority for conservation, restoration or habitat creation (interpreted boundary areas mapped as partially transparent)

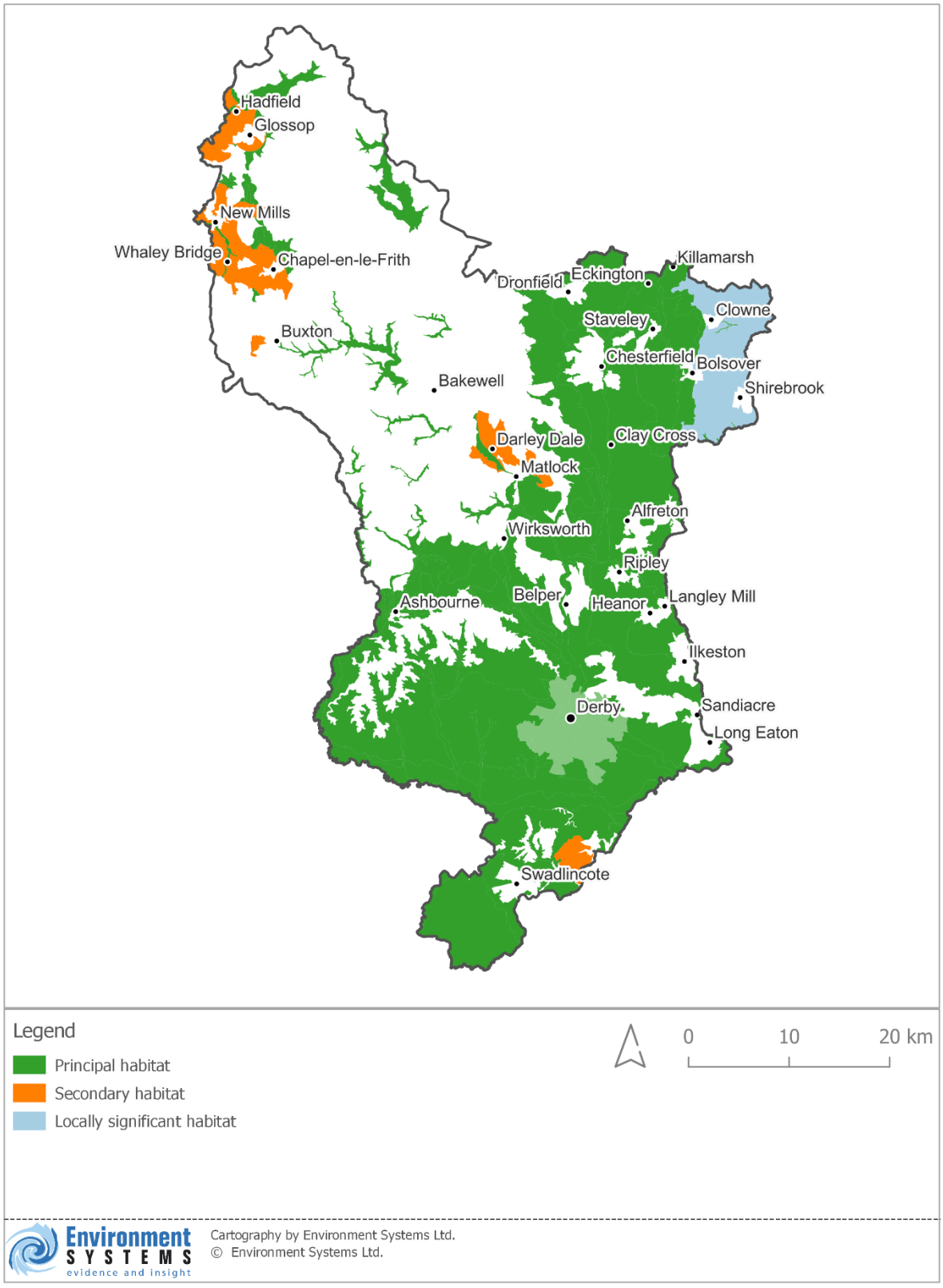

Figure 69: Landscape Character Types where the Rivers & Lakes broad habitat type is a priority for conservation, restoration or habitat creation (interpreted areas mapped as partially transparent)

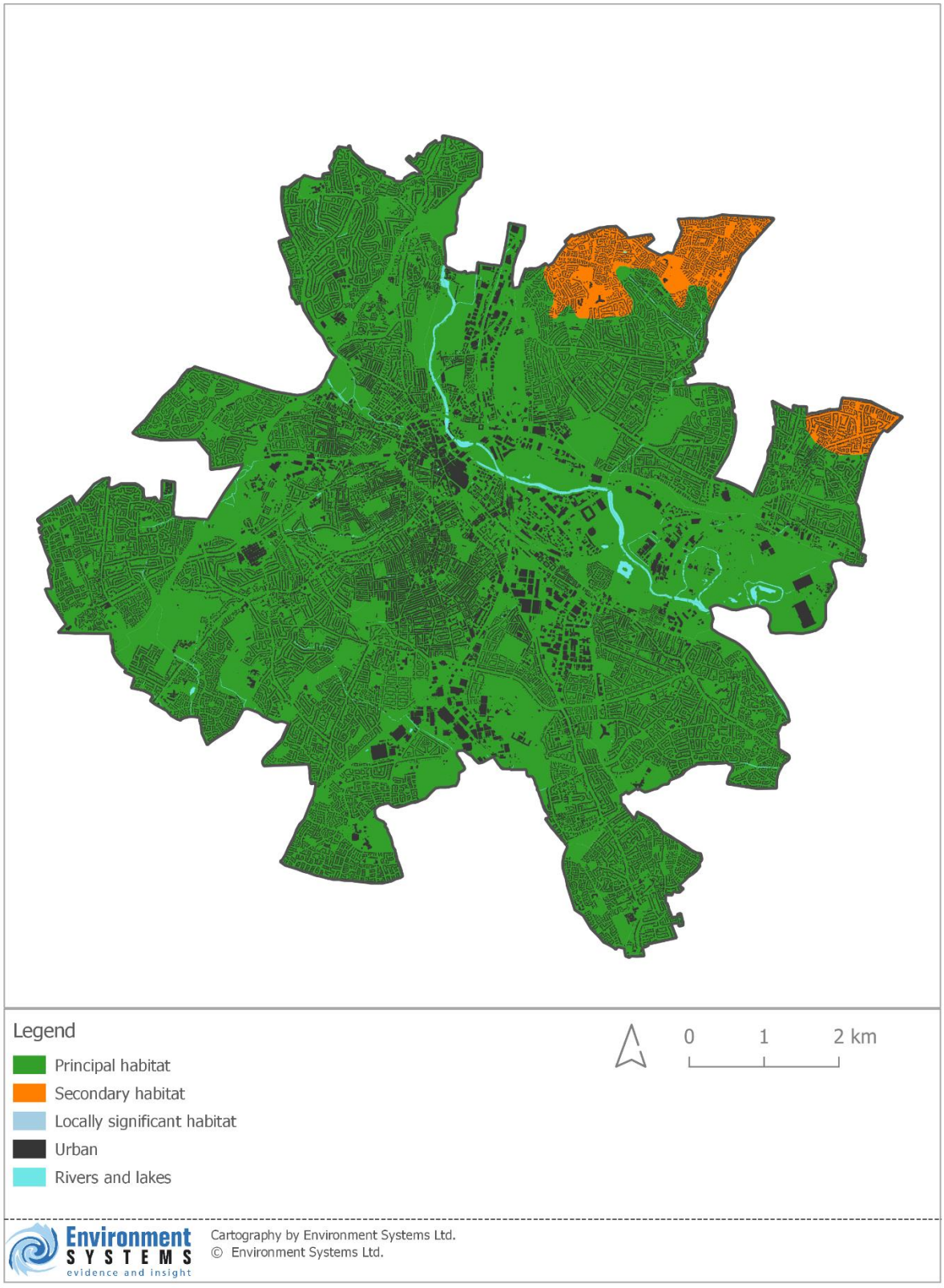

Figure 70: Landscape Character Types (interpreted boundaries) within Derby City where the Grassland broad habitat type is a priority for conservation, restoration or habitat creation

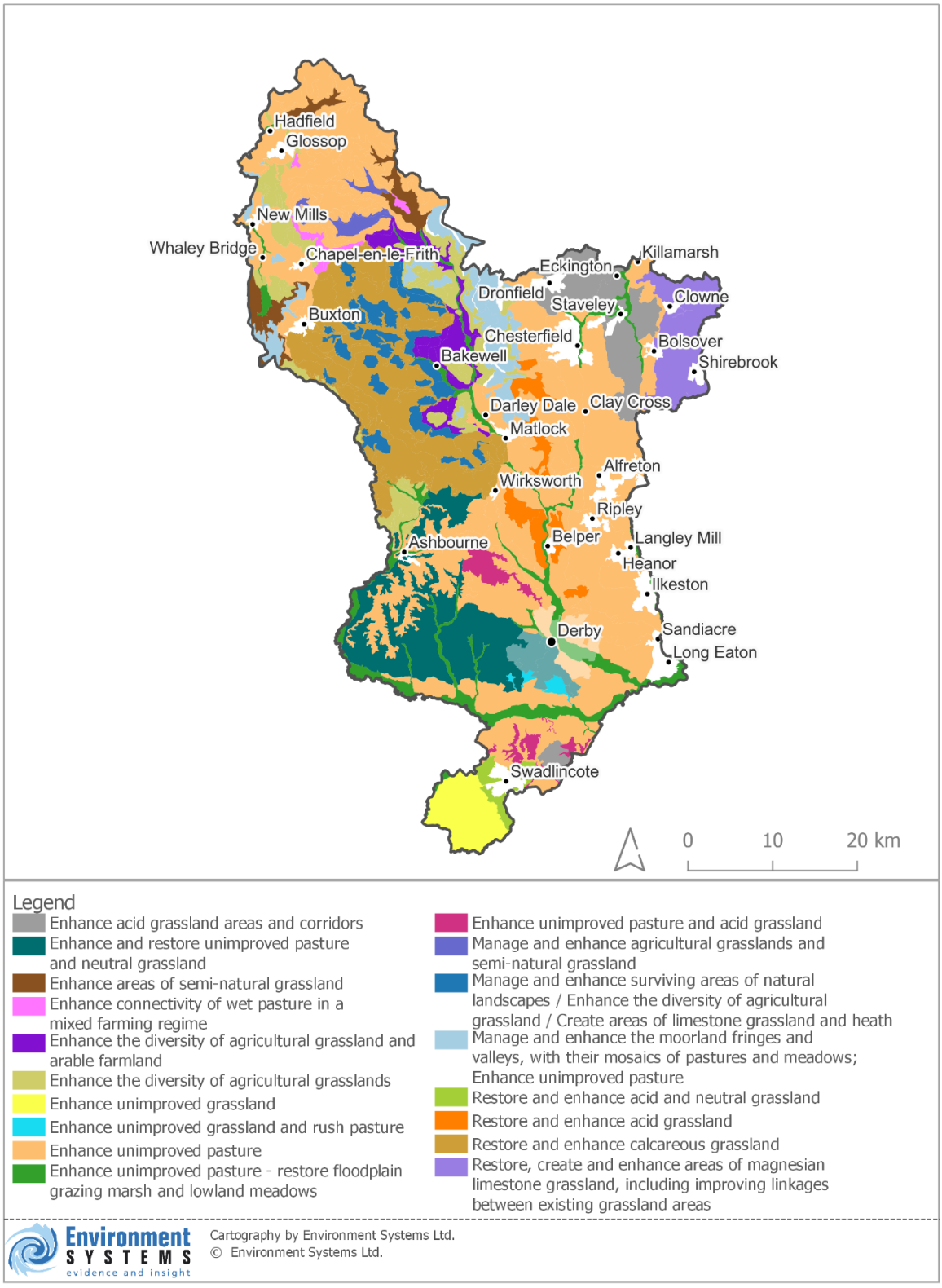

Figure 71: Locations where grassland-based habitat restoration or nature-based solutions could support the Landscape Character Type (interpreted boundary areas mapped as partially transparent)

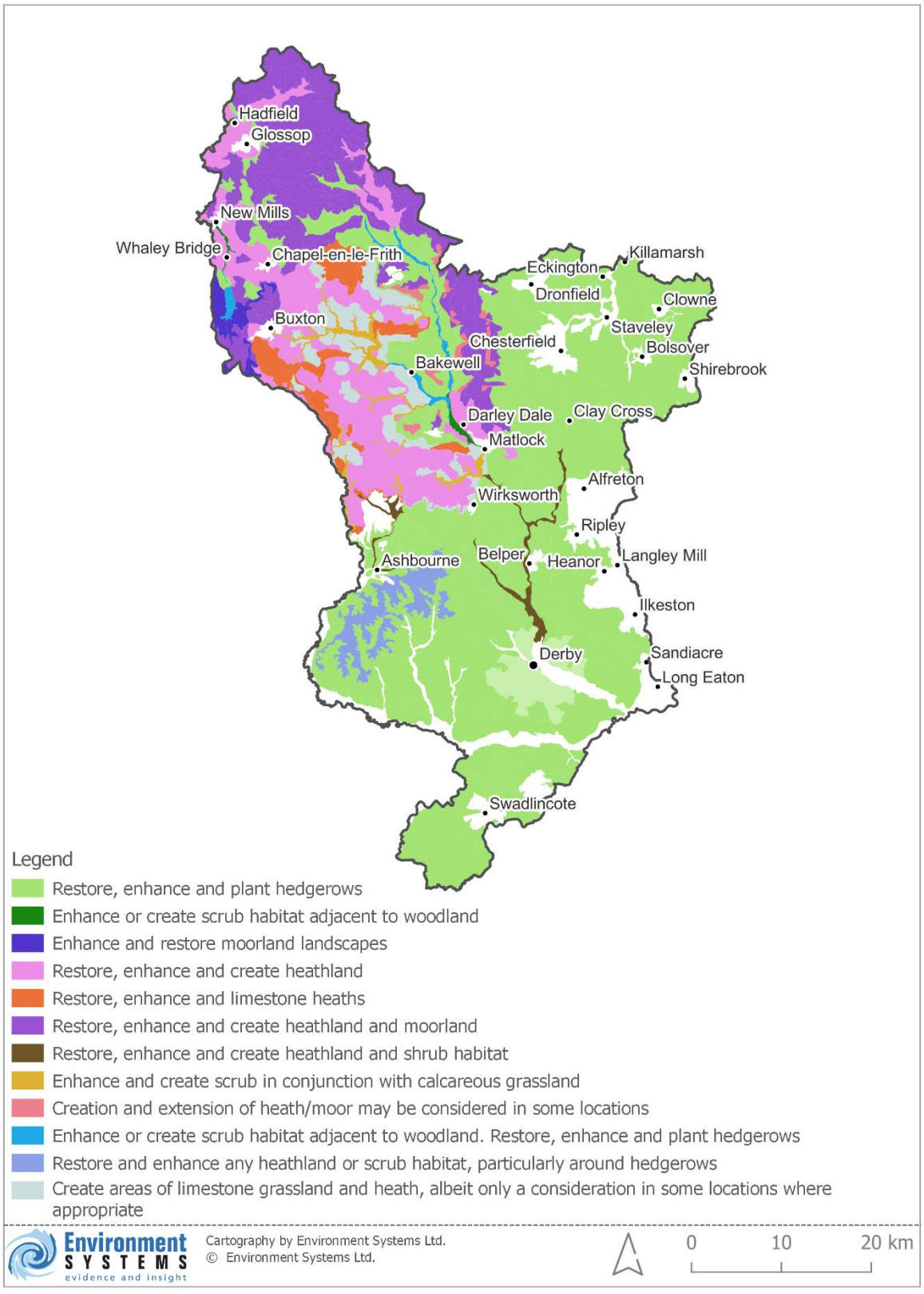

Figure 72:Locations where heathland-based habitat restoration or nature-based solutions could support the Landscape Character Type (interpreted boundary areas mapped as partially transparent)

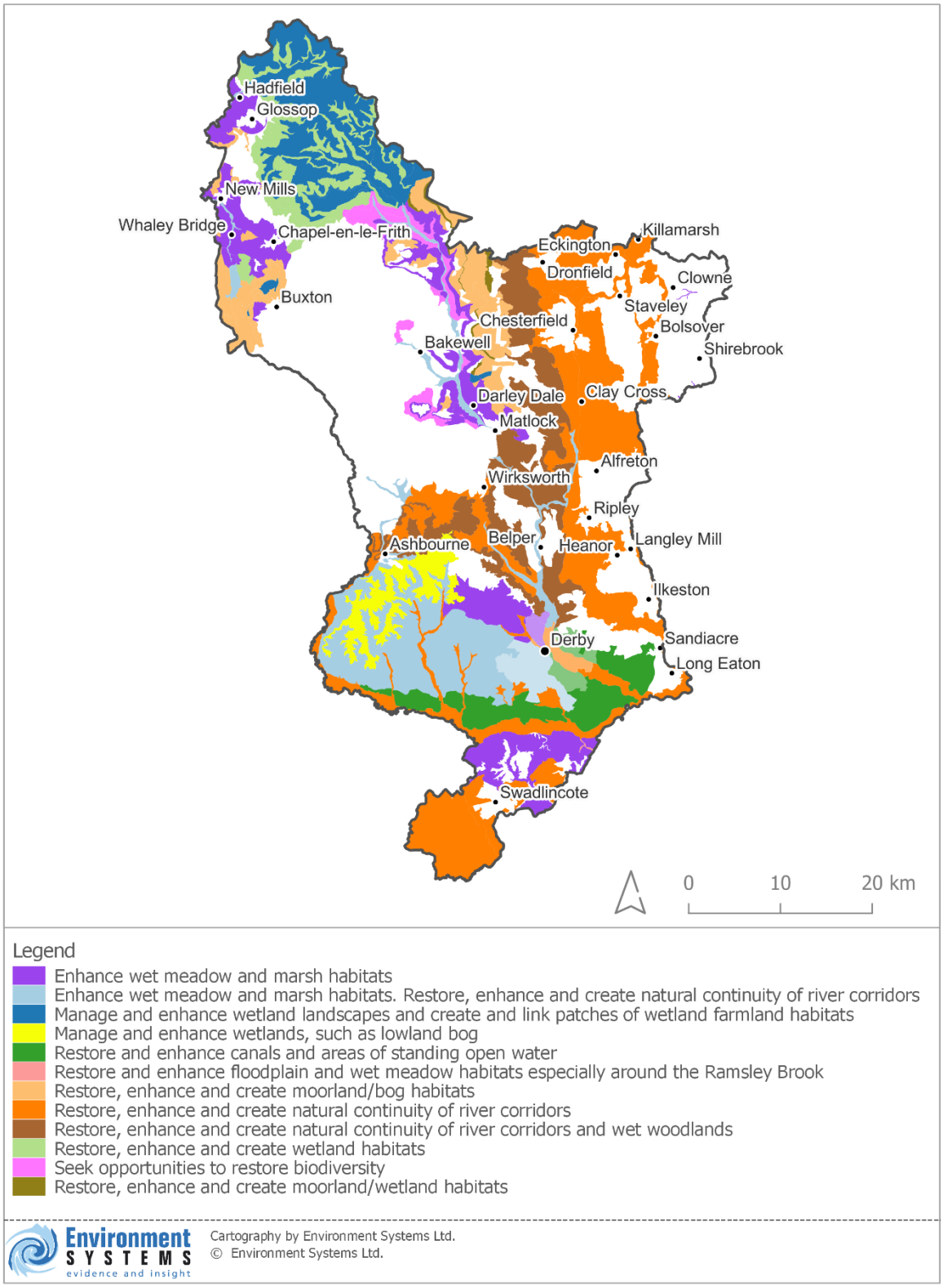

Figure 73: Locations where wetland-based habitat restoration or nature-based solutions could support the Landscape Character Type (interpreted boundary areas mapped as partially transparent)

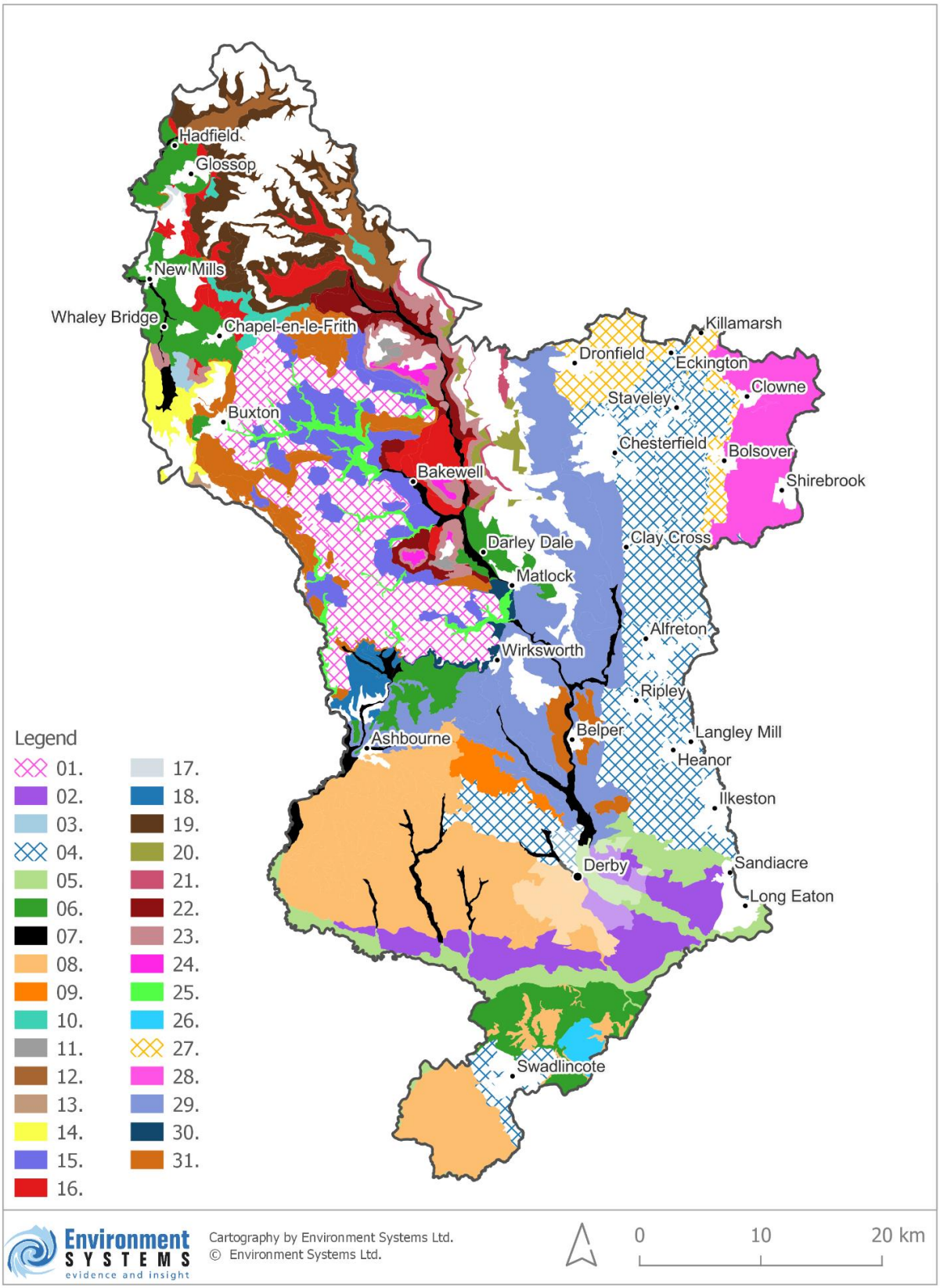

Figure 74: Locations where woodland-based habitat restoration or nature-based solutions could support the Landscape Character Type (interpreted boundary areas mapped as partially transparent); key to LCT regions shown in Figure 75)

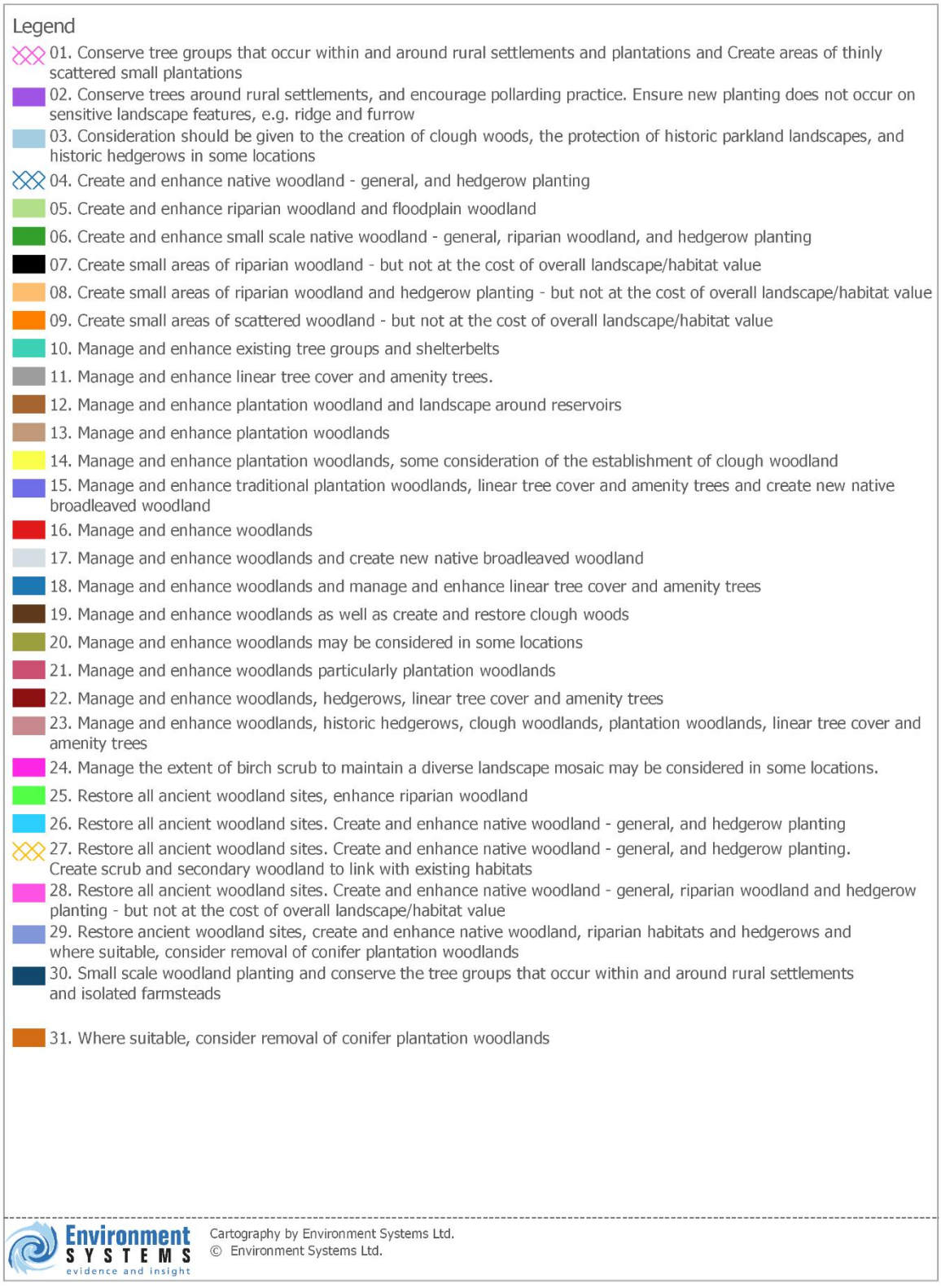

Figure 75: Key to LCT regions as applied to woodland NBS actions (Figure 74)

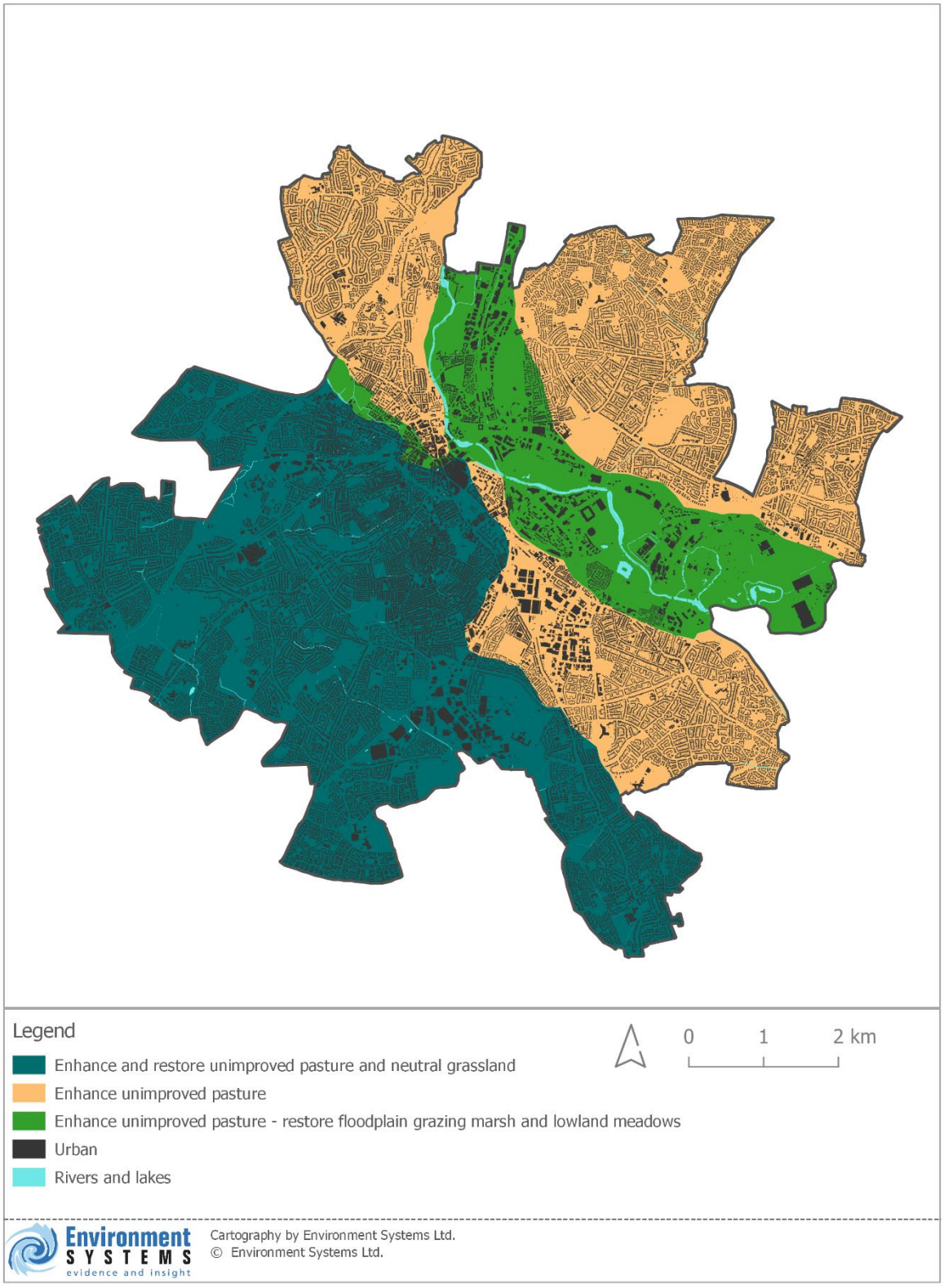

Figure 76: Locations where grassland-based habitat restoration or nature-based solutions could support the Landscape Character Type in Derby City (interpreted LCT boundary data)

Chapter 6: Cultural Historic Heritage

In Derbyshire it is recognised that heritage assets may contribute to, constrain or influence the delivery of natural capital projects, and decision making seeks to ensure the appropriate protection and enhancement of heritage assets as well as natural capital.

The natural capital of a heritage asset may be an integral element of the asset whilst at the same time allowing for/facilitating the provision of ecosystem services. For example, woodland within a Registered Park and Garden holds natural capital but in terms of heritage significance Illustrates a design Intention important to an understanding of the designed landscape of the park. Any natural capital projects affecting the woodland would need to consider the effect on significance of the park.

Furthermore, outside the footprint of a heritage asset, a woodland or other natural capital stock which includes important habitat types/natural capital resources may be an important element of setting contributing towards the significance of a heritage asset. Change to these resources could adversely or positively affect a heritage asset and its ecosystem services through 'setting' change.

This association between heritage assets and habitat, while largely coincidental, therefore means that natural capital change could affect heritage assets and/or ecosystem services. Due to overlaps between natural and heritage capitals, plus the lack of market values attributable to certain cultural services, sub-optimal decisions can be made around 'capital maintenance' and indeed valuable assets are often implicitly given zero value and overlooked.

Decision making related to the maintenance and enhancement of natural capital should therefore consider the effect of proposals on designated heritage assets, whether this be proposals within the footprints of designated heritage assets or within the 'setting' of those assets; natural capital gain should be sympathetic/beneficial to heritage assets, wherever possible, and to the ecosystem services which they provide. Natural capital and ecosystem services that derive from heritage assets should be considered concurrently wherever this is appropriate to do so.

Whilst designated status is not necessarily an indication of the potential for natural capital and the provision of ecosystem services, it can be a useful starting point to enable the natural capital of heritage assets to be considered. The designated heritage assets present within the non-urban areas of Derbyshire include:

- World Heritage Sites;
- Scheduled Monuments;
- Grade I and II* Listed Buildings;
- Registered Parks and Gardens (RPGs); and
- Registered Battlefields.

Urban areas are excluded due to their more limited potential for natural capital projects in comparison to non-urban areas. Grade II Listed Buildings are excluded due to the size of the Grade II dataset and the relative significance of these assets, albeit the general principles presented with respect to Grade I and II* Listed Buildings would still apply to Grade II Listed Buildings.

To assist in the understanding of the ecosystem services that a heritage asset may hold, the potential ecosystem services discussed in this section are those provided in Enabling a

Natural Capital Approach.[26] These include 'cultural services' which recognises the importance of intangible services such as the sense of public wellbeing that can derive from appreciation of artistic expression, spiritual fulfilment, sense of place and community and educational resources inherent to certain heritage assets.

Assets are principally described by their designated status. However, where specific sub-types of assets require particular focus, or where there are nuances associated with their natural capital context, this is highlighted.

A dataset on cultural heritage has been collated and analysed and conclusions drawn for purposes of preliminary review and discussion, in order to assist in the longer-term development of a methodology that can be applied to specific heritage assets. It informs the natural capital strategy but does not consider the detailed effect of natural capital projects on specific heritage assets/types of assets, an exercise which would require project specific consideration on a case-by-case basis.

The results of this review are shown in Appendix 11. They are listed by type of designation and the ecosystem services they might be expected to interact with. The risks and opportunities for each ecosystem service are also reviewed.

[26] Department for Environment, Food and Rural Affairs (2020)

Chapter 7: Monitoring plan

This chapter provides a summary of the monitoring plan produced for the Natural Capital Strategy (Appendix 12); it is designed to help the continued monitoring of natural capital within Derbyshire, with a focus on habitats as key resources underpinning the delivery of natural capital strategy. Monitoring natural capital:

- Supports initiatives for nature recovery, biodiversity net gain, and wider ecosystem service delivery by providing a mechanism whereby the success of the schemes can be judged.
- Identifies and quantifies both known and unexpected changes to natural capital that affect the value of the resource.

Key to monitoring is maintaining an up-to-date habitat map as habitats are the factor which is most likely to show quantifiable change within the timeframe of a few years. By contrast, the other factors used in modelling such as landform, soil, geology and land hydrology are much less likely to do so. The update process for the Habitat map is shown in Figure 77.

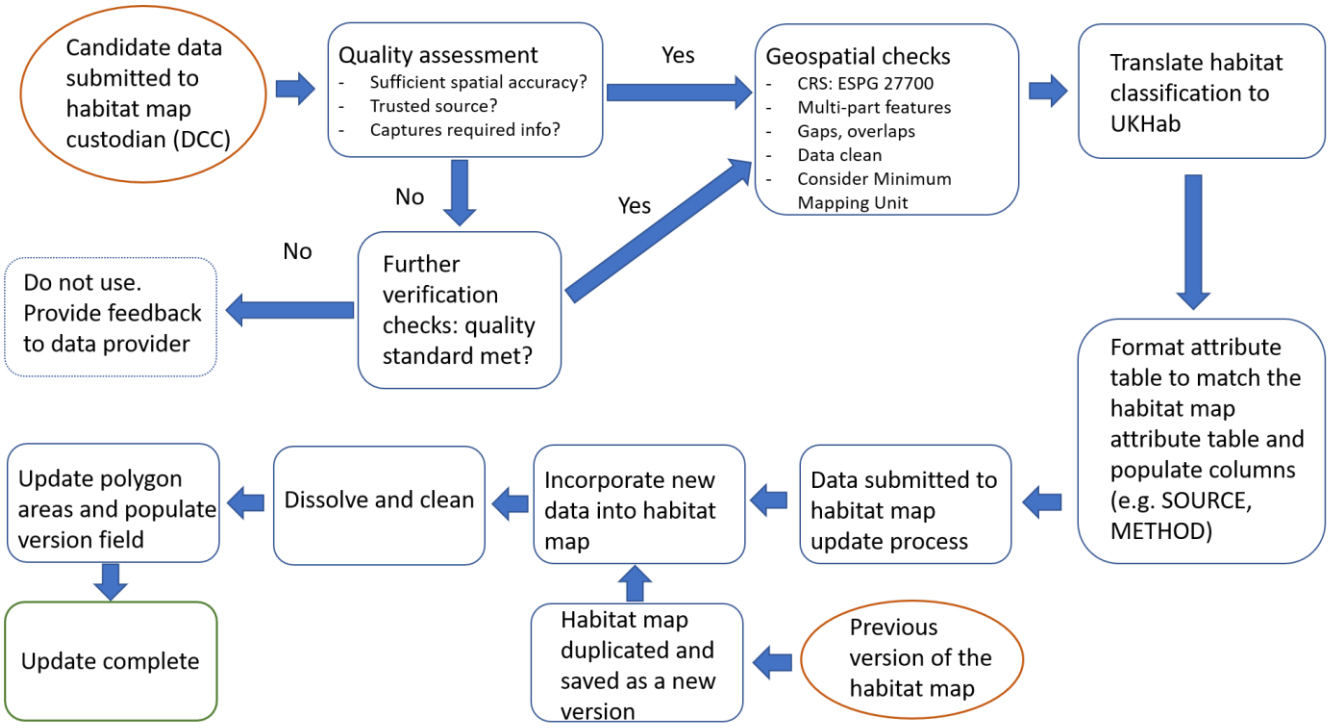

Figure 77: Habitat map update process

The accounts and ecosystem services should be re-run at least every five years as change can be expected within this timeframe that is material to the natural capital accounts. This change will be as a result of increased investment in nature-

based solutions together with increasing pressures on land, including those from climate change.

The Derbyshire natural capital asset account will also need to be periodically updated to monitor the benefits and underlying assets presented in the account. The level of analysis and frequency for such updates depends on changes to underlying data and available resources, but some aspects of the account can be readily updated on an annual basis. For example, market benefits such as water supply and minerals data can be updated to the latest annual market values. Other benefits require data inputs from external models (such as air quality regulation) which are updated less frequently. More detailed updates to the accounts would be beneficial if spatial plans or other strategic documents are renewed and the recommended frequency of this is a 5-yearly update as set out in the monitoring plan.

Chapter 8: The impacts of climate change

Climate change has the potential to significantly disrupt the natural capital of Derbyshire; the predicted changes in temperature and rainfall patterns in particular will alter growing conditions, meaning that some places become less suitable for supporting particular species and habitats, while other places become more suitable.

This is significant because for natural capital, the 'what' (what species, habitats, soils etc.) is very important for determining the level of benefits people can derive. Equally important is the 'where'; where in the landscape those assets are located, because the level of ecosystem service delivered by an asset depends on where it is situated in the landscape, and how that relates to other assets.

Climate change will not affect all assets equally, and it is important to understand how changing extents and distribution of natural assets could affect ecosystem services in Derbyshire; which places could come under more pressure and require more support.

This section presents an overview of some of the climatic trends that are projected to occur in Derbyshire, based on two sources of climate data; UKCP1827 (for analysis of changes in agricultural land grade), and WorldClim28 (for analysis of bioclimatic variables).

Climate change models are complex, and it is important to recognise the spatial limitations of the data, which is of coarser spatial resolution than the datasets used for production of the habitat map and ecosystem service maps. However, the data provide a valuable insight into the types of changes that will be faced by Derbyshire, and how these could impact natural capital and ecosystem service delivery.

Rainfall and temperature changes

Rainfall and temperature trends were investigated through analysis of WorldClim bioclimatic data. Analysis of the maximum temperature of the warmest month of the year (WorldClim Bioclimatic variable 5) identified that maximum temperatures are predicted to increase by 8oC consistently throughout Derbyshire by 2080.

Temperature increases, and an increase in heatwave events, are particularly significant for densely populated and deprived urban areas, where there is a greater risk of heat stroke and other impacts on health and well-being. To mitigate the effects of heat, green corridors and cooling features such as trees and wetlands are expected to become increasingly valuable, particularly in urban environments.

[27] https://www.metoffice.gov.uk/research/approach/collaboration/ukcp
[28] https://www.worldclim.org

Temperature increases also influence the distribution of many species. Derbyshire is currently at the northern limit of the distribution of many native 'southern' species; e.g. wild service tree (Sorbus torminalis), and the southern limit of the distribution of many native 'northern' species; e.g. northern brown argus butterfly (Aricia artaxerxes). Temperature changes could alter the distribution of native species in Derbyshire, through the impact of changes in site suitability or competition from other species.

Temperature seasonality (WorldClim bioclimatic variable 4) is expected to increase throughout Derbyshire between the present day and 2080 (Figure 79), meaning that heat waves are predicted to become more frequent. However, there is spatial variation in the magnitude of these changes; lowland areas, which coincide with the most productive agricultural land, are predicted to experience greater fluctuations in temperature than the uplands; this will increase pressure on farmers and pose an increased risk to agricultural food production.

Two aspects of precipitation were analysed; annual precipitation, and the seasonality of rainfall (coefficient of variation). Annual precipitation describes the total rainfall received during the course of the year, while the seasonality of precipitation describes how spread out throughout the year the precipitation events are. A comparison was undertaken between rainfall parameters for the present day (based on WorldClim historical average data) and modelled data for 2080 under climate change scenario Shared Socio-economic Pathway (SSP) 370 (Meinshausen et al., 2020).

The analysis showed that very little change in annual precipitation between the present day and 2080, with a maximum of 4mm difference in rainfall received at any location; this is not a significant change in the total annual rainfall. However, visualisation of the change in seasonality of rainfall (WorldClim bioclimatic variable 15) identifies that there will be changes in the pattern of precipitation events Figure 81. This means that although the total amount of rainfall received throughout the year in 2080 will be very similar to that of today, the seasonality will increase; the rainfall will fall in sharper, more intense bursts, with longer dry periods between them. The northern and upland parts of Derbyshire are predicted to be subjected to greater change in seasonality than the lowlands; while seasonality throughout the lowlands is predicted to double compared to the present day, the uplands are predicted to experience a six-fold increase in seasonality.

This trend is very significant for agriculture, habitats and individual species, as the required amount of rainfall may be less likely to fall at key times of year, for example to support germination and fruiting, or to stop ponds from drying out. Conversely, more intense bursts of rainfall are likely to increase surface water runoff increasing, flood risk, and causing soil erosion and water quality issues. This highlights the importance of taking early action in support of natural flood management, soil conservation, and protection of waterbodies from harmful inputs.

Blanket bog and other rainfall-fed habitats are particularly vulnerable to climate change. These habitats support unique flora and fauna, and are also extremely

valuable for their surface water regulation and carbon storage properties, due to the underlying peat layer. Peatland habitats are key targets for habitat maintenance and restoration in order to protect and enhance these vital ecosystem services, but there is a risk that these habitats will become less resilient under climate change due to changes in hydrology; should the habitats not receive enough rainfall, the conditions will not be suitable for peat formation, making peat restoration projects less likely to succeed. Furthermore, damaged peatlands would be less able to recover, and be more likely to become a source of carbon emissions than those which sequester carbon.

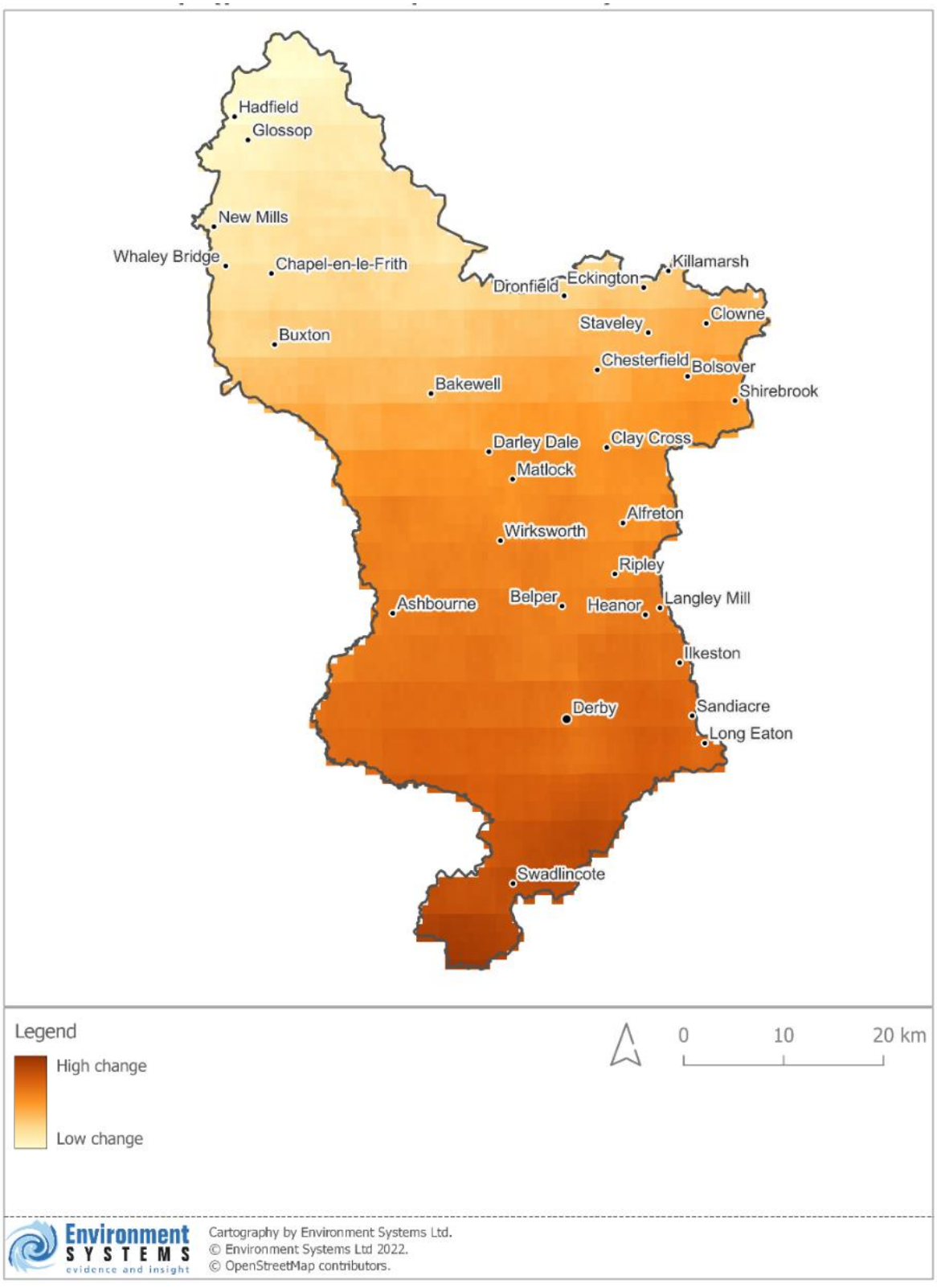

Figure 78: Change in seasonality due to temperature between the present day and 2080 (WorldClim ssp370)Impacts on habitats

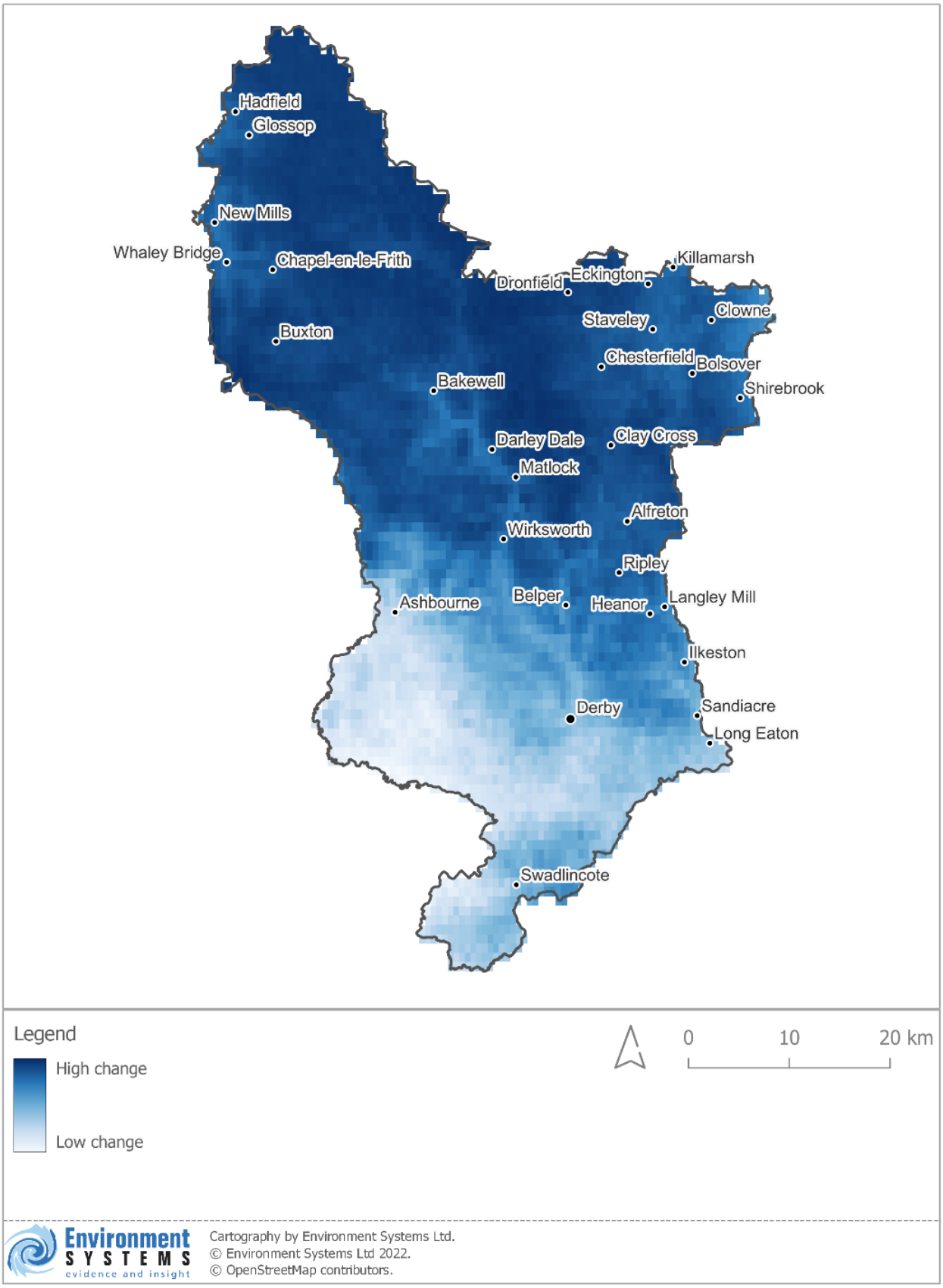

Figure 79: Change in seasonality due to precipitation between the present day and 2080 (WorldClim ssp370)Impacts on habitats

Although little difference in annual rainfall is predicted to occur throughout Derbyshire as a whole, the predicted change could be significant for habitats that are currently located at the extreme limit of their biophysical range. Analysis of trends in annual average rainfall (Figure 81) and the number of field capacity days (the number of days at which the soil pores are fully hydrated under gravity (Figure 83); shows a predicted decrease in the area of land where hydrological conditions will support the formation of blanket bog (although existing habitat could be stable if managed appropriately). This means that blanket bog habitats (peatlands) will come under increasing pressure due to climate change induced changes to hydrological conditions.

Parts of Kinder Scout, running south to the peaks of Brown Knoll and Lords Seat are predicted to become particularly vulnerable as they are located at the edge of the areas that are currently hydrologically suitable for peatland formation, and in the future peat formation is predicted to become less achievable. This provides a strong argument for targeting peatland restoration measures to this vulnerable area; by restoring peatlands the existing carbon stock locked away in the peat will be more resistant to oxidation due to drying-out. At the same time, protecting the peat resource also maintains the important water-regulating function of peat.

The management practice of burning heather moorland poses a risk to peat formation and peat condition if not controlled. However, under-managed moorlands build up large quantities of woody or dead heather, which are a significant wildfire risk. Therefore, woodland management plans must balance peat formation, habitat and species goals with wildfire risk, economics and logistical considerations.

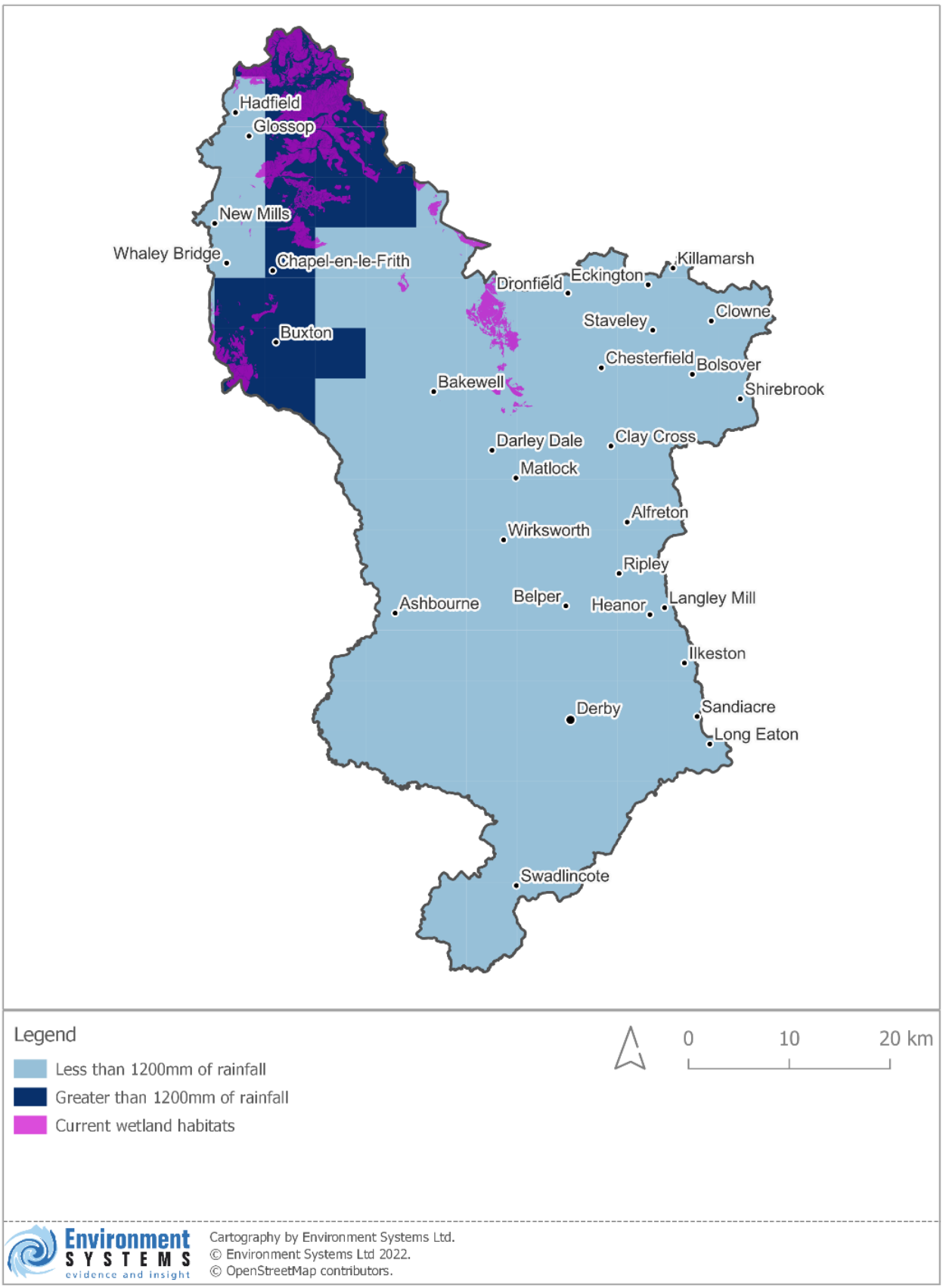

Figure 80: Comparison of areas receiving at least 1200mm Annual Average Rainfall in the present day (UKCP18 RCP 6.0)

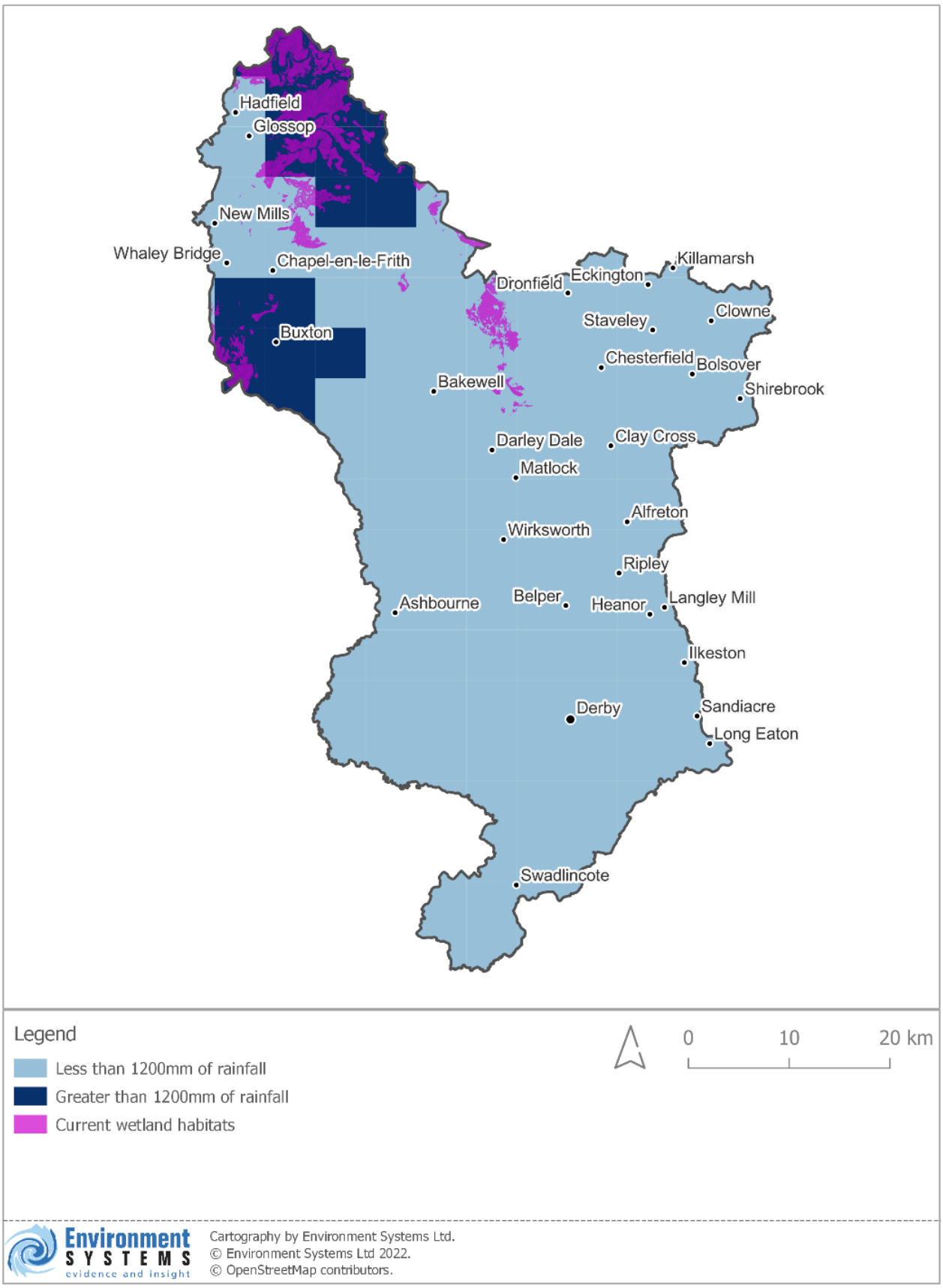

Figure 81: Comparison of areas receiving at least 1200mm Annual Average Rainfall in 2080 (UKCP18 RCP 6.0)

Impacts on agricultural land quality

Soil moisture characteristics are a fundamental component of the Agricultural Land Classification, which grades the land according to its capability for farming. Changes in temperature and precipitation patterns affect the soil moisture status, and different soil types will be affected by these changes to different extents according to their physical properties (i.e. the proportion of sand, silt, clay and organic matter) and management practice.

Figure 84 illustrates how agricultural land capability is predicted to change between the present day and 2080. Most areas will not see a change in the overall ALC grade, although the nature of the main limiting factors could change (for example a soil that is currently limited by wetness could by 2080 become limited instead by another factor, but retain the same grade overall if the level of limitation is comparable). Some areas have the potential to improve in soil quality for agriculture; these areas are located near the upland fringes, which suggests that they are currently limited by soil wetness, but under climate change (particularly the trend of increasing precipitation and temperature seasonality; longer hot/dry spells) these soils become less limited by wetness, and the climate more favourable for crop growth.

Conversely, some areas display a decrease in agricultural land quality by 2080. An analysis of the main limiting factor in ALC terms reveals that this change is largely due to an increase in soil drought conditions. Figure 86 shows a substantial increase in areas where drought becomes a main, or joint equal, limiting factor for agriculture; and this includes significant areas of land that is currently good quality, Grade 2 and Grade 3 land, around the Chesterfield/ S Yorkshire Notts & Derbyshire Coalfield area, and in the Trent Valley. In these areas, particular consideration should be given towards supporting agricultural management practices for enhancing soil carbon (which improves soil moisture retention), increasing on-farm water storage (including wetland creation), agroforestry, or growing alternative, drought resilient crop varieties.

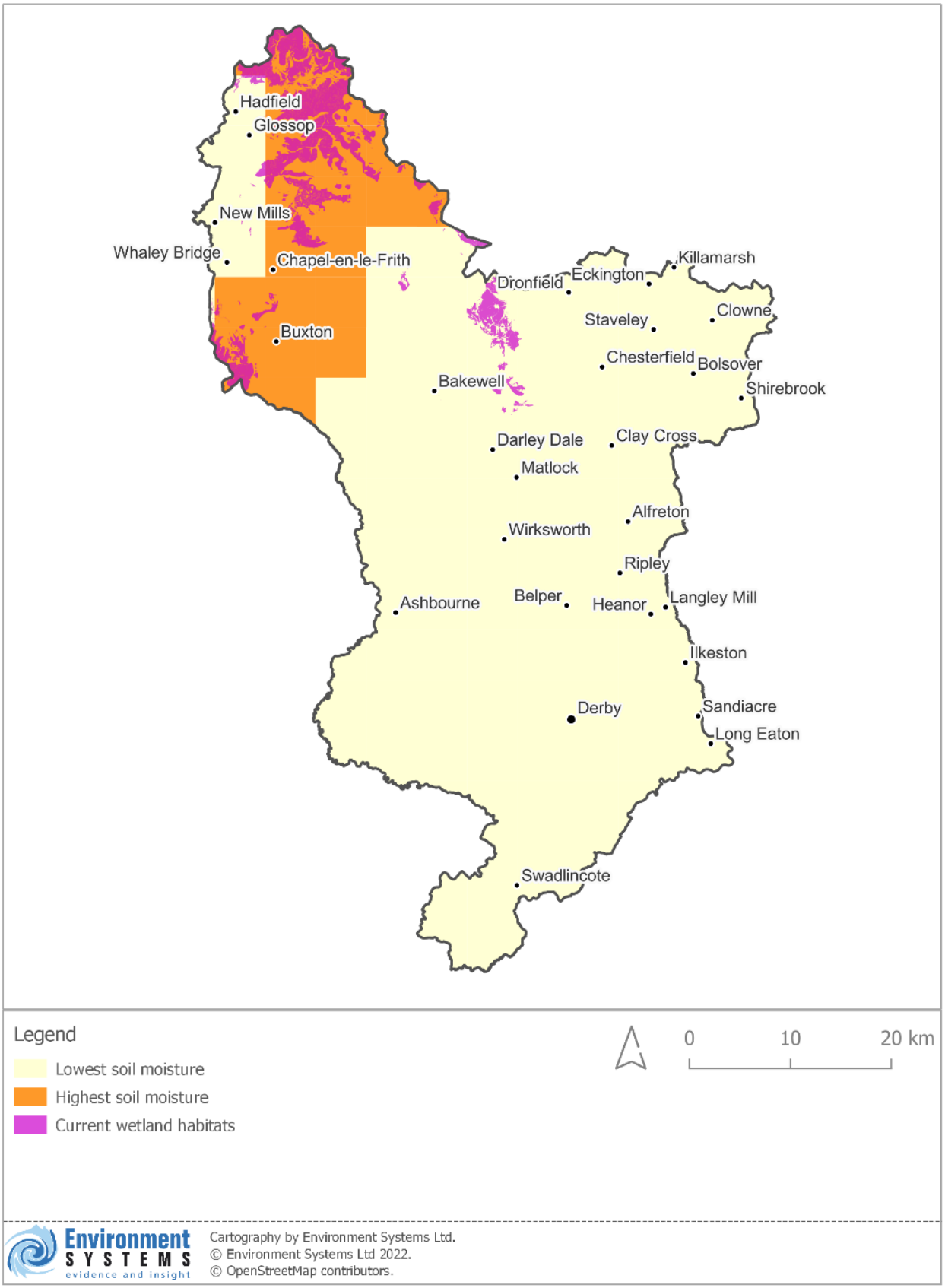

Figure 82: Comparison of areas where the soil experiences at least 270 Field Capacity Days in the present day (UKCP18 RCP 6.0)

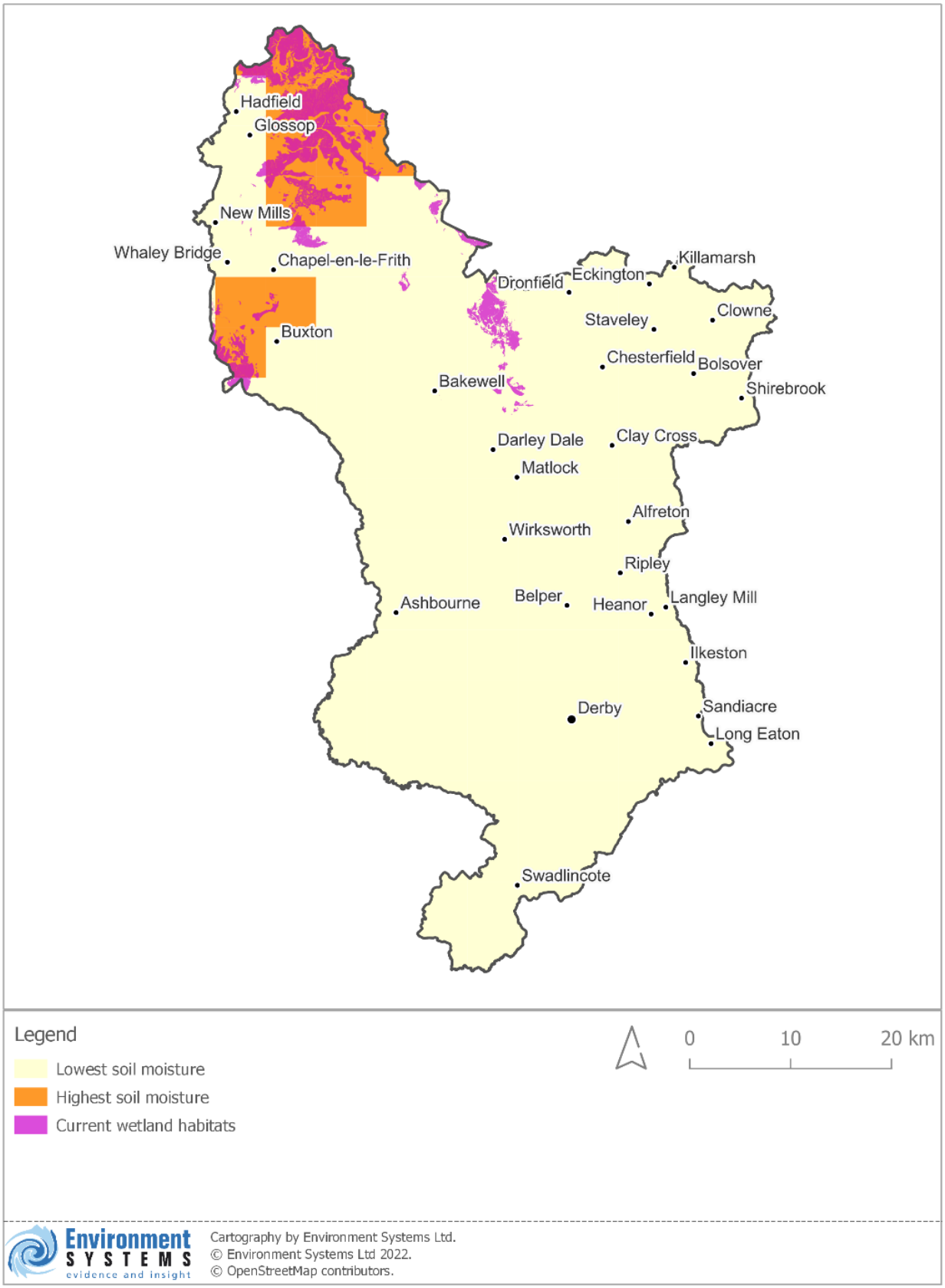

Figure 83: Comparison of areas where the soil experiences at least 270 Field Capacity Days in 2080 (UKCP18 RCP 6.0)

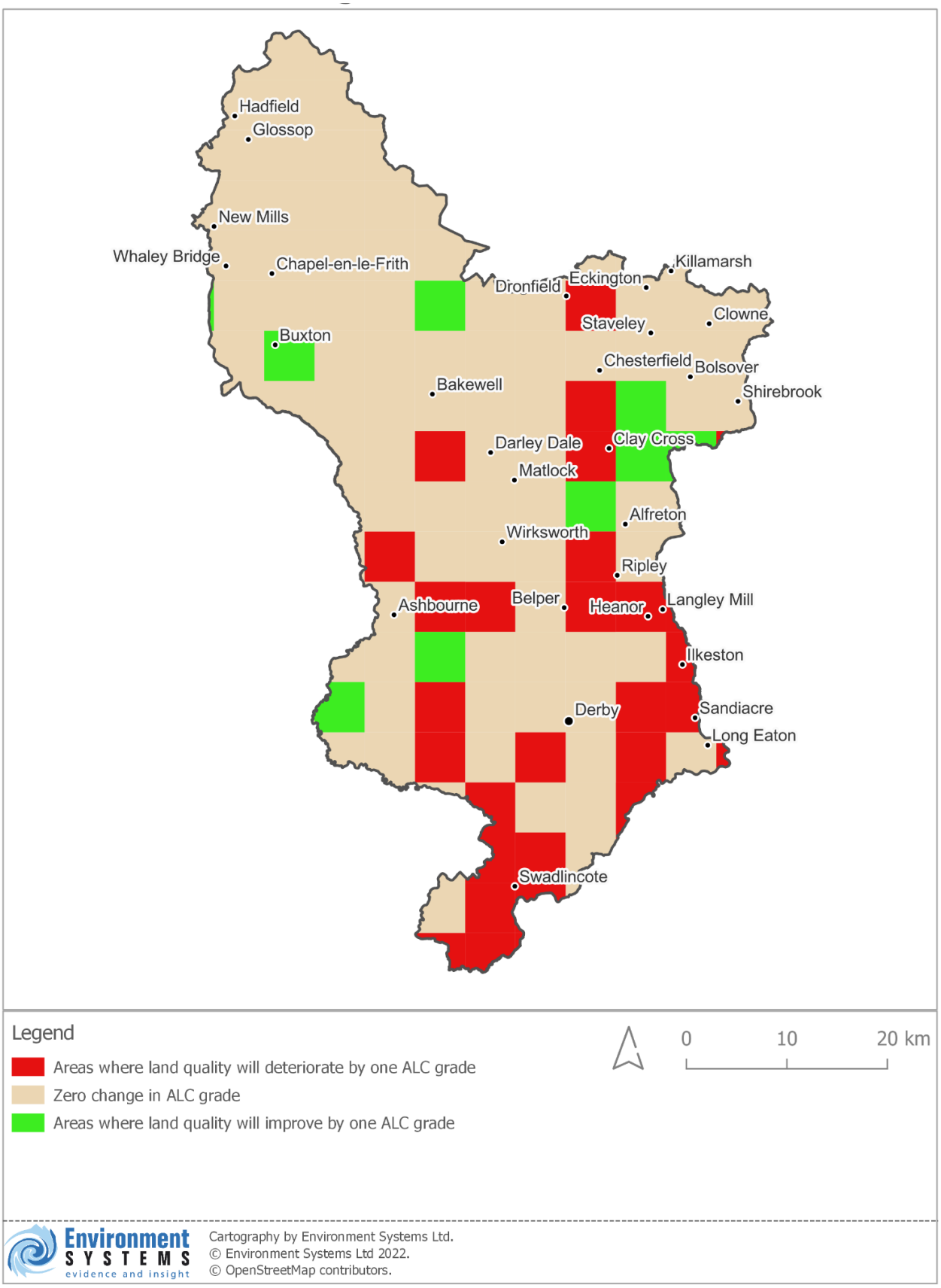

Figure 84: Predicted changes in Agricultural Land Classification grade between the present day and 2080 (UKCP18 RCP 6.0)

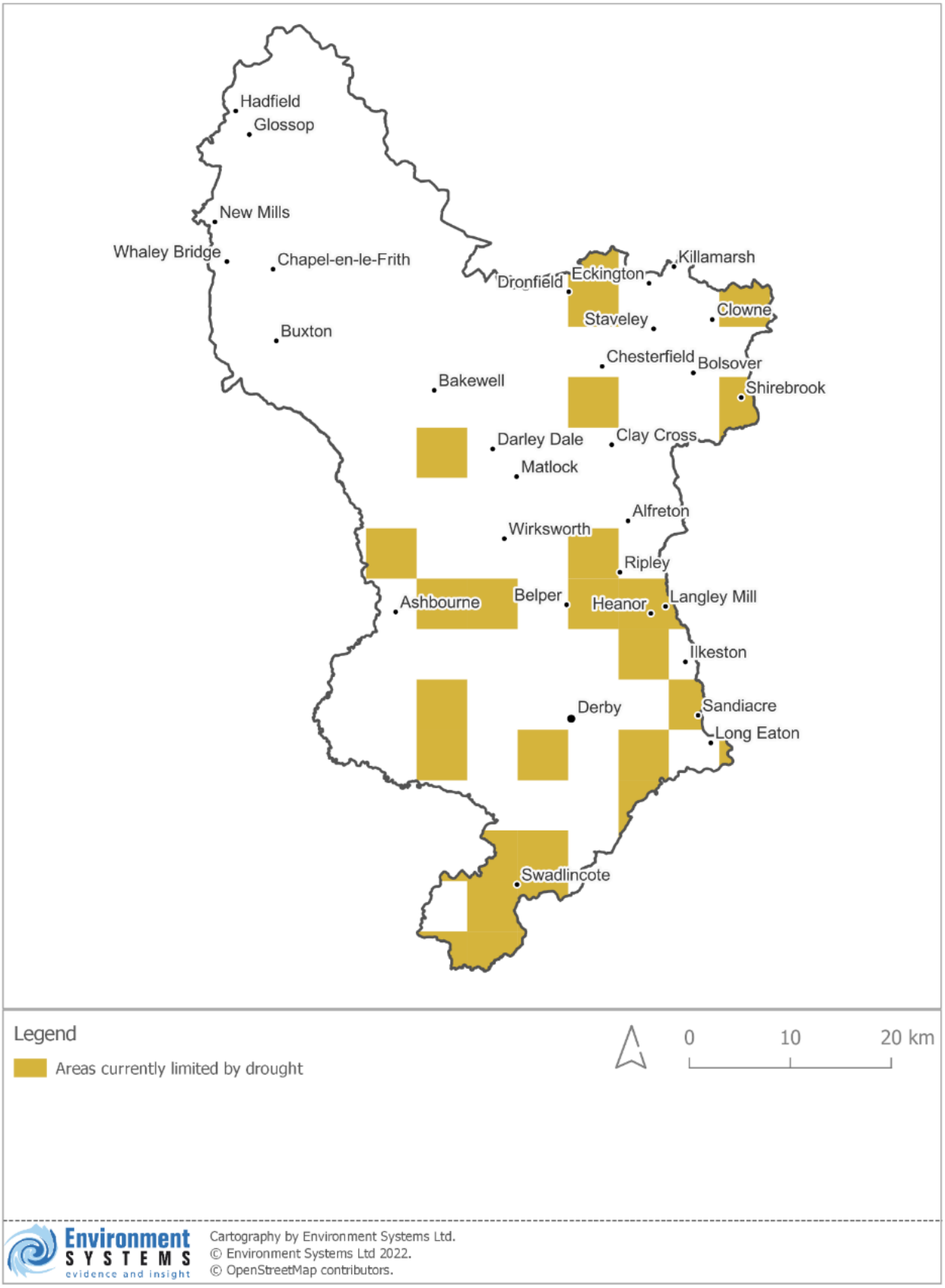

Figure 85: Areas where drought is a significant limiting factor for agriculture: present day UKCP18 RCP 6.0

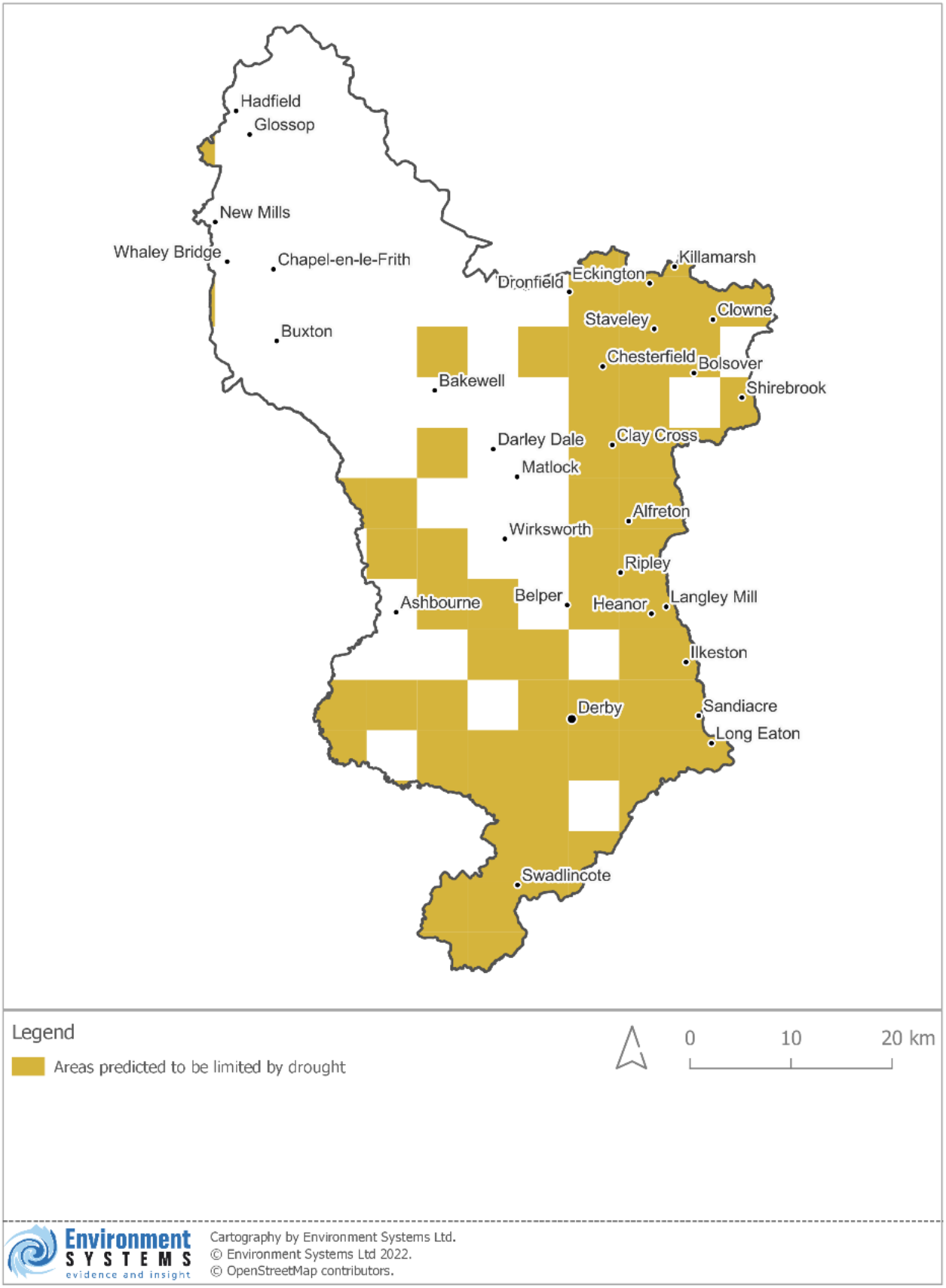

Figure 86: Areas where drought is a significant limiting factor for agriculture: 2080, UKCP18 RCP 6.0

Chapter 9: Identification of further funding mechanisms

There is a need to integrate goals for nature with funding streams, policy and statutory duties. Within this section we introduce funding mechanisms presented according to the primary benefit they seek to support (biodiversity, tourism etc). However, most have overarching or multiple goals which reflect the need for, and benefits of, partnership working.

Potential funding and delivery mechanisms are presented, some of which are currently open for calls for projects. These initiatives might be suitable to support direct delivery of, or attract investment in, natural capital and ecosystem services delivery in the county.

Funding mechanisms for nature-based solutions are increasing, seeking to address climate change, and deliver ecosystem service protection to the benefit people and biodiversity.

Accessing these funds mostly requires working in partnership. Derbyshire County Council, the City Council and National Park have the advantage here of having land within their ownership which can be offered up for partnership projects led by charities and NGOs. There are several funding schemes which work on this model and could benefit council owned land and local people. A good example is: www.fundingforall.org.uk/funds/ba-better-world-community-fund/.

Biodiversity

UK Government is establishing a range of funding and duties to underpin the NRN. This includes Countryside Stewardship and three future schemes that will reward environmental land management. A range of funding opportunities for nature have been announced. The 'Nature for Climate Fund' commits £640 million to support:

- creation, restoration and management of woodland and peatland habitats
- a tripling of afforestation rates across England
- restoration of 35,000 hectares of peatland by 2025

The Green Recovery Challenge Fund (£80 million) is for nature-based projects to restore nature, tackle climate change and connect people with the natural environment. It is helping to address environmental renewal and sustain and build capacity in the environment sector.

The funding base for the NRN is being broadened, for example by encouraging private and third sector businesses to invest in the natural environment and there is incentivising action for businesses in the development sector by mandating biodiversity net gain (BNG).

Outside of the larger partnership projects, funding mechanisms for biodiversity are being supplemented by the development of a BNG market in England. This is due to form after adoption of the proposals in the Environment Act (2021) and will allow land to benefit significantly from habitat restoration to enhance biodiversity for both plants and other species. The demand for restoration arises from developers who are taking land for development and who are required to offset the biodiversity loss of such schemes. The Natural Capital Strategy for Derbyshire is a key mechanism for guiding the development of such offsetting schemes. The maps of opportunities for biodiversity identify land where offsetting activities will be likely to deliver biodiversity enhancement more quickly and with

more resilience than other locations; this comprises places that mainly fall within the existing ecological networks. Land which is marked as providing multiple ecosystem benefits on the opportunity maps will be especially valuable to wider society if used for this purpose.

There is currently limited voluntary trading in BNG schemes. Economic modelling work has been undertaken which gives an indication of the potential market price for Biodiversity Units (BUs). However, these prices have significant uncertainty, and are likely to vary depending on the types of habitats BUs are needed for. Prices will also vary between the locations BUs are needed. BUs may be sold immediately but the time taken to deliver them from different habitats can vary significantly. The price per BU is therefore uncertain, but could range from £11,000 to £25,000, with an expected mid-point of £15,000 in a county such as Derbyshire29 30. Levels of demand are also hard to predict, but can be estimated from past rates of development, planned infrastructure, housing and other developments in local plans.

The annual loss of biodiversity in Derbyshire is predicted, based on recent patterns of development, at 363 BUs per year. This does not take account of future targets to accelerate land use development (e.g. for housebuilding). It is estimated that only Derby City is likely to have any shortage of BU supply to meet demand, all other LPAs in Derby should have an adequate supply. Therefore, Derby's demand can be met by supply from neighbouring authorities. The data for Derby is uncertain, as modelling urban development is harder; for example the biodiversity metric is more difficult to apply when quantifying previously developed land impacts. As the surrounding LPAs around Derbyshire also have adequate supply of BUs to meet demand, there is unlikely to be additional demand within Derbyshire from neighbouring planning authority areas.

Agricultural subsidies

The public goods generated by agriculture and land management justify the payment of public money to land managers through agricultural subsidies. The intention for Environmental Land Management Schemes (ELMS) is to allow land managers to receive its payments and sell other services in markets. However, rules for simultaneously receiving payments from the future ELMS and payments for BUs (so-called 'stacking') are not clear, especially in the light of the recent changes in government policy and the abandonment of biodiversity recovery, climate change mitigation and potentially the ELMS scheme.

Nature-friendly farming, regenerative agriculture and re-wilding are growing areas of interest to some farmers and land managers. The maps within the Derbyshire Natural Capital Strategy are a key resource for gaining on overall understanding of where biodiversity-focussed action is likely to deliver the greatest benefit.

Using council owned land, it will be possible to apply for future grants related to Natural England's NRN. This is a grant which ties in with the major commitment in the government's 25 Year Environment Plan. By bringing together partners, legislation and funding, Natural

[29] eftec, WSP, ABPmer (2021). Biodiversity Net Gain Market Analysis Tool

[30] Defra (2019). Biodiversity net gain and local nature recovery strategies. Impact assessment. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/839610/net-gain-ia.pdf

England are seeking projects to restore and enhance the natural environment and launch periodic funding calls (www.gov.uk/government/publications/nature-recovery-network).

Water quality

For water quality, there is potential for agricultural land managers to generate revenue from payments to reduce nutrient inputs. Not all nutrient reductions may qualify – farmers are expected to contribute their 'fair share' of reductions in catchments with elevated levels of nutrients. However, a growing driver of market potential is 'nutrient neutrality' for housing developments, which is now being implemented in some catchments. These schemes aim to use reductions in nutrient inputs, in particular phosphates, in a catchment to offset the increased nutrient levels resulting from treating the additional wastewater from new housing.

Nutrient neutrality is a relatively new concept, and so there remains uncertainty as to how extensively it will work and what payment levels it will generate. However, based on catchment trading schemes in other parts of the UK a revenue of £100/ha/year is assumed in return for nutrient management actions, and may be possible for areas 500m either side of a watercourse. Along a kilometre of a watercourse's length, this could cover 100 ha and result in revenue of £10,000 per year. The majority of payments will come from developers who need a nutrient neutrality statement to support their development or water companies with specific water quality issues. The Derbyshire water quality stock and opportunity maps are good evidence base for identifying potential sites for action. Site based, specific actions at a sub catchment scale, with a known value will need to be calculated for specific schemes. Environment Systems can provide further advice in this regard.

Flood risk

There are many locations in the UK where regular flooding is a problem, and this is expected to worsen with climate change. Natural flood management (NFM) measures including runoff management and floodplain storage are increasingly being considered as part of integrated flood management within catchments, to deliver reductions in existing flood risk and/or increase resilience to future expected flood risk. The maps produced in this plan show where the land is currently suppling NFM benefit and where opportunities are which are likely to benefit NFM based actions.

The value of, and therefore potential income from, NFM actions, will depend on their cost and the extent to which they will reduce flood risk to downstream property. These factors are very location specific, and so a typical payment rate cannot be estimated.

Carbon

Markets for land management actions that reduce concentrations of greenhouse gases in the atmosphere are now operating for woodland (under the Woodland Carbon Code (WCC)) and peatland restoration under the Peatland Cabon Code. Other habitats such as grasslands can also sequester carbon and reduce GHG concentrations, and codes are being developed to take account of this and actions such as planting hedgerows. These additional codes are not sufficiently developed to link specific land management actions to quantities of GHG reductions and the market is not yet ready, although county councils are looking to support codes for habitat types relevent to their areas.

The extent and condition of woodland and peatland habitats are identified in the Derbyshire accounts, and within the ecosystem opportunity maps along with estimates of current sequestration/ emissions. Both the woodland and peatland codes provide a specific method for calculating GHG benefits and the tCO2e that can be traded. Funding for carbon credits can be obtained from private investment in each project through a range of organisations. Such funding tends to cover larger sites with peatland which is within the peatland codes eligible classes.

The Climate Action Fund (UK) currently has an open call for demonstration projects, this could be a potential avenue for council land where climate change is the key benefit. https://naturalengland.blog.gov.uk/2022/07/14/new-grant-scheme-opens-nature-based-solutions-for-climate-change-at-the-landscape-scale/

The Heritage Lottery Fund has a current call for the National Lottery Community Fund's £100 million Climate Action Fund. www.tnlcommunityfund.org.uk/funding/programmes/climate-action-fund-programme

Up to £8 million is available to community projects throughout the UK that are focusing on the link between nature and climate. There is again the opportunity for council owned land to be included in partnership projects as groups can apply for National Lottery funding of up to £1.5 million over two to five years to support place-based and UK-wide partnerships that use nature to encourage more community-led climate action and help communities tackle climate change. Development grants of £50,000 to £150,000 over 12 to 18 months are also available for those communities wanting to develop initial ideas.

For peatland restoration, it is important to target extensive areas of actively eroding, flat, bare peat and actively eroding haggs and gullies, which are likely to be found in Peak District. This is because if private finance is to be sought the project will need to be of significant scale and extent in terms of restoration. Understanding opportunities for restoration by using the peatland code is essential and many organisations use a trusted adviser to plan and prepare restoration projects. There are good examples of success in restoring larger areas of peat where the community of local land managers/owners get together to create a community interest company (CIC) or partnership (e,g, Moors for the Future) so that all key stakeholders are involved and there is clarity on the distribution of future carbon payments.

Recreation and public health

The Derbyshire account quantifies the recreational and health benefits supported by public access to the natural environment. This includes access via public rights of way and open access land, which land managers must maintain, or permissive footpaths. Provision of enhanced access to greenspace usually results in increased levels of physically activity, which has a positive impact on public health. This can be quantified and valued, but health funding for such provision is uncommon. Funding is usually targeted at specific health interventions (e.g. providing specific activities in outdoor environments for those at risk of, or suffering from, mental ill-health). Funding for these activities generally support the provision of the activity, rather than the management of the outdoor environment location. The provision of enhancements to ensure adequate access to green space for new communities can potentially be funded via Section 106 agreements, so new housing developments are also a potential funder.

Tourism

Linking tourism to better preserved natural green spaces is the subject of an open ESA research call https://business.esa.int/funding/space-for-tourism which has a broad scope and seeks demonstrator projects to show how space-based technology and data can help facilitate successful actions that benefit tourism. The Derbyshire Natural Capital plan used ESA data and further analysis could be done, so this and other similar calls may be a potential funding stream to consider.

There is potential to grow the tourism sector beyond the Peak District, especially along the River Trent corridor. This could be facilitated a new environmental/leisure corridor using biodiversity net gain funding associated with minerals extraction and housing growth (see Trent Valley Vision).

Natural Environment Investment Readiness Fund

Of relevance for funding nature-based projects to address challenges including flood risk, water quality improvement, climate mitigation and biodiversity decline, is the Natural Environment Investment Readiness Fund (NEIRF). The NEIRF supports the government's goals in the 25 year Environment Plan, Green Finance Strategy and 10 Point Plan for a Green Industrial Revolution. It aims to stimulate private investment and market-based mechanisms that improve and safeguard our domestic natural environment by helping projects get ready for investment.

The NEIRF is a competitive grants scheme providing grants of between £10,000 and £100,000 to support the development of environmental projects in England that:

- help achieve one or more natural environmental outcomes from the 25-year environment plan
- have the ability to produce revenue from ecosystem services to attract and repay investment
- produce an investment model that can be scaled up and reproduced
- Proposals should focus on generating revenue from ecosystem services, rather than goods or commodities. Examples of ecosystem services that could produce revenue include:
- selling 'catchment services' (such as improved water quality and natural flood management benefits) resulting from natural environment improvements
- selling biodiversity units from a habitat bank, using the Natural England biodiversity offsetting metric; and
- selling carbon credits from woodland creation or peatland restoration, using the Woodland Carbon Code or Peatland Code

Obtaining the most funding for land

There is potential for combinations of ecosystem services to be sold from the same area of land. If this is delivered under different contracts it is called 'stacking'. An example would be where a land manager sells carbon credits and BUs separately. If delivered under a single contract it is called 'bundling', for example, where a high-value biodiversity and carbon credit is sold, such as under the Peatland Code.

Clear rules are required from Government on whether and how stacking and bundling will operate within UK environmental markets. They bring opportunities for increased incentives for environmental management, but present risks to market credibility (e.g., through lack of additionality). This market is emerging.

Other websites which help find funding

Some websites provide a 'one-stop shop' for organisations who are seeking funding for projects that use nature based solutions. An example is:
https://www.fundingforall.org.uk/available-funds/

This site does not directly fund organisations or individuals but seeks to help applications for funds from other trusts and foundations to increase the chances of success. The website hosts the latest grants currently open to applications.

General help in finding funding can also be found at:
https://www.grantsonline.org.uk/news/16051.html

The Landscape Enterprise Networks (LENS) (https://landscapeenterprisenetworks.com/) is a system for organising the buying and selling of nature-based solutions. LENS brings a diversity of private and public-sector organisations together around a common interest in funding nature-based solutions within a given geography. LENs then brokers negotiations, and eventually transactions, between these buyers and groups of landowners who can deliver them on the ground.

Chapter 10: The Natural Capital Strategy: conclusions and recommendations

Conclusions

This report, along with the modelling, mapping, proposed land management actions and financial accounts comprises Derbyshire's Natural Capital Strategy.

The natural capital baseline assessment provides a strong evidence base for Derbyshire County Council, PDNPA, Derby City Council and local stakeholders. It quantifies the extent, condition and monetary value of existing natural capital assets in the county. The strategy proposes appropriate implementation of nature-based solutions to support nature recovery by taking account of biodiversity considerations, natural capital (and the ecosystem services it provides), landscape character, and cultural heritage.

The natural capital accounts identify the natural assets in Derbyshire and the moneraty value of the benefits they give to the county. The natural capital baseline account shows that natural capital within Derbyshire is worth £2.6 billion per year. This value is formed of key provisioning services such as agriculture (£96 million), public water supply (£132 million), and minerals (£298 million). Natural Capital also plays a large role in benefits for recreation (£181 million), tourism (£105 million) and physical health (£86 million). Carbon sequestration by habitats in Derbyshire is worth £1.6 billion per year; 62% of the total natural capital of Derbyshire.

Combining this data with quantified future trends, the value of natural capital assets In Derbyshire Is estimated at £86bn over the next 60 years. There is insufficient data to represent some expected future changes (such as climate change risks) in the account. Therefore the values may change due to future trends, and will partly depend on the actions taken to mitigate and adapt to climate change.

The account can be used in different ways to help manage natural capital:

- It provides data that can be used to make a business case to central government for support and funding to invest in natural capital.
- It gives a consistent evidence base for different groups and decision-makers to refer to (e.g. Biodiversity Net Gain, ELMS design).
- The accounting structure also allows for comparison of the sub-regions using a consistent approach and data.

A habitat map has been created for the whole of Derbyshire to inform the natural capital baseline accounts and a new dataset of hedgerows has been specifically created to support the natural capital strategy. The coverage and level of detail that these maps provide gives Derbyshire County Council a particularly good start in designing local nature recovery projects.

The ecological networks created for woodland, heathland, wetland and grassland tie in well with the national networks produced by Natural England for the NRN. They provide the evidence to develop Derbyshire's LNRS to expand, improve and connect the NRNs across Derbyshire's cities, towns and countryside.

Understanding the delivery, risks and opportunities associated with the nine key ecosystem services enhances the information available to deliver LNRS and other aspects of Derbyshire's natural capital strategy. It is enhanced further by taking account of landscape character. It improves knowledge of where to focus management action, such as tree planting and peatland restoration, and how to broaden the range of environmental benefits delivered to provide a 'bundle' of environmentally and socially beneficial outcomes.

Grassland, woodland and wetland management action is a priority in most Landscape Character Types (LCTs) in Derbyshire, as is hedgerow planting (outside the White Peak), restoration of ancient woodland sites, riparian/floodplain woodland planting, river restoration and enhancement of the natural continuity of river corridors.

Restoration and enhancement of existing semi-natural grasslands, and floodplain grazing marsh, is a priority for all except the Enclosed Moorland, Open Moors, and Wooded Hills & Valleys LCTs. Wetlands are a priority for many LCTs, with priority actions for grassland focussed on enhancing existing wet meadows and marshes, and restoration of upland and lowland bog habitats. Heath has restricted distribution across Derbyshire and a balance will need to be struck between heath enhancement/expansion and grassland enhancement/expansion to work towards a sustainable habitat matrix.

Cropland priorities focus on improving the ecological value of intensive farmlands, and conserving and enhancing the mixed farm landscape where it is still present. Eight LCTs are identified as being under particular pressure from urban development.

The suite of maps and associated guidance are a key resource for realising the maximum benefit from any actions as they strengthen spatial planning for environmental net gain (including biodiversity net gain) and natural capital enhancement projects.

A dataset on cultural heritage has been collated and analysed and conclusions drawn for purposes of preliminary review and discussion, in order to assist in the longer-term development of a methodology that can be applied to specific heritage assets. It informs the natural capital strategy but does not consider the detailed effect of natural capital projects on specific heritage assets/types of assets, an exercise which would require project specific consideration on a case-by-case basis.

Climate change has the potential to significantly disrupt the natural capital of Derbyshire. The information presented puts Derbyshire in a strong position to address the challenges of climate change and biodiversity decline, and provides basline evidence for carbon accounting that can be used to monitor progress towards delivering net zero commitments.

Predicted changes in temperature and rainfall patterns in particular will alter the growing conditions, meaning that some places become less suitable for supporting particular species and habitats, while other places become more suitable. Future peat formation on blanket bog is predicted to become less achievable in parts of Kinder Scout. The upland fringes will become more important for arable crops, and drought will affect many of the areas where crops are currently grown.

These and other trends will affect the values provided by Derbyshire's natural capital In future, and actions to adapt to future climate change will be Important to maintain natural capital assets.

Monitoring provides a mechanism for judging and quantifying the success of natural capital projects, including to funders, and for identifying unexpected changes to natural capital that affect the materiality of the accounts. A monitoring plan for the Natural Capital Strategy focuses on the need to update information on habitats and associated natural capital values, as a key driver in natural capital assessment. Habitats are likely to show quantifiable change within timeframes of a few years and a process for keeping the habitat map up-to-date is identified.

Funding for the implementation of nature-based solutions is growing rapidly; key funding streams, including government funding specifically to support NRNs, have been identified in readiness for partnership working on nature recovery projects. Central to this is the 'Nature for Climate Fund' for the creation, restoration and management of woodland and peatland habitats and a tripling of afforestation rates across England. There is also the 'Green Recovery Challenge Fund' for nature-based projects. There is an increasing emphasis on private and third sector businesses to invest in the natural environment, including through mandating biodiversity net gain.

The coverage and level of detail provided by the mapping and analysis gives Derbyshire council a particularly good start on designing local nature recovery projects that are in keeping with landscape character. The data and analysis can be revisited and further developed to at a finer scale of detail for site specific projects; it can also be extended to encompass further ecosystems services, and different constraints. When applying for funding there is the evidence to show where taking action can deliver enhancement to multiple ecosystem services.

Recommendations

Implementation priorities for nature recovery

Maximum value from the Natural Capital Strategy will be realised by embedding the findings into local government strategy and development planning. This requires users to understand the range of Information provided - mapping and quantification of assets, measurement of ecosystem services, and monetary valuation of annual benefits and assets. This will ensure an integrated approach to planning, that will lead to making the most of opportunities for natural capital protection and enhancement and bring wider understanding of the societal benefits of natural capital.

- Recommendation 1: The findings of the Natural Capital Strategy should be incorporated into future Development Plans and embedded into a wide range of relevant policy. Key actions for incorporation into these plans and policies are summarised in the boxes of 'key points and recommendations' presented under each ecosysterm service theme in Chapter 3: Spatial Distribution of Ecosystem Services, Risks and Opportunities. These should be cross-referenced against the lanscape character considerations in Chapter 5: Using landscape character to inform decision making.

The boxes of key points and recommendations in Chapter 3 and Chapter 5 allow specific land management actions to be targeted to specific regions within Derbyshire. Many of the

recommendations will have multiple benefits across several ecosystem service themes. For example cross-slope hedgerow planting for improved surface water regulation will increase carbon sequestration, and can enhance biodiversity and water quality regulation. Therefore, while different locations within Derbyshire will have different ecosystem service priorities (e.g. flood risk or water quality issues), it is important to view mitigative action holistically, identifying the wide range of benefits and NBS action can provide across all of the ecosystem service themes, and in building resilience to climate change.

Derbyshire currently has a very strong woodland network in some areas and where hedgerows occur these greatly enhance woodland connectivity. There are clear opportunities to strengthen the woodland network by planting and this is a way to deliver significantly towards net zero through carbon sequestration. However, planting must be done in the right place.

- Recommendation 2: The maps and proposed land management guidance for LCTs are always used to ensure appropriate siting of woodland expansion in order to deliver the carbon, biodiversity, water regulation and landscape benefits. Through development of the National Forest there is an opportunity to enhance connectivity of large areas of core woodland habitat that are currently relatively isolated

Peat formation on blanket bog is predicted to become less achievable in parts of Kinder Scout due to climate change.

- Recommendation 3: This provides a strong argument for targeting peatland restoration measures to this vulnerable area; by restoring peatlands the existing carbon stock locked away in the peat will be more resistant to oxidation due to drying-out. At the same time, protecting the peat resource also maintains the important water-regulating function of peat.

Climate change analysis has shown the upland fringes becoming more important for arable crops and drought is predicted to affect many of the areas where crops are currently grown.

- Recommendation 4: In agricultural areas particular consideration should be given towards supporting agricultural management practices for enhancing soil carbon (which improves soil moisture retention), increasing on-farm water storage (including wetland creation), agroforestry, or growing alternative, drought resilient crop varieties.

There is a large number of highly fragmented grassland habitat patches within the Needwood & South Derbyshire Claylands, and Peak Fringe & Lower Derwent regions; the grassland network is not currently working well in these areas. These core habitat patches are likely to be less resilient/ more vulnerable to pressures as a result. Agri-environment schemes are likely to be key to supporting the recovery of the grassland network in these areas.

- Recommendation 5: For grassland opportunities, a site-level assessment is likely to be needed to assess habitat condition and ensure the most appropriate nature-based solutions.
- Recommendation 6: For heathland expansion, investigate areas of coniferous plantation that may have been on former heath sites; such areas could revert quickly back to heath habitat.

The key to realising funding, including for nature-based solutions on land owned by the councils and national park authority is to form partnerships with local stakeholders.

- Recommendation 6: The 'Nature for Climate Fund' and 'Green Recovery Challenge Fund' should be explored for funding for creation, restoration and management of woodland and peatland habitats, afforestation opportunities, and nature-based projects.
- Recommendation 7: Consider joining the NRN Delivery partnership as this will open up networking opportunities, including a regular NRN conference, workshops and meetings.

There is an increasing emphasis on private and third sector businesses to invest in the natural environment, including through mandating biodiversity net gain.

- Recommendation 8: There is potential to grow the tourism sector beyond the Peak District, especially along the River Trent corridor. This could be facilitated a new environmental/ leisure corridor using biodiversity net gain funding associated with minerals extraction and housing growth (see Trent Valley Vision).

Keeping the Natural Capital Strategy up to date

The level of analysis and frequency for updating underlying data and the timing of re-assessment of natural capital depends on the rate of changes to underlying data and available resources.

- Recommendation 9: When new LCTs from PNDPA are available these should be incorporated into the analysis of ecosystems services to assess the implications for future land management.
- Recommendation 10: An update cycle of five years is recommended for the habitat map and re-running the ecological network and ecosystem services modelling.
- Recommendation 11: More detailed updates to the accounts would be beneficial at the time that spatial plans (recommended at least every five years) or other strategic documents are renewed. Some aspects of the natural capital asset account can be readily updated on an annual basis (e.g. water supply and minerals data can be updated to the latest annual volumes, and market price values can be updated annually).

Improving the Natural Capital Account

Improvements could be made to broaden and strengthen future versions of the accounts.

- Recommendation 12: Refining the partial benefit estimates included in the account that are material, but only calculated for parts of Derbyshire (e.g. education and volunteering). Local data collection is required to quantify these on a local and regional scale and will require liaison with local and regional stakeholders.

As described in Chapter 6, a complete natural capital account would include an assessment of current and planned spending on maintaining the extent and condition of the natural capital assets, including in response to future trends (e.g. climate change) providing the benefits assessed. This enables comparison of expected costs and benefits, and consideration of whether enough resources are being put into the right actions to ensure those benefits and the natural capital assets that provide them are sustained over time.

- Recommendation 13: Assess the cost of maintaining natural capital assets, including current spending levels and actions needed in response to future pressures, e.g. from climate change. At the Derbyshire scale this would require buy-in from key public and private stakeholders who manage the majority of relevant spending and their willingness to provide such data.

The economic value of natural capital assets is calculated by aggregating the value of benefits they can provide over time. Expected future changes in the quantity and/or value of benefits are reflected in the estimates where relevant data is available (such as increasing value of mitigating carbon emissions). However, there is insufficient data to represent some expected future changes (such as climate change risks) in the account.

Furthermore, while the account provides useful information to help manage natural capital it should be noted positive values do not necessarily mean that the natural capital assets are being managed sustainably. To assess this, more understanding of future trends (e.g. climate change) and estimations of maintenance costs would need to be factored in.

- Recommendation 14: Better understanding is needed of future trends in benefits from natural capital, including those caused by climate change. Monitoring trends from the baseline will over time build a greater understanding of how sustainably natural capital assets are being managed.

Communication of the Natural Capital Strategy:

The Natural Capital Strategy would benefit from further communication materials.

- Recommendation 15: A Storyboard is developed to communicate the Natural Capital Strategy to stakeholders and the wider public to improve accessibility of the findings and promote the key messages. This would include making selected large scale and/or interactive copies of the habitat maps available.
- Recommendation 16: A process could be developed to demonstrate, promote and track the activity being carried out to deliver the Natural Capital Strategy. This could involve development of a dedicated web resource; planning and cost analysis would be needed to ensure adequate staff resources.

List of appendices