Lot 4: Natural Capital Mapping

FULL REPORT

June
2022

NATURAL ENGLAND

Nottingham City Council

ecosulis

Natural Capital Strategy
Lot 4: Natural Capital Mapping

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1 INTRODUCTION

Ecosystem services are generally considered to be the natural benefits offered by the environment that are useful to humans - sometimes referred to as natural capital. The definition of ecosystem services used by the International Union for Conservation of Nature (IUCN) aptly categorises them into four distinct categories. Those that provide provisioning services, regulating services, supporting services and cultural services. The first three categories account for the material contributions of the natural world to things such as the provision of food and natural raw materials such as wood; regulatory effects on the climate and hydrological cycle; and other supporting roles such as the production of atmospheric oxygen, soil formation and nutrient cycling. The remaining cultural ecosystem services capture all the non-material benefits that can be enjoyed by humans - such as through health, recreation, aesthetic appreciation and spirituality[1].

In the current cultural environment in the UK, particularly following the COVID-19 pandemic, one of the most important services offered by natural capital assets is the availability of spaces for recreation. When considering this ecosystem service, areas with more open space with opportunities for recreation are able to offer greater improvements in wellbeing if they are used by the community. Mapping the distribution of ecosystem services across urban spaces is therefore important for Councils to consider since it can highlight areas where a communities access to natural benefits can be celebrated whilst highlighting non-financial deprivation trends relating to access to nature.

1.1 Objectives

Ecosulis were commissioned by Nottingham City Council in August 2021 to undertake a series of spatial nature planning activities to allow detailed analysis of the city's natural resources, habitat networks, tree stock, and ecosystem services.

This report relates to the natural capital mapping element (Lot 4) of the project. The aims of the exercise were to map cultural and non-cultural ecosystem services across Nottingham using a standardised approach. This technical report contains two main sections. The first of these is an introduction to the methodology applied to map Nottingham's ecosystem services. The second specifies the methodological approach taken to generate the suite of ecosystem service maps and presents the outputs of the mapping exercise. Supplementary annexes include additional methodological detail and full-size mapping outputs. In this study, both cultural and non-cultural ecosystem services have been mapped based on the current or baseline distribution of services across Nottingham. The mapping exercise was also used to identify opportunity areas that may be best targeted for increases in ecosystem service benefit.

[1]International Union for Conservation of Nature (IUCN) Cultural Ecosystem Services factsheet: https://www.iucn.org/downloads/urbes_factsheet_08_web_1.pdf

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2 METHODOLOGICAL APPROACH

2.1 Overview of Method

To map Nottingham's baseline ecosystem services and to show opportunities for improvement, we applied the Habitat Service Scoring Matrix (HSSM) approach developed by Smith (2020).[2] It involves developing a matrix of scores that describe the ability of different habitats (types of land cover) to provide a range of ecosystem services. These scores are then mapped using a land cover dataset to show ecosystem service potential. The key methodological steps are shown in Figure 1, below.

The first step in the process was to produce a land cover dataset, in this case a habitat map, for the City of Nottingham to determine the current distribution of different land covers - and therefore ecosystem services - across the city. The habitat map was produced by 4 Earth Intelligence (4EI) in partnership with Ecosulis using a combination of high-resolution satellite imagery and on-the-ground site visits by trained ecologists to confirm the satellite observations.

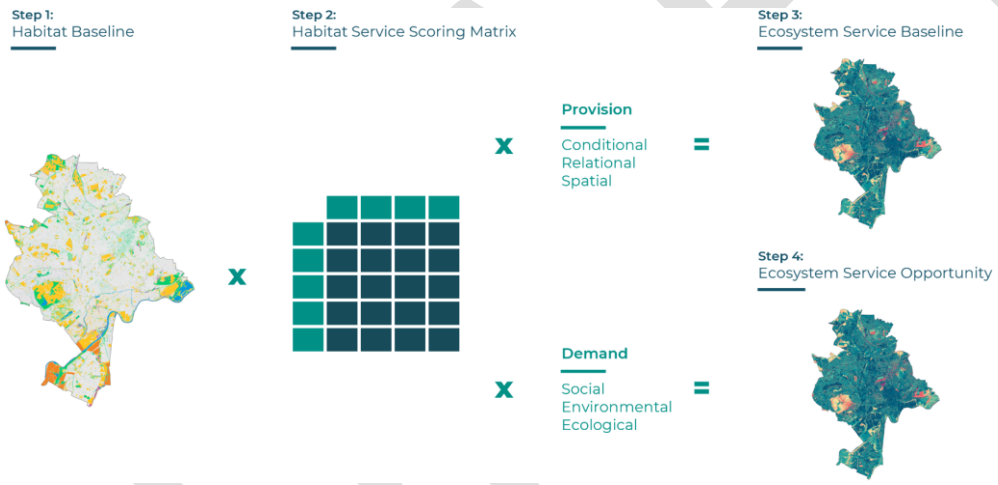


Figure 1.

Methodological flow used to map ecosystem services. Adapted from Smith (2020)

Secondly, each habitat type in the map was assigned a value through the HSSM, where values of 0 mean that the habitat does not provide a given ecosystem service, values of 1–3 represent a low level of provision, 4–6 a moderate level and 7–10 a high level. In summary, habitats with a higher HSSM score for each ecosystem service offer greater benefits than habitats with a lower score. These values were reviewed and updated in consultation with Nottingham City Council. This ensured that assigned values were appropriate to the local context of the City of Nottingham study area (Annex 1).

[2] Smith, A., 2020. Natural capital in Oxfordshire: Short report. Environmental Change Institute, University of Oxford.

The HSSM approach produces up to two outputs for each ecosystem service: baseline and opportunity (or demand) maps. In the third step, ecosystem service baseline maps are produced for all ecosystem services and represent the potential of existing natural capital assets to deliver an ecosystem service. Opportunity maps are produced where ecosystem service demand for a given ecosystem service is associated with specific geographic areas. For example, local climate regulation demand is considered highest in areas of high population density and therefore areas with a high population density that lack climate regulating habitat types in the present day, might be allocated as having good opportunity for increasing this ecosystem service. Alongside the habitat mapping, baseline and opportunity ecosystem services maps were in some cases adjusted using modifiers in the form of weightings applied to the HSSM values. These modifiers incorporate additional geospatial conditions which may affect the potential of – or opportunity for – a habitat to provide an ecosystem service. For example, the ability of a habitat to provide the ecosystem service of air pollution regulation is impacted by its proximity to air pollution sources. Proximity to air pollution sources is therefore used as a modifier for the air pollution regulation ecosystem service.

For each ecosystem service analysed in this study, the HSSM values are mapped across the city to give an overall distribution of baseline and opportunity services. These results are presented in Section 0.

2.2 Natural Capital Baseline Map

As the HSSM approach applies habitat types, an overview of the different habitat types present throughout Nottingham is presented in Table 1 and the distribution of these habitats shown in Figure 2. As expected, the majority of habitats (64.19%) in Nottingham are urban, followed by grassland (16.91%) and woodland and forest habitats (11.97%).

Table 1. *Broad habitat types present in Nottingham given as proportions and absolute values*

Broad Habitat	**Area** (ha)	**Coverage** (%)
Cropland	160	2.12
Grassland	1,279	16.91
Heathland and shrub	215	2.84
Rivers and lakes	142	1.88
Urban	4,854	64.19
Wetland	7	0.10
Woodland and forest	905	11.97

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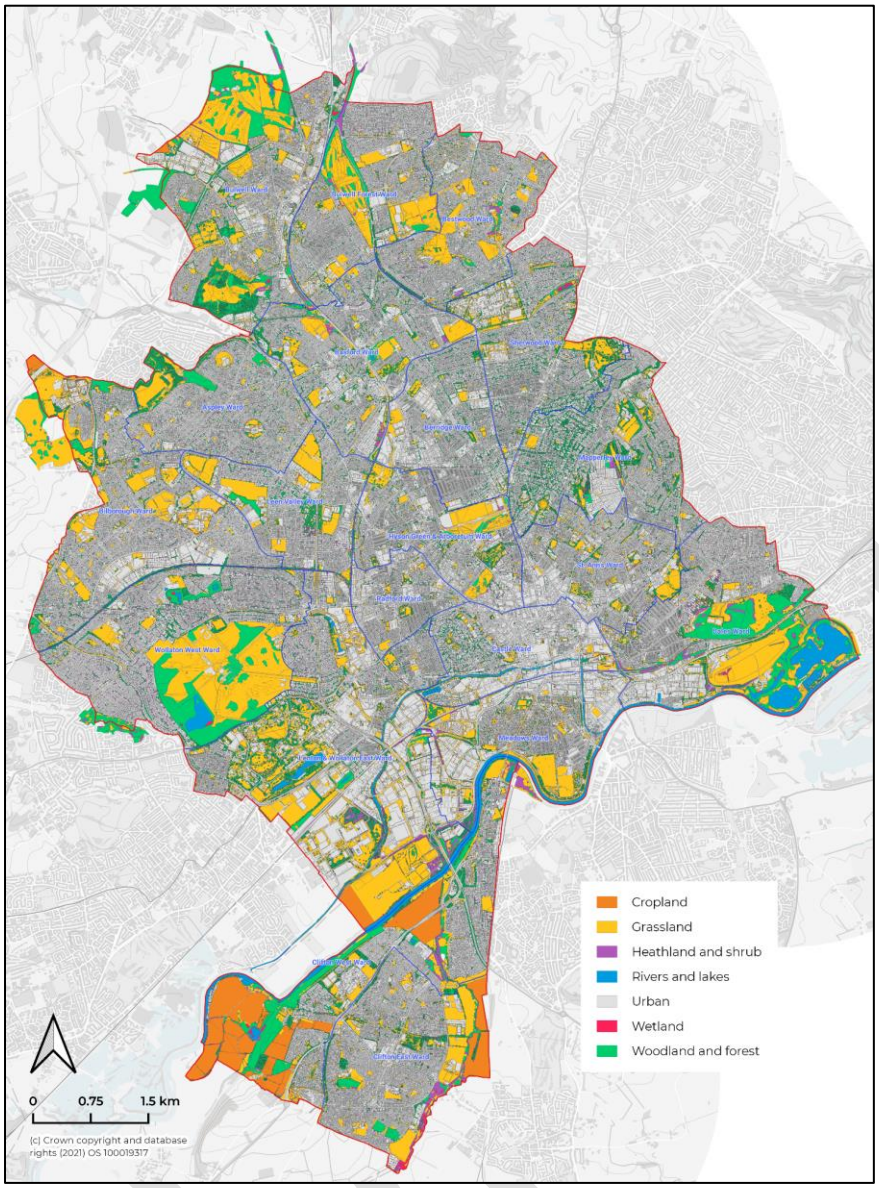


Figure 2.

Overview of Nottingham habitat mapping showing the distribution of broad habitats

2.3 Mapping Outputs

The outputs of the mapping exercise are presented in the following sections for each of 13 ecosystem services assessed in this study. For each ecosystem service, a standardised reporting structure is used, comprising the following sections: (i) a definition of the ecosystem service, (ii) the methods used to generate the ecosystem service baseline and (where relevant) opportunity datasets and accompanying summary maps, (iii) a summary interpretation of the mapping presented, and (iv) a summary of the limitations and recommended future development for each of the figures. A table summarising the spatial modifier datasets and modification values is provided in Annex 2.

Ecosystem services are split into four groups:

1. Provisioning services
2. Regulating services
3. Bundled services (contributing services to multiple categories)
4. Cultural services

The figures in the next sections are generated from GIS data which have been submitted alongside this report as a series of GIS-compatible raster files. Full-size maps are provided in Annex 3.

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3 PROVISIONING SERVICES

3.1 Food Provision

3.1.1 ECOSYSTEM SERVICE DEFINITION

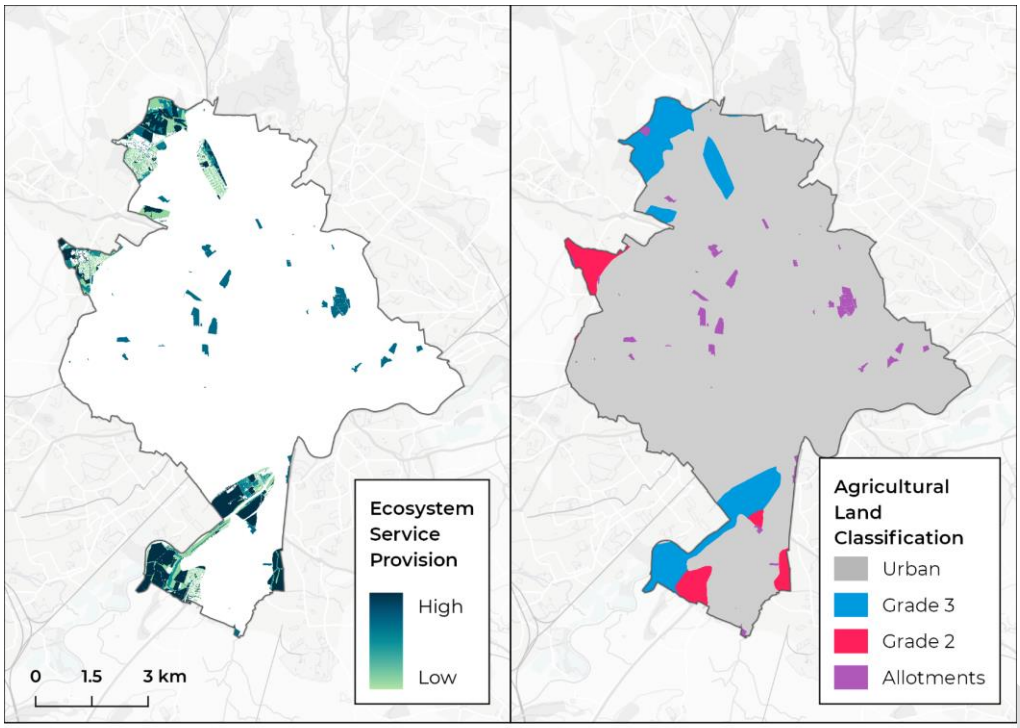
The ecosystem service of food provision is defined as the agricultural and horticultural production of food products via arable crops, livestock, vegetables, and fruits. This definition also includes the production of food products (i.e., berries, fungi, and game) through gathering and hunting practices. Food provision is a provisioning ecosystem service (non-cultural) and was mapped here using the habitat mapping alongside the Agricultural Land Classification.

3.1.2 BASELINE METHODS AND RATIONALE

To produce the food provision services map, each habitat was scored based on its ability to produce food. For example, modified grassland and arable habitats are very important for food provision and so score 10, whereas areas of bracken, unfavourable for food production, score only 1 (the lowest value possible).

A relational dataset was then applied to these scores because the location of a given habitat was judged to be important in influencing its productivity, and therefore the ecosystem service. The modifying dataset were derived from the Oxfordshire natural capital study (Smith, 2020), which applied Agricultural Land Classification (ALC) data produced by Natural England (2020a) as a modifier to weight the productivity of each habitat type for the food provision ecosystem service. These identified values were based on estimated differences in productivity between each land class and are provided in Annex 2. Higher grade agricultural land was given a higher weighting than lower grade agricultural land to demonstrate the likelihood that food production could be higher in productive high-grade land. Allotments were identified using OS MasterMap data and have also been applied as a spatial modifier to reflect community food provision.

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Figure 3.

Food provision ecosystem service baseline (L) and Agricultural Land Classification modifier (R)

3.1.3 OPPORTUNITY METHODS AND RATIONALE

Food provision is an ecosystem service where demand for the service is typically diffuse and non-localised. A modifier was not applied to the opportunity layer for the food provision ecosystem service opportunity due to the absence of an appropriate dataset that can be used to assess opportunity for food provision.

3.1.4 INTERPRETATION OF RESULTS

The mapping shows that food production in Nottingham City is understandably limited, with agricultural land limited to the northwest and south of the city, and allotments limited to small areas within the council area - urban areas typically rank poorly for food production due to urban land uses not being suitable for productive agriculture. The map indicates that areas of greatest provision of the ecosystem service are where cropland intersects areas of land classified as Grade 2 in the ALC (the highest-grade present in Nottingham).

3.1.5 LIMITATION AND FURTHER DEVELOPMENT

The food provision map is produced based on the assumption that land classed as Grade 2 in the ALC is highly productive - something that has not been checked as part of this study. As such, habitat classification does not fully account for management regimes which may have a substantial impact on food production output. In this approach, the habitat service scoring matrix assumes that all habitats of a given type will contribute equally to food provision, without full consideration of food production intensity within a given habitat parcel. Future work could include an assessment of different approaches to agriculture and food production (e.g., intensive, small-scale, crops, livestock) to provide a greater understanding of the spatial

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distribution of food provision in the county. Supporting documentation for ALC data suggests that it is not accurate enough to be used as anything other than general guidance (Natural England, 2020). As a result, this dataset should not be used for assessment of individual land parcels, but rather for comparative higher-level analysis.

Private gardens have not been included in the analysis because of the variable productivity of private gardens since not all are used for growing food crops.

Constraints are not included within the food provision opportunity layer and thus future work may seek to explore integrating constraints such as urban areas, utilities, and certain designated sites.

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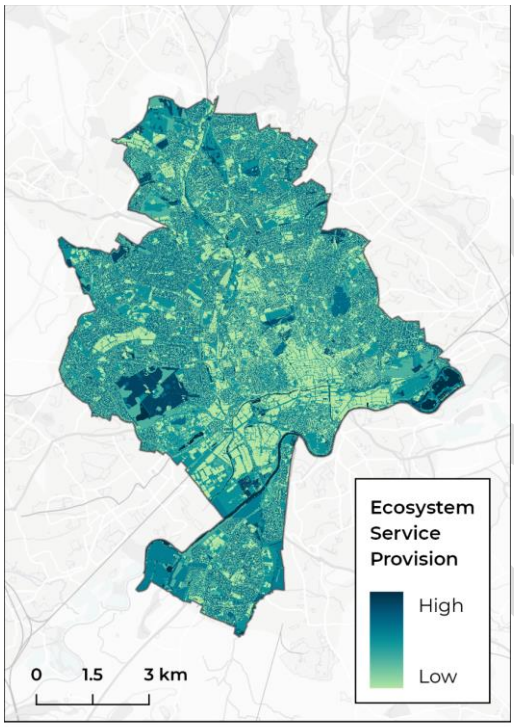
3.2 Water Supply

3.2.1 ECOSYSTEM SERVICE DEFINITION

The ecosystem service of water supply is defined as the extent to which river channel flows and groundwater recharge are impacted by land use through the interrelated processes of run-off and infiltration. Water supply is a provisioning ecosystem service as it contributes to the wider water supply network.

3.2.2 BASELINE METHODS AND RATIONALE

The water supply ecosystem service baseline is based solely on the Habitat Service Scoring Matrix (HSSM) (Annex 1) with each habitat scored on its contribution to the supply of water by generating runoff or encouraging infiltration. A modification dataset was not applied to the water supply ecosystem service baseline, therefore the ecosystem service baseline reflects the raw HSSM scores.



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Figure 4.

Water supply ecosystem service baseline

3.2.3 OPPORTUNITY METHODS AND RATIONALE

The Environment Agency's (2021) Water Resource Availability and Abstraction Reliability Cycle 2 dataset was used to weight the HSSM data and produce the water supply opportunity map. These data are modelled and indicate the availability of additional water for abstraction (Environment Agency, 2021). The greatest modification values were applied where water resource availability was low and therefore there was high opportunity for improvement. The logic being that where availability of water for abstraction is most limited, opportunity for the ecosystem service will be greatest.

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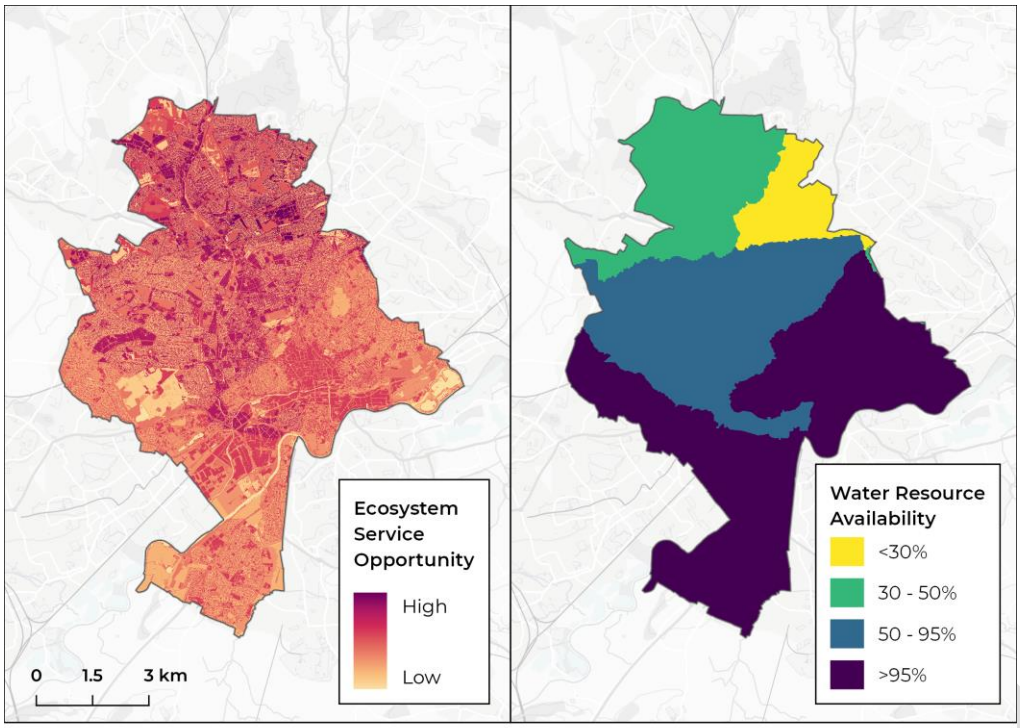


Figure 5.

Water supply ecosystem service opportunity (L) and water resource availability modifier (R)

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3.2.4 INTERPRETATION OF RESULTS

The water supply baseline mapping indicates that the provision of the ecosystem service is lowest in habitat where the surface is sealed. Consequently, buildings and built features are identified as areas of low provision, highlighting urban areas towards the centre of the city as low provision water supply areas. Areas of high water supply include open water and open grassland habitats, for example Wollaton Park in the west of the city and Colwick Country Park to the east.

The opportunity mapping shows that urban areas generally have the highest opportunity and, mirroring the water resource availability dataset, the highest opportunity are generally located towards the north of the city. Key opportunity areas include large patches of sealed surface near the River Leen within the northern part of the city.

3.2.5 LIMITATION AND FURTHER DEVELOPMENT

Future work could incorporate additional modification layers to the baseline analysis to account for spatial variation of water supply production at a more detailed level than can be deduced from habitat classes alone. These datasets may include climate datasets (i.e., temperature, sun exposure, precipitation) and geological datasets (i.e., porosity, and aquifer location).

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4 REGULATING SERVICES

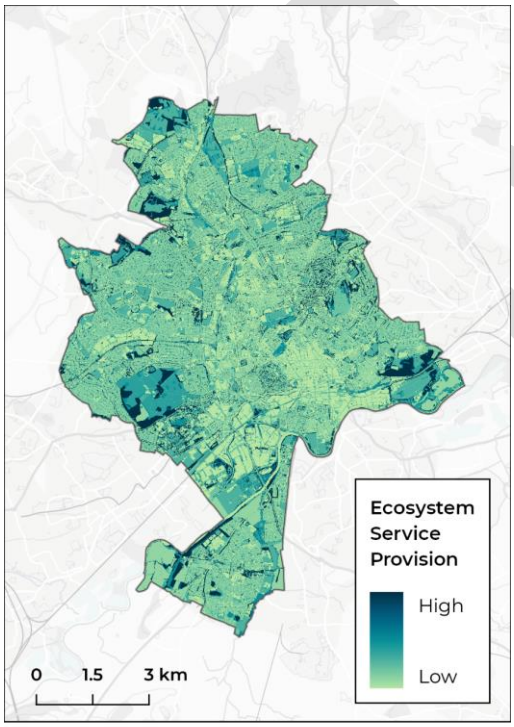
4.1 Carbon Storage

4.1.1 ECOSYSTEM SERVICE DEFINITION

The ecosystem service of carbon storage is defined as the storage of carbon in soil and vegetation. Carbon storage is a regulating ecosystem service as the process regulates atmospheric carbon dioxide through photosynthesis in plants, by taking in atmospheric carbon dioxide through leaves and storing carbon in plant matter as plants grow, and by storing carbon in soil as soil organic carbon. Managing land for carbon storage is becoming a global priority as it is one natural mechanism for minimising greenhouse gas induced climate change. Healthy, growing plants, particularly trees and mosaic grasslands tend to most easily store large volumes of carbon dioxide, although wetlands and the soil itself can also store vast amounts of carbon.

4.1.2 BASELINE METHODS AND RATIONALE

The baseline map was produced using the Habitat Service Scoring Matrix (HSSM) which scored each habitat type by its ability to store carbon in the top 30 cm of soil (Cantarello et al., 2011; Smith, 2020). No modifier was used to weight the HSSM because of the complex interaction between a habitat's spatial configuration and its ability to store carbon which is difficult to capture in a single dataset.



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Figure 6.

Carbon storage ecosystem service baseline

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4.1.3 OPPORTUNITY METHODS AND RATIONALE

Carbon storage as an ecosystem service is not required at specific locations due to the generally well mixed atmospheric gases which avoid locally high carbon dioxide concentrations.. Consequently, an additional modifier has not been applied to produce a separate opportunity layer. Areas of opportunity may be identified through a review of areas where current provision of the carbon storage ecosystem service is low.

4.1.4 INTERPRETATION OF RESULTS

As expected, the baseline map indicates that carbon storage is likely to be concentrated within woodland habitats throughout the city. This includes woodland along the River Trent and within the parks of the city (e.g., Wollaton Park, Colwick County Park).

4.1.5 LIMITATION AND FURTHER DEVELOPMENT

The incorporation of atmospheric carbon into wetlands and soils is less well established than its incorporation into plants and in particular, trees which makes it harder to accommodate in ecosystem services modelling such as this. Carbon storage in soils, and the rate of its accumulation as a result of vegetation type, has not been incorporated into the HSSM for this study but future work could incorporate soil organic carbon estimates from satellite derived datasets to glean more insight into the spatial distribution of carbon storage across the city. Soil depth – and the impact this may have on carbon storage – can vary across similar habitats and is not accounted for in the eco-metric scoring (Smith, 2020).

This study did not use a modifier to weight carbon storage potential by the proximity to sources of carbon emissions. Literature indicating the extent to which habitats near to sources of carbon emissions store carbon in relation to those further from these sources could provide insights into developing a meaningful modifier to further refine the mapping for this ecosystem service.

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4.2 Water Flow Regulation

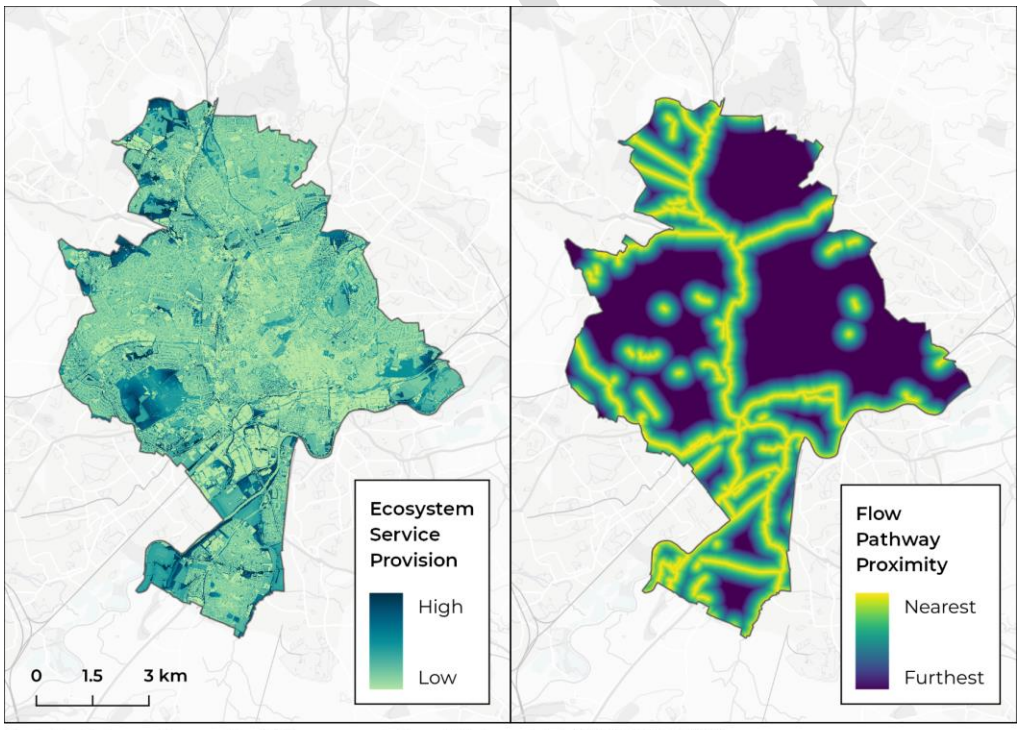
4.2.1 ECOSYSTEM SERVICE DEFINITION

The ecosystem service of water flow regulation is defined as the impact of soil and vegetation on naturally reducing surface water run-off, river peak flows, and flood extents. Mechanisms include interception, evapotranspiration, infiltration, and physically slowing the flow of surface waters.

4.2.2 BASELINE METHODS AND RATIONALE

The HSSM was used to rate each habitat type by its ability regulate water flow. A spatial modifier was applied to the water flow regulation baseline based on flow pathways derived from OS MasterMap data (Ordnance Survey, 2021).

A proximity analysis was then undertaken to score each location within the study area on a scale of 1-10 dependent on how close to the nearest flow pathway the location is (where 10 is closest and 1 is furthest). The logic behind using proximity to watercourses as a modifier is that cumulative surface water flow is likely to increase with proximity to watercourses and therefore the importance of flow regulation becomes higher the closer to a watercourse you become. A maximum distance from flow pathways that the modifier is applied to was set to 500 m. This proximity analysis was then applied as a modifier layer to the scores generated through the HSSM, as per Annex 1.



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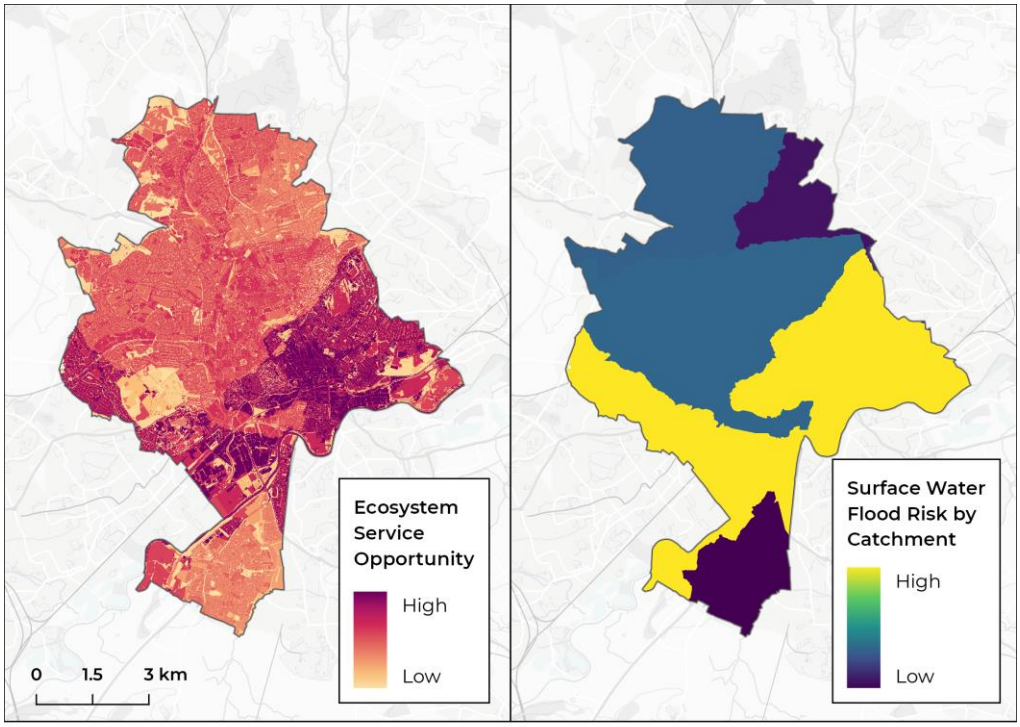
Figure 7.

Water flow regulation ecosystem service baseline (L) and flow pathway proximity modifier (R)

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4.2.3 OPPORTUNITY METHODS AND RATIONALE

The water flow regulation ecosystem service opportunity was mapped using a spatial modifier layer taking areas of flood risk and river catchments as input. This model calculated indicative total flood risk values (identified by Environment Agency (2020) data) within each river catchment. These were calculated at the catchment scale, so transboundary downstream and upstream impacts and areas of flood risk were considered. Catchments were then filtered to remove any that do not intersect the City of Nottingham boundary. Remaining catchments were applied as a modifying layer, whereby the catchment containing the highest total flood risk was assigned a modifier value of 2, with the lowest total flood risk receiving a modifier value of 1. All other modifying values were positioned between these linearly using the indicative total flood risk value. Full modifier values are provided in Annex 2.



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Figure 8.

Water flow regulation ecosystem service opportunity (L) and surface water flood risk modifier (R)

4.2.4 INTERPRETATION OF RESULTS

The water flow regulation baseline indicates that provision of the ecosystem service is generally lowest within Nottingham city centre and greatest within the suburbs of the city where there more vegetation. The influence of the modifier layer where water flows extend through the city is not readily apparent in many areas within the baseline map. This reflects the widespread coverage of low-scoring urban habitats and sealed surfaces in the areas surrounding many of the mapped watercourses. Because the modifier is multiplicative, these habitats are impacted in a more limited manner than high-scoring habitats.

The water flow opportunity mapping highlights habitats within the highest surface water flood risk area as being of highest opportunity for increasing provision of the water flow regulation ecosystem service within Nottingham.

4.2.5 LIMITATION AND FURTHER DEVELOPMENT

This analysis does not fully incorporate flood risk data in terms of fluvial, groundwater and surface water flood risk in the context of engineered flood prevention infrastructure and any green flood prevention measures such as natural flood management schemes. The maps therefore only infer the indicative potential of the land cover types to regulate water flows.

The flow pathway proximity analysis does not account for topography (mainly relief and slope) which may impact the ability of a habitat to regulate water flows. Topographic analysis may be valuable in exploring this impact further. Modifier values for the watercourse proximity modifier layer assume that the ability of a habitat to regulate water flow increases linearly as proximity to watercourses increases. Further work should explore relevant literature to update these values to be more evidence-based and more accurately reflect this relationship.

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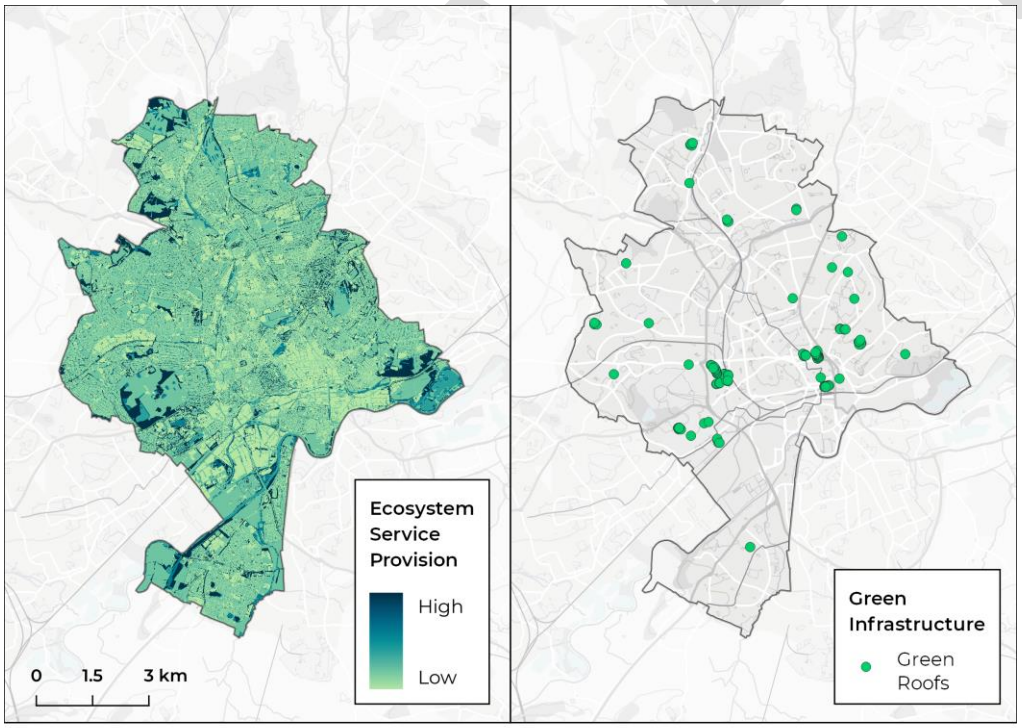
4.3 Local Climate Regulation

4.3.1 ECOSYSTEM SERVICE DEFINITION

The local climate regulation ecosystem attempts to map the potential moderating effects of vegetation and water as they act to counteract the heating effects typically seen in urban areas - referred to as the "urban heat island" effect. Urban areas are typically warmer than rural areas due to greater heat absorption on hard man-made surfaces, and the heat released by vehicles, heating systems and industry. Natural vegetation and water can offer locally cooler conditions in the summer and warmer conditions in the winter.

4.3.2 BASELINE METHODS AND RATIONALE

The local climate regulation ecosystem service baseline map is based on the HSSM alongside green roof mapping undertaken by project partners 4EI. The green roof mapping was applied as a modifier to add further detail in urban areas. This data consists of locations of green roofs on buildings, identified through analysis of aerial imagery and topographic vector data. The modifier increases the HSSM score for buildings with green roofs to 2 - the value assigned to similar habitats (for example grasslands and many types of urban green space).



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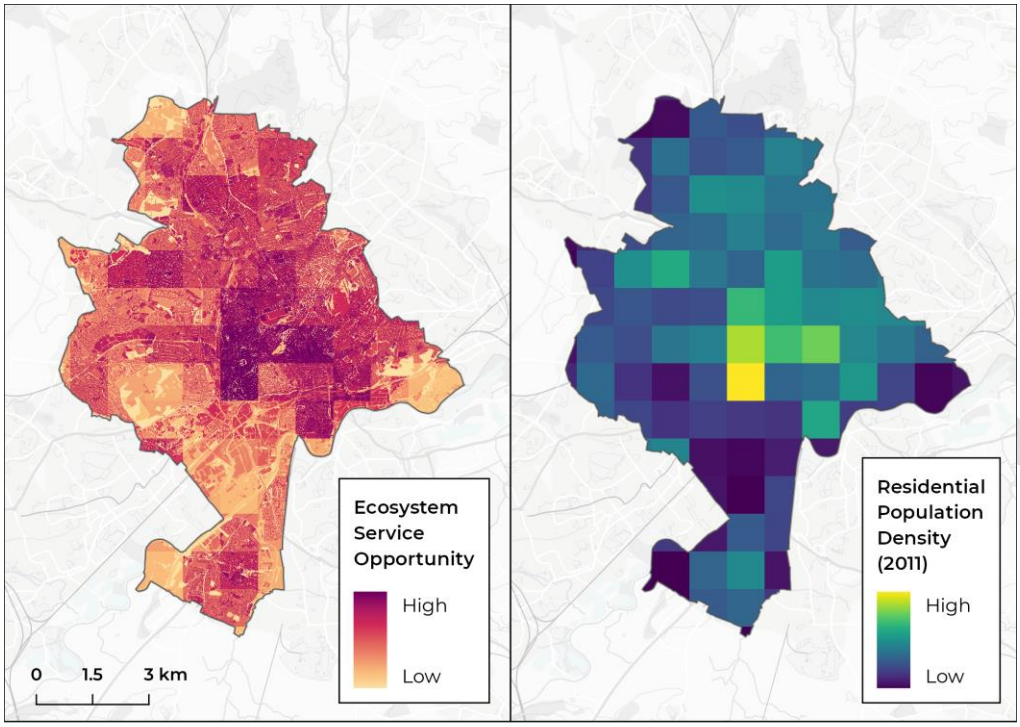
Figure 9.

Local climate regulation ecosystem service baseline (L) and location of green roofs (R)

4.3.3 OPPORTUNITY METHODS AND RATIONALE

The local climate regulation opportunity mapping used the inverse of the baseline HSSM scores along with gridded residential population density data (Reis *et al.*, 2017) as a modifier to take account of the demand for air pollutant removal being greatest in residential areas where human populations reside (Smith, 2020).

To determine modifier values, 1km population density grid cells which intersect the City of Nottingham boundary were extracted. Population density values within extracted grid cells were then normalised on a scale of 1-2, where 1 is the minimum population density and 2 the maximum. These normalised values were then applied to the inverted baseline values, resulting in opportunity values being multiplied by a factor of 2 within the most densely populated areas and 1 in the least densely populated areas.



Reis, S.; Liska, T.; Steinle, S.; Carnell, E.; Leaver, D.; Roberts, E.; Vieno, M.; Beck, R.; Dragosits, U. (2017). UK gridded population 2011 based on Census 2011 and Land Cover Map 2015 NERC Environmental Information Data Centre. Contains Ordnance Survey data (c) Crown copyright and database rights (2021) OS 100019317

Figure 10.

Local climate regulation ecosystem service opportunity (L) and population density modifier (R)

4.3.4 INTERPRETATION OF RESULTS

The local climate regulation baseline map illustrates the role of wooded vegetation throughout Nottingham in offering a greater level of local climate regulation due to their ability to provide shade. Areas with a prevalence of sealed surfaces show the lowest potential for offering local climate regulation.

The local climate regulation ecosystem service opportunity mapping highlights that the current provision of the ecosystem service is generally low in areas of high residential population density. This reflects more densely populated areas typically being more urbanised and therefore having the least natural vegetation and open water whilst also being subject to the greatest urban heat island effects. These areas are therefore most susceptible to higher cooling costs in a warming climate unless opportunities can be identified to increase the coverage of natural vegetation in these areas.

4.3.5 LIMITATION AND FURTHER DEVELOPMENT

Traffic data could also be used in conjunction with urban tree locations to further account for variations of localised heating within the urban environment. Earth observation data can be used to produce urban heat mapping, this may provide further context to the outputs provided here.

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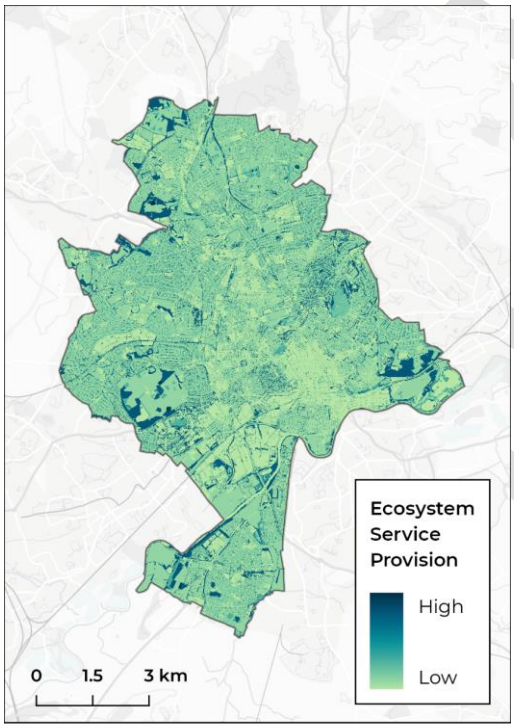
4.4 Air Pollutant Removal

4.4.1 ECOSYSTEM SERVICE DEFINITION

Air pollutant removal relates to the positive effects of vegetation on lowering concentrations of air pollutants through mechanisms including deposition of particulate matter, absorption, and chemical breakdown. The removal of pollutants improves air quality for the benefit of community health, improves agricultural yields and also benefits the natural world by providing a more natural air concentration than would otherwise be the case if no vegetation was present.

4.4.2 BASELINE METHODS AND RATIONALE

The air pollutant removal ecosystem service baseline is based on the removal of air pollutants in general, rather than the removal of individual pollutants. The HSSM was developed to reflect air pollution being most effectively removed by trees relative to smaller plants, with coniferous species, in leaf all year, generally having a greater positive impact than broadleaved trees. Urban land uses including large amounts of sealed surfaces do not aid the removal of air pollutants in the same way that water does not - these types of surfaces were therefore given the lowest scores in the HSSM.



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Figure 11.

Air pollutant removal ecosystem service baseline

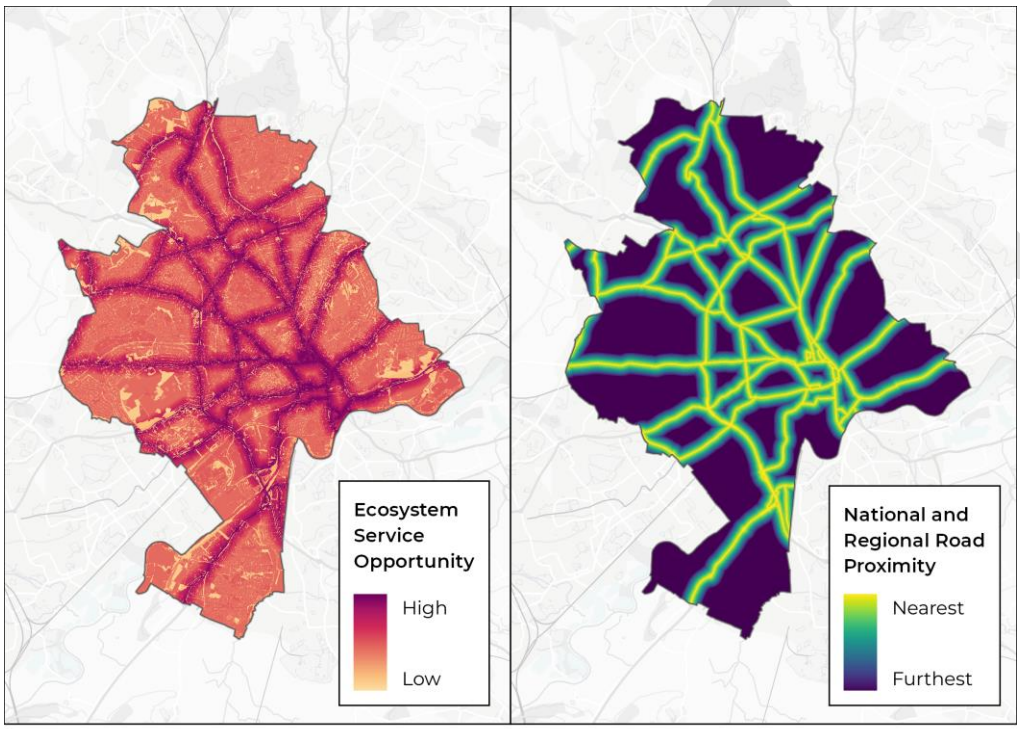
4.4.3 OPPORTUNITY METHODS AND RATIONALE

The opportunity map for the air pollutant ecosystem service has been modelled in consideration of the proximity of habitats to major roads since roads currently account for one of the largest acute sources of air pollution in urban areas (at least in the age of internal combustion engine

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vehicles). Habitats closer to major roads could therefore have the greatest potential to removal air pollutants.

Major roads have been defined according to those categorised as 'national' or 'regional' roads within OS Open Zoomstack data (Ordnance Survey 2022). A proximity analysis was then undertaken to score each location within the study area on a scale of 1-10 dependent on its proximity to the nearest major road (where 10 is closest and 1 is furthest). The greater weighting given to habitats close to roads was only applied to habitats within 300 m of a major road. This distance was selected based a Natural England (2016) report which found significantly elevated nitrogen concentrations in vegetation up to 300 m from roads. This proximity analysis was then applied as a modifier layer to the scores generated through the HSSM, as per Annex 1.



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Figure 12.

Air pollutant removal ecosystem service opportunity (L) and major road proximity modifier (R)

4.4.4 INTERPRETATION OF RESULTS

The air pollution removal baseline map indicates that the potential for air pollutant removal is likely to be concentrated within patches of woodland habitats around the city, which are centred in parkland and in the city's suburbs. Smaller areas of trees do have a similarly high value for the removal of air pollutants but do not have the capacity to trap the same volume of pollutants as a whole forest.

The ecosystem service opportunity mapping highlights areas alongside major roads within Nottingham where the potential to removal air pollutants is currently low. Areas of high opportunity are most notable around the city centre, at least in part due to the high concentration of major roads and limited green space within this part of Nottingham.

4.4.5 LIMITATION AND FURTHER DEVELOPMENT

Not all sources of air pollution within Nottingham – both point and diffuse – have been accounted for in this analysis. These sources may include point source emissions from industrial sources, commercial cooking facilities and household boilers. Incorporating a greater range of emission sources and mapping these relative to areas of higher population density, active travel corridors and sites of recreation where people may be exposed to greater outdoor air pollution may offer a more complete picture of where air pollutant removal is most required relative to the baseline mapping.

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5 BUNDLED SERVICES

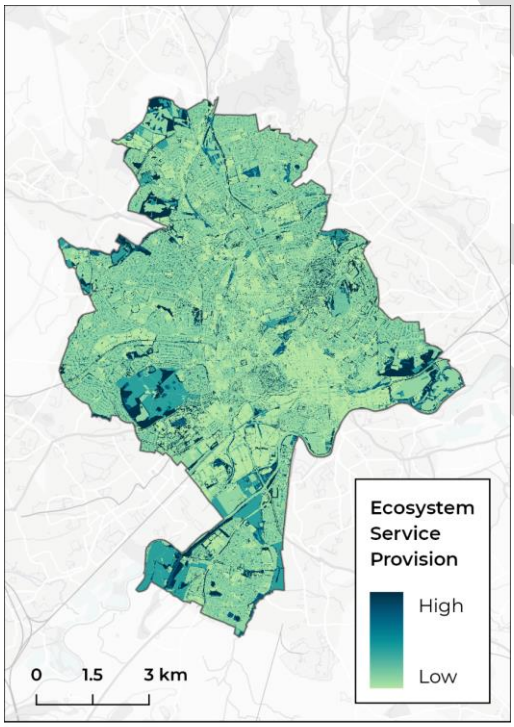
5.1 Water Quality

5.1.1 ECOSYSTEM SERVICE DEFINITION

The ecosystem service of water quality relates to the uptake of pollutants dissolved or suspended in water by vegetation, and the ability of vegetation to prevent pollutants reaching waterbodies through interception and filtration. Good water quality provides safe drinking water and enhances the role of waterbodies in providing recreational benefits. Water quality is a bundled ecosystem service.

5.1.2 BASELINE METHODS AND RATIONALE

The water quality ecosystem service baseline is based on the Habitat Service Scoring Matrix (HSSM) (Annex 1) with each habitat scored on its ability to improve water quality. HSSM values were developed in recognition of the role of wetland habitats (e.g., bogs, marshes, swamps, and reedbeds) in maintaining and improving water quality. Similarly, urban land uses, and intensive agriculture and horticulture receive amongst the lowest values in the HSSM as habitats which can act as a source for pollution of water bodies.



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Figure 13.

Water quality ecosystem service baseline

5.1.3 OPPORTUNITY METHODS AND RATIONALE

A non-relational opportunity layer was produced for the water quality ecosystem service due to the absence of an existing appropriate dataset that can be used to assess opportunity for water

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quality. Data forming this layer is effectively the inverse of the water quality baseline, designed to highlight areas of high opportunity.

5.1.4 INTERPRETATION OF RESULTS

The modelled water quality ecosystem service baseline indicates that the provision of the ecosystem service is largely focused within woodland habitats. As with other ecosystem services where woodland habitats are high-scoring, areas of high provision of the ecosystem service are generally concentrated to habitats within the suburbs of Nottingham. Trees within gardens and street trees, also play a role in the provision of these ecosystem services within Nottingham, however. This role can be seen more clearly in the full resolution maps presented in Annex 3.

5.1.5 LIMITATION AND FURTHER DEVELOPMENT

The water quality baseline assumes habitat is the only factor in determining how a given habitat influences water quality. The reality is much more complex with factors such as land management, topography and water flow rate, and underlying geology all influencing water quality. Water Framework Directive (WFD) data whereby water bodies are assessed for their quality based on a series of indicators, may be a useful supporting dataset for this analysis.

Inclusion of flow accumulation modelling may also allow detailed analysis of overland flows, in turn, further analysis of the potential of a given area of land to deliver the water quality ecosystem service.

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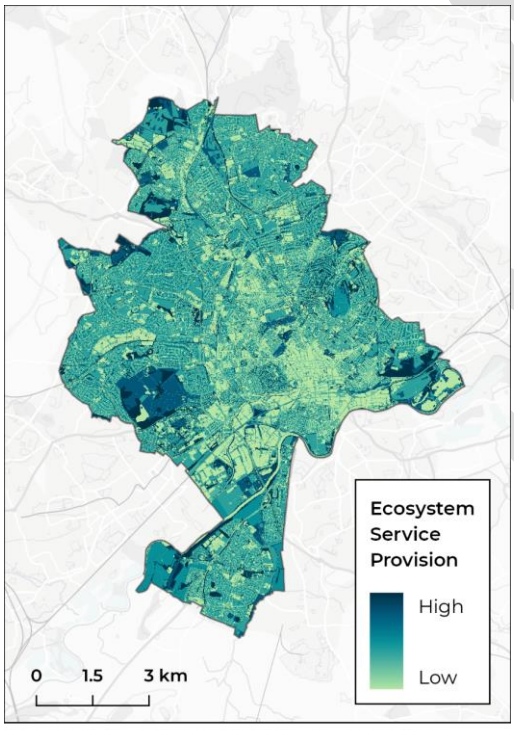
5.2 Soil Health

5.2.1 ECOSYSTEM SERVICE DEFINITION

The ecosystem service of soil health describes the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans. Benefits provided by soil in good health vary with soil type but generally include nutrient cycling function, carbon storage, and regulation of surface water flows. High-scoring habitats for soil health in the HSSM mostly consist of woodland, grassland, and heathland habitats. Soil health is a bundled ecosystem service.

5.2.2 BASELINE METHODS AND RATIONALE

A non-relational dataset was produced to map the soil health ecosystem service baseline within the City of Nottingham. The rationale for not selecting a modification layer for the soil health baseline was the absence of an available dataset that could be used as a spatial modifier for the soil health ecosystem service, whilst accounting for localised variation in soils. Data describing land management practices may be a valuable additional dataset here, providing a further layer of depth into soil health analysis. As a result, the soil health baseline represents the HSSM values directly applied to the habitat basemap.



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Figure 14.

Soil health ecosystem service baseline

5.2.3 OPPORTUNITY METHODS AND RATIONALE

A non-relational opportunity layer was produced for the soil health ecosystem service due to the absence of an existing appropriate dataset that can be used to assess opportunity for soil health. Consequently, an additional modifier has not been applied to produce a separate opportunity

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layer. Areas of opportunity may be identified through a review of areas where current provision of the soil health ecosystem service is low, however.

5.2.4 INTERPRETATION OF RESULTS

Mapping of the soil health ecosystem service applying the HSSM scores reveals that the role of green spaces in the provision of the ecosystem service throughout the City of Nottingham. Areas dominated by buildings score low as expected, however, the much of suburban areas of the city show moderate levels of ecosystem service provision. This is likely to be a result of the presence of suburban mosaic habitats increasing with distance from the city centre, in addition

5.2.5 LIMITATION AND FURTHER DEVELOPMENT

Due to limitations in available data containing soil chemistry parameters for the City of Nottingham, this dataset assumes that habitat is the only determinant of soil health. Whereas soil health is dependent on a complex series of additional factors: land management regimes, topography, and climate, for example.

Concentrations of phosphorous in soils may provide a useful indicator of soil health that could be applied as a modifier layer, should an appropriate dataset be identified.

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6 CULTURAL SERVICES

Cultural ecosystem services can be thought of as the benefits obtained by humans through exposure to greenspaces by taking part in a range of activities. Benefits can include health, social connection, sensory experiences, learning and greater overall wellbeing.[3,4] In a post-pandemic world being outside and enjoying nature is of particular value to many people, which has guided the mapping of cultural ecosystem services in this study. The activities that provide benefits are here framed as value generating activities (VGA's) and the methods for mapping each of the ecosystem services in the following sections sought to assess how well different areas of Nottingham support people in conducting those VGA's and therefore obtaining the benefits.

6.1 Recreation

6.1.1 ECOSYSTEM SERVICE DEFINITION

The ecosystem service of recreation relates to the provision of green and blue spaces that can be used for any leisure activity (e.g., walking, cycling, running, picnicking, camping, boating, playing, or just relaxing). As a result, wetland and certain types of grassland and woodland are high scoring habitats for recreation within the HSSM. As with all cultural ecosystem service HSSM scores, these values have been derived from analysis of the variety and range of activities which can be undertaken in each habitat.

6.1.2 BASELINE METHODS AND RATIONALE

The recreation ecosystem service baseline is derived from the scoring of each habitat by its suitability for recreation. A spatial modifier was applied to recognise that the accessibility of land strongly influences the extent to which the recreation ecosystem service is obtained by people. The methods detailed below were derived from the Natural Capital in Oxfordshire study (Smith, 2020), and align with those applied to the education ecosystem service baseline.

Land classed as ‘open’ was identified as land covered under the Countryside Rights of Way Act (Natural England, 2021a), and land within the Outdoor Recreation Valuation (ORVal) dataset (Day and Smith, 2018). In addition to land classed as 'open' access by Smith (2020), land classified as 'Parks and Gardens' according to the Nottingham City Council Open Green Spaces data has also been included within this classification. These areas were given a weighting of 1.00 in the analysis to reflect that they provide the greatest access for recreation.

A further set of attributions was then carried out to detect land parcels with some access for recreation, but which is not as publicly accessible as open land. Land classed as ‘semi-restricted’ was identified through applying a buffer of 50m to public rights of way within the study area.

[3] Lackey, Q. N., D. A. Tysor, G. D. McNay, et. al. (2019) Mental Health Benefits of Nature-based Recreation: A Systematic Review. Annals of Leisure Research. doi:10.1080/11745398.2019.1655459

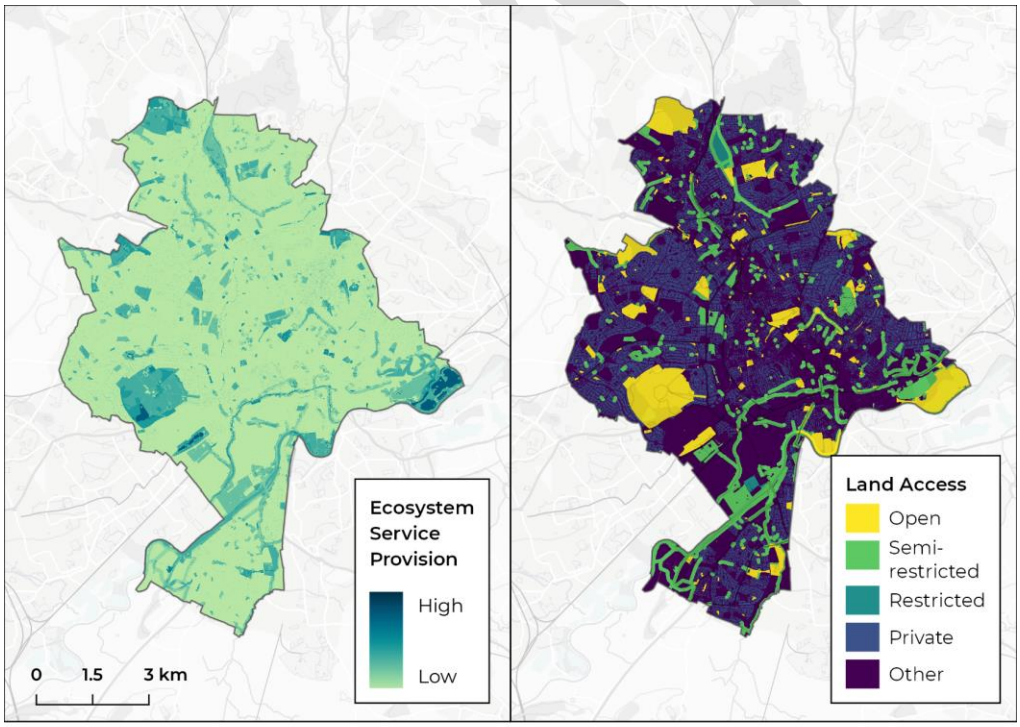
[4] Brymer, E., E. Freeman, and M. Richardson (2019) One Health: The Wellbeing Impacts of Humannature Relationships. Frontiers in Psychology. doi:10.3389/fpsyg.2019.01611.

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These were identified through a combination of the ORVal path data (Day and Smith, 2018), Sustrans path network data (Sustrans, 2022), and City of Nottingam public right of way data (Nottingham City Council, 2021). Community growing spaces and allotments, as well as limited access sports clubs (i.e., bowling greens, tennis courts, and other sport facilities) identified through OS MasterMap Greenspace data (Ordnance Survey, 2021) were classed as 'semi-restricted'. Finally, surface water was also classed as 'semi-restricted' since it can be used for water-based recreation activities, however, has limitations to access through the requirement for equipment (e.g., for boating) or training (e.g., for swimming). These areas were weighted 0.75 in the analysis.

The next most restrictive land class was 'restricted' and included sports clubs where membership is more expensive (e.g., golf clubs) – these were also identified through the OS MasterMap Greenspace data (Ordnance Survey, 2021). These areas were weighted 0.50 in the analysis.

Land classed as 'private' was identified using OS MasterMap data which enables land parcels classified as private gardens to be extracted. This is to recognise the role of gardens in providing citizens with access to private green space which does deliver ecosystem services but not in an equally accessible manner. These areas were weighted 0.25 in the analysis while all other land was received a value of 0.



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Figure 15.

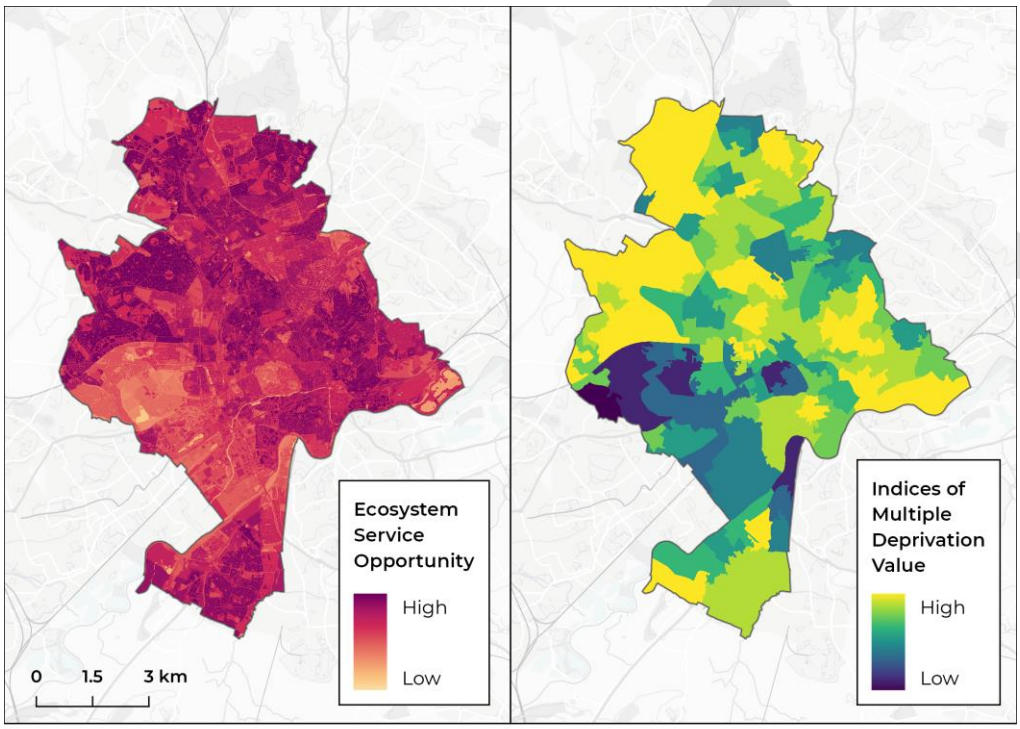
Recreation ecosystem service baseline (L) and land access modifier (R)

6.1.3 OPPORTUNITY METHODS AND RATIONALE

To produce a relational recreation opportunity dataset, the inverse of the baseline dataset was modified by indices of multiple deprivation (IMD) data (Ministry of Housing, Communities, and

Local Government, 2019) at the lower-layer super output area (LSOA) level (Office for National Statistics, 2016). The rationale for using IMD data is that in areas of high deprivation individuals are likely to be less able to travel to access areas where the recreation ecosystem service is provided. The IMD modifier here is applied identically to the recreation and education ecosystem service opportunity maps.

The weighting factor applied to the IMD dataset was calculated by dividing the decile of IMD within a given LSOA by 10 and adding this value to one to produce a range of values from 0.1 to 1.0. Deciles scored 10 for the most deprived LSOAs, and 1 for the least deprived. These deciles were calculated based on data for the whole of England to ensure the outputs are compatible on a national scale, should these methods be applied elsewhere.



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Figure 16.

Recreation ecosystem service opportunity (L) and indices of multiple deprivation modifier (R)

6.1.4 INTERPRETATION OF RESULTS

Baseline recreation ecosystem service analysis illustrates how areas of high provision are distributed throughout the city. Large areas of public green space, including Wollaton Park, Colwick Country Park, and Bulwell Hall Park are areas of high provision. Habitats alongside public rights of way are also identified as being important in the provision of spaces for recreation and the benefits it delivers. Recreation opportunity mapping highlights areas of low ecosystem service provision in IMD deciles with the highest levels of deprivation. These areas include large parts of Apsley, Bilborough, and Bulwell to the north of the city, and parts of Dales, Mapperley, and St Ann's ward to the east.

6.1.5 LIMITATION AND FURTHER DEVELOPMENT

Future work may look to include population data to assess different community's access to Local Nature Reserves and other high value nature sites. The use of IMD data assumes that the demand for interaction with nature is greatest in LSOAs where deprivation is highest. However, there are also likely to be additional factors that impact this accessibility alongside deprivation. These may include demographic and public transportation data.

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6.2 Education

6.2.1 ECOSYSTEM SERVICE DEFINITION

The ecosystem service of education relates to the provision of green and blue spaces that can provide educational benefit. High HSSM values for the education ecosystem service have been assigned to grassland, woodland, heathland, and wetland habitats. Similar to HSSM scores for other cultural ecosystem services, these values have been produced by analysis of the variety and range of activities which can be undertaken in each habitat.

6.2.2 BASELINE METHODS AND RATIONALE

The education ecosystem service baseline is based on the cultural ecosystem service analysis with each habitat scored on its ability to support learning. As with recreation, a spatial modifier was applied to recognise that accessibility of land strongly influences the extent to which the education ecosystem service is captured by people. The methods detailed below were derived from the Natural Capital in Oxfordshire study (Smith, 2020), and align with those applied to the education ecosystem service baseline.

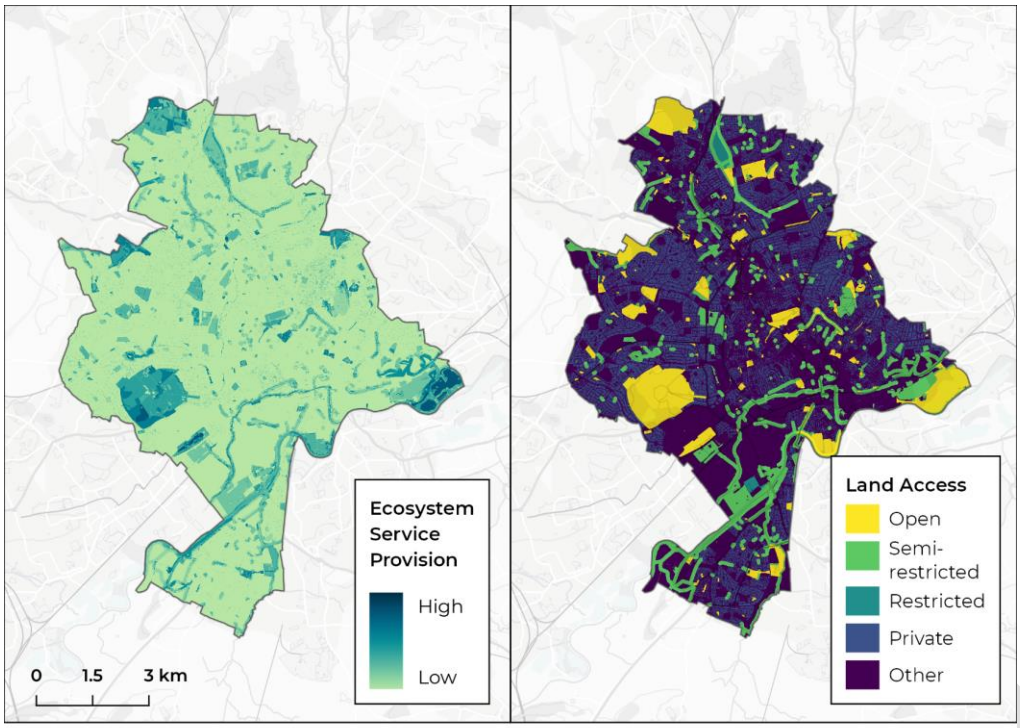
Land classed as 'open' was identified through land covered under Countryside Rights of Way Act (Natural England, 2021a), and land within the Outdoor Recreation Valuation (ORVal) dataset (Day and Smith, 2018). In addition to land classed as 'open' access by Smith (2020), land classified as 'Parks and Gardens' according to the Nottingham City Council Open Green Spaces data has also been included within this classification. These areas were weighted 1.00 in the analysis to reflect that they provide the greatest access for learning.

Land classed as 'semi-restricted' was identified through applying a buffer of 50m to public rights of way within the study area. These were identified through a combination of the ORVal path data (Day and Smith, 2018), Sustrans path network data (Sustrans, 2022), and City of Nottingam public right of way data (provided by Nottingham City Council). Community growing spaces and allotments, as well as limited access sports clubs (i.e., bowling greens, tennis courts, and other sport facilities) identified through OS MasterMap Greenspace data (Ordnance Survey, 2021) were classed as 'semi-restricted'. Surface water was classed as 'semi-restricted' access, as it can be used for water-based recreation activities, however, has limitations to access through the requirement for equipment (e.g., for boating) or training (e.g., for swimming). These areas were weighted 0.75 in the analysis.

Land classed as 'restricted' included sports clubs where membership is more expensive (e.g., golf clubs) – these were also identified through the OS MasterMap Greenspace data (Ordnance Survey, 2021). These areas were weighted 0.50 in the analysis.

Land classed as 'private' was identified by using OS MasterMap data which enables land parcels classified as private gardens to be extracted. This is to recognise the role of gardens in providing citizens with access to private green space. These areas were weighted 0.25 in the analysis and all other areas of Nottingham were given a value of 0 to exclude them from being shown as sites with high potential to support education.

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Figure 17.

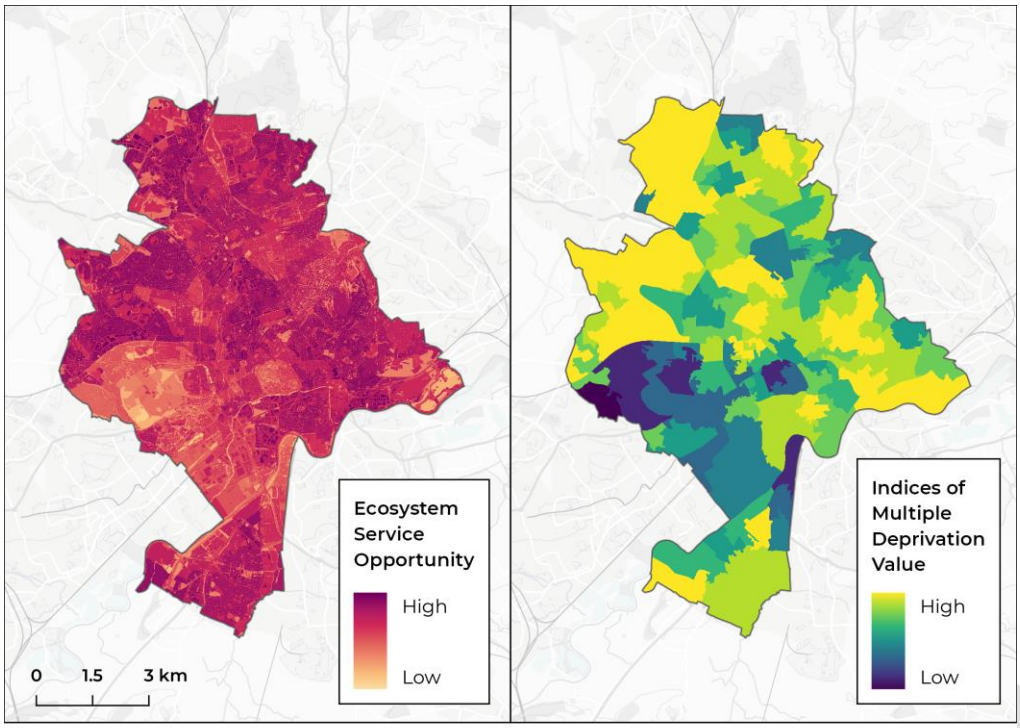
Education ecosystem service baseline (L) and land access modifier (R)

6.2.3 OPPORTUNITY METHODS AND RATIONALE

To produce a relational education opportunity dataset, the inverse of the baseline dataset was modified by IMD data (Ministry of Housing, Communities, and Local Government, 2019) at the lower-layer super output area (LSOA) level (Office for National Statistics, 2016). The rationale for using IMD data is that in areas of high deprivation individuals are likely to be less able to travel to access areas where the education ecosystem service is provided. The IMD modifier here is applied identically to the recreation and education ecosystem service opportunity maps.

The weighting factor applied to the IMD dataset was calculated by dividing the decile of IMD within a given LSOA by 10 and adding this value to one to produce a range of values from 0.1 to 1.0. Deciles scored 10 for the most deprived LSOAs, and 1 for the least deprived. These deciles were calculated based on data for the whole of England to ensure the outputs are compatible on a national scale, should these methods be applied elsewhere.

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Figure 18.

Education ecosystem service opportunity (L) and indices of multiple deprivation modifier (R)

6.2.4 INTERPRETATION OF RESULTS

Baseline and opportunity education ecosystem service analysis mapping presents similar results to those given by recreation ecosystem service mapping. This is in part because both are modified using land access and IMD modifiers.

As described with mapping of the recreation ecosystem service, large areas of public green space, including Wollaton Park, Colwick Country Park, and Bulwell Hall Park are areas of high provision, with habitats alongside public rights of way also identified as being important in the provision of the ecosystem service.

Education opportunity mapping highlights areas of low ecosystem service provision in IMD deciles with the highest levels of deprivation. These areas include large parts of Apsley, Bilborough, and Bulwell to the north of the city, and parts of Dales, Mapperley, and St Ann's ward to the east.

6.2.5 LIMITATION AND FURTHER DEVELOPMENT

The use of IMD data assumes that the demand for interaction with nature is greatest in LSOAs where deprivation is highest. However, there are also likely to be additional factors that impact this accessibility alongside deprivation. These may include demographic and public transportation data.

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6.3 Interaction with Nature

6.3.1 ECOSYSTEM SERVICE DEFINITION

The ecosystem service of interaction with nature is defined as the provision of opportunities for formal or informal nature-related activities (e.g., birdwatching, wildlife encounters, forest bathing or simply 'feeling connected with nature'). There is some overlap with biodiversity, but access by people can have negative impacts on some wildlife habitats. The activities here exclude recreational fishing, hunting, and shooting.

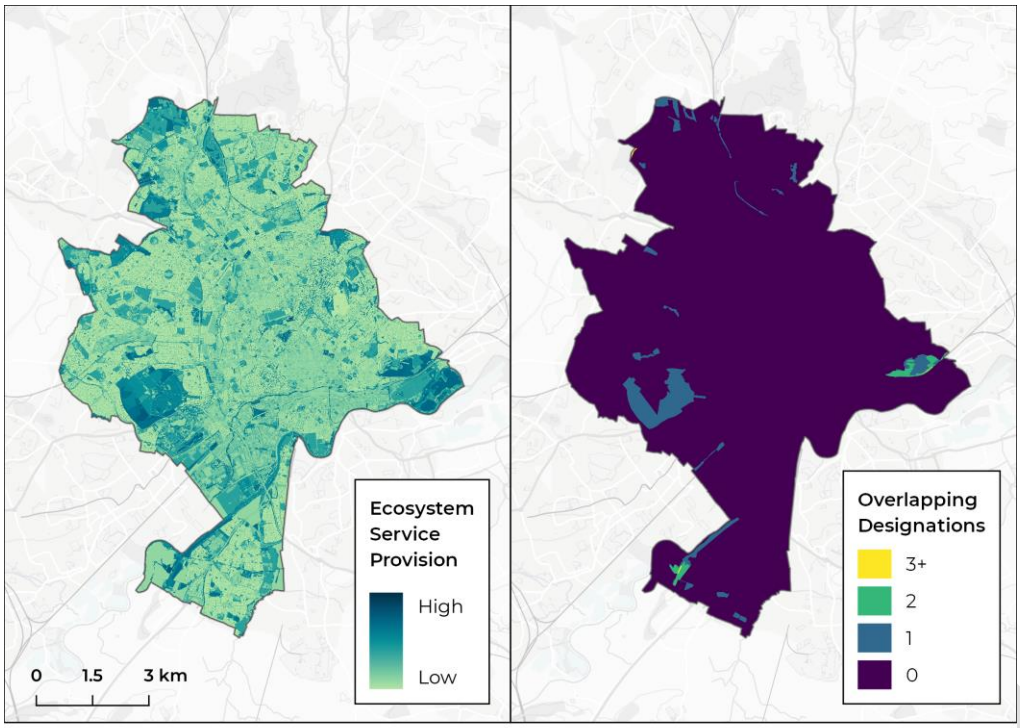
6.3.2 BASELINE METHODS AND RATIONALE

The interaction with nature ecosystem service baseline is based on the cultural ecosystem service analysis with each habitat scored on the extent to which it provides access to nature. A spatial modifier was applied to the HSSM values to map the interaction with nature ecosystem service baseline within the City of Nottingham. Overlapping designated sites were used as a modifying dataset following the methods of (Smith, 2020) who states that protected areas are more likely to support a greater amount and diversity of wildlife. Some designated sites may also preserve other natural or semi-natural features of interest (i.e., geological features), and features of cultural or historical importance (i.e., scheduled monuments).

Designated sites included: Local Nature Reserves (LNRs) (Natural England, 2022a), Sites of Special Scientific Interest (SSSIs) (Natural England, 2022b), and ancient woodland (Natural England, 2022c). Greater modifier values were applied where a greater number of designated sites overlapped. These values are presented in Annex 1.

Some designations were not present within the City of Nottingham boundary and therefore could not be included as modifiers. These were Special Areas of Conservation (SACs) and National Nature Reserves (NNRs).

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Figure 19.

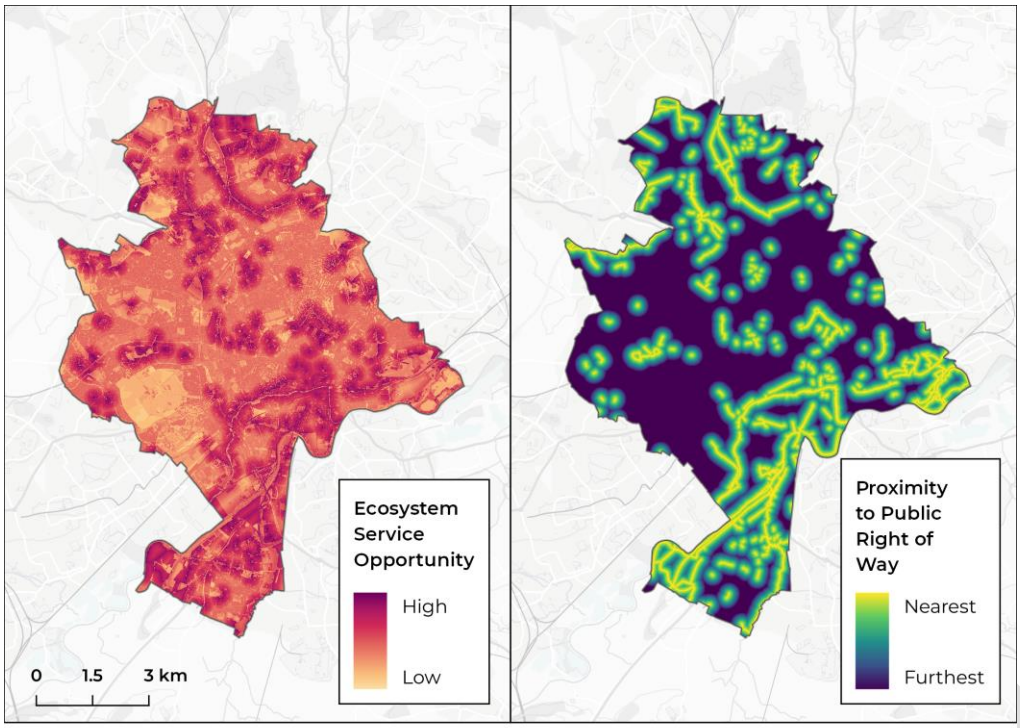
Interaction with nature ecosystem service baseline (L) and designated sites modifier (R)

6.3.3 OPPORTUNITY METHODS AND RATIONALE

To produce a relational interaction with nature opportunity dataset, the inverse of the baseline dataset was modified by the proximity of habitats to public rights of way. The rationale for using public rights of way data was public rights of way enable access to land which holds opportunity to facilitate interaction with nature.

To develop multiplier values the proximity values were normalised on a scale of 1.0 to 2.0, where 1.0 represents habitats greater than 300 m from a public rights of way and 2.0 represents habitats closest to public rights of way. These values were then applied to the baseline as modifier values, with habitats closest to public rights of way being modified by 2.0 and habitats greater than 300 m from public rights of way were multiplied by a value of 1.0. This scoring reflects the greater opportunity for improving provision of the interaction with nature ecosystem service in areas with better public access.

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Figure 20.

Interaction with nature ecosystem service opportunity (L) and public rights of way proximity modifier (R)

6.3.4 INTERPRETATION OF RESULTS

The baseline mapping highlights large green spaces as being areas providing the greatest interactions with nature. The River Trent (and habitats alongside) and Beeston Canal are also visible as linear features which are indicated as being areas of high ecosystem service provision, in part an outcome of the high scores assigned to open water habitats in the HSSM.

Interaction with nature opportunity mapping highlights habitats within 300 m of public rights of way which are low scoring for provision of nature interaction in the HSSM. This analysis also prominently highlights linear features including Beeston Canal, and the River Trent. As open water features score highly in the HSSM, it is generally features which are situated nearby to Beeston Canal and the River Trent which receive high opportunity scores, rather than the water bodies themselves.

6.3.5 LIMITATION AND FURTHER DEVELOPMENT

The application of public rights of way data is limited urban areas where public access is shaped by additional factors. Data on transport connections and visitor infrastructure (i.e., car parking, facilities, visitor centres) which may also influence the ability of a population to interact with nature.

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6.4 Sense of Place

6.4.1 ECOSYSTEM SERVICE DEFINITION

The ecosystem service of sense of place is defined as the aspects of a place that make it special and distinctive – this could include locally characteristic species, habitats, landscapes, or features; places related to historic or cultural events, or places important to people for spiritual or emotional reasons.

6.4.2 BASELINE METHODS AND RATIONALE

A relational dataset was produced to map the interaction with nature ecosystem service baseline within the City of Nottingham. Overlapping designated sites were used as a modifying dataset following the methods of (Smith, 2020) who stated that protected areas are more likely to support a greater amount and diversity of wildlife.

Some designated sites may also preserve other natural or semi-natural features of interest (i.e., geological features), and features of cultural or historical importance (i.e., scheduled monuments). Designated sites included: local nature reserves (LNRs) (Natural England, 2022a), sites of special scientific interest (SSSIs) (Natural England, 2022b), country parks (Natural England, 2021b), Doorstep Greens (Natural England, 2020b), ancient woodland (Natural England, 2022c), green belt (Ministry of Housing, Communities and Local Government, 2022) registered battlefields (Historic England, 2018a), registered parks and gardens (Historic England, 2018b), and scheduled monuments (Historic England, 2018c).

Some designations were not present within the City of Nottingham boundary and therefore not included as a modifier. These were special areas of conservation, areas of outstanding natural beauty, Millennium Greens, registered battlefields and national nature reserves.

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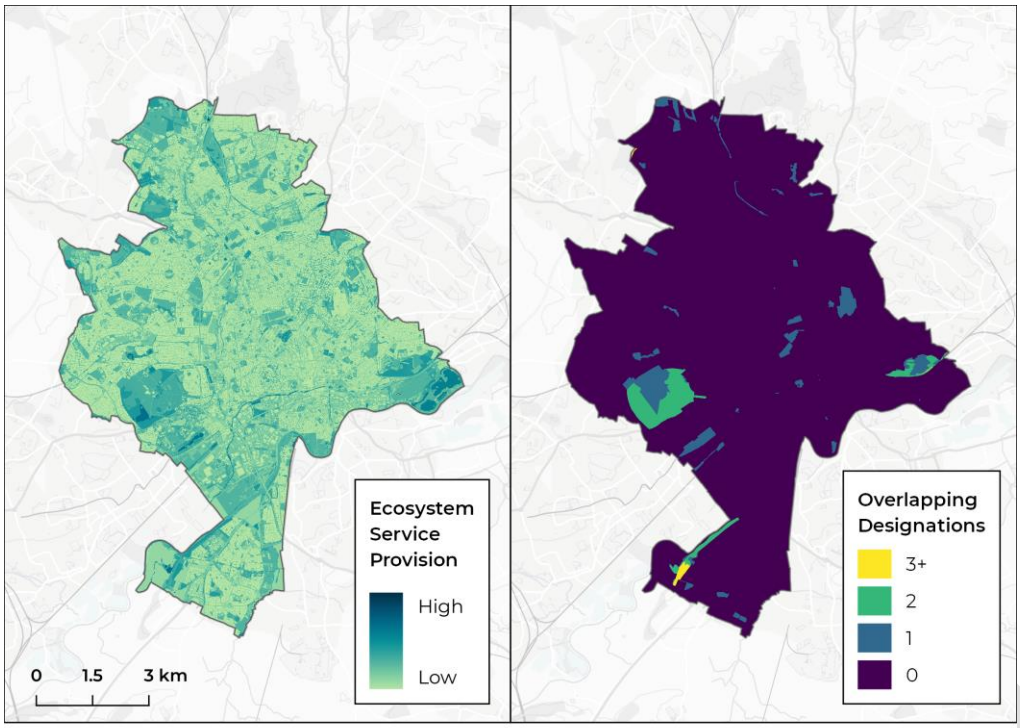


Figure 21.

Sense of place ecosystem service baseline (L) and designated sites modifier (R)

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6.4.3 OPPORTUNITY METHODS AND RATIONALE

An opportunity dataset was not produced for the sense of place ecosystem service due to the absence of meaningful data that can be used to assess where the benefits of sense of place currently being delivered by natural capital assets are not meeting demand for delivery of the ecosystem service.

6.4.4 INTERPRETATION OF RESULTS

Sense of place baseline ecosystem service mapping highlights designated sites and landscape features including water bodies as being areas of high service provision. For example, both Wollaton Park and Colwick Country Park are prominent within the ecosystem service baseline mapping. Additional areas of ecosystem service provision are distributed throughout the City of Nottingham, including land near the River Trent and Nottingham Arboretum near the city centre.

6.4.5 LIMITATION AND FURTHER DEVELOPMENT

Using designated sites assumes that high wildlife abundance and diversity are found at designated sites, yet the condition of these sites has not been accounted for within the analysis. Likewise, the analysis assumes that all designated sites are of equal value in contributing to the sense of place ecosystem service, something that is not likely to be the case. The built environment also makes an important contribution to the sense of place associated with a given area. Future work may seek to include a wider range of designated sites and distinct architecture as well as other data to better reflect the role of the built environment in producing the benefits of an area having a sense of place.

7 SUMMARY

This study has mapped ecosystem service provision across Nottingham using established techniques combined with the best available datasets available for Nottingham and nationally. The results of the assessment highlight the key importance of woodland in providing ecosystem services across the spectrum of habitats in Nottingham. This is produced by the result of (a) woodland habitats scoring generally high for many ecosystem services, and (b) the prominence of woodland habitats within Nottingham (e.g., Colwick Woods). Wetland habitats are also highly scoring in the HSSM, however, these are less present in Nottingham and therefore also make a smaller contribution to provision of the city's ecosystem services.

Grassland habitats are also valuable for the provision of ecosystem services throughout Nottingham, with large areas of grassland habitat being prominent in the baseline mapping. For example, both Wollaton Hall Park and Bulwell Hall Park (for example) are both prominent in most of the ecosystem system service baseline maps.

The ecosystem service baseline and opportunity maps presented here are designed to support high-level strategic decision-making within Nottingham. The next steps may be to take the mapping outputs and use those, alongside the other reports published as part of the wider natural capital project to determine a set of priority sites and to then assess the feasibility of improving the provision of ecosystem services from these sites by enhancing or creating habitat in a holistic way.

DRAFT

REFERENCES

Cantarello, E., Newton, A.C., & Hill, R.A., 2011. Potential effects of future land-use change on regional carbon stocks in the UK. *Environmental Science & Policy*, 14, pp.40-52.

Day, B. H., & G. Smith, 2018. *Outdoor Recreation Valuation (ORVal) User Guide: Version 2.0.* Land, Environment, Economics and Policy (LEEP) Institute, Business School, University of Exeter.

Environment Agency, 2020. Indicative Flood Risk Areas (shapefiles). Available at: https://data.gov.uk/dataset/7792054a-068d-471b-8969-f53a22b0c9b2/indicative-flood-risk-areas-shapefiles [accessed: 01/04/2022]

Environment Agency, 2021. Water Resource Availability and Abstraction Reliability Cycle 2. Available at: https://data.gov.uk/dataset/b1f5c467-ed41-4e8f-89d7-f79a76645fd6/water-resource-availability-and-abstraction-reliability-cycle-2 [accessed: 04/04/2022]

Historic England, 2018a. Registered Battlefields GIS Data. Available at: https://data.gov.uk/dataset/3b327613-faa1-4d0b-8fb8-75436fed80cc/registered-battlefields-gis-data [accessed: 13/04/2022]

Historic England, 2018b. Registered Parks and Gardens GIS Data. Available at: https://data.gov.uk/dataset/88cfe0de-85cd-431f-9836-2bee841d8165/registered-parks-and-gardens-gis-data [accessed: 13/04/2022]

Historic England, 2018c. Scheduled Monuments GIS Data. Available at: https://data.gov.uk/dataset/640d5dab-4295-4b85-bc26-a8369abb73f6/scheduled-monuments-gis-data [accessed: 13/04/2022]

Ministry of Housing, Communities, and Local Government, 2019. Indices of Multiple Deprivation (IMD) 2019. Available at: https://data-communities.opendata.arcgis.com/datasets/5e1c399d787e48c0902e5fe4fc1ccfe3/about [accessed: 12/04/2022]

Ministry of Housing, Communities, and Local Government, 2022. English Local Authority Green Belt Dataset. Available at: https://data.gov.uk/dataset/ccb505e0-67a8-4ace-b294-19a3cbff4861/english-local-authority-green-belt-dataset [accessed: 13/04/2022]

Natural England, 2016. *The ecological effects of air pollution from road transport: an updated review*. Ricardo AEA, Harwell, Didcot.

Natural England, 2020a. Provisional Agricultural Land Classification (ALC). Available at: https://data.gov.uk/dataset/952421ec-da63-4569-817d-4d6399df40a1/provisional-agricultural-land-classification-alc [accessed: 04/04/2022]

Natural England, 2020b. Doorstep Greens Polygons. Available at: https://data.gov.uk/dataset/6a80e5a7-017e-49ba-a981-5cd0c727086f/doorstep-greens-polygons [accessed: 13/04/2022]

Natural England, 2021a. CRoW Act 2000 - Access Layer. Available at: https://data.gov.uk/dataset/05fa192a-06ba-4b2b-b98c-5b6bec5ff638/crow-act-2000-access-layer [accessed: 05/04/2022]

Natural England, 2021b. Country Parks (England). Available at: https://data.gov.uk/dataset/e729abb9-aa6c-42c5-baec-b6673e2b3a62/country-parks-england [accessed: 13/04/2022]

Natural England, 2022a. Local Nature Reserves (England). Available at: https://data.gov.uk/dataset/acdf4a9e-a115-41fb-bbe9-603c819aa7f7/local-nature-reserves-england [accessed: 13/04/2022]

Natural England, 2022b. Sites of Special Scientific Interest (England). Available at: https://data.gov.uk/dataset/5b632bd7-9838-4ef2-9101-ea9384421b0d/sites-of-special-scientific-interest-england [accessed: 13/04/2022]

Natural England, 2022c. Ancient Woodland (England). Available at: https://data.gov.uk/dataset/9461f463-c363-4309-ae77-fdcd7e9df7d3/ancient-woodland-england [accessed: 13/04/2022]

Nottingham City Council, 2021. Open Data Nottingham: Public Rights of Way. Available at: https://www.opendatanottingham.org.uk/dataset.aspx?id=74 [accessed: 12/04/2022]

Office for National Statistics, 2016. Lower Layer Super Output Area (LSOA) boundaries. Available at: https://data.gov.uk/dataset/fa883558-22fb-4a1a-8529-cffdee47d500/lower-layer-super-output-area-lsoa-boundaries [accessed: 12/04/2022]

Ordnance Survey, 2021. OS MasterMap Topography Layer. Available at: https://www.ordnancesurvey.co.uk/business-government/products/mastermap-topography [accessed under licence from Nottingham City Council]

Ordnance Survey, 2022. OS Open Zoomstack. Available at: https://www.ordnancesurvey.co.uk/business-government/products/open-zoomstack [accessed: 02/02/2022]

Reis, S., Liska, T., Steinle, S., Carnell, E., Leaver, D., Roberts, E., Vieno, M., Beck, R., Dragosits, U. 2017. UK gridded population 2011 based on Census 2011 and Land Cover Map 2015. *NERC Environmental Information Data Centre*. Available at: https://data.gov.uk/dataset/ca2daae8-8f36-4279-b15d-78b0463c61db/uk-gridded-population-2011-based-on-census-2011-and-land-cover-map-2015 [accessed: 05/04/2022]

Smith, A., 2020. Natural capital in Oxfordshire: Short report. Environmental Change Institute, University of Oxford.

Sustrans, 2022. Sustrans' Open Data. Available at: https://data-sustrans-uk.opendata.arcgis.com/ [accessed: 12/04/2022]

Annex 1: HABITAT SERVICE SCORING MATRIX (ADAPTED FROM SMITH, 2020)

		PROVISIONING		REGULATING				BUNDLED			CULTURAL			
HABITAT GROUP	HABITAT DESCRIPTION	Food Provision	Water Supply	Carbon storage	Water flow regulation	Local climate regulation	Air pollutant removal	Biodiversity	Water quality	Soil health	Recreation	Education	Interaction with Nature	Sense of Place
G Grassland	grassland	6	7	3	3	2	1	2	1	4	4	6	4	5
	acid grassland	6	9	4	8	2	1	8	4	8	5	7	5	6
	lowland dry acid grassland	6	8	5	8	2	1	10	4	8	2	9	2	2
	bracken	1	8	4	8	2	1	5	5	8	2	2	2	2
	calcareous grassland	6	9	3	8	2	1	10	4	8	3	5	3	4
	lowland calcareous grassland	6	9	3	8	2	1	10	4	8	2	3	2	2
	neutral grassland	6	9	4	8	2	1	8	4	8	3	5	3	4
	lowland meadows	6	9	4	8	2	1	10	4	8	2	3	2	2
	modified grassland	10	5	3	3	2	1	2	1	4	3	4	3	3
	wet grassland	3	9	4	9	2	1	9	5	8	7	3	4	5
	seasonally wet grassland	4	9	4	9	2	1	9	5	8	1	2	1	2
	traditional orchard	5	7	5	8	8	4	9	8	8	2	3	2	3
W Woodland and Forest	woodland	0	1	8	10	10	10	2	5	6	4	6	4	5
	broadleaved mixed and yew woodland	1	3	10	9	10	8	10	10	10	4	6	4	6
	other woodland	5	7	5	6	6	3	10	8	8	3	5	3	4
	coniferous woodland	0	1	8	5	10	10	2	5	6	2	4	2	3
	native pine woodland	0	3	7	9	10	8	8	6	8	5	7	5	6
	other coniferous woodland	0	1	8	10	10	10	2	5	6	2	4	2	3
	broadleaved scattered trees	5	7	5	6	6	3	10	8	8	1	1	1	1
	wood pasture	5	7	9	9	8	6	9	8	8	5	8	5	7
	felled woodland	0	4	1	1	1	0	2	0	0	1	1	1	2
H Heathland and Shrub	heathland	1	8	4	7	2	4	8	7	8	3	4	3	3
	dwarf shrub heath	1	8	4	7	2	4	8	7	8	5	7	5	7
	lowland heathland	1	8	4	7	2	4	10	7	8	5	7	5	6
	wet heathland with cross-leaved heath	1	9	5	7	2	4	10	7	8	2	2	2	2
	hedgerows	1	4	5	8	6	8	10	7	8	1	1	2	2
	dense scrub	1	4	6	8	6	7	6	7	8	1	1	1	1
	wetland	1	10	10	6	4	1	10	8	8	9	8	10	10

		PROVISIONING		REGULATING				BUNDLED			CULTURAL			
HABITAT GROUP	HABITAT DESCRIPTION	Food Provision	Water Supply	Carbon storage	Water flow regulation	Local climate regulation	Air pollutant removal	Biodiversity	Water quality	Soil health	Recreation	Education	Interaction with Nature	Sense of Place
F Wetland	bog	1	10	10	6	4	1	10	8	8	6	6	7	7
	fen marsh and swamp	1	10	7	6	4	1	10	8	8	9	8	9	10
	reedbeds	0	10	5	6	4	1	10	8	8	6	6	7	7
C Cropland	arable and horticulture	10	6	1	4	2	1	4	4	5	1	1	1	1
	arable margins	0	6	2	4	2	1	7	4	7	2	2	1	2
	temporary grass and clover leys	7	6	1	5	2	1	7	4	7	1	1	1	1
	cereal crops	10	7	1	2	2	1	2	1	1	1	1	2	2
	non cereal crops (e.g. biofuel)	2	3	4	4	2	1	5	1	2	1	1	1	1
	intensive orchards	10	3	5	8	8	4	2	1	6	3	1	1	1
	horticulture (e.g. community gardens, allotments)	7	7	3	5	2	2	8	1	1	1	1	2	1
	small-scale food growing	7	7	3	5	2	2	8	1	1	1	1	1	1
	orchard	7	7	3	5	2	2	8	1	1	2	2	1	2
U Urban	built up areas and gardens	0	0	0	0	0	0	0	0	0	2	2	2	2
	open mosaic habs on previously developed land	1	5	1	2	2	1	8	1	4	1	1	1	1
	sealed surface	0	0	0	0	0	0	0	0	0	0	1	0	0
	artificial unvegetated unsealed surface	0	4	0	1	0	0	1	1	0	0	0	0	0
	suburban/mosaic of developed/natural surface	1	7	2	3	2	2	3	2	5	0	0	0	1
	built linear features - cyclepath and footpath	0	5	2	2	2	1	2	1	3	1	1	1	2
	built linear features - road verge	0	5	3	3	2	1	2	2	4	1	1	1	1
	scattered trees	0	1	7	6	8	6	5	2	6	1	1	1	1
	ruderal and tall herb	1	8	4	8	2	1	4	5	8	1	1	1	1
	parks and gardens	0	7	4	3	4	3	6	2	5	0	1	1	1
	natural sports pitches/playground	0	7	3	3	2	1	2	2	3	2	3	2	2
	open space/amenity grassland	0	7	3	3	2	1	2	2	4	1	1	1	1
	cemetaries/churchyards	0	7	4	3	2	2	5	2	4	1	1	1	1
	other natural functional green space	0	7	3	3	2	1	4	2	3	3	3	2	3
S Sparsely Vegetated Land	sparsely vegetated land	0	0	0	1	2	0	6	0	0	1	2	2	2
	inland rock	0	0	0	0	0	0	8	0	0	2	3	2	2
	supralittoral rock	0	0	0	1	2	0	6	7	3	5	5	6	6
	supralittoral sediment	0	0	4	5	3	1	8	7	3	2	2	2	2

		PROVISIONING		REGULATING				BUNDLED			CULTURAL			
HABITAT GROUP	HABITAT DESCRIPTION	Food Provision	Water Supply	Carbon storage	Water flow regulation	Local climate regulation	Air pollutant removal	Biodiversity	Water quality	Soil health	Recreation	Education	Interaction with Nature	Sense of Place
	bare ground	0	1	1	1	1	0	1	1	0	2	3	2	2
	quarry - hard rock	0	0	0	1	2	0	4	5	3	4	3	3	4
	quarry - sand and gravel	0	0	0	1	2	0	4	5	3	1	2	2	1
R Rivers and Lakes	rivers and lakes	0	10	0	1	4	0	8	1	0	3	5	4	4
	standing open water and canals	0	10	1	4	4	0	8	1	0	6	7	7	8
	rivers and streams	2	10	0	1	4	0	8	1	0	5	5	5	6
T Marine Inlets and Transitional Waters	marine inlets and transitional waters	0	0	0	1	2	0	6	5	1	2	3	2	2
	littoral rock	0	0	0	1	2	0	6	7	1	1	1	1	1
	littoral sediment	0	0	4	5	3	1	8	7	3	1	1	1	1
	coastal saltmarsh	4	0	10	9	4	1	10	5	5	1	2	2	2
	intertidal mudflats	0	5	10	5	4	1	10	7	7	1	2	2	1

Annex 2: SUMMARY OF ECOSYSTEM SERVICE DEFINITIONS AND APPLIED MODIFIERS

<table>
<tr><th colspan="2">Ecosystem Service</th><th>Definition</th><th>Baseline Modifier</th><th>Opportunity Modifier</th></tr>
<tr><td rowspan="2">PROVISIONING</td><td>Food Provision</td><td>Agricultural and horticultural production of food products via arable crops, livestock, vegetables, and fruits. Production of food products (i.e., berries, fungi, and game) through hunting and gathering practices.</td><td>Agricultural Land Classification (ALC) grade (Natural England, 2020):

<table><tr><th>ALC Grade</th><th>Multiplier</th></tr><tr><td>1</td><td>3.03</td></tr><tr><td>2</td><td>2.40</td></tr><tr><td>3a</td><td>1.83</td></tr><tr><td>3</td><td>1.33</td></tr><tr><td>3b</td><td>1.00</td></tr><tr><td>4</td><td>0.67</td></tr><tr><td>5</td><td>0.50</td></tr></table></td><td>Not used.</td></tr>
<tr><td>Water Supply</td><td>The extent to which surface flow and groundwater recharge are impacted by soils and vegetation through processes of run-off and filtration.</td><td>No modifier applied.</td><td>Water resource availability as a percentage of time (Environment Agency, 2020a):

<table><tr><th>Percentage</th><th>Multiplier</th></tr><tr><td><30</td><td>2.00</td></tr><tr><td>30-49</td><td>1.80</td></tr><tr><td>50-69</td><td>1.60</td></tr><tr><td>70-94</td><td>1.40</td></tr><tr><td>>=95</td><td>1.20</td></tr></table></td></tr>
<tr><td>CULTURAL</td><td>Recreation</td><td>Provision of green and blue spaces that can be used for any leisure activity (e.g., walking, cycling, running, picnicking, camping, boating, playing, or just relaxing).</td><td>Accessibility of land:

<table><tr><th>Land Access</th><th>Multiplier</th></tr><tr><td>Open</td><td>1.00</td></tr><tr><td>Semi-restricted</td><td>0.75</td></tr><tr><td>Restricted</td><td>0.50</td></tr><tr><td>Private</td><td>0.25</td></tr><tr><td>Other</td><td>0.00</td></tr></table></td><td>Indices of multiple deprivations (IMD):

<table><tr><th>IMD Decile</th><th>Multiplier</th></tr><tr><td>10th decile</td><td>1.0</td></tr><tr><td>9th decile</td><td>0.9</td></tr><tr><td>8th decile</td><td>0.8</td></tr><tr><td>7th decile</td><td>0.7</td></tr><tr><td>6th decile</td><td>0.6</td></tr><tr><td>5th decile</td><td>0.5</td></tr><tr><td>4th decile</td><td>0.4</td></tr><tr><td>3rd decile</td><td>0.3</td></tr><tr><td>2nd decile</td><td>0.2</td></tr><tr><td>1st decile</td><td>0.1</td></tr></table></td></tr>
</table>

<table>
<tr><th colspan="2">Ecosystem Service</th><th>Definition</th><th>Baseline Modifier</th><th>Opportunity Modifier</th></tr>
<tr><td></td><td>Education</td><td>Provision of green and blue spaces that can provide educational benefit.</td><td>Accessibility of land:

<table><tr><th>Land Access</th><th>Multiplier</th></tr><tr><td>Open</td><td>1.00</td></tr><tr><td>Semi-restricted</td><td>0.75</td></tr><tr><td>Restricted</td><td>0.50</td></tr><tr><td>Private</td><td>0.25</td></tr><tr><td>Other</td><td>0.00</td></tr></table></td><td>Indices of multiple deprivations (IMD):

<table><tr><th>IMD Decile</th><th>Multiplier</th></tr><tr><td>10th decile</td><td>1.0</td></tr><tr><td>9th decile</td><td>0.9</td></tr><tr><td>8th decile</td><td>0.8</td></tr><tr><td>7th decile</td><td>0.7</td></tr><tr><td>6th decile</td><td>0.6</td></tr><tr><td>5th decile</td><td>0.5</td></tr><tr><td>4th decile</td><td>0.4</td></tr><tr><td>3rd decile</td><td>0.3</td></tr><tr><td>2nd decile</td><td>0.2</td></tr><tr><td>1st decile</td><td>0.1</td></tr></table></td></tr>
<tr><td></td><td>Interaction with Nature</td><td>Provision of opportunities for formal or informal nature-related activities (e.g., birdwatching, wildlife encounters, or ‘feeling connected with nature’). There is some overlap with biodiversity, but access by people can have negative impacts on some wildlife habitats. Excludes recreational fishing, hunting, shooting, intrinsic value of nature, and existence value.</td><td>Overlapping designations:

<table><tr><th>Designations</th><th>Multiplier</th></tr><tr><td>3+</td><td>1.15</td></tr><tr><td>2</td><td>1.10</td></tr><tr><td>1</td><td>1.05</td></tr><tr><td>0</td><td>1.00</td></tr></table></td><td>Proximity to Public Rights of Way (PRoW):

<table><tr><th>PRoW Proximity</th><th>Multiplier</th></tr><tr><td>0 m</td><td>2.0</td></tr><tr><td>30 m</td><td>1.9</td></tr><tr><td>60 m</td><td>1.8</td></tr><tr><td>90 m</td><td>1.7</td></tr><tr><td>120 m</td><td>1.6</td></tr><tr><td>150 m</td><td>1.5</td></tr><tr><td>180 m</td><td>1.4</td></tr><tr><td>210 m</td><td>1.3</td></tr><tr><td>240 m</td><td>1.2</td></tr><tr><td>270 m</td><td>1.1</td></tr><tr><td>>= 300 m</td><td>1.0</td></tr></table></td></tr>
<tr><td></td><td>Sense of Place</td><td>The aspects of a place that make it special and distinctive – this could include locally characteristic species, habitats, landscapes, or features; places related to historic or cultural events, or places important to people for spiritual or emotional reasons.</td><td>Overlapping designations:

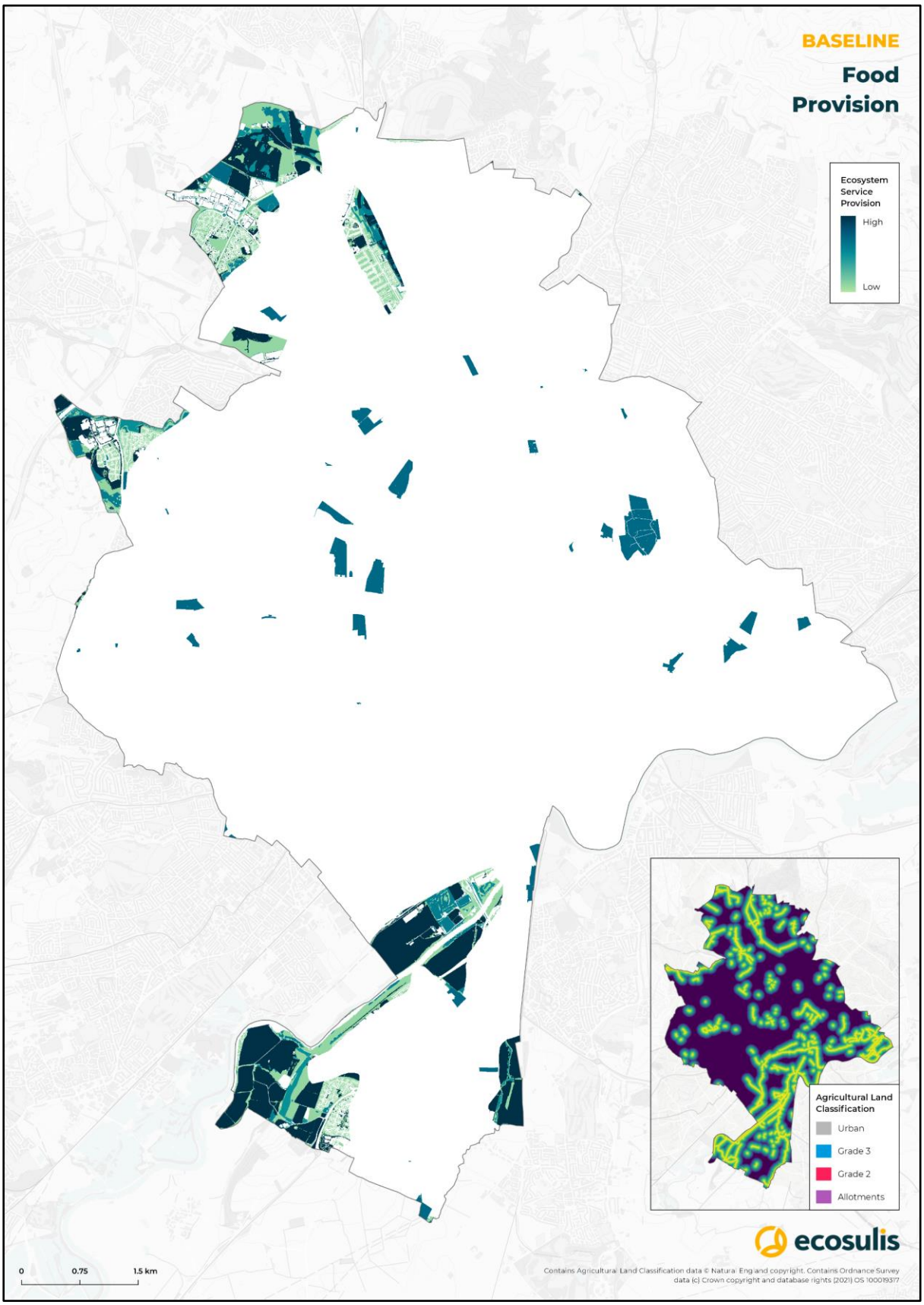
<table><tr><th>Designations</th><th>Multiplier</th></tr><tr><td>3+</td><td>1.15</td></tr><tr><td>2</td><td>1.10</td></tr><tr><td>1</td><td>1.05</td></tr><tr><td>0</td><td>1.00</td></tr></table></td><td>Not used.</td></tr>
</table>

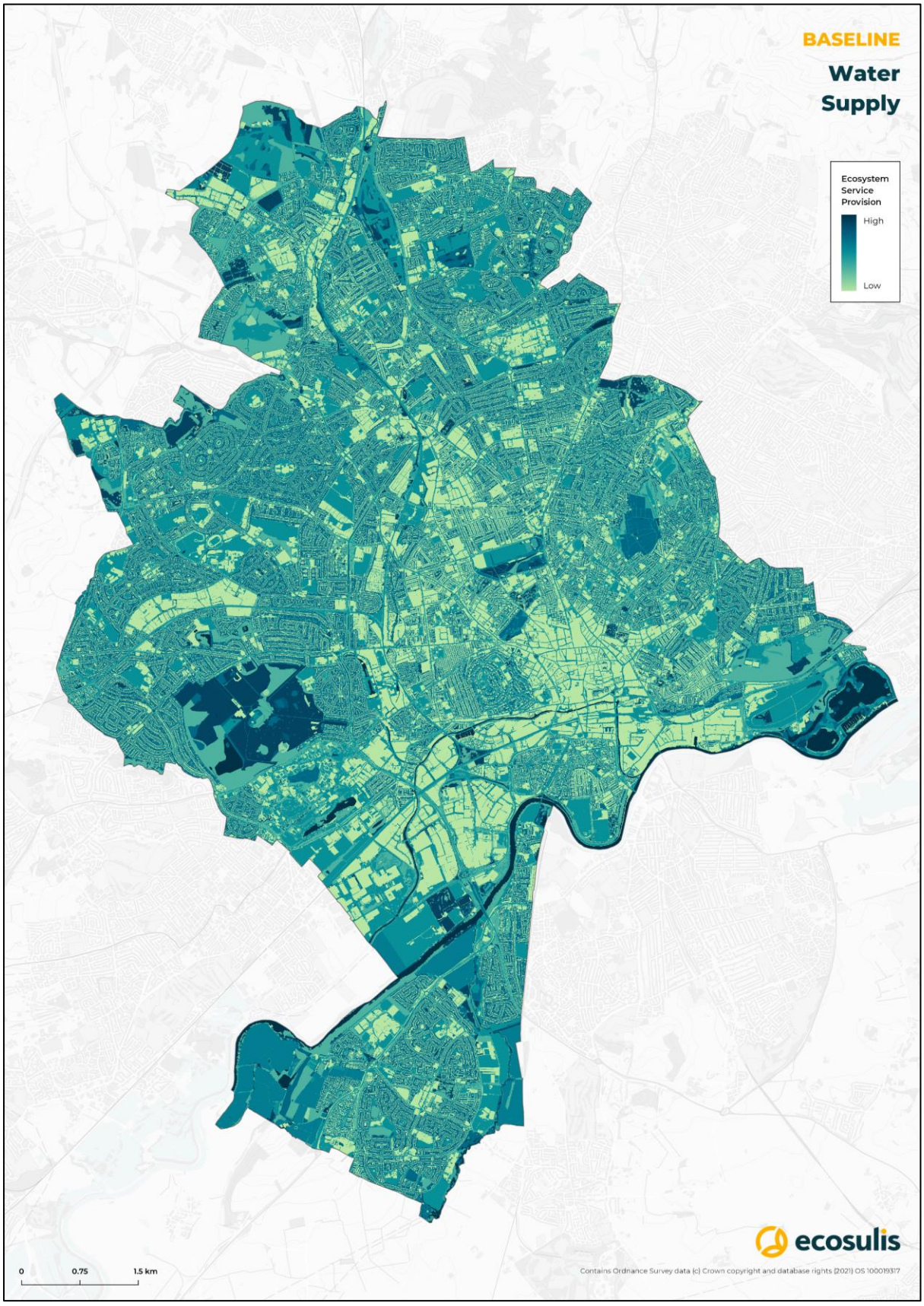
<table>
<tr><th colspan="2">Ecosystem Service</th><th>Definition</th><th>Baseline Modifier</th><th>Opportunity Modifier</th></tr>
<tr><td rowspan="3">REGULATING</td><td>Carbon Storage</td><td>Quantities of carbon stored in soil and vegetation.</td><td>Not used.</td><td>Not used.</td></tr>
<tr><td>Water Flow Regulation</td><td>Impact of soil and vegetation on reducing surface run-off, peak flow, and flood extent and depth. Mechanisms include interception, evapotranspiration, infiltration, and physical water flow slowing.</td><td>Proximity to flow pathway:
<table><tr><th>Proximity to Flow Pathway</th><th>Multiplier</th></tr><tr><td>0 m</td><td>2.0</td></tr><tr><td>50 m</td><td>1.9</td></tr><tr><td>100 m</td><td>1.8</td></tr><tr><td>150 m</td><td>1.7</td></tr><tr><td>200 m</td><td>1.6</td></tr><tr><td>250 m</td><td>1.5</td></tr><tr><td>300 m</td><td>1.4</td></tr><tr><td>350 m</td><td>1.3</td></tr><tr><td>400 m</td><td>1.2</td></tr><tr><td>450 m</td><td>1.1</td></tr><tr><td>500 m</td><td>1.0</td></tr></table></td><td>Cumulative surface water flood risk in catchment:
<table><tr><th>Cumulative Flood Risk Value (% of maximum - minimum)</th><th>Multiplier</th></tr><tr><td>100 %</td><td>2.0</td></tr><tr><td>90 %</td><td>1.9</td></tr><tr><td>80 %</td><td>1.8</td></tr><tr><td>70 %</td><td>1.7</td></tr><tr><td>60 %</td><td>1.6</td></tr><tr><td>50 %</td><td>1.5</td></tr><tr><td>40 %</td><td>1.4</td></tr><tr><td>30 %</td><td>1.3</td></tr><tr><td>20 %</td><td>1.2</td></tr><tr><td>10 %</td><td>1.1</td></tr><tr><td>0 %</td><td>1.0</td></tr></table></td></tr>
<tr><td>Local Climate Regulation</td><td>Cooling effects of vegetation and water, in particular in urban areas where these can reduce heating and cooling costs and provide areas of shade.</td><td>Buildings where green roofs have been identified as being present have had their score increased by 2.</td><td>Residential population density:
<table><tr><th>Population Density (% of maximum - minimum)</th><th>Multiplier</th></tr><tr><td>100 %</td><td>2.0</td></tr><tr><td>90 %</td><td>1.9</td></tr><tr><td>80 %</td><td>1.8</td></tr><tr><td>70 %</td><td>1.7</td></tr><tr><td>60 %</td><td>1.6</td></tr><tr><td>50 %</td><td>1.5</td></tr><tr><td>40 %</td><td>1.4</td></tr><tr><td>30 %</td><td>1.3</td></tr><tr><td>20 %</td><td>1.2</td></tr><tr><td>10 %</td><td>1.1</td></tr><tr><td>0 %</td><td>1.0</td></tr></table></td></tr>
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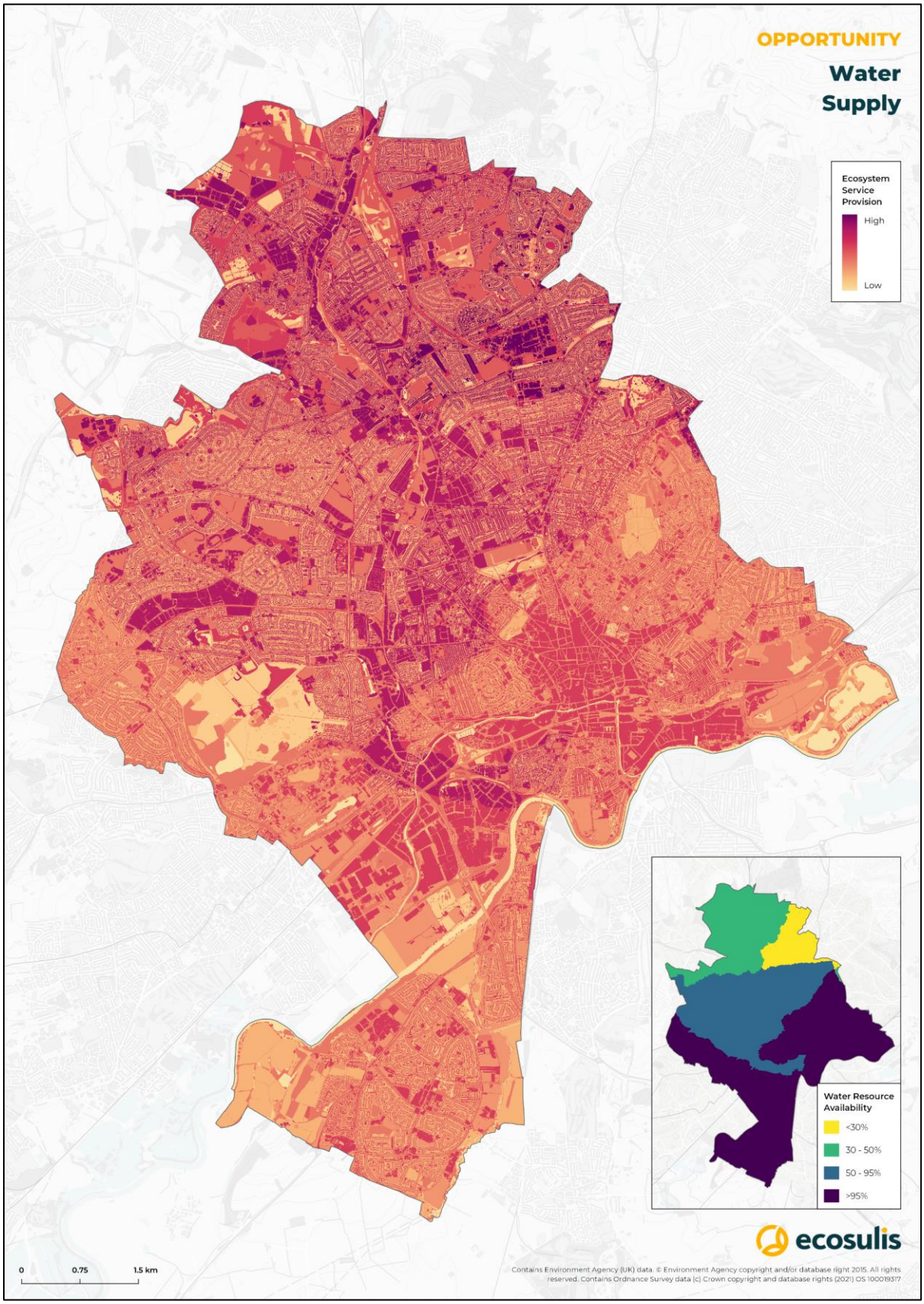
<table>
<tr><th colspan="2">Ecosystem Service</th><th>Definition</th><th>Baseline Modifier</th><th>Opportunity Modifier</th></tr>
<tr><td></td><td>Air Pollutant Removal</td><td>Effect of vegetation on concentrations of air pollutants through mechanisms including deposition, absorption, and chemical breakdown.</td><td>Not used.</td><td>Proximity to regional and national roads:

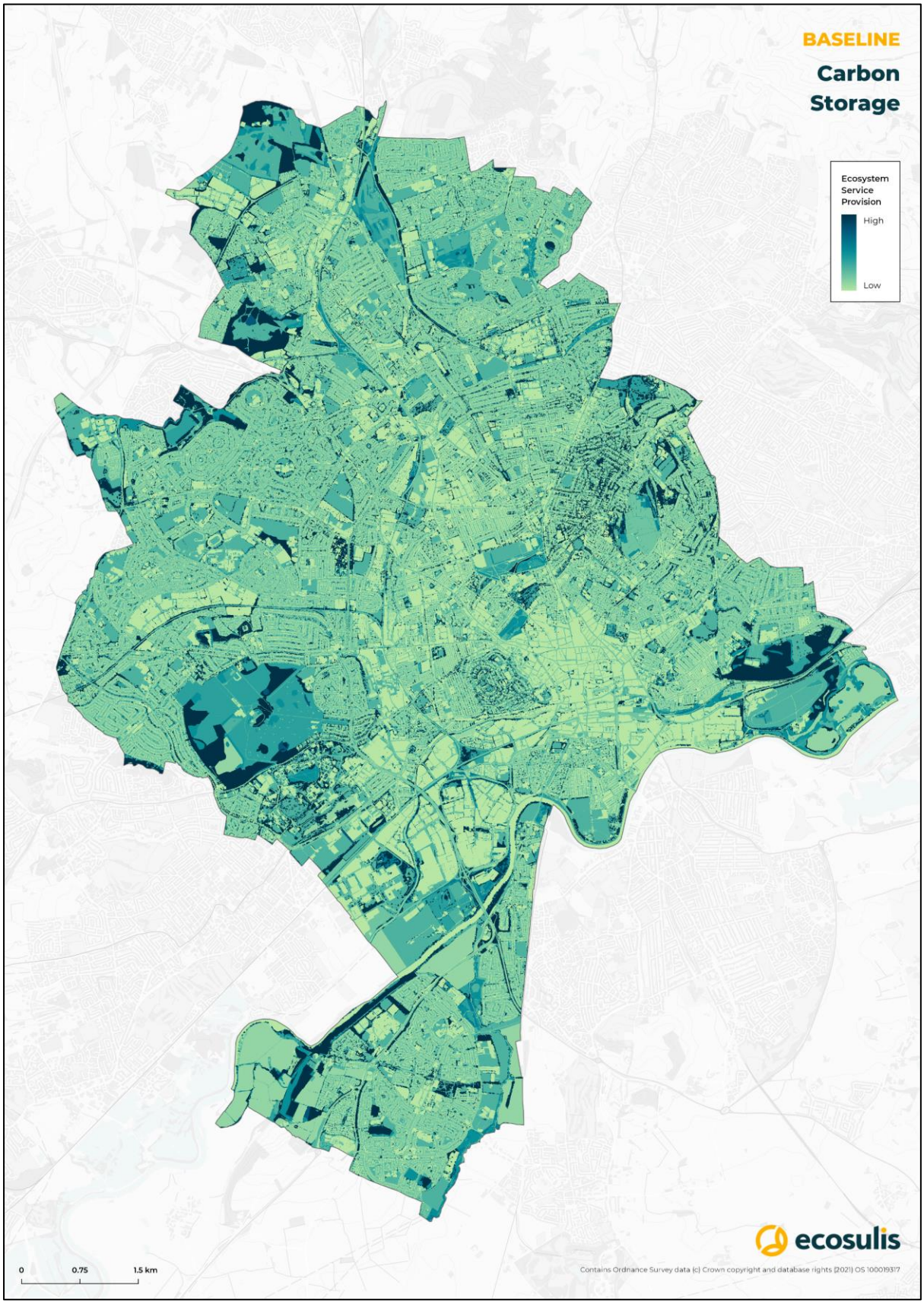
<table><tr><th>Road Proximity</th><th>Multiplier</th></tr><tr><td>0 m</td><td>2.0</td></tr><tr><td>30 m</td><td>1.9</td></tr><tr><td>60 m</td><td>1.8</td></tr><tr><td>90 m</td><td>1.7</td></tr><tr><td>120 m</td><td>1.6</td></tr><tr><td>150 m</td><td>1.5</td></tr><tr><td>180 m</td><td>1.4</td></tr><tr><td>210 m</td><td>1.3</td></tr><tr><td>240 m</td><td>1.2</td></tr><tr><td>270 m</td><td>1.1</td></tr><tr><td>>= 300 m</td><td>1.0</td></tr></table></td></tr>
<tr><td>BUNDLED BENEFITS</td><td>Biodiversity</td><td>The ability of a habitat to support a diverse range of species, providing a variety of environmental, social, and economic benefits.</td><td>No modifier applied.</td><td>Not used.</td></tr>
<tr><td></td><td>Water Quality</td><td>Uptake of pollutants dissolved or suspended in water by vegetation, and the ability of vegetation to prevent pollutants</td><td>No modifier applied.</td><td>Not used.</td></tr>
<tr><td></td><td>Soil Health</td><td>The continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans.</td><td>No modifier applied.</td><td>Not used.</td></tr>
</table>

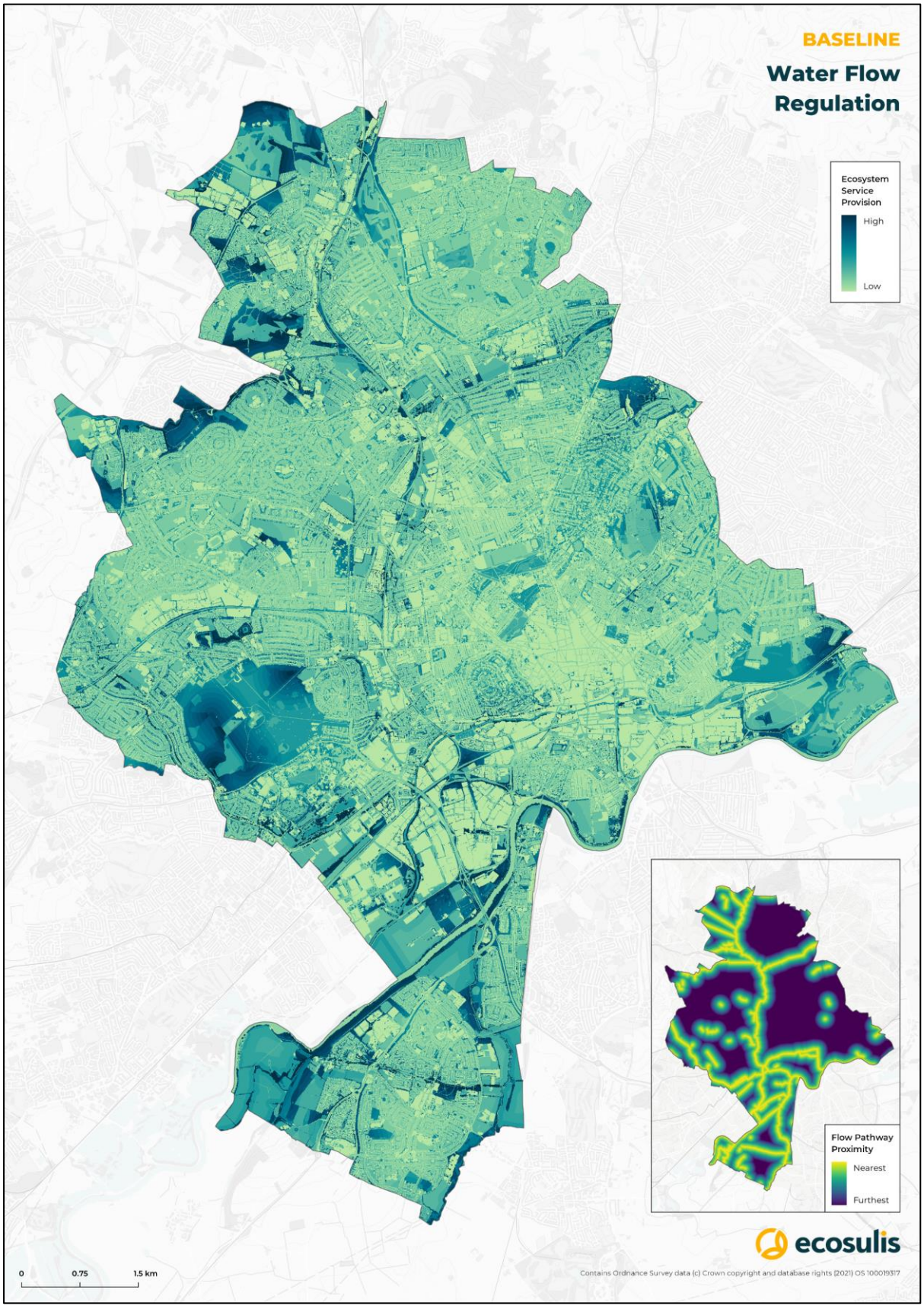
Annex 3: FULL-SIZE ECOSYSTEM SERVICE MAPS

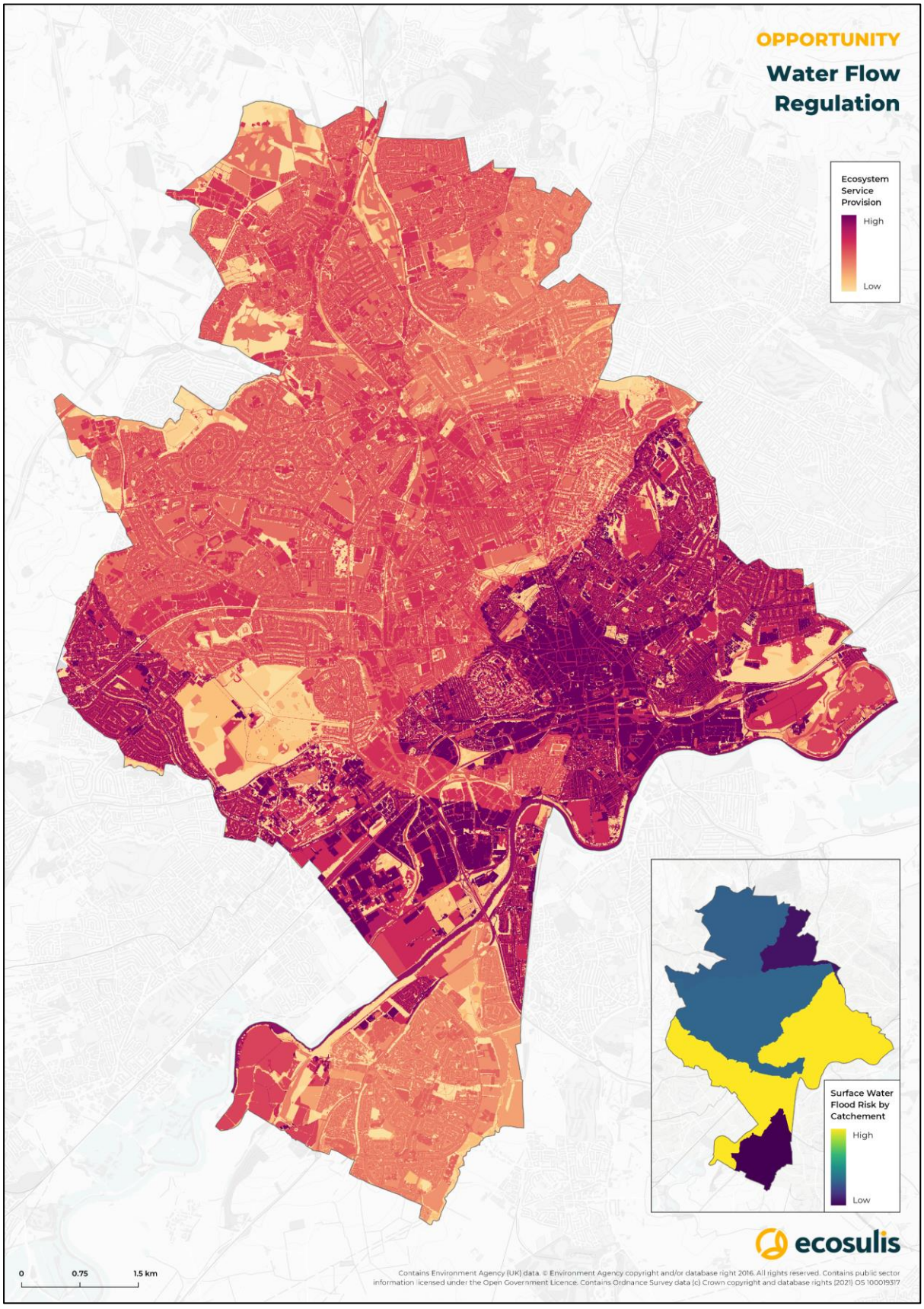

BASELINE
Food Provision
Ecosystem Service Provision
High
Low
Agricultural Land Classification
Urban
Grade 3
Grade 2
Allotments
ecosulis
0
0.75
1.5 km
Contains Agricultural Land Classification data © Natural England copyright. Contains Ordnance Survey data (c) Crown copyright and database rights (2021) OS 100019317

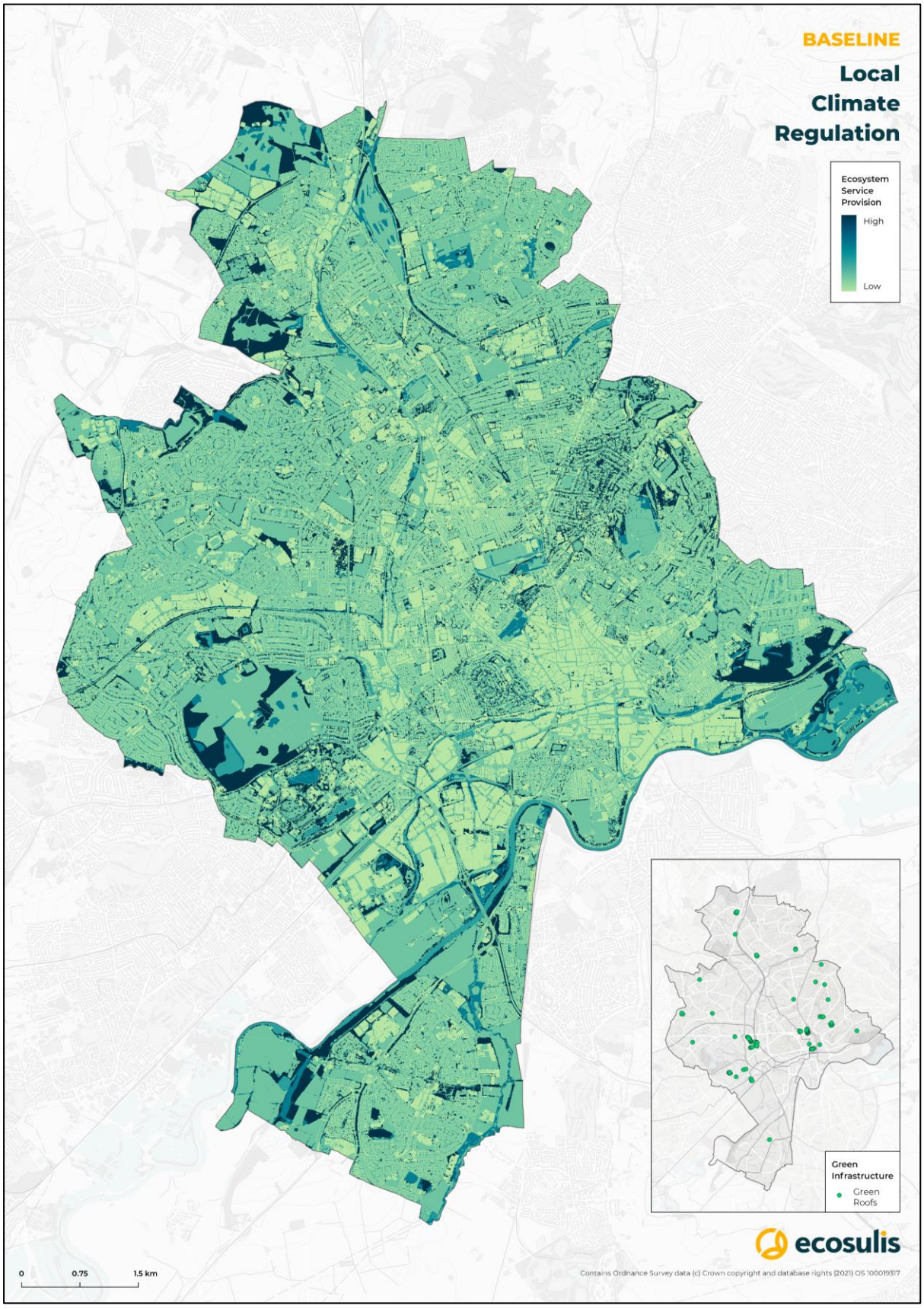

BASELINE
Water Supply
Ecosystem Service Provision
High
Low
0
0.75
1.5 km
ecosulis
Contains Ordnance Survey data (c) Crown copyright and database rights (2021) OS 100019317

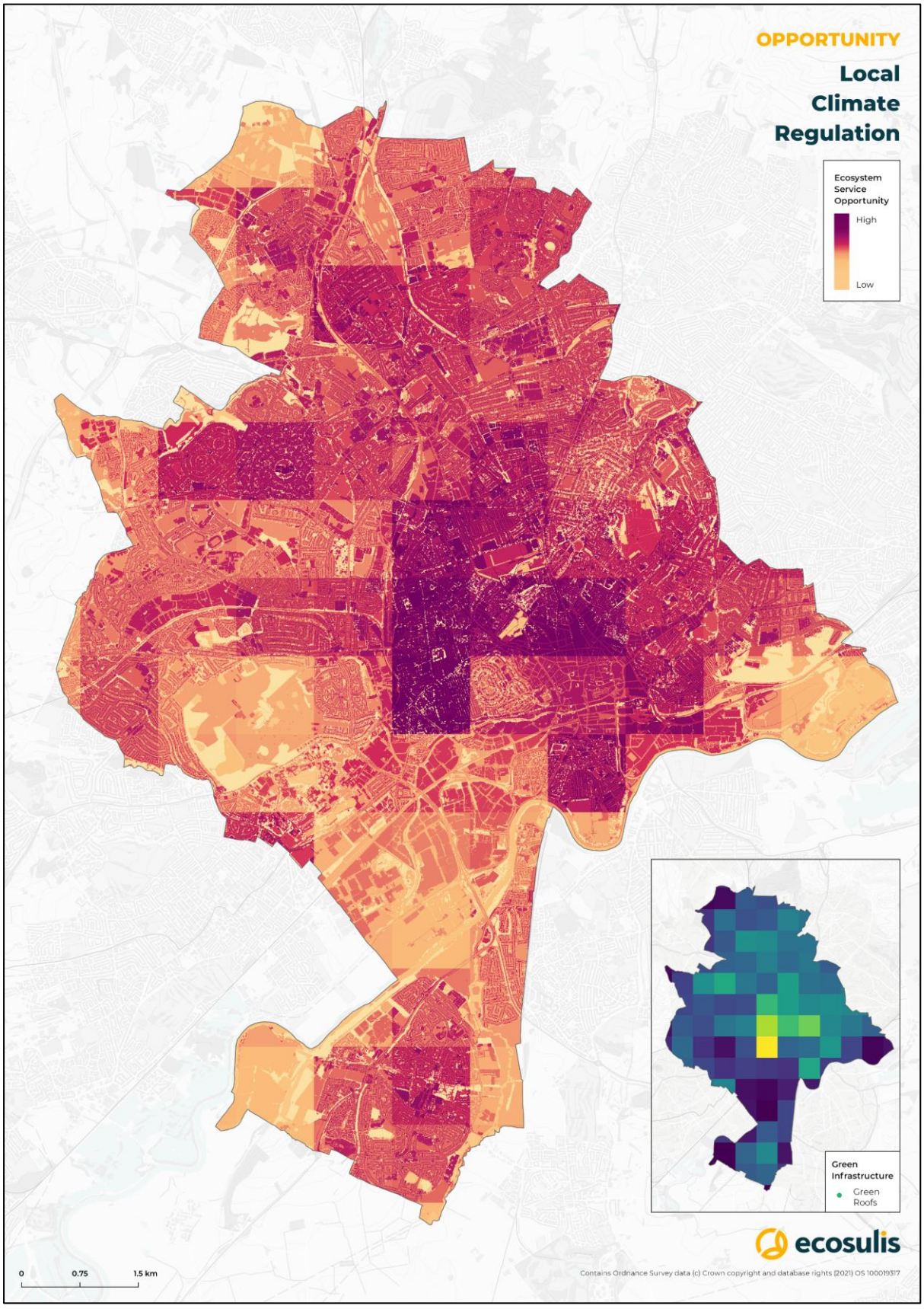

OPPORTUNITY
Water Supply
Ecosystem Service Provision
High
Low
Water Resource Availability
<30%
30 - 50%
50 - 95%
>95%
ecosulis
0
0.75
1.5 km
Contains Environment Agency (UK) data. © Environment Agency copyright and/or database right 2015. All rights reserved. Contains Ordnance Survey data (c) Crown copyright and database rights (2021) OS 100019317

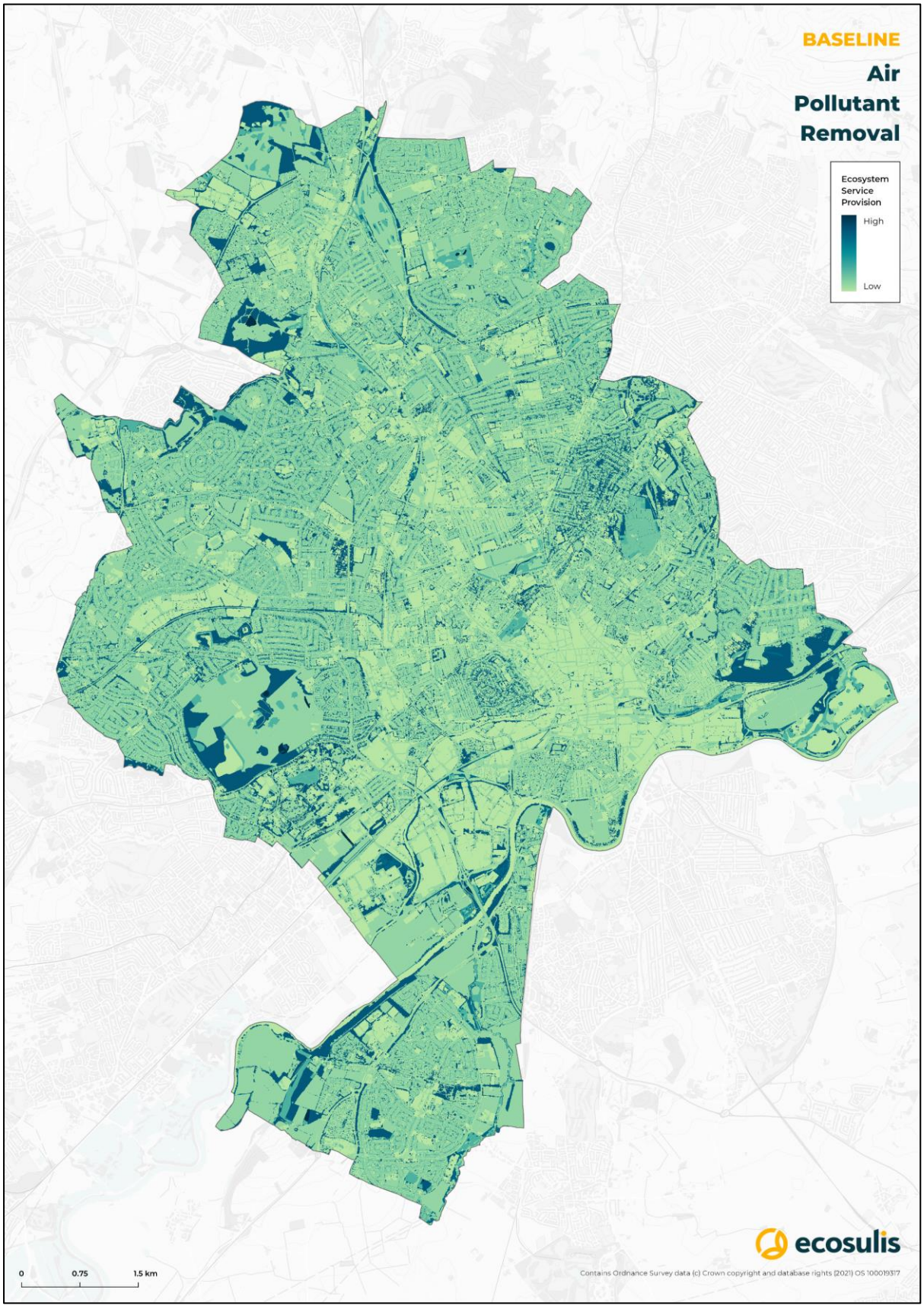

BASELINE
Carbon Storage
Ecosystem Service Provision
High
Low
ecosulis
0
0.75
1.5 km
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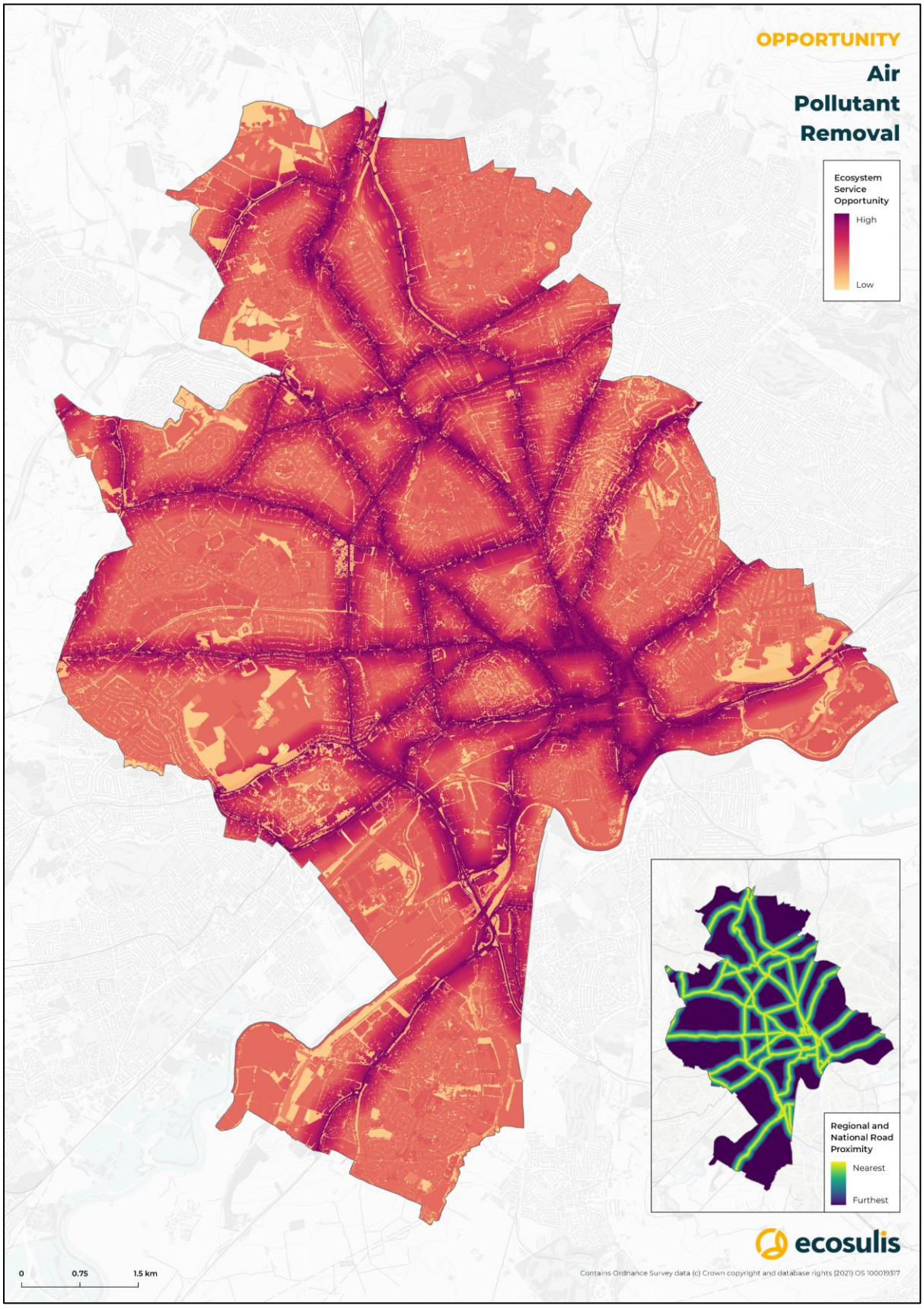

BASELINE
Water Flow Regulation
Ecosystem Service Provision
High
Low
Flow Pathway Proximity
Nearest
Furthest
ecosulis
0
0.75
1.5 km
Contains Ordnance Survey data (c) Crown copyright and database rights (2021) OS 100019317

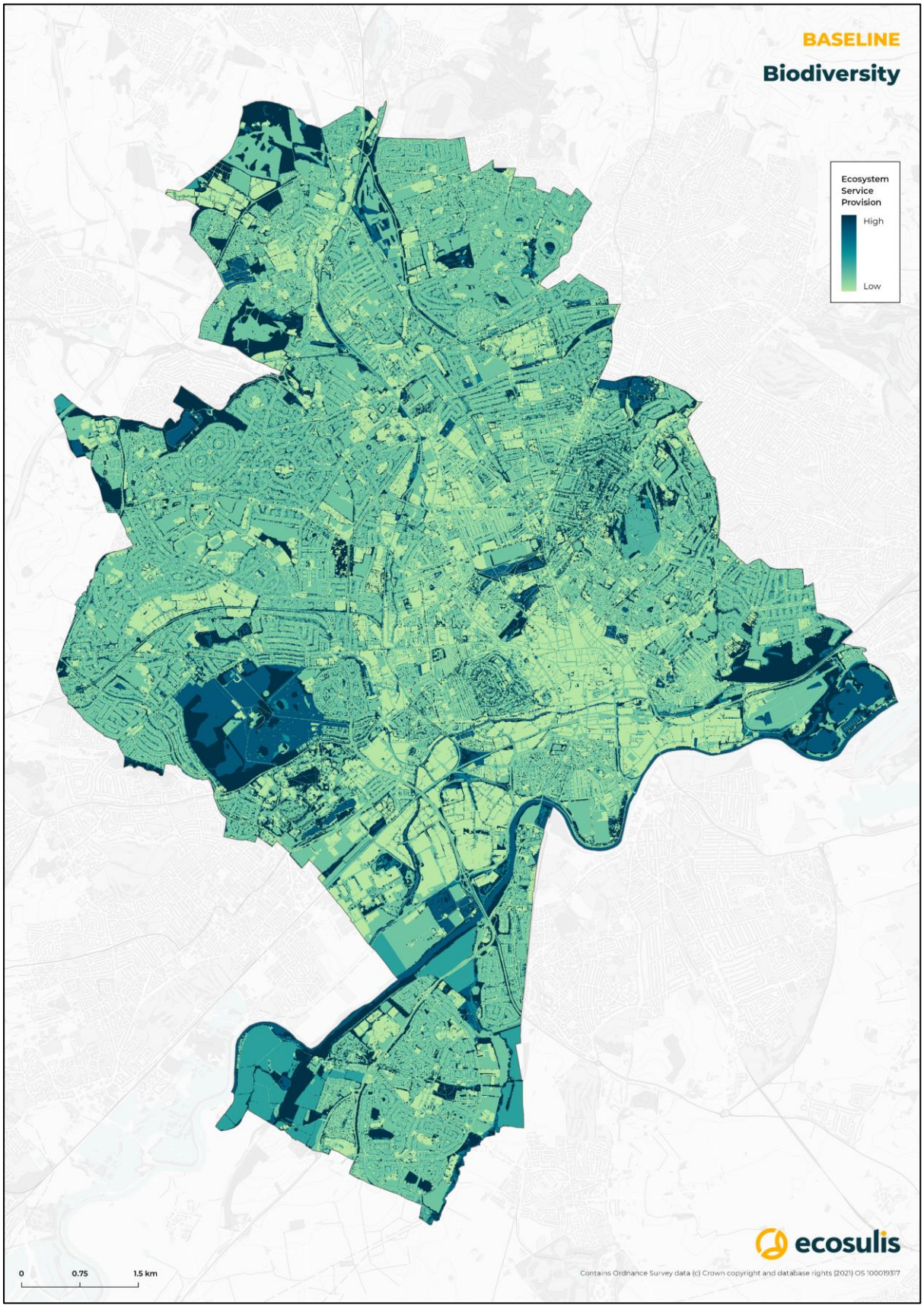

OPPORTUNITY
Water Flow Regulation
Ecosystem Service Provision
High
Low
Surface Water Flood Risk by Catchement
High
Low
ecosulis
0
0.75
1.5 km
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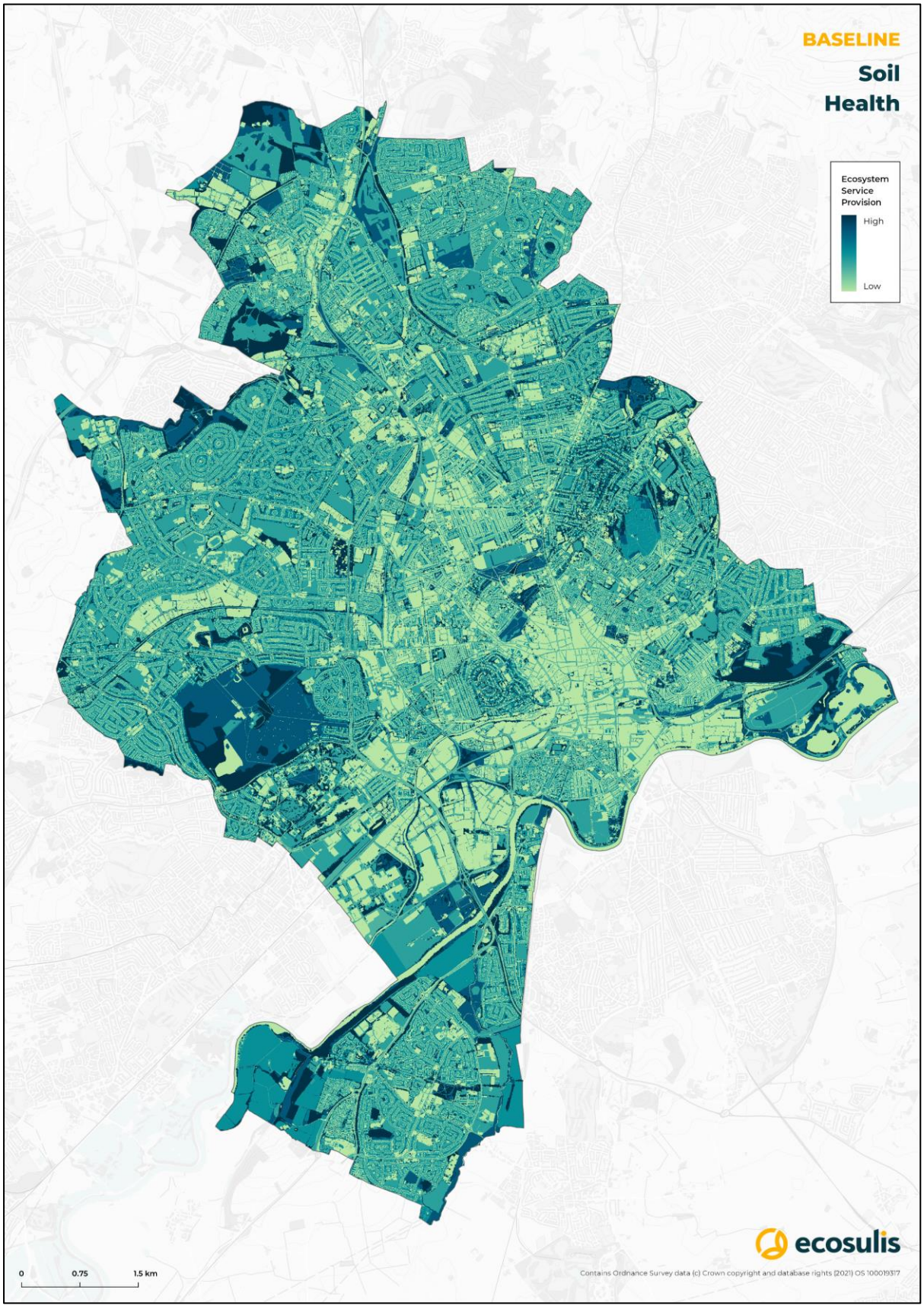

BASELINE
Local Climate Regulation
Ecosystem Service Provision
High
Low
Green Infrastructure
Green Roofs
ecosulis
0
0.75
1.5 km
Contains Ordnance Survey data (c) Crown copyright and database rights (2021) OS 100019317

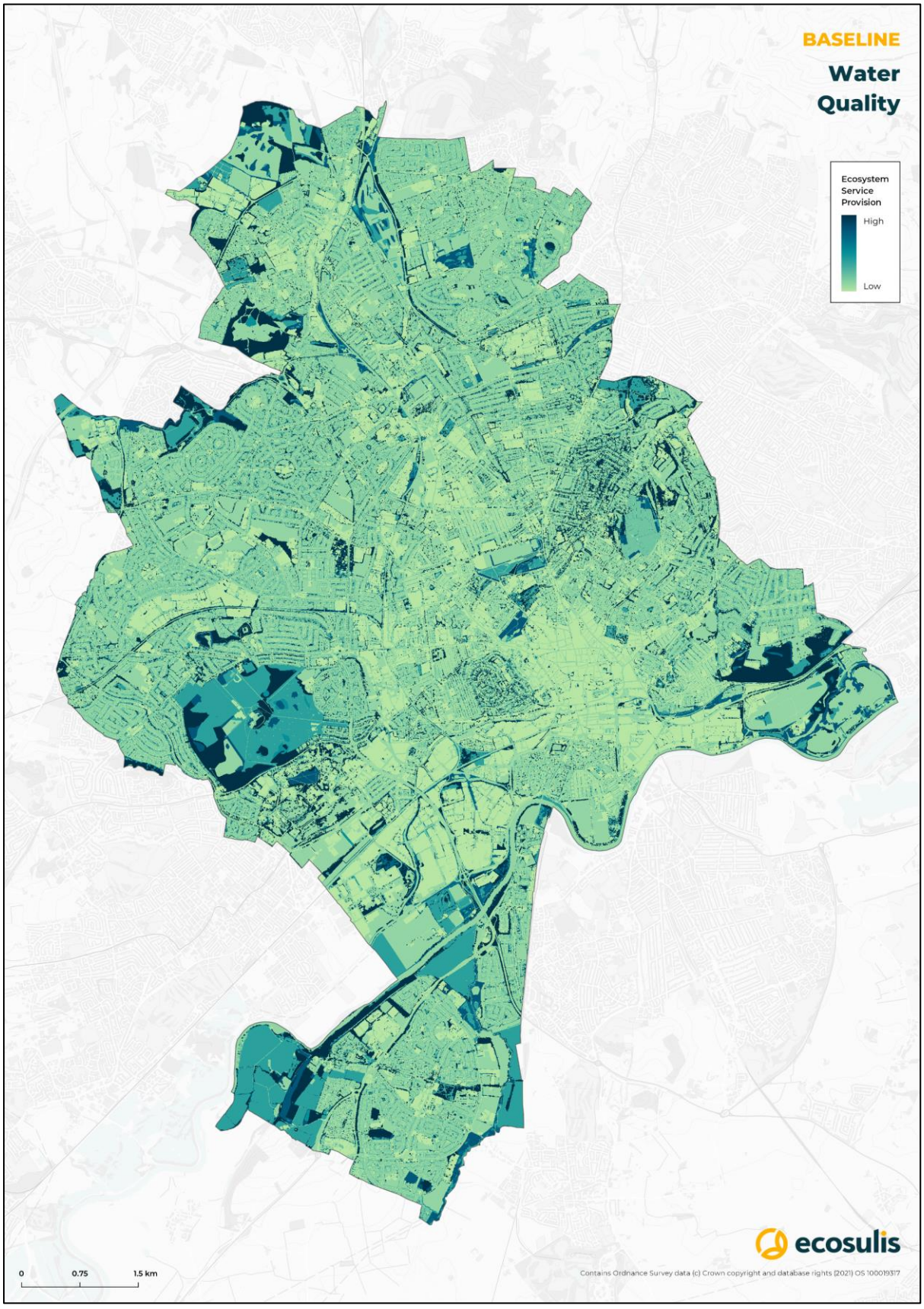

OPPORTUNITY
Local Climate Regulation
Ecosystem Service Opportunity
High
Low
Green Infrastructure
Green Roofs
ecosulis
0
0.75
1.5 km
Contains Ordnance Survey data (c) Crown copyright and database rights (2021) OS 100019317

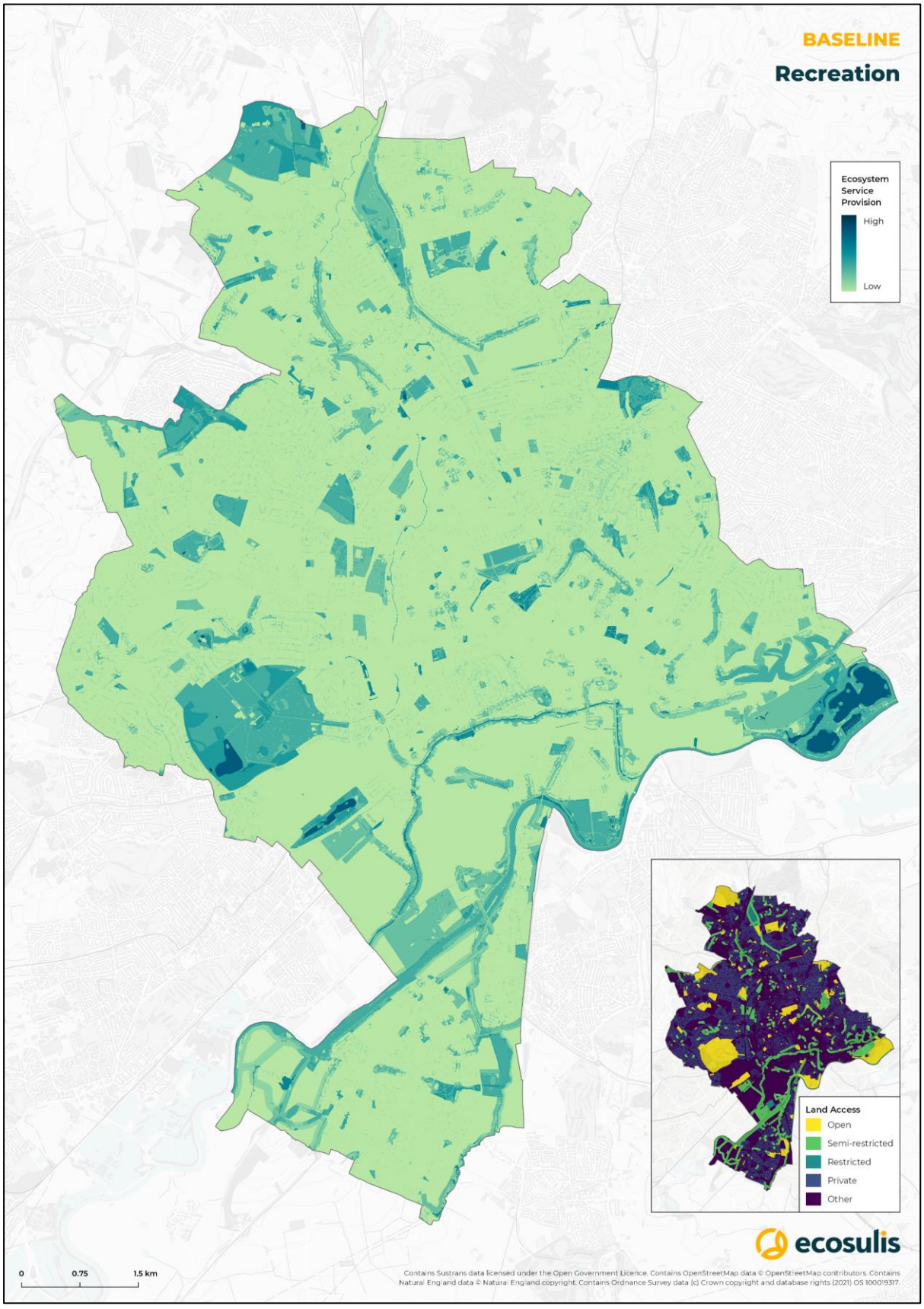

BASELINE
Air Pollutant Removal
Ecosystem Service Provision
High
Low
0
0.75
1.5 km
ecosulis
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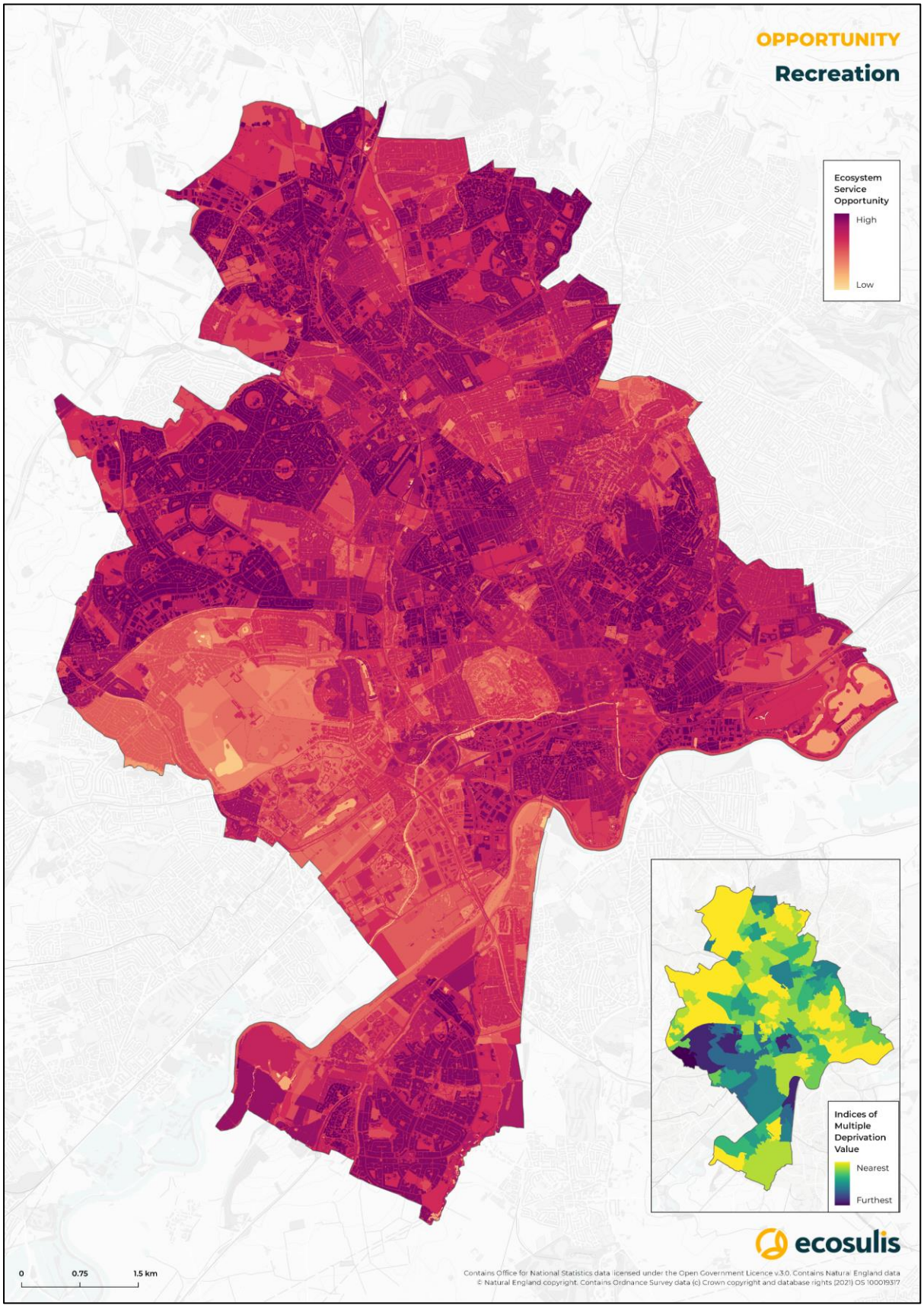

OPPORTUNITY
Air Pollutant Removal
Ecosystem Service Opportunity
High
Low
Regional and National Road Proximity
Nearest
Furthest
ecosulis
0
0.75
1.5 km
Contains Ordnance Survey data (c) Crown copyright and database rights (2021) OS 100019317

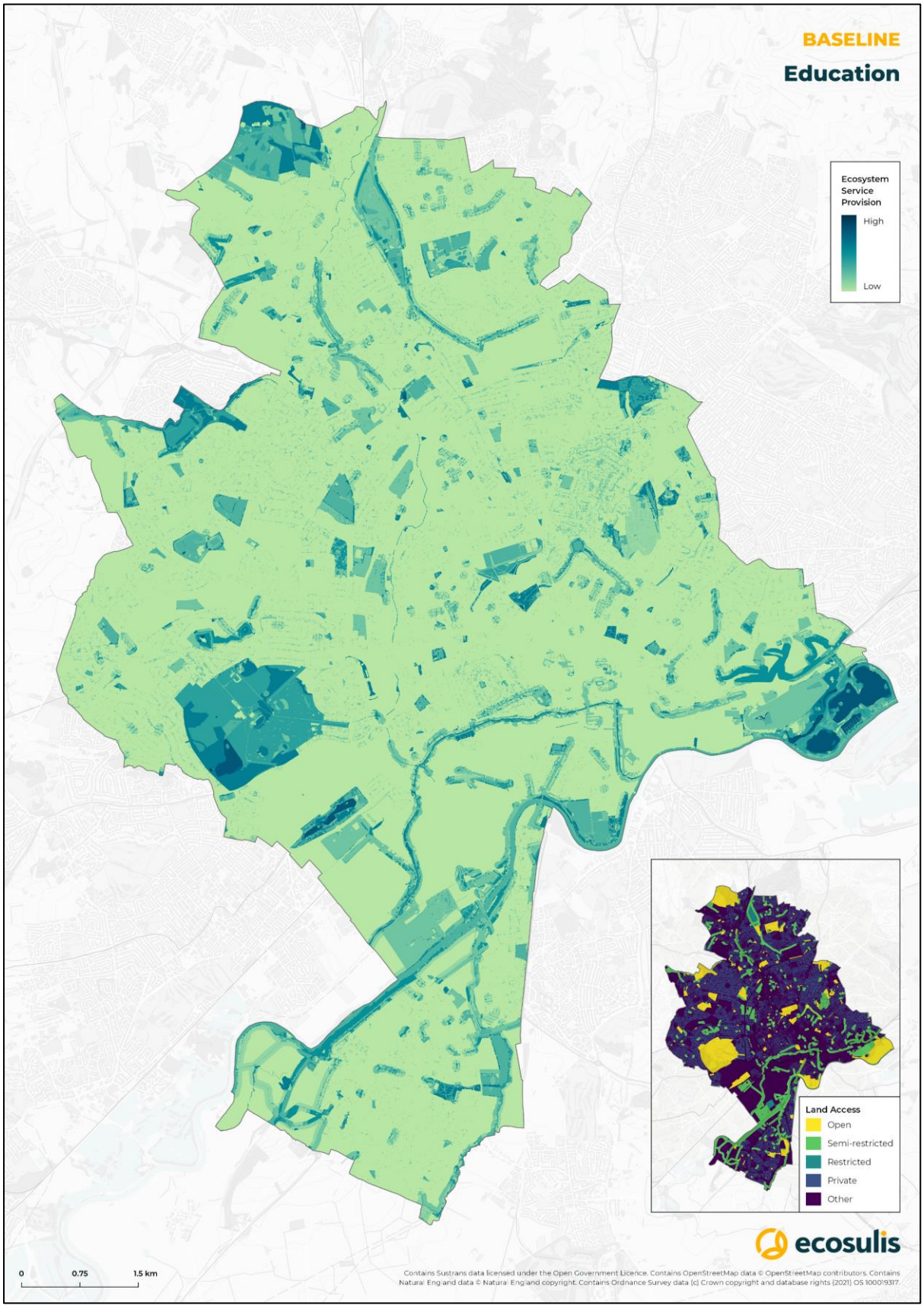

BASELINE
Biodiversity
Ecosystem Service Provision
High
Low
0
0.75
1.5 km
ecosulis
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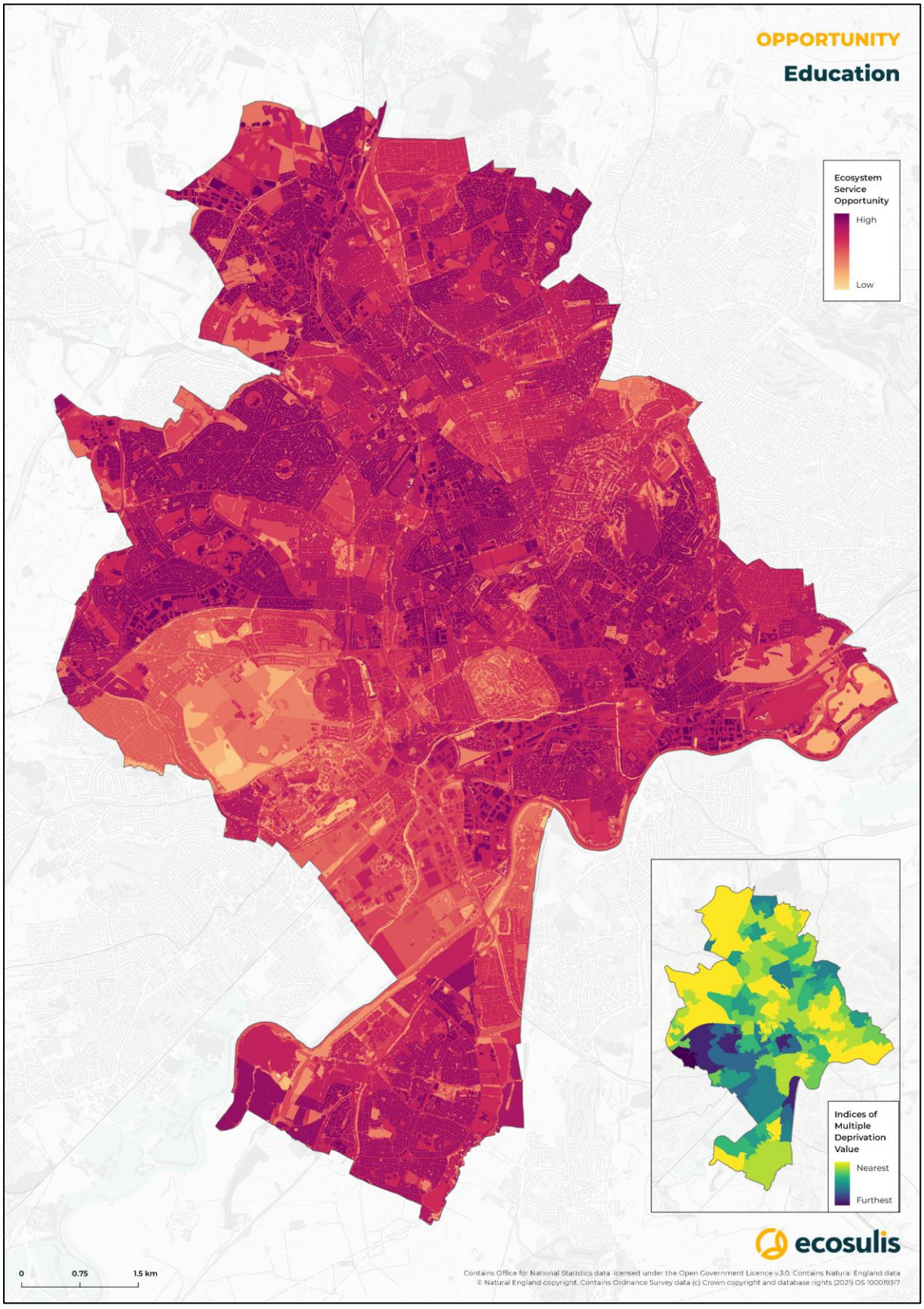

BASELINE
Soil Health
Ecosystem Service Provision
High
Low
0
0.75
1.5 km
ecosulis
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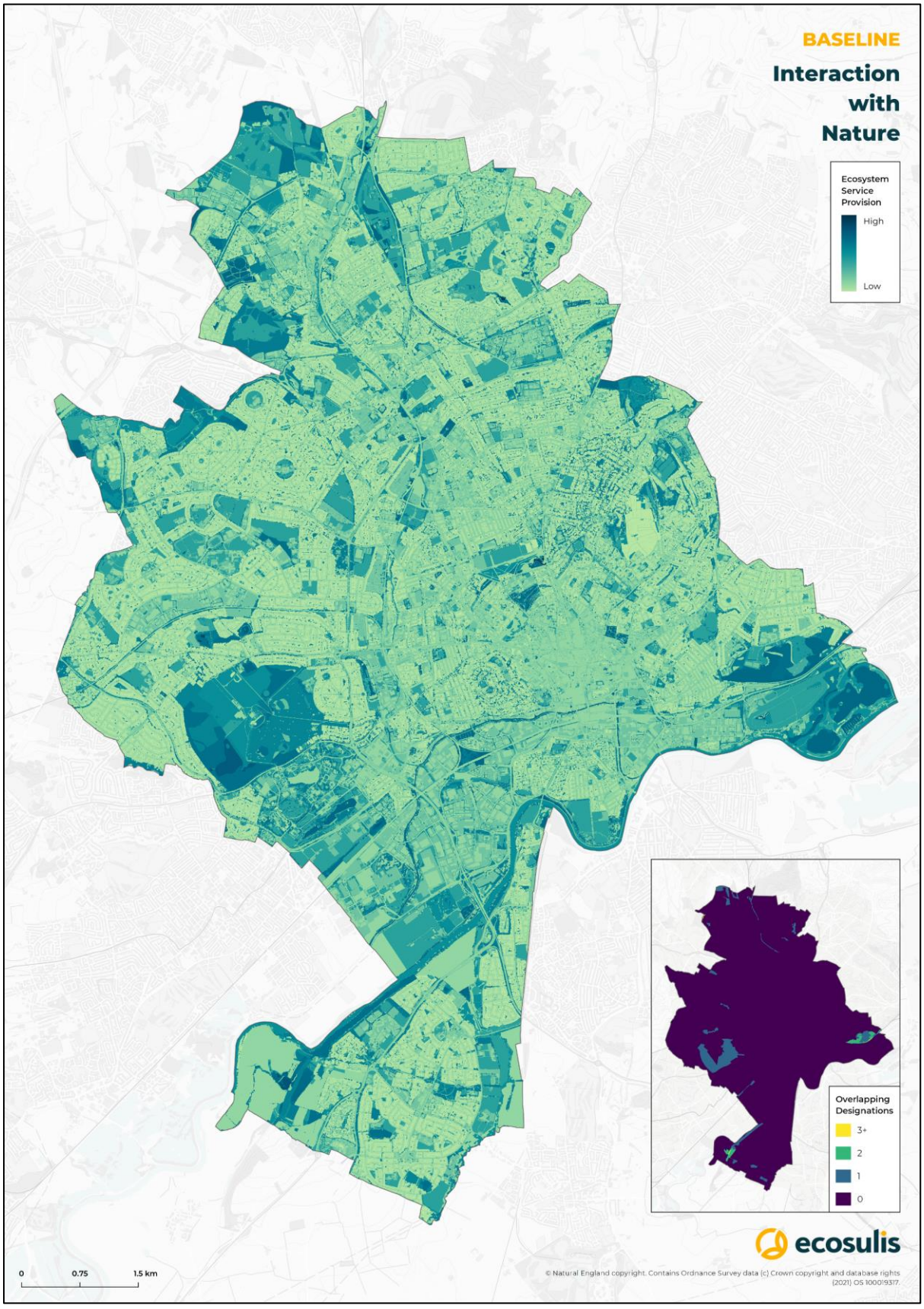

BASELINE
Water Quality
Ecosystem Service Provision
High
Low
ecosulis
0
0.75
1.5 km
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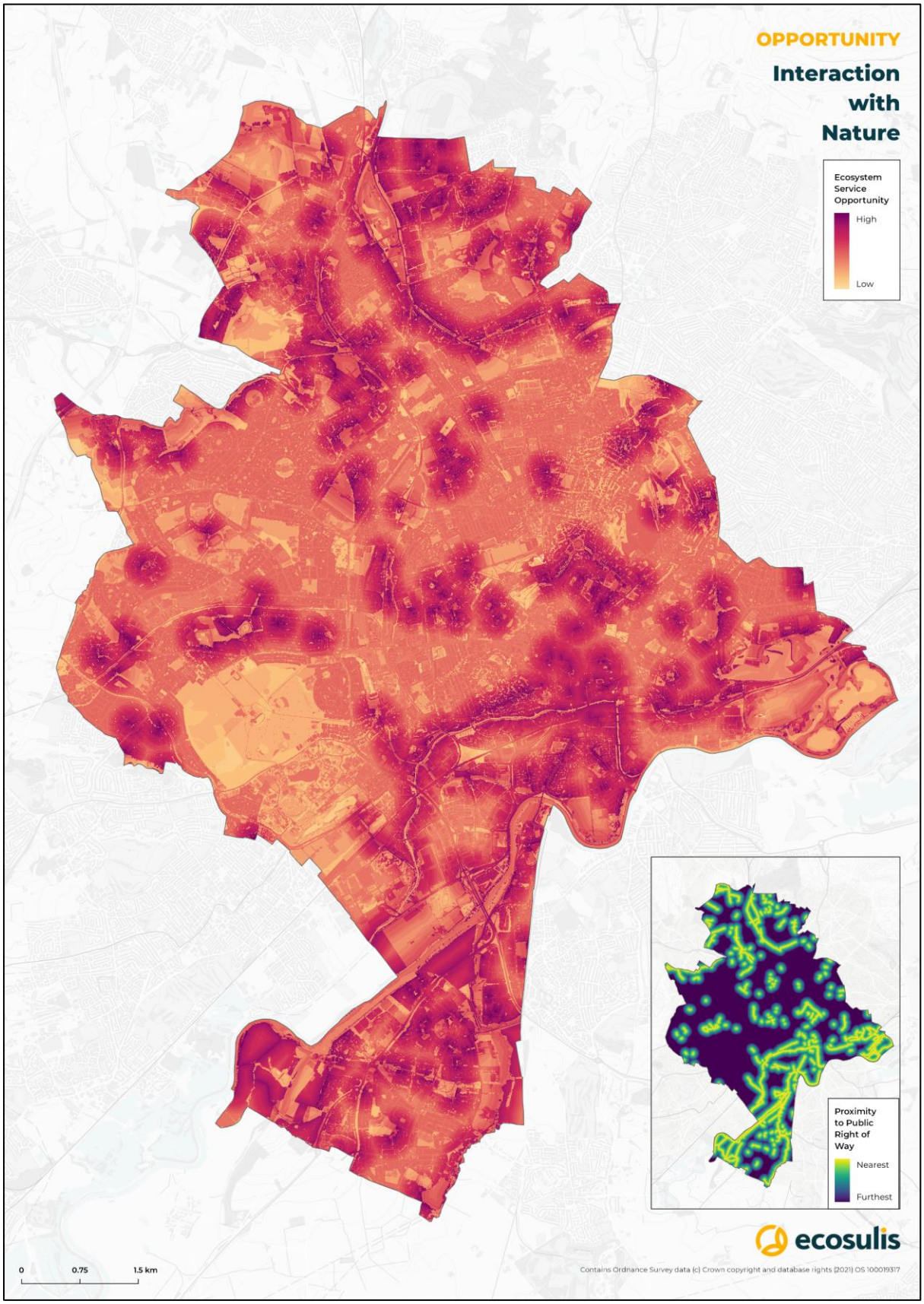

BASELINE
Recreation
Ecosystem Service Provision
High
Low
Land Access
Open
Semi-restricted
Restricted
Private
Other
ecosulis
0
0.75
1.5 km
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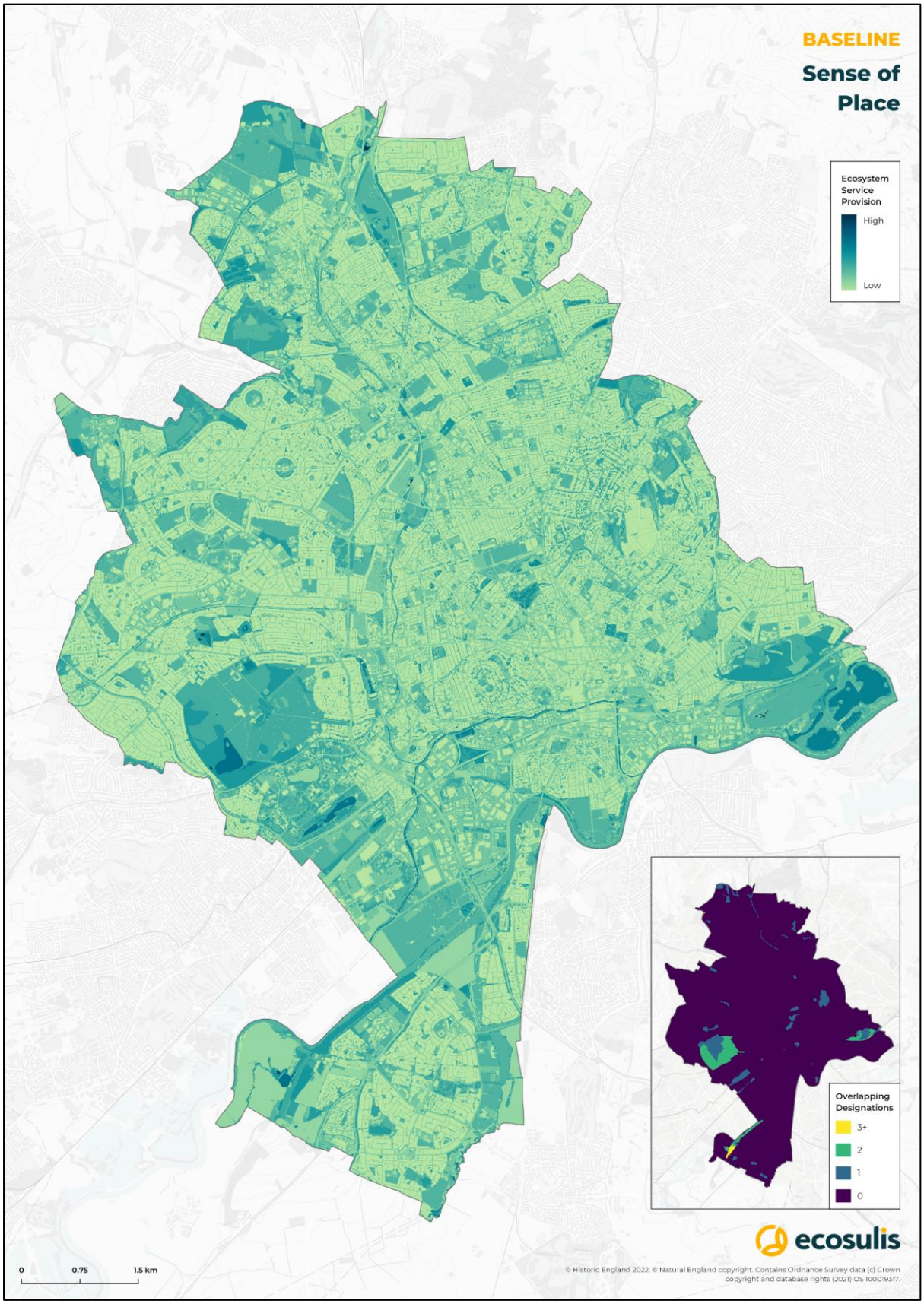

OPPORTUNITY
Recreation
Ecosystem Service Opportunity
High
Low
Indices of Multiple Deprivation Value
Nearest
Furthest
ecosulis
0
0.75
1.5 km
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BASELINE
Education
Ecosystem Service Provision
High
Low
Land Access
Open
Semi-restricted
Restricted
Private
Other
ecosulis
0
0.75
1.5 km
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OPPORTUNITY
Education
Ecosystem Service Opportunity
High
Low
Indices of Multiple Deprivation Value
Nearest
Furthest
ecosulis
0
0.75
1.5 km
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BASELINE
Interaction with Nature
Ecosystem Service Provision
High
Low
Overlapping Designations
3+
2
1
0
ecosulis
0
0.75
1.5 km
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OPPORTUNITY
Interaction with Nature
Ecosystem Service Opportunity
High
Low
Proximity to Public Right of Way
Nearest
Furthest
ecosulis
0
0.75
1.5 km
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BASELINE
Sense of Place
Ecosystem Service Provision
High
Low
Overlapping Designations
3+
2
1
0
ecosulis
0
0.75
1.5 km
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