Malvern Hills Area of Outstanding Natural Beauty

Natural Capital Scoping Study

December 2017

by

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I.   Executive Summary

The overall aim of the project was to generate an initial picture of the value of Natural Capital in the Malvern Hills Area of Outstanding Natural Beauty (AONB) – especially how people benefit from this valuable asset through ecosystem services.

Natural Capital is the stock of natural assets which include geology, soil, air, water and all living things. The benefits people obtain from this Natural Capital stock such as food and timber, recreational opportunities, aesthetic values, health benefits, flood risk regulation, air and water quality regulation, and many more, are called ecosystem services.

This indicative but systematic assessment of the Malvern Hills AONB has revealed that healthy, high quality Natural Capital assets are critically important to both people and wildlife. It is clear that the Natural Capital of the AONB is not just a 'good to have', but is essential for the wellbeing of those living in the AONB as well as those visiting the area. The AONBs Natural Capital is also directly and indirectly contributing to the visitor-based economy.

Figure I.1 shows how different Natural Capital assets contribute to different ecosystem services provided in the AONB. The assessed Natural Capital asset types have different extents within the AONB which is indicated by the box sizes. The box colour indicates the relative importance of each Natural Capital asset category for providing that ecosystem service where dark green indicates the highest positive importance for people's wellbeing whilst red indicates a potential negative effect.

The assessment shows that agricultural Natural Capital assets, arable land and improved grassland, fall below the highest importance in terms of food provision because the land in the Malvern Hills AONB is only of medium productivity. These assets also score low for providing other ecosystem services when compared to other Natural Capital assets and even have a potential negative effect on water quality due to diffuse pollution issues.

Semi-improved and neutral grassland is less productive in terms of food provision but more valuable for biodiversity and aesthetic values. These Natural Capital assets are also likely to have some positive effect on water quality regulation as opposed to their more intensively

managed counterparts. Biodiversity Action Plan (BAP) priority grasslands, dominated by lowland dry acid grassland, provide an even higher biodiversity value. They also offer a high recreational value which is due to the good accessibility of BAP priority grasslands in the AONB, particularly on the Malvern Hills and Commons.

Woodland and traditional orchards provide the most balanced level of ecosystem service provision across all assessed Natural Capital assets. Woodlands and traditional orchards are at least of medium importance for each ecosystem service[1] and superior to other Natural Capital assets in terms of air and climate regulation services (mitigation and adaptation).

The Natural Capital value of the Malvern Hills AONB benefits particularly from the diversity of assets in one area. The comparatively high value of woodland and traditional orchards should not lead to the misinterpretation that the whole AONB should be overplanted with woodland. This may be beneficial for some regulating services but is likely to impact negatively on biodiversity as well as cultural services such as recreation and aesthetic values because views and sceneries would be less diverse.

Another very important service provided by Natural Capital in the AONB is the contribution to public health. Because this is a cross-cutting ecosystem service it has not been assessed directly in Figure I.1 below but as part of other ecosystem services. Natural Capital does not only clean the air we breathe and the water we drink. Access to valuable Natural Capital assets in the AONB also improves people's physical health by providing opportunities for 'green exercise' which helps to prevent diseases such as obesity, diabetes, heart diseases and strokes. Contact with nature is also known to have restorative effects and therefore improves mental health. A healthier population in turn also increases workforce productivity. A detailed assessment of each ecosystem service and how the AONB's different Natural Capital assets contribute to them is provided in Chapter 2 of this report.

It should be noted that the assessment was based on incomplete and sometimes dated data. The underlying science in many areas is also still evolving. This is why this assessment is an indicative assessment. The box frame colour in Figure I.1 indicates the confidence in the assessment for each Natural Capital asset/ecosystem service combination.

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[1] Except harvested products provision by traditional orchards which is likely to be low in average.

Figure I.1 Indicative Natural Capital Assessment for the Malvern Hills AONB

Ecosystem service and group	Natural Capital Asset	Arable 2,826 ha	Improved Grassland 2,746 ha	Semi-Improved & Neutral Grassland 1,311 ha	BAP Priority Grassland 711 ha	Woodland 2,365 ha	Traditional Orchards 141 ha
Provisioning	Harvested Products						
Provisioning	Biodiversity						
Cultural	Recreation						
Cultural	Aesthetic Values & Sense of Place						
Regulating	Flood Regulation						
Regulating	Water Quality Regulation						
Regulating	Air Quality Regulation						
Regulating	Local Climate Regulation						
Regulating	Global Climate Regulation						

Indicative relative level of ecosystem service importance of Natural Capital Asset category in the MH AONB

- High Positive
- Medium Positive
- Low Positive
- Negligible/Unclear
- Likely Negative

Indicative Natural Capital extent in ha

- 2,350-2,850 ha
- 700-1,350 ha
- 141 ha

Confidence in relative level of ecosystem service provision

- High
- Medium
- Low

The assessment is purely indicative and its purpose is to provide a general overview rather than giving a definite answer for each Natural Capital/ecosystem service combination. The figure indicates relative average levels of ecosystem services importance (marginal per ha) provided by different Natural Capital assets. It should be noted that comparison is only feasible within ecosystem services (across Natural Capital asset categories) but not across ecosystem services. It should be stressed that the assessment is indicative and based on incomplete evidence. A main evidence gap was information about the condition, quality and management of habitats. Often an indication was based on national trends rather than local evidence. For more information see the relevant sections of Chapter 2.

*Source: **Author assessment***

It is important to stress that the comparatively high value of Natural Capital in the AONB is not a given. It is a co-product of active management carried out by many individuals and organisations and it faces many pressures. Climate change will lead to higher temperatures which can put vulnerable people at risk. Development pressures, including in surrounding areas visible from the AONB, can disturb views and tranquillity. Potential agricultural intensification can negatively impact on many non-food services including water quality. And increasing visitor pressures can for example lead to overcrowding, the disturbance of biodiversity and increased litter.

In light of these pressures one of the report's key conclusions is that additional efforts and resources are likely to be needed to manage the Natural Capital of the Malvern Hills AONB in the longer term. Underfunding, under-management and neglect of these assets could have significant negative effects – not just for biodiversity and people's wellbeing, but also for public health and the local economy. It is also often difficult and expensive to recreate valuable Natural Capital assets after they have been lost. Continuing enhancements of Natural Capital assets in the Malvern Hills AONB, on the other hand, would further enhance people's wellbeing, health and economic prosperity.

A secondary aim of this study was to assess the potential for valuing Natural Capital assets in the Malvern Hills AONB in monetary terms based on available data and evidence. Out of the 54 Natural Capital asset category/ecosystem services combinations (boxes as per Figure I.1), 23 can (almost) be fully quantified in monetary terms whilst 8 can be partially quantified. However, for some calculations additional data would need to be generated to inform a monetary assessment. The study found that it will be possible to quantify the physical health value related to 'green exercise' and it may also be possible to quantify the mental health value attached to the AONB's Natural Capital. For the other Natural Capital asset category/ecosystem services combinations, robust scientific evidence suitable for monetary quantification is lacking and these assets cannot be monetised.

The global climate regulation services provided by Natural Capital in the AONB (carbon stored in vegetation and topsoils) have already been valued at £59 million (see Section 2.2.9). Which combinations can and can't be quantified is summarised in Figure 3.1 of the

main report. An introduction to monetary valuation as well as full details about additional data requirements are given in Chapter 3 of the main report.

The report concludes with a range of recommendations including a workshop series to fill evidence gaps and a monetary valuation study to make the value of the AONB's Natural Capital more tangible for non-specialists. For the medium to long term it is also recommended that land-use maps should be updated and that a new visitor survey revealing Natural Capital preferences should be conducted. Further recommendations include bringing more traditional orchards and woodlands into management and promoting low intensity farming and local food markets. Proposed climate change adaptation measures include the introduction of more trees to protect visitors and livestock from UV radiation, the provision of additional water storage capacities and the selection of resilient plant species for future habitat creation.

II.   Acknowledgements

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1. Introduction and Background

1.1 Project Aims and Objectives

The aim of the Malvern Hills AONB Natural Capital Scoping Study project was to generate a better understanding of the Natural Capital of the AONB to inform decision making within and between those organisations which influence the character and use of the AONB. The specific objectives were:

1. To establish a broad AONB Natural Capital asset register for the AONB,

2. To list and describe the different ecosystem goods and services which are provided by these key Natural Capital asset types,

3. To broadly grade these elements according to which are likely to be the most and least valuable to people,

4. To identify the forces for change, probability of change and indicators of change affecting them, and

5. To assess the potential for valuing/monetising the Natural Capital assets in the AONB based on the data sets/valuation evidence available.

The assessment is also likely to inform the upcoming review of the AONB Management Plan.

1.2 Introduction to the Malvern Hills AONB

The Malvern Hills Area of Outstanding Natural Beauty is dominated by the granitic ridge of the Malvern Hills. The AONB is 105 km^2 in size, covering parts of the three counties of Gloucestershire, Herefordshire and Worcestershire. It stretches from the edge of Malvern in the east to the edge of Ledbury in the west, and from the A44 in the north to the M50 in the south. The AONB has an estimated population of 12,200. From the early 1800s the area was very popular for its pure spring water which lead to great popularity with tourists and visitors.

Figure 1.1 Malvern Hills AONB Location Map
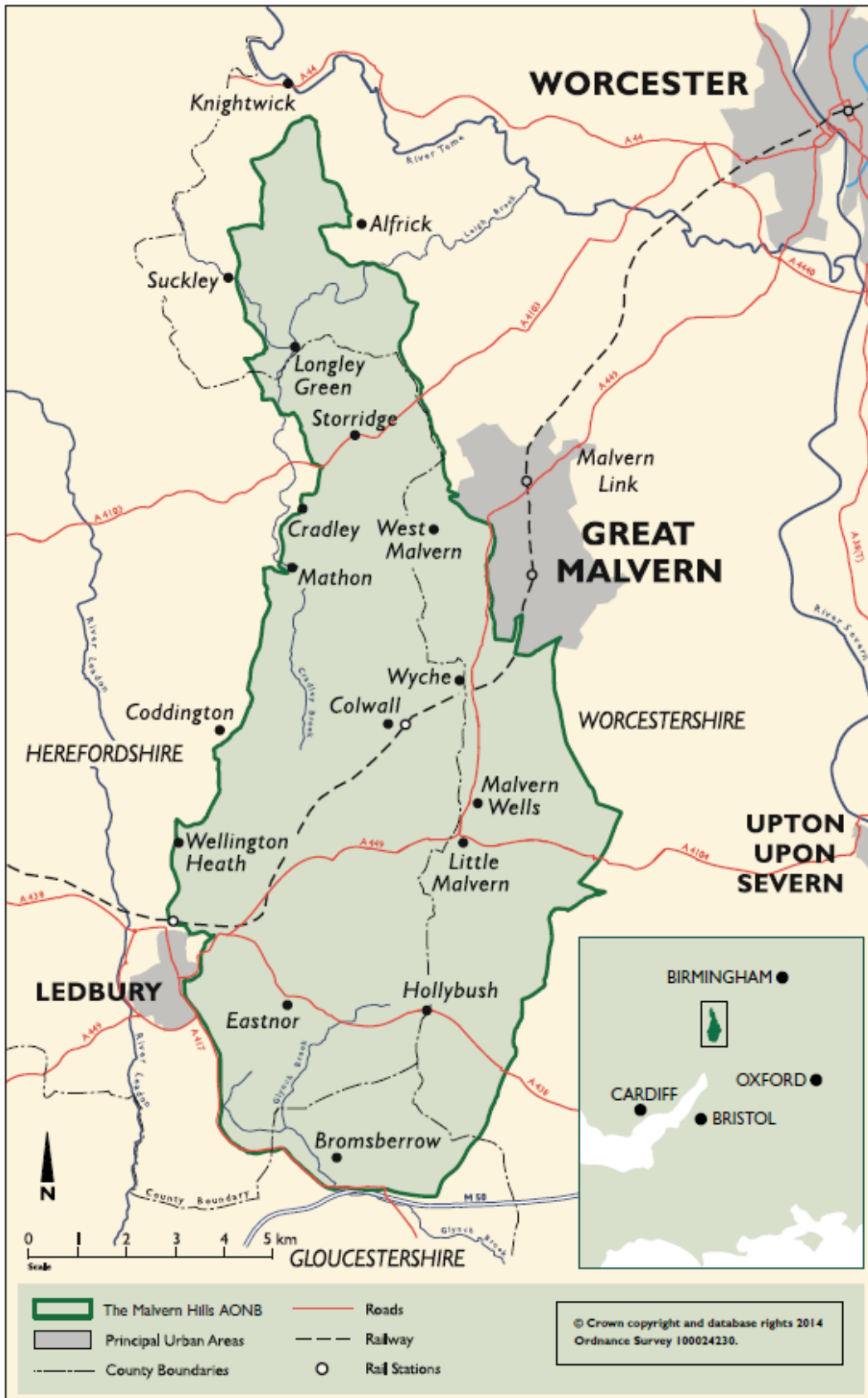
Source: Extracted from Malvern Hills AONB Partnership 2014

The area was designated an AONB in 1959; demonstrating that the area's distinctive character and natural beauty is so outstanding that it is in the nation's interest to safeguard it. The landscapes of AONBs are equal in value to those of our National Parks and command the same levels of planning protection. 'Natural beauty' is taken to include geology, climate, soils, plants, animals, communities, archaeology, buildings, the people who live in it, past and present, and the perceptions of those who visit it.

The Malvern Hills AONB Partnership includes local authorities, government bodies, parish councils, landowners, communities and voluntary groups. The AONB Partnership is the only body that has responsibility for the AONB as a whole and was established to provide strategic direction and coordination, principally through the implementation of an AONB Management Plan. For more information see www.malvernhillsaonb.org.uk.

1.3   Natural Capital & Ecosystem Services Introduction

The natural environment surrounding us is not just 'good to have' but is critically important to our wellbeing and economic prosperity.[2] Ecosystems, such as a water catchment, a forest or even a single tree, provide us with many goods and services including food, timber, space for recreation, a pleasant amenity, water and air quality regulation functions, climate regulation benefits, and many more including their wider health and wellbeing benefits. These natural assets are often called Natural Capital which can be defined as:

> *"The world's stocks of natural assets which include geology, soil, air, water and all living things. It is from this Natural Capital that humans derive a wide range of services, often called ecosystem services, which make human life possible."*[3]

Ecosystem services are commonly defined as *"the benefits people obtain from ecosystems"*.[4] Ecosystem services are often categorised into provisioning, cultural, regulating and supporting services. Provisioning services are the goods and services we physically gather from nature such as food and timber. Cultural services describe the effects of contact with nature on human wellbeing such as recreational opportunities and aesthetic values including

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[2] UK NEA 2011a.
[3] World Forum on Natural Capital, Edinburgh 2015
[4] Millennium Ecosystem Assessment 2005.

related health benefits. When nature has an indirect effect on our wellbeing for example by improving air quality, mitigating the impacts of climate change or reducing the risk of flooding then we describe such services as regulating services. Supporting services such as pollination or soil formation, as the name indicates, support the provision of all other ecosystem services we are directly benefiting from. For more examples for ecosystem services see Figure 1.2 below[5]. For more details about Natural Capital and ecosystem services science see for example the UK National Ecosystem Assessment.[6]

The UK National Ecosystem Assessment 2011 has revealed that many ecosystem services in the UK are already in a degraded and/or declining state. Drivers of change such as population growth and climate change are likely to further increase pressure on ecosystem services in the future.[7] The following sections of this report outline the ecosystem services assessed within the scope of this study in greater detail.

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[5] Supporting services are not listed in the figure because of the indirect effect. The figure only shows so called final ecosystem services with an immediate effect on human wellbeing.
[6] UK NEA 2011a.
[7] UK NEA 2011b.

Figure 1.2 Examples of Ecosystem Services

Provisioning Services

Food: Ecosystems provide the conditions for growing food.

Raw materials: For example timber to construct furniture.

Fresh water: Ecosystems provide surface and groundwater.

Cultural Services

Wild species diversity: Ecosystems provide everything that an individual plant or animal needs to survive.

Recreation: Accessible greenspace offers a space for many recreational opportunities including walking, picnicking, sports, etc.

Aesthetic Values & Sense of Place: People benefit from a view of beautiful landscapes.

Health Benefits: Contact with ecosystems has positive effects on physical as well as mental health.

Regulating Services

Climate regulation: Vegetation captures and stores carbon; it also mitigates extreme temperatures in urban settings.

Moderation of extreme events: Ecosystems create buffers against natural hazards such as flooding events.

Water and air quality regulation: Micro-organisms and plants remove and decompose pollutants from air and water bodies.

Note: The above is a selection of ecosystem services and not an exhaustive list.

*Source: **Based on TEEB, 2010 and UK NEA, 2011.***

The continuing decline of Natural Capital means that we cannot keep on taking such ecosystem services for granted anymore. Natural Capital needs to be actively protected, enhanced and managed to secure a sustainable flow of ecosystem services; and ultimately our own human wellbeing and economic prosperity.

In its Natural Environment White Paper (NEWP), published in 2011, the Government states that:

"Nature is sometimes taken for granted and undervalued. But people cannot flourish without the benefits and services our natural environment provides. Nature is a complex, interconnected system. A healthy, properly functioning natural environment is the foundation of sustained economic growth, prospering communities and personal wellbeing. This is why we must properly value the economic and social benefits of a healthy natural environment while continuing to recognise nature's intrinsic value. The Government wants this to be the first generation to leave the natural environment of England in a better state than it inherited."[8]

In reaction to the Government's NEWP the Natural Capital Committee has been established as an independent advisory committee which provides advice to the government on the sustainable use of Natural Capital. In its 3rd State of Natural Capital report, the National Capital Committee stresses that:

"Successive 'natural capital deficits' have built up a large natural capital debt and this is proving costly to our wellbeing and the economy. If economic growth is to be sustained, natural capital has to be safeguarded. Pressures on natural capital are already too high but they are set to intensify, with more people expected to be added to England's population over the next 25 years than in any previous similar time period. Given these increasing pressures, significant changes to past practice will be required if we are to achieve the Government's laudable commitment to be the first generation to leave the natural environment in a better state."[9]

Biodiversity is essential in the context of Natural Capital and ecosystem services. Biodiversity underpins all ecosystem services as all, at least partially, depend on living organisms and processes. Usually the level and stability of ecosystem services also increases with species

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[8] HM Government 2011, 3.
[9] Natural Capital Committee 2015, 2.

diversity.[10] This makes species diversity essential for our wellbeing. But biodiversity is not just supporting other ecosystem services but is also an ecosystem service in its own right as people usually have a preference for a diverse flora and fauna as compared to for example monocultures and species poor habitats and landscapes.[11] The widely recognised Lawton Review 'Making Space for Nature', published in 2010, summarises:

> *"The essence of what needs to be done to enhance the resilience and coherence of England's ecological network can be summarised in four words: more, bigger, better and joined."*[12]

A first step is to better understand and assess Natural Capital because *'what gets measured gets managed'*. This Natural Capital Scoping Study is designed to advance the understanding of Natural Capital and the ecosystem services that flow from them in the Malvern Hills AONB.

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[10] Norris et al. 2011.
[11] UK NEA 2011b.
[12] Lawton et al. 2010, viii.

2. Natural Capital Asset Check

The Malvern Hills AONB Management Plan (2014-19) recognises that the AONB provides a wide range of benefits to society and that a healthy, natural environment is a cost-effective tool that should help partners to, inter alia, support economic and social regeneration and improve public health. The management plan also states that there is a need to consider the value of these services when taking actions that affect the AONB.[13]

The first step towards valuing ecosystem services is to establish a robust baseline of Natural Capital assets. This is in line with Policy BP5 of the Management Plan: Lack of data.[14] Section 2.1 of this report assesses and maps the Natural Capital assets which exist within the Malvern Hills AONB. Section 2.2 assesses the importance of the ecosystem services that flow from these assets. This includes an analysis of the supply of and demand for ecosystem services as well as drivers of change. Based on these individual assessments Section 2.3 then provides an overview of the importance and indicative value of the ecosystem services which flow from the AONB's different Natural Capital assets.

This assessment follows the Natural Capital Asset Check (NCAC) framework produced as part of the National Ecosystem Assessment Follow-On (NEAFO).[15] However, not all elements are included within scope of this scoping study and the framework has been modified accordingly.[16]

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[13] Malvern Hills AONB Partnership 2014a.
[14] Ibid., 28.
[15] Dickie, Cryle, and Maskell 2014.
[16] A NCAC offers a way of analysing available evidence to provide insights into the productive relationships that define natural capital through the following questions: (a) How much of a natural capital asset do we have? (b) What does it produce? (c) How do our decisions affect (a) and (b) over time? (Ibid., 5) Within scope of this study the focus was on question a and b but without economic quantification. Less emphasis has been given to question c although drivers of change have been analysed and some recommendations on how decisions could sustain and/or enhance Natural Capital value in light of pressures such as climate change.

2.1   Spatial Natural Capital Asset Register

Before we can assess the importance and value of Natural Capital in the Malvern Hills AONB, we need to establish the scope and physical boundaries of the assessment. Within the scope of this assessment the focus is on renewable Natural Capital assets that perform ecosystem services as opposed to non-renewable assets such as for example gas and gravel.

The physical boundaries of the assessment are defined by the boundaries of the Malvern Hills AONB. However, ecosystem services usually do not stop at the boundaries and can for example even have a global effect such as in case of climate regulation services. Here, we focus on ecosystem services produced by Natural Capital within the AONB boundary, even if the benefits may well exceed the AONB boundaries.

Geographic Information System (GIS) software was used to establish a register of Natural Capital assets. Spatial land-use information was provided by different sources including the Centre for Ecology & Hydrology (CEH), the Forestry Commission, Malvern Hills District Council, Malvern Hills Trust and Natural England.

Because different spatial land-use/habitat datasets had different levels of detail, were established at different points in time and had different spatial coverage, an order of data was established to make the best use of existing datasets. For each single spatial area, the highest order dataset was used first to help establish the Natural Capital asset register. The order of data is mainly related to the year of data with the most recent dataset generally being used first. Malvern Hills District Landcover Assessment has been given priority over the Land Cover Map 2007 because it is more detailed. Table 2.1 summarises the datasets informing the spatial analysis as well as the order of data.

Table 2.1 Datasets Informing the Natural Capital Asset Register

Order of data	Dataset	Source of data	Spatial Coverage of the Malvern Hills AONB	Year of data
1	Biodiversity Action Plan Priority Habitat Inventory	Natural England	Full	2015
2	Ancient Woodland Inventory	Natural England	Full	2015/16
3	National Forest Inventory (NFI)	Forestry Commission	Full	2015/16
4	Malvern Hills Trust Land Phase 1 Habitat Assessment	Malvern Hills Trust	Partial (Trust Land Only)	2013
5	Malvern Hills District Landcover Assessment[17]	Malvern Hills District Council	Partial (Malvern Hills District Only)	2005-2009
6	Land Cover Map 2007[18]	CEH	Full	2007

Source: **Author**

By combining these datasets an excellent spatial coverage of 98% of the Malvern Hills AONB was achieved. The different land-use types described by the datasets were grouped into broader Natural Capital asset categories to make the data manageable for the service flow analysis in the following sections. An overview of the different asset categories is provided in Table 2.2. Please refer to Appendix A to see a more detailed Natural Capital asset register including which land-use types are included in each asset category and by which datasets they were informed.

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[17] This landcover map covered the whole Malvern Hills District and is based on the Integrated Habitat System (IHS). For more information see http://ihs.somerc.co.uk/.
[18] Land Cover Map 2007 is derived from satellite images and digital cartography and gives land cover information for the entire UK. Land cover is based on UK Biodiversity Action Plan Broad Habitats. For more information see https://www.ceh.ac.uk/services/land-cover-map-2007.

Table 2.2 **Malvern Hills AONB Natural Capital Asset Categories**

Natural Capital Asset Category	Area in ha	Coverage in % of AONB
Arable	2,825.9 ha	27%
Traditional Orchards	140.8 ha	1.3%
Improved Grassland	2,746.1 ha	26%
Semi-Improved & Neutral Grassland	1,310.6 ha	12%
BAP Priority Grasslands	711.3 ha	7%
Wetland	3.6 ha	0.03%
Woodland	2,364.6 ha	22%
Open Water	28.1 ha	0.3%
Other (e.g. build-up areas and gardens)	277.2 ha	3%
Total coverage	10,437.9 ha	98%

*Source: **Author calculation based on data provided by ERCCIS.***

Considering that some of the datasets informing the asset register were quite dated, it should be noted that some land-uses may have changed in the meantime. However, this register is based on the most complete and advanced GIS data that was available to the project at the time of compilation. Figure 2.1 shows a map with all identified Natural Capital assets.

It should also be noted that intensively managed orchards have not been mapped as such but are likely to have been categorised as 'arable and horticulture' in the Land Cover Map 2007 dataset. Further mapping and 'ground-truthing' work would be beneficial to identify the total orchards resource across the AONB which would also allow an assessment of traditional/commercial orchard proportion.

Figure 2.1 Spatial Natural Capital Asset Register for the Malvern Hills AONB

Legend
- Arable
- Traditional Orchards
- Improved Grassland
- Semi-Improved & Neutral Grassland
- BAP Priority Grassland
- Wetland
- Woodland
- Open Water
- Other

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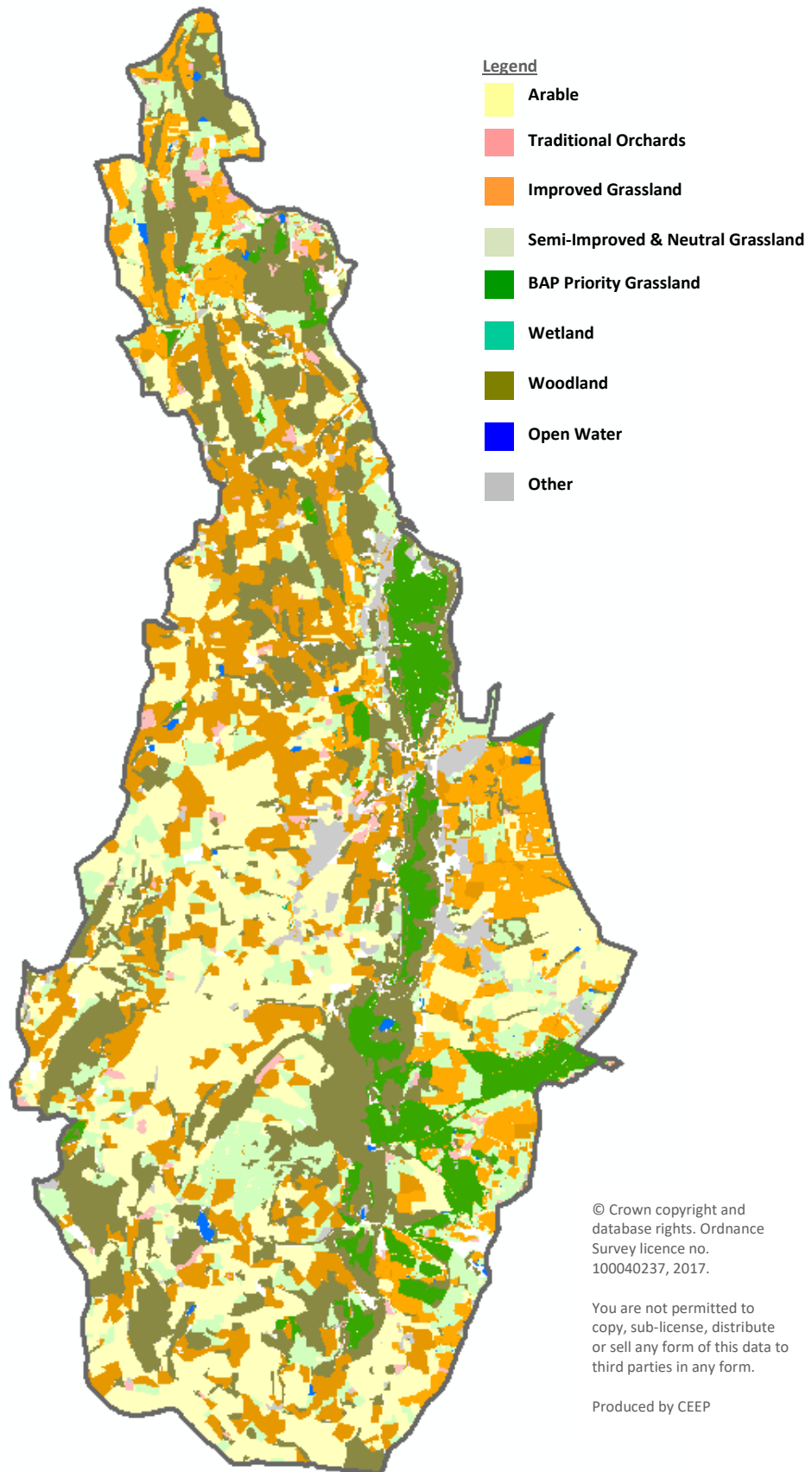
*Source: **Based on GIS data provided by different sources (see Table 2.1)***

2.2   Ecosystem Services Flow Analysis

The Malvern Hills AONB Management Plan (2014-19) recognises that ecosystem services[19] provide a wide range of benefits to society including economic and health benefits and that these services   needs to be managed sustainably so that benefits are not eroding over time.[20] Different Natural Capital assets provide different ecosystem services to different extents. In this section the ecosystem services provided by different Natural Capital assets within the Malvern Hills AONB were systematically assessed and graded (high, medium, low importance) in terms of their importance to people and society. This also includes beneficiaries outside the boundaries of the AONB which are for example affected by water quality regulation services. The scoring is based on different local and national statistics and evidence as well as the expertise of the consultant.

The relative level of importance in this context means that Natural Capital asset A (e.g. arable land) is likely to provide on average more of a certain ecosystem service per ha than Natural Capital asset B (e.g. traditional orchard). It must be noted that within this framework comparison is only feasible for Natural Capital assets across a single ecosystem service and not between different ecosystem services. It should also be noted that the grades given represent averages across all assessed Natural Capital assets and areas grouped into each Natural Capital asset category. The importance of areas and assets within these asset categories can vary quite significantly. So for example, traditional orchards in one part of the AONB may be considerably more important for biodiversity than orchards in another area.

Finally, it should also be acknowledged that within the terms of this scoping study only an indicative assessment of ecosystem services importance was possible. A monetary valuation study would add more detail and accuracy to the understanding of Natural Capital value within the Malvern Hills AONB (see also Chapter 3).

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[19] Also called 'environmental services' as in the Management Plan.
[20] Malvern Hills AONB Partnership 2014a, 8.

2.2.1 Harvested products

The ecosystem service 'harvested products' is one of the more obvious provisioning ecosystem services and includes things like food, timber and woodfuel we physically grow and gather from nature. It also includes activities like collecting mushrooms or hunting as well as for example ornamental resources used for decorative, artistic or educational purposes including stones and minerals.

For food production, agricultural land is the most significant Natural Capital asset. Figure 2.2 shows that most land in the Malvern Hills AONB is of moderate or low agricultural productivity with only small areas falling within the higher Agricultural Land Classification (ALC) grades 1 and 2. Most of the land has an ALC grade of 3 or 4 which also explains why much of the land is managed to produce grassland rather than arable crops.

Considering that land in the Malvern Hills AONB is only of moderate quality for food production both arable and improved grassland have been attributed a moderate importance in terms of harvested products provision when compared to more fertile land. The fact that many farms which receive Entry Level Stewardship also receive Higher Level Stewardship may support this assessment as Higher Level Stewardship usually encourages benefits beyond food production maximisation.

The productivity in terms of harvested products of semi-improved and neutral grassland (including BAP priority grasslands) is generally lower than that of improved grassland due to lower intensity grazing and limited/no use of fertilisers.

Traditional orchards provide a wide range of benefits including biodiversity, aesthetic values etc. However, the provision of harvested products is likely to be limited when for example compared to commercial orchards which are often maximised for harvesting but provide little added benefits. Fruit trees, mainly apple, pear and cherry, provide for example the main ingredients for increasingly popular cider production in England. Considering that some traditional orchards in the Malvern Hills AONB are lacking management[21] there seems to be

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[21] Ibid., 41.

an opportunity to increase both, harvested products and biodiversity value if brought into sustainable management.

Figure 2.2 Agricultural Land Classification (Provisional) within the Malvern Hills AONB
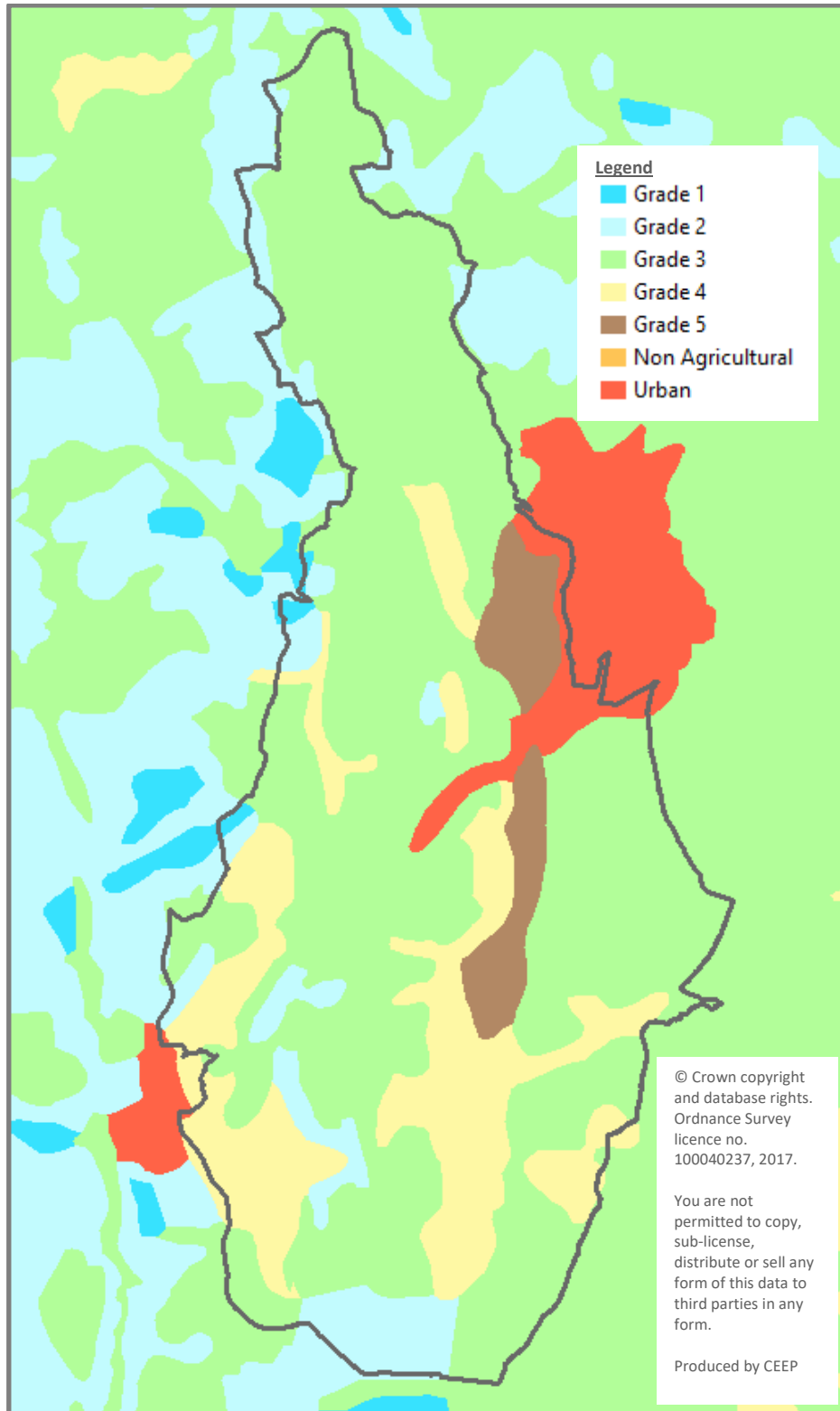
*Source: **Based on GIS data provided by Natural England***

Woodland is commonly managed to produce timber and also increasingly for woodfuel. But in the Malvern Hills AONB many woodland areas are under- or unmanaged. Furthermore, woodlands within the Malvern Hills AONB are often small, fragmented and difficult to access which limits the harvesting potential.[22] The comparatively small areas of coniferous woodland (173 ha; 7% of total woodland) and felled woodland (11 ha; <0.5%) within the AONB also indicates that productivity in terms of timber/woodfuel production is limited.[23] There are also other harvested products services provided by woodlands in the AONB such as providing cover for game birds and the provision of berries and mushrooms but these services are unlikely to be significant and will not make up for the limited timber/woodfuel provision which is why woodland has been graded 'medium' in terms of provisioning services.

Table 2.3 **Indicative Value of Harvested Products by Natural Capital Asset**

Natural Capital Asset Category	Relative Importance
Arable	Medium
Traditional Orchards	Low
Improved Grassland	Medium
Semi-Improved & Neutral Grassland	Low
BAP Priority Grasslands	Low
Woodland	Medium

*Source: **Author assessment***

Agricultural intensification and the uptake of more short-rotation energy crops could somewhat increase productivity but the potential is always likely to be limited. Intensification is also likely to conflict with other important ecosystem services such as water quality regulation (increased diffuse pollution) and biodiversity.

Another adverse effect of agricultural intensification is the impact on pollinators such as bees, bumblebees and hoverflies. Such pollinators are vulnerable to incorrectly applied pesticides which can increase mortality rates and reduce reproduction rates. The replacement or reduction of semi-natural habitats such as hedgerows and unimproved grassland by intensively farmed areas could also reduce populations of natural pollinators

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[22] Ibid., 40.
[23] 2015 based National Forest Inventory statistics © Forestry Commission copyright 2017.

which, UK-wide, are already in undersupply.[24] This is likely to make intensified agricultural production in the AONB more expensive because more commercially produced pollinators such as commercial bumblebees may need to be purchased.

Instead, the promotion and branding of local food markets may be beneficial as it may allow farmers to achieve a price premium, increase the sense of local 'ownership', and reduces carbon due to short transport routes. However, this requires for example educating the local population as well as visitors about the benefits of localised, organic markets and supply chains.

In light of the increasing demands for renewable energy sources such as woodfuel there is also potential to increase woodland productivity. In March 2017 only 53% of woodland in the AONB was considered to be actively managed which is a slight decline from the year before.[25] Only 60 ha of woodland were managed under Environmental Stewardship in March 2017.[26]

This increasing demand for woodfuel may bring woodland areas which were formally economically unviable for harvesting into active management which usually also supports other ecosystem services such as biodiversity. Collective management of smaller patches of woodland in diverse ownerships may be one way to increase management efficiency.

2.2.2   Biodiversity

The term 'biodiversity' generally describes the diversity of life on earth, both between and within species. Biodiversity underpins all ecosystem services as all, at least partially, depend on living organisms and processes.[27]

> *"…evidence shows that, in general terms, the level and stability of ecosystem services tend to improve with increasing biodiversity."*[28]

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[24] Dickie, Cryle, and Maskell 2014.
[25] Woodland statistics © Forestry Commission copyright 2017.
[26] Source: Natural England
[27] Norris et al. 2011, 64.
[28] Ibid.

But biodiversity is not just a supporting service to other ecosystem services but also a cultural ecosystem service as people have a preference for a high biodiversity and the preservation of species – even if they do not directly use (watch/experience) biodiversity themselves.[29]

Semi-natural habitats are generally known to better support biodiversity than agriculturally improved areas and coniferous woodland plantations. Lowland meadows, for example, sometimes support more than 100 species.[30] In light of continuing biodiversity losses across the UK, the Lawton Review calls for more, bigger, better and joined semi-natural habitats as being key to support biodiversity.[31]

Figure 2.3 shows the semi-natural habitat network within the Malvern Hills AONB. One can see that there is a comparatively good extent of semi-natural habitats across the AONB (4,492 ha; 42% of AONB area). With 12% area coverage, the Malvern Hills AONB has for example one of the highest ancient woodland (ASNW & PAWS) proportions across AONBs and National Parks in England.[32] The map also suggests that, in most areas, semi-natural habitats are well connected although connectivity could be improved in the centre-west, the centre-east and the very south of the AONB. Connectivity to semi-natural areas outside the AONB has not been assessed as part of this scoping study but this would be a desirable task for the future. The underlying geodiversity including diverse soil types is also an important factor in shaping the diversity of habitat types.[33]

The high biodiversity value of the Malvern Hills AONB is also evidenced by the fact that almost 11% of the AONB area (15 sites in total) benefits from Sites of Special Scientific Interest (SSSIs) designation; most to protect biodiversity. In addition, there is one Local Nature Reserve and a further 63 Local Wildlife Sites covering 2,274 ha.[34] The AONB is also

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[29] Norris et al. 2011.
[30] Natural England 2015.
[31] Lawton et al. 2010.
[32] Ancient Woodland Inventory data © Natural England copyright. Contains Ordnance Survey data © Crown copyright and database right 2017
[33] Malvern Hills AONB Partnership 2014a, 12.
[34] Ibid., 26.

recognised as a 'Category V Protected Landscape' by the International Union for the Conservation of Nature (IUCN) which is usually related to its high biodiversity.[35]

Figure 2.3 Semi-Natural Habitat Network in the Malvern Hills AONB

Legend
- Traditional Orchards
- Semi-Improved & Neutral Grassland
- BAP Priority Grassland
- Wetland
- Broadleaved Woodland & ASNW/PAWS
- Open Water

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Produced by CEEP
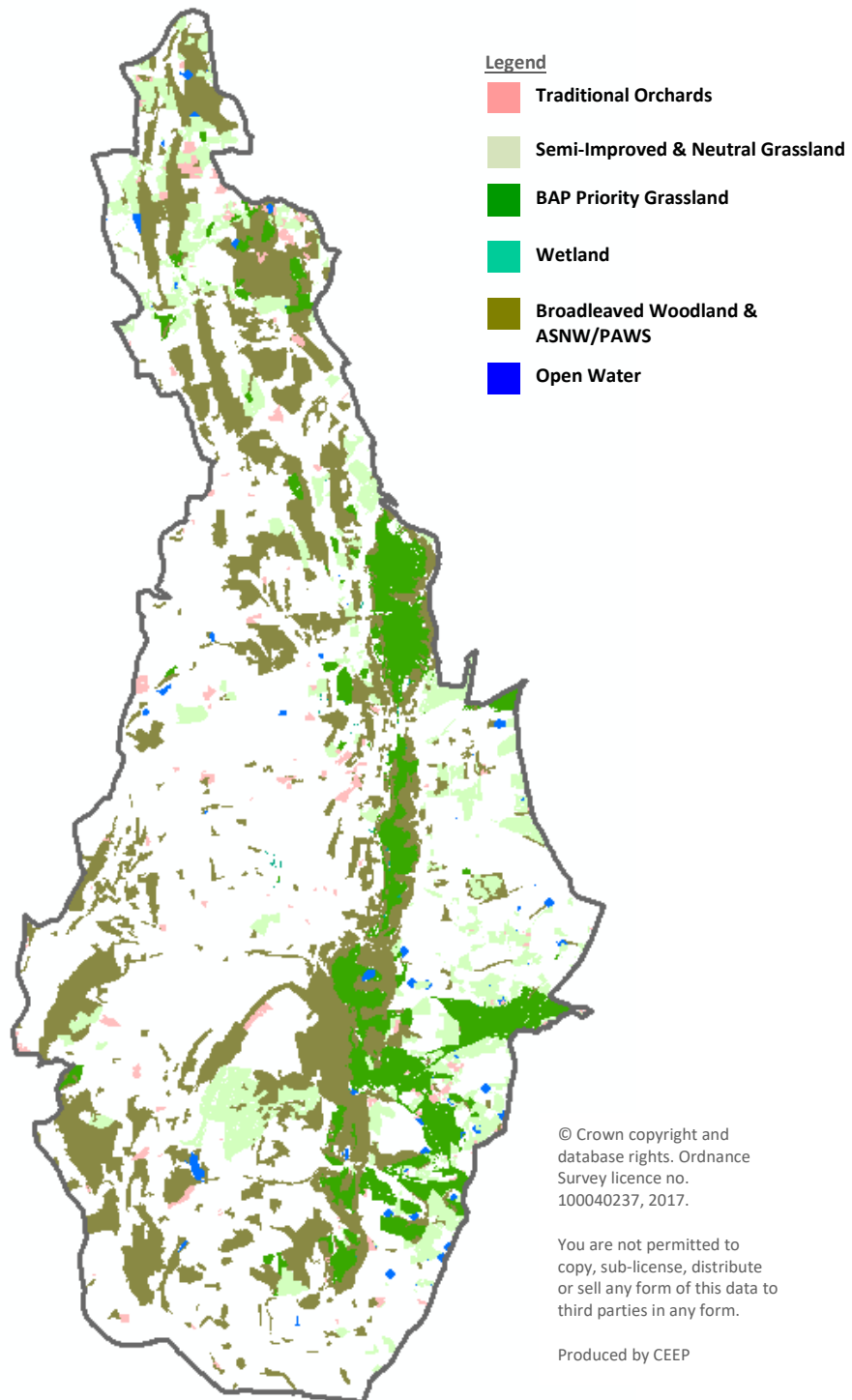
*Source: **Based on GIS data provided different sources (see Table 2.1)***

[35] Ibid., 12.

Habitat condition is also an important factor when assessing biodiversity values. Within Malvern Hills SSSIs, 45% of the area (523 ha) is in favourable and 55% (636 ha) is in unfavourable recovering condition. This picture has hardly changed since 2013 but is an improvement to 2009.[36] The vast majority (535 ha) of unfavourable recovering habitat is Lowland Acid Grassland as can be seen in Figure 2.4. Information about habitat condition outside SSSIs could not be obtained.

Figure 2.4 **SSSI Condition in Malvern Hills AONB in March 2017**
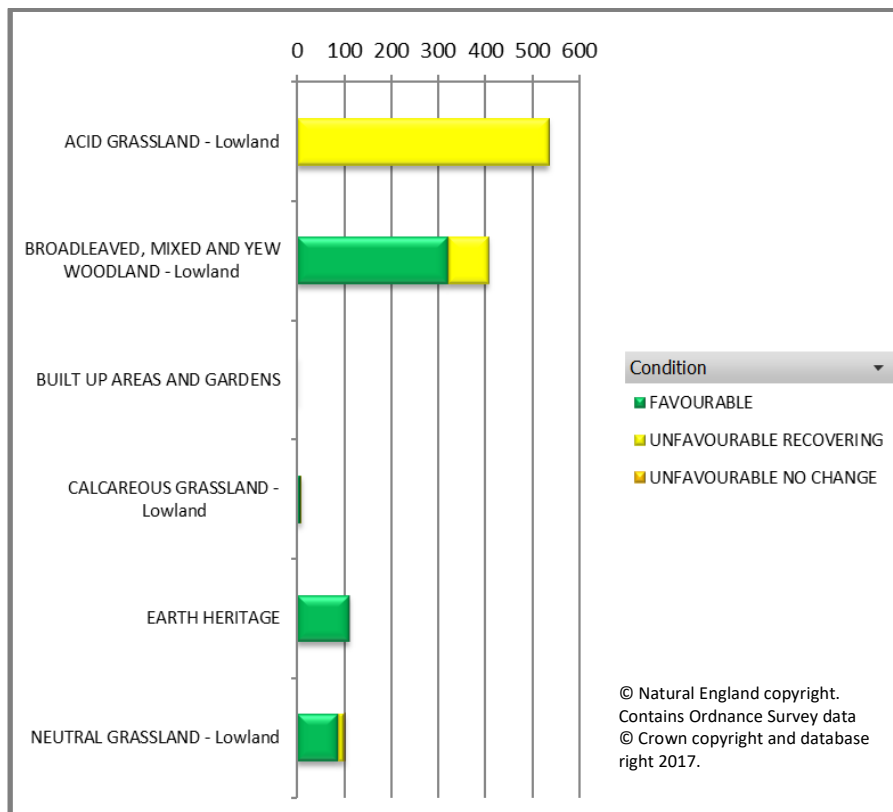
*Source: **Natural England***

Biodiversity of arable fields and improved grassland is generally low when compared to semi-natural habitats. Even if farming in the Malvern Hills is less intensive than in other areas the biodiversity value is still likely to be within the 'low' margin; even if it may be at the upper end.

Not included in the arable and improved grassland category are hedgerows which are often of high importance for biodiversity. A survey in 2009 found, based on a sample, that more

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[36] Malvern Hills AONB Partnership 2014b, 24.

than 50% of hedgerows in the AONB were species-rich.[37] Veteran hedges are typical within the AONB.[38] However, the biodiversity value of the hedgerow resource may be somewhat in decline as, in some areas, it has been reported that enclosure patterns haven been broken down and that hedgerow trees are often not replaced or restored.[39]

Semi-improved and neutral grassland is generally species richer than improved grassland, for example because of greater plant diversity and limited or no input of fertilisers and pesticides. Biodiversity Action Plan (BAP) Priority Grasslands are generally of high biodiversity value. This is not just related to the diversity of species within these habitats (the actual species diversity of lowland dry acid grassland, for example, is not particularly high[40]), but also because how rare these Natural Capital asset types are in general. They significantly contribute to the species diversity across the UK which is why they are classified as priority habitats.

In recent decades many grassland areas, particularly on the high hills and surrounding commons, have been undermanaged which led to an increase in scrub and bracken but grazing activities have increased again since the early 2000s.[41] This is a positive trend. Increasing visitor pressure, on the other hand, has for example eroded areas of lowland acid grassland[42] and may have contributed to a reduction in ground-nesting birds such as skylarks. This shows the usage/management trade-offs that occur between certain Natural Capital assets.

Traditional orchards with open-grown trees set in herbaceous vegetation are also generally high in biodiversity value and are also recognised as BAP Priority Habitat. Commercial orchards on the other hand have a rather low biodiversity value due to the application of pesticides and inorganic fertilisers, frequent mowing of the orchard floor, and planting of short-lived dwarf or bush fruit trees.

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[37] Lashley 2009, 2.
[38] Natural England 2015, 21.
[39] Malvern Hills AONB Partnership 2014a, 18; Natural England 2015, 11.
[40] Christie et al. 2011.
[41] Natural England 2015, 29.
[42] Malvern Hills AONB Partnership 2014a, 27.

The woodland resource can also be classified as being of high biodiversity value. Some areas within the Malvern Hills have been acknowledged as *"outstanding national deadwood resource for invertebrates"* by Natural England.[43] Particularly valuable is the high proportion of Ancient Semi-Natural Woodland (ASNW) in the AONB due to its irreplaceable character and high biodiversity value. This is followed by broadleaved Plantations on Ancient Woodland Sites (PAWS), and other semi-natural broadleaved and mixed woodland. Less valuable in terms of supporting biodiversity are coniferous woodland plantations but they only account for about 7% of the woodland resource in the AONB.[44] Restoring coniferous PAWS could further increase the biodiversity value of woodland within the Malvern Hills AONB.

Table 2.4 **Indicative Biodiversity Value by Natural Capital Asset**

Natural Capital Asset Category	Relative Importance
Arable	Low
Traditional Orchards	High
Improved Grassland	Low
Semi-Improved & Neutral Grassland	Medium
BAP Priority Grasslands	High
Woodland	High

Source: **Author assessment**

2.2.3   Recreation

The cultural ecosystem service 'recreation' is part of general leisure, and is not always easily distinguished from other services such as aesthetic appreciation. It usually refers to doing things and interacting with others.[45] Accessible greenspace provides the settings for a wide range of human activities including walking, running, cycling, climbing and horse riding. It also provides space, for example, for picnicking, observing nature, and for informal relaxation. Furthermore, recreation-based tourism provides a valuable contribution to the local economy.

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[43] Natural England 2015, 23.
[44] National Forest Inventory © Forestry Commission copyright 2017
[45] Church et al. 2011.

Recreational activities raise individual wellbeing and are therefore a value in themselves.[46] But there are also strong links between recreation and health benefits. Natural Capital provides great opportunities for 'green' exercise improving physical health. About three out of four UK adults agree that green spaces are important for their general health.[47] An increase in accessible greenspace close to where people live is increasingly being recognised to improve people's health by providing space for physical activity.[48] This in turn helps prevent the onset of diseases such as obesity, diabetes, heart diseases and strokes. Several studies have shown that regular park users are healthier than their counterparts. This applies for a range of measures such as diastolic and systolic blood pressure, depression score and perception of general health.[49] The Department of Health suggests that increasing accessible open spaces could reduce healthcare costs in the UK by more than £2 billion annually.[50] This shows that recreation and health benefits are closely related which is also why health benefits have not been assessed separately but as part of recreation, air quality regulation and aesthetic values to avoid overlaps.

Within the scope of this assessment 'recreation' refers to localised on-site activities which require access to relevant sites as opposed to 'aesthetic values and sense of place' (Section 2.2.4) which refers to the benefits associated with the view and scenery of the landscape as a whole without requiring access to each site.

The Malvern Hills has a long history as visitor attraction. The dominant hill ridge set within a natural and quiet setting has attracted many people for over two centuries. Pure spring water was for a long time a major pull factor, attracting visitors since at least medieval times. The springs and spouts arise at fault lines and at junctions between different rock types.[51] This shows just how important the diverse geology of the Malvern Hills is; for shaping the Malvern Hills themselves and for providing the setting and geology for the springs. The spring water of the Malvern Hills also had a great impact on forging the spa town of Great Malvern and other settlements in and around the AONB.

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[46] See e.g. UK NEA 2011b.
[47] Kuppuswamy 2009.
[48] Coombes, Jones, and Hillsdon 2010.
[49] Ho et al. 2003.
[50] pers comm., Mallika Ishwaran, Defra, 2011, cited in UK NEA 2011b, 1104.
[51] Natural England 2015, 11.

Nowadays, an estimated 1.25 million people visit the Malvern hills AONB each year.[52] This makes the Malvern Hills one of England's most popular inland countryside destinations.[53] About 80% of the visits is from outside the AONB itself and the main reasons for visits are walking (67%), general countryside visit (26%) and peace and quiet (17%).[54] These activities clearly indicate that most visitors are attracted by the natural character of the Malvern Hills which means that the Natural Capital value of the AONB is the main visitor attraction.

All Natural Capital assets, and especially the mix of them, play a role in the indisputably high recreational value of the AONB. Unfortunately, footfall statistics identifying areas where people spend most time within the AONB were not available. To indicatively estimate the relative contribution of each Natural Capital asset to the recreational value of the AONB, access maps were overlaid with the different Natural Capital assets to assess which Natural Capital assets are most accessible. Table 2.5 sets out the different datasets that have been used to establish the accessibility map.

Table 2.5 **Datasets Informing the Accessibility Assessment**

Dataset Name	Source	Copyright Acknowledgement
OS Open Greenspace	Ordnance Survey	Contains OS data © Crown copyright and database right 2017.
CROW Access Land	Natural England	OGL. Contains Ordnance Survey data © Crown copyright and database right 2017. Contains Royal Mail data © Royal Mail copyright and database right 2017. Contains bathymetry data by GEBCO © Copyright 2017.
CROW Act 2000 Open Access Mapping Areas		
CROW Act 2000 S4 Conclusive Registered Common Land		
CROW Act 2000 S15 Land		
Section 16 Dedicated Land		
Malvern Hills Trust Land (all accessible)	Malvern Hills Trust	Copyright @ Malvern Hills Trust
Public Right Of Way (PROW)	Herefordshire Council and Worcestershire Council	Copyright @ Herefordshire Council and Worcestershire Council

*Source: **See table.***

Figure 2.5 shows the network of publicly accessible areas as well as the vast Public Rights of Way (PROW) network (including a 50m buffer around PROW). Please note that PROW data

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[52] Malvern Hills AONB Partnership 2014a, 57.
[53] Natural England 2015, 9.
[54] Heart of England Tourist Board 2000, 2.

was only available for the areas of the Malvern Hills AONB within Herefordshire Council and Worcestershire Council but not for the small area in Gloucestershire. Therefore, the assessment is based on incomplete data but covers the vast majority of the AONB.

Figure 2.5 Accessibility Network

Legend

- Arable
- Traditional Orchards
- Improved Grassland
- Semi-Improved & Neutral Grassland
- BAP Priority Grassland
- Wetland
- Woodland
- Open Water
- Other

- Publicly Accessible Land
- PROW +50m Buffer

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Produced by CEEP
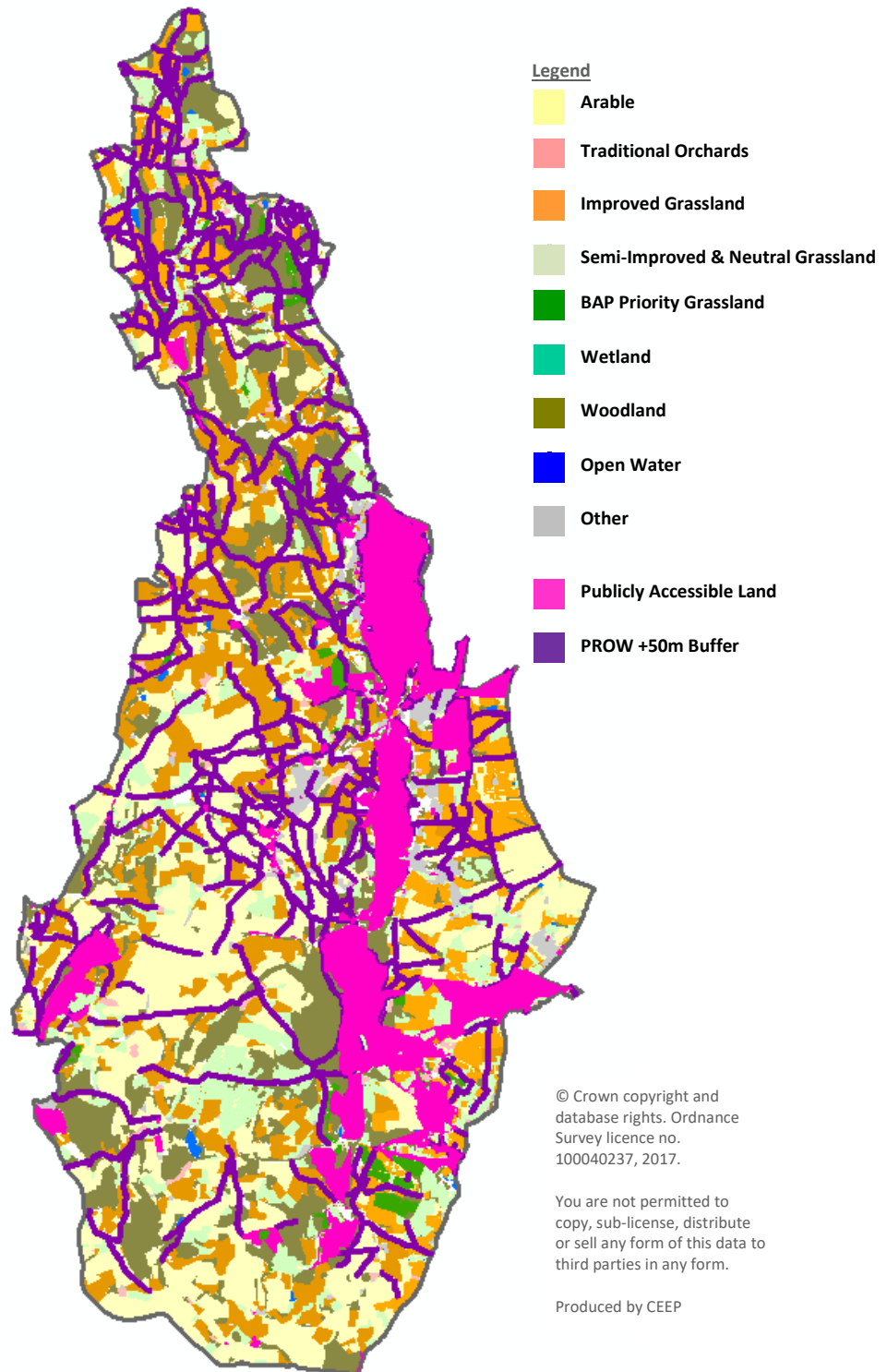
*Source: **Based on GIS data provided different sources (see Table 2.5)***

To assess the relative importance for recreation, the proportion of accessible land has been assessed for each Natural Capital asset category. Because PROWs are mapped as a linear feature, a 50m buffer has been created around PROW resulting in 100m wide corridors around PROW paths and bridleways. This was necessary to translate the linear feature into an area-based feature. For the purposes of this exercise it has been assumed that the area 50m either side of a PROW directly contributes to the recreational value whilst areas further away relate to aesthetic values only.

The proportion of accessible land was used as the indicator instead of the total accessible land area because the total area is already indicated by the box size in Figure 3.1. Therefore, it was more sensible to use the proportion of accessible land as the main indicator to indicate the recreational value of each Natural Capital asset category. The proportion of accessible land for each Natural Capital asset is outlined in Table 2.6.

Table 2.6 **Natural Capital Accessibility**

Natural Capital Asset Category	Total area in ha	Accessible area in ha	Accessible area in %
Arable	2,825.9 ha	578.4 ha	20%
Traditional Orchards	140.8 ha	48.7 ha	35%
Improved Grassland	2,746.1 ha	786.5 ha	29%
Semi-Improved & Neutral Grassland	1,310.6 ha	332.8 ha	25%
BAP Priority Grasslands	711.3 ha	609.4 ha	86%
Woodland	2,364.6 ha	874.7 ha	37%
Total	10,437.9 ha	3,239.5 ha	31%

Source: ***Author calculation based on data provided by ERCCIS.***

To indicate the relative value of each Natural Capital asset category, three categories were defined:

- Lowest third (0% - 33% accessible area) = low relative importance
- Middle third (34% - 66% accessible area) = medium relative importance
- Highest third (67% - 100% accessible area) = high relative importance

The findings are presented in Table 2.7 below.

Table 2.7 **Indicative Recreational Value by Natural Capital Asset**

Natural Capital Asset Category	Relative Importance
Arable	Low
Traditional Orchards	Medium
Improved Grassland	Low
Semi-Improved & Neutral Grassland	Low
BAP Priority Grasslands	High
Woodland	Medium

Source: **Author assessment**

It should be noted, however, that this is a very indicative assessment because recreational opportunity is not the same as recreational use. Recreational use is not evenly distributed across all accessible sites and paths in the AONB. Certain main attraction points and those closer to settlements are much more valuable for recreation than other hidden areas. Furthermore, the 50m buffer around PROW is a proxy and certain recreational opportunities such as informal access arrangements to woodland or traditional orchards may not have been mapped and are therefore not included in this indicative assessment.

To get a clearer picture of recreational access it would be necessary to collect more information about the footfall within the AONB – where do people actually spend most time. This could be assessed through a survey or potentially be approximated through a stakeholder mapping workshop.

The main threats to the recreational value of the Malvern Hills AONB is a loss and/or degradation of Natural Capital value due to (infrastructure) development and over-use. Due to expected growth in South Worcestershire, demand for recreation in the Malvern Hills is likely to increase.[55] Considering that many visitors value the tranquillity, naturalness and peace in the AONB, it is important to manage access to mitigate overcrowding of certain landmarks and attractions because overcrowding can lead to the erosion of Natural Capital value and a sense of place/nature (see also Section 2.2.4).

Overcrowding would also increase visitor conflicts as well as conflicts with the local population. Problems that could increase with increased visitor numbers include conflicts between different user groups such as walkers, dog walkers, horse riders and mountain

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[55] Malvern Hills AONB Partnership 2014, 68.

bikers.[56] Nevertheless, in 1999/2000, 87% were returning visitors indicating satisfaction with former visits.[57]

Overuse can also lead to degradation or destruction of important habitats and increased litter, fly tipping and wildlife disturbance which in turn has a negative effect on biodiversity values and other ecosystem services including aesthetics and recreation itself. Valuable BAP priority grasslands are particularly vulnerable as 86% of this resource is publicly accessible. To mitigate overcrowding, less busy areas of the AONB can be promoted to move people away from the most vulnerable areas. This may include providing access to new areas as well.

2.2.4 Aesthetic Values & Sense of Place

The visual amenity and aesthetic appreciation of environmental landscapes can have a significant influence on human wellbeing.[58] A large body of evidence demonstrates that people prefer to live in areas with high quality environmental landscapes and many studies suggest that such green landscapes increase, for example, property prices and land values.[59] Natural landscapes also have restorative effects and thereby contribute to mental health.[60] A recently published study carried out in the UK found that a view of grassland from home has a positive influence on emotional wellbeing.[61] There are numerous case studies supporting this view. See for example Saraev (2012) for an overview.[62]

A Malvern Hills AONB visitor survey in 1999/2000 has revealed that 47% of respondents (domestic and tourists) particularly like the scenery and view of the landscape during their visit.[63] In a more recent visitor survey from 2015/16 for the Malvern Hills District, which only partially overlaps with the AONB, 33% of respondents stated that they particularly liked the view/scenery.[64] This is likely to be related to the hills and the AONB and supports the earlier

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[56] Heart of England Tourist Board 2000, 4.
[57] Ibid., 2.
[58] Church et al. 2011.
[59] See e.g. Saraev 2012 for an overview.
[60] Kaplan 1995.
[61] Mourato et al. 2010.
[62] Saraev 2012.
[63] Heart of England Tourist Board 2000, 4.
[64] King 2016, iv.

survey outcomes for the AONB itself. It is estimated that the Malvern Hills AONB attracts about 1.25 million visitors each year, many of whom will come because of the natural features and Natural Capital.[65]

The aesthetic value of the Malvern Hills AONB cannot be meaningfully considered without reference to the geodiversity of the area. The geology has formed the landscape including the Malvern Hills ridge itself. On the one hand, the hills provide a very visible and prominent landscape feature. On the other hand, the summit ridge itself offers extensive views on the landscape - way beyond the AONB boundaries. It is very unlikely that the Malvern Hills would be so widely valued for its aesthetic values and sense of place if it was a shallow landscape without the hills and its geological features and sites. The geological value of the area is recognised nationally with the designation of some geological Sites of Special Scientific Interest (SSSIs) and the creation of the Abberley and Malvern Hills Geopark and locally through the designation of a number of geological Local Sites.[66]

The outstanding amenity value of the Malvern Hills AONB is well evidenced; not least through the AONB designation itself.[67] The area has attracted many artists in the past and continues to do so, underlying its cultural importance.[68] These values are predominantly attributable to the AONB's natural beauty and therefore Natural Capital assets including the geology shaping the landscape.

Whilst the overall amenity value and sense of place of the AONB is obvious, it is less clear how the different Natural Capital assets assessed within the scope of this study contribute to this value. The tranquillity and 'naturalness' of the AONB is very likely to play a major role. It is also likely that the high diversity of different Natural Capital assets within a comparable small area is an important determinant, since people tend to have a preference for diverse habitats and landscapes.

Based on such general preferences for naturalness, it is likely that that semi-natural habitats have a comparatively higher aesthetic value when compared to other assets. Considering

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[65] Malvern Hills AONB Partnership 2014a, 57.
[66] Ibid., 12.
[67] Heart of England Tourist Board 2000; Malvern Hills AONB Partnership 2014a; Natural England 2015.
[68] Natural England 2015, 11.

preferences for habitat diversity also suggests that diverse habitats in one place are preferred over monotonous landscapes with little diversity. This favours rarer Natural Capital assets over the more dominating assets such as arable fields and improved grassland. However, this is an assessment based on the actual circumstances. If, for example the extent of arable fields was dramatically reduced then it is likely that its value would increase because it is becoming rarer within the local landscape.

Based on these considerations and assumptions, arable fields and improved grassland have been ascribed a medium aesthetic and sense of place value whilst all other assessed Natural Capital assets have been ascribed a high value. Woodland covers a significant part of the AONB but is a more diverse habitat category in itself. People generally have a strong preference for broadleaved woodland views which are dominant in the area.[69] There is for example a higher preference across England to live within short proximity to broadleaved woodland rather than enclosed farmland.[70] The aesthetic value of traditional orchards is also likely to be of high.

Table 2.8 **Indicative Aesthetic & Sense of Place Value by Natural Capital Asset**

Natural Capital Asset Category	Relative Importance
Arable	Medium
Traditional Orchards	High
Improved Grassland	Medium
Semi-Improved & Neutral Grassland	High
BAP Priority Grasslands	High
Woodland	High

Source: **Author assessment**

It should be stressed, however, that the naturalness and the mix of Natural Capital assets is likely to be important in the aesthetic values of the AONB. This also means that development and intensification of farming is a mayor threat. Activities that lead to more man-made structures and infrastructure may disturb the perceived naturalness of the landscape and may also reduce tranquillity and quietness.

Man-made structures that are 'non-traditional' elements in the landscape such as modern style or large buildings as well as for example polytunnels can have a very negative effect on

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[69] Ulrich 1984; Ulrich and Simons 1986; Garrod 2002; Quine et al. 2011.
[70] Mourato et al. 2010, 20.

the aesthetics of the landscape, especially when considering the cumulative effect over time. Overcrowding can also be a threat to the landscape aesthetics because it reduces the sense of tranquillity, quietness, peace and privacy. It usually also comes with additional traffic and could increase the demand for road infrastructure.

Considering that the views from the hill ridges reach far beyond the AONB boundaries, development in the surrounding areas also needs to be considered when managing the aesthetic value and sense of place of the AONB. The Malvern Hills AONB cannot be managed in isolation from the surroundings and cross-boundary issues need to be addressed.

2.2.5   Flood Regulation

In the UK, soil cover has changed significantly due to human activity, especially within the past 50 years.[71] The increase in surface sealing, especially in urban areas but also in rural areas due to soil compaction and other land-use changes reducing the extent of vegetation with high infiltration capacities, has increased soil erosion as well as reducing the natural capacity of ecosystems to retain and store water. Reduced vegetation cover also generates faster water run-off rates which promotes flooding events.[72] The total costs to UK insurers of the 2007 flooding were estimated to be in the order of £3 billion.[73]

Habitats and green vegetation can help to mitigate extreme weather events, and in particular the risk of flooding. Floodplain habitats fill rapidly during flooding events, at least to a point of saturation, and then slowly filter back retained water to buffer surface flows.

Figure 2.6 shows the probability of flooding from rivers and seas for the Malvern Hills AONB plus a 5km buffer. One can see that flood risk zones within the AONB are very uncommon. However, that does not mean that flood risk regulation services within the AONB are not required. This is a very indicative assessment and further flood risk modelling may be beneficial but it is likely that the flood risk within the AONB is limited due to the great extent of natural vegetation cover storing water, mitigating run-off and therefore flooding events and flood risk. We can also see that within 5km around the AONB there are indeed larger

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[71] Smith et al. 2011.
[72] Ibid.
[73] Pitt 2007.

areas affected by flood risk. Vegetation in the Malvern Hills is not just mitigating flooding events locally but is also likely to impact on the extent of flooding events downstream – especially considering the high altitude of the area. Therefore, flood risk regulation provided by Natural Capital within the AONB may well be an important service, not just for the population within the AONB but also in surrounding areas.

Figure 2.6 **Risk of Flooding from Rivers and Sea within 5km around the Malvern Hills AONB**
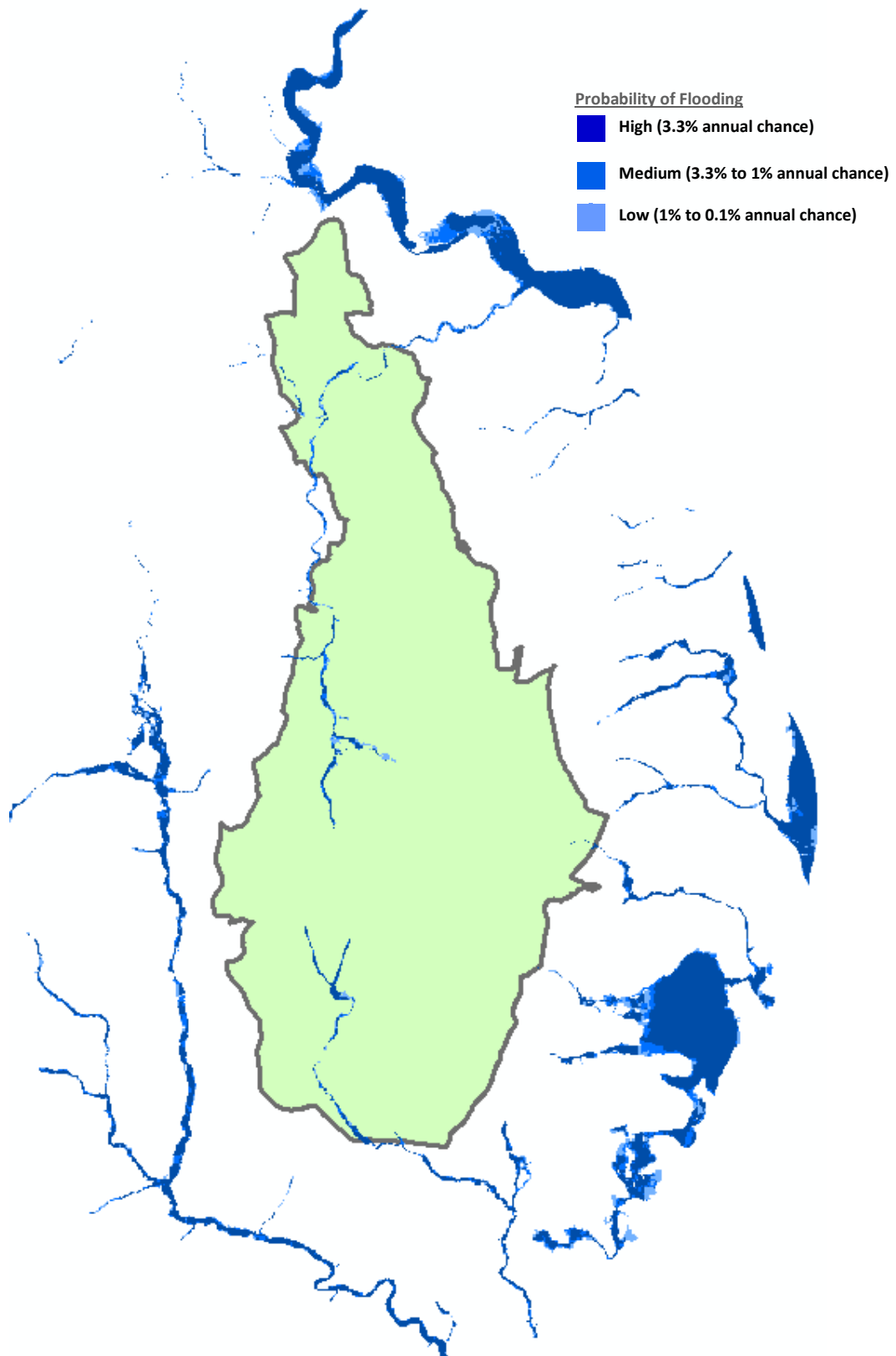
Probability of Flooding

High (3.3% annual chance)

Medium (3.3% to 1% annual chance)

Low (1% to 0.1% annual chance)

*Source: **Based on GIS data provided by Worcestershire Council and the Environment Agency***

Indicatively, the overall value in terms of flood risk regulating services of assessed Natural Capital assets within the Malvern Hills may be low to medium.

The effect of arable fields is likely to be relatively low because of increased soil compaction due to the use of machinery and limited vegetation cover. The effect of grasslands is likely to be higher. The highest flood risk regulation effect is likely to come from woodland cover including traditional orchards because of the extensive vegetation cover which can significantly reduce water run-off.

However, it should be stressed that this is a very indicative assessment. Flood risk modelling is complex and such modelling including for example soil drainage capacity, water run-off based on altitude and slope etc. was not possible as part of this scoping study. This should be acknowledged when interpreting the findings.

Table 2.9 **Indicative Flood Risk Regulation Value by Natural Capital Asset**

Natural Capital Asset Category	Relative Importance
Arable	Low
Traditional Orchards	High
Improved Grassland	Medium
Semi-Improved & Neutral Grassland	Medium
BAP Priority Grasslands	Medium
Woodland	High

Source: **Author assessment**

Surface sealing due to development and the increased use of heavy machinery to manage agricultural land which can lead to increased soil compaction can be seen as the main threats to the flood risk regulation capacity of Natural Capital in the Malvern Hills. Soil compaction also leads to soil erosion which can increase this effect.

2.2.6   Water Quality Regulation

Another important benefit provided by Natural Capital is the regulation of water quality. This occurs through processes such as the retention, removal and transformation of nutrients, organic matter and sediment, and bacterially-driven denitrification, nitrification and mineralisation, plant uptake and the trapping or filtering of particulates.[74]

Referring to Figure 2.7, most of the Malvern Hills AONB is located within Nitrate Vulnerability Zones (NVZs) which are areas designated as being at risk from agricultural nitrate pollution. Referring to the latest Environment Agency maps[75], all of the AONB is located within a 'What's In Your Backyard (WIYBY) Priority Waters'[76] area. The information for the Malvern Hills AONB indicates that water is at risk from nitrate and phosphate pollution as well as sediment losses due to agriculture. 2016 river quality data also shows that all of the 24.5 km of Water Framework Directive (WFD) water bodies[77] within the Malvern Hills AONB fail to achieve high or good status (23.7km moderate and 0.8km poor).[78] This shows that there is a clear demand for water quality regulating services within the whole of the AONB.

Intensively managed arable fields and improved grassland are likely to have a particularly negative effect on water quality. The more intensive the fertilisation of land the more excess nitrogen compounds which cannot be taken up by plants can be released as nitrate to ground and surface water bodies. Other agricultural contaminants include phosphorus, sediments and pesticides.[79] Nationally, the use of inorganic fertilisers and excessive use of pesticides has been steadily reduced within the past 30 years or so but the overall effect is still likely to be negative and satisfactory water quality levels are still not met.

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[74] Maltby et al. 2011.

[75] http://maps.environment-agency.gov.uk/wiyby/wiybyController?topic=farming&layerGroups=default&lang=_e&ep=map&scale=1&x=357682.99999999994&y=355133.99999999994 (accessed: 19/10/2017)

[76] WITBY Priority Waters include bathing water catchments, shellfish water catchments, Source Protection Zones, Nitrate Vulnerable Zones, rivers at risk of not meeting Good Ecological Status for Phosphates, and areas where agricultural sediment are known to impact on river quality.

[77] Rivers, canals and surface water transfers.

[78] © Natural England copyright. Contains Ordnance Survey data © Crown copyright and database right 2017.

[79] UK NEA 2011b.

Figure 2.7 Nitrate Vulnerable Zones (NVZs)

Legend

Surface Water NVZs

Ground- and surface water NVZs

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*Source: **Based on GIS data provided by the Environment Agency***

Semi-natural grassland types are likely to have a positive effect on water quality regulation because they can filter water that runs through vegetation and trap pollutants. However, the general effect is probably low unless specifically designed as, for example, buffer strips to sources of diffuse pollution such as arable fields. Woodland and traditional orchards can have a more positive effect on water quality in general. But the location, design and proximity to sources of pollution is important.

Table 2.10 **Indicative Water Quality Regulation Value by Natural Capital Asset**

Natural Capital Asset Category	Relative Importance
Arable	Likely negative
Traditional Orchards	Medium
Improved Grassland	Likely negative
Semi-Improved & Neutral Grassland	Low
BAP Priority Grasslands	Low
Woodland	Medium

Source: **Author assessment**

Agricultural intensification on existing arable and improved pasture and an increase of such land-uses could worsen water quality in the area. Both of which may appear under demands for us to grow more of our food in a post-Brexit UK. Awareness raising and the promotion of low-intensity farming may help to mitigate such effects. The level of diffuse pollution from farming could also be mitigated for example by introducing grass buffer strips and ponds to trap contaminants.

2.2.7 Air Quality Regulation

Complex vegetation and particularly trees have a positive effect on the regulation of local air quality. In general, the main sources for pollution are vehicle exhaust, industry and intensive agriculture.[80] Trees and other vegetation absorb, through physical deposition as well as chemical reactions, deleterious pollution such as nitrogen dioxide; but also carbon monoxide (CO), sulphur dioxide (SO_x), ozone (O_3) and fine particulates (PM_{10}) which are responsible for major illnesses such as respiratory ailments, heart disease and cancer.[81] A case study modelling the mitigation effects of particulate (PM_{10}) pollution in East London estimates that an increase of grassland and tree cover could avert two PM_{10}-related deaths and two hospital admissions annually in a 10 km^2 area.[82]

In general, due to high levels of vehicle exhaust, air quality issues are more pressing in urban areas rather than rural areas such as the Malvern Hills AONB. In 2007, the air quality in the AONB was assessed to be good overall[83] and in June 2017 there was no Air Quality Management Area (AQMA) in or within short proximity to the AONB.[84] Therefore, the local demand for air quality regulating services is likely to be limited as air pollution is not a major issue. However, it may be a localised issue around main transport routes; especially when in close proximity to residential areas or visitor attractions/busy foot/bicycle paths.

Leaf area is a main factor for air quality regulation which makes trees and woodland areas (including traditional orchards) particularly valuable. The tree location and species composition in this respect is important and needs to be carefully planned. In general, trees are well placed as buffers next to the pollution source such as main roads but they can also have a negative effect on local pollution levels if the tree cover creates a tunnel, trapping pollutants in a street corridor.

On the one hand, arable fields and improved grassland vegetation has some positive effect on air quality regulation by capturing pollutants from the air. On the other hand, livestock excretions are a major source for ammonia which is a nitrogen compound released by the

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[80] van Oudenhoven et al. 2012.
[81] McPherson, Nowak, and Rowan 1994.
[82] Tiwary et al. 2009.
[83] Grove 2007.
[84] https://uk-air.defra.gov.uk/aqma/maps

breakdown of livestock urine, manure and inorganic fertiliser. Ammonia harms biodiversity and can cause odour nuisance. The net effect on air quality in the Malvern Hills AONB is not clear.

Semi-natural grasslands often have more vegetation cover than improved grassland and arable fields but less than high-standing vegetation such as woodlands. The negative effects of livestock and inorganic fertilisers are also limited which is why such Natural Capital assets are likely to have some positive impact overall.

Table 2.11 **Indicative Air Quality Regulation Value by Natural Capital Asset**

Natural Capital Asset Category	Relative Importance
Arable	Unclear
Traditional Orchards	Medium
Improved Grassland	Unclear
Semi-Improved & Neutral Grassland	Low
BAP Priority Grasslands	Low
Woodland	Medium

Source: **Author assessment**

As mentioned before, poor air quality is not likely to be or become an issue within the Malvern Hills AONB. It may be worth, however, monitoring air quality close to sources of air pollution such as busy roads, especially if they are close to people.

2.2.8   *Local Climate Regulation (Climate change adaptation)*

Referring to ClimateJust[85], a climate portal by Climate UK, JRF, the Environment Agency and the University of Manchester, mean summer maximum temperatures in the Malvern Hills AONB are likely to increase by about 3.5 percent to 23.5-24.0 °C[86] by the mid-2050s and could increase within the same time period by up to 7 percent to 27.0-27.5 °C under the highest emission scenarios.[87]

Heat disadvantage indicators (heat-related social vulnerability combined with the potential for exposure to heat-related events) show that the vulnerability of the local population in the area to increasing temperatures is relatively high in most parts of the Malvern Hills

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[85] http://www.climatejust.org.uk/map
[86] Medium emission scenario, central estimate.
[87] High emission scenario, high estimate.

AONB.[88] The indicators account for both the likelihood of coming into contact with high temperatures as well as the severity of negative impacts on the health and wellbeing of local communities that could occur as a result of that contact.[89] This does not even take into account the demand by tourists visiting the area from outside.

Green vegetation can have a significant influence on the local climate. The temperature around green vegetation is reduced by evapotranspiration. Furthermore, trees in particular provide shading and protection from heat and UV radiation.[90]

Local climate regulation services are usually more relevant in dense urban areas. The built environment retains heat, which is released during the night, and the concentration of waste heat from warming and cooling causes a so called Urban Heat Island Effect (UHIE). But climate change adaptation measures are also necessary in more rural areas – especially in areas where many people are outside and therefore exposed to high temperatures and UV radiation such as in the Malvern Hills AONB.

Due to building control, high urbanisation is unlikely within the AONB and the UHIE is therefore not a real threat. However, increased UV radiation can affect the wellbeing and health of vulnerable groups of the population. The elderly sector of the population and young children are thought to have a lower tolerance to extreme temperatures. Excessive heat can be a significant contributory factor to exacerbating illnesses and contributing to increased mortality for these groups.[91]

In particular trees such as street trees, trees along walking paths, and tree islands at main visitor destinations where other shelter is scarce, will provide additional shelter opportunities from heat and UV radiation exposure. The effect of other vegetation types is likely to be very limited considering that dense urbanisation within the AONB is an unlikely scenario.

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[88] Based on the population weighted vulnerability and mean summer maximum temperatures in the 2050s; based on 25km grid.
[89] For more information see http://www.ppgis.manchester.ac.uk/climatejust/info/sheet8.html
[90] Forest Research 2010.
[91] Tomlinson et al. 2011.

In addition, livestock may also be affected from increased summer temperatures. The continuing trend of loosing field and hedgerow trees without replacement reduces shelter opportunities for livestock. This could have negative effects on livestock health and productivity. Trees also provide shelter for insects and other animals. Increasing canopy cover across the AONB could therefore act as important climate change adaptation measure.

Table 2.12 Indicative Local Climate Regulation Value by Natural Capital Asset

Natural Capital Asset Category	Relative Importance
Arable	Negligible
Traditional Orchards	Medium
Improved Grassland	Negligible
Semi-Improved & Neutral Grassland	Negligible
BAP Priority Grasslands	Negligible
Woodland	Medium

Source: **Author assessment**

But Natural Capital assets do not just help to adapt to climate change and protect the population from its negative effects, but also need to be adapted to climate change themselves. Possible effects of climate change are more frequent and severe droughts as well as general water scarcity which could also trigger more frequent wildfires. More extreme weather events such as storms and flooding are also possible. Therefore, the Natural Capital infrastructure needs to be adapted to such risks, for example by providing more water storage capacities and by selecting tree and grassland species that are more resilient to high temperatures and water scarcity. Providing a strong ecological network is also important because it allows species that are vulnerable to temperature changes to move freely from one area to another.

2.2.9   Global Climate Regulation (Climate Change Mitigation)

Since the pre-industrial era global Greenhouse Gas (GHG) emissions due to human activity have increased to a level unprecedented in at least the last 800,000 years. These anthropocentric GHG emissions are "extremely likely" to be the dominant cause for the observed global warming since the mid-20th century.[92] Ecosystems play an important role in mitigating climate change and its negative impacts by sequestering and storing carbon. The

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[92] IPCC 2014.

photosynthetic activities of trees and other vegetation sequester carbon dioxide from the atmosphere and therefore act as a net carbon sink, especially when carbon is stored into corresponding soils.[93]

Woodland is particularly important for sequestering and storing carbon where broadleaved woodland stores more carbon than coniferous woodland. The Forestry Commission estimates that increased UK woodland stock could contribute an emission abatement equivalent to 10% of the total UK greenhouse gas inventory in 2050. This could be achieved by replanting an additional 4% of the UK land cover with woodland.[94] Other land-uses also store carbon but to a lesser extent. Please note that the assessment in Table 2.13 is based on above-ground carbon only and does not include other greenhouse gasses or below ground carbon.

Table 2.13 **Indicative Global Climate Regulation Value by Natural Capital Asset**

Natural Capital Asset Category	Relative Importance
Arable	Low
Traditional Orchards	Medium
Improved Grassland	Low
Semi-Improved & Neutral Grassland	Low
BAP Priority Grasslands	Low
Woodland	High

*Source: **Author assessment***

Based on an analysis of carbon stock modelling by the NERC Environmental Information Data Centre[95], an above ground (vegetation) carbon stock of 147,646 tonnes carbon has been estimated. This is in addition to 65,117 tonnes stored in topsoils (15 cm depth). When accounting for above ground and topsoil carbon together, Natural Capital assets in the Malvern Hills AONB are estimated to store about 212,763 tonnes of carbon. This is equivalent to 780,132 tonnes of carbon dioxide equivalent (t CO_2e). The estimated average non-traded price over the next 25 years per t CO_2e is £76[96] which means that the estimated value of carbon stored in Malvern Hills AONB Natural Capital vegetation and topsoils is in the region of £59 million.

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[93] Read et al. 2009.
[94] Ibid.
[95] Henrys, Keith, and Wood 2016.
[96] 2016 prices, applying a discount rate of 1.5%. For more information see DECC 2009.

2.3   Indicative Ecosystem Services Flow Value Analysis

Figure 2.8 below summarises the findings from the dedicated ecosystem services sections above for each assessed Natural Capital/ecosystem service combination – 54 in total. The box size indicates the extent of the Natural Capital resource within the AONB, the box colour indicates the relative importance of each Natural Capital asset category for providing that ecosystem service, and the box frame colour indicates the confidence in the assessment. Please see the information provided in the figure for more details.

The assessment reveals that the typical agricultural Natural Capital assets, arable land and improved grassland, fall below the highest importance in terms of food provision because the land in the Malvern Hills AONB is only of medium productivity. For other assessed ecosystem services, apart from aesthetic values and flood regulation, they score rather low and in terms of water quality regulation even likely negative due to diffuse pollution.

Semi-improved and neutral grassland is less productive in terms of food provision but more valuable for biodiversity and aesthetic values. These Natural Capital assets are also likely to have some positive effect on water quality regulation as opposed to their more intensively managed counterparts. Biodiversity Action Plan priority grasslands provide an even higher biodiversity value as would be expected. Not necessarily expected is the high recreational value which is due to the very high proportion of accessible BAP grasslands in the AONB.

Woodland and traditional orchards provide the most balanced level of service provision across all assessed ecosystem services. Woodland and traditional orchards are at least of medium importance for all assessed ecosystem services (except harvested products for traditional orchards) and superior to the other Natural Capital assets in terms of air and climate regulating services. However, this should not lead to the conclusion that the whole AONB should be overplanted with trees. Whilst this may be the preferred option to optimise for regulating services, cultural services such as recreation and aesthetics as well as biodiversity benefit from the diversity of Natural Capital assets which in turn provide a greater diversity of views and sceneries, recreational opportunities and species defining the AONB.

Figure 2.8 **Indicative Natural Capital Assessment for the Malvern Hills AONB**

Natural Capital Asset / Ecosystem service and group	Arable 2,826 ha	Improved Grassland 2,746 ha	Semi-Improved & Neutral Grassland 1,311 ha	BAP Priority Grassland 711 ha	Woodland 2,365 ha	Traditional Orchards 141 ha
Provisioning — Harvested Products	Medium Positive	Medium Positive	Low Positive	Low Positive	Medium Positive	Low Positive
Biodiversity	Low Positive	Low Positive	Medium Positive	High Positive	High Positive	High Positive
Cultural — Recreation	Low Positive	Low Positive	Low Positive	High Positive	Medium Positive	Medium Positive
Aesthetic Values & Sense of Place	Medium Positive	Medium Positive	High Positive	High Positive	High Positive	High Positive
Regulating — Flood Regulation	Low Positive	Medium Positive	Medium Positive	Medium Positive	High Positive	High Positive
Water Quality Regulation	Likely Negative	Likely Negative	Low Positive	Low Positive	Medium Positive	Medium Positive
Air Quality Regulation	Negligible/Unclear	Negligible/Unclear	Low Positive	Low Positive	Medium Positive	Medium Positive
Local Climate Regulation	Negligible/Unclear	Negligible/Unclear	Negligible/Unclear	Negligible/Unclear	Medium Positive	Medium Positive
Global Climate Regulation	Low Positive	Low Positive	Low Positive	Low Positive	High Positive	Medium Positive

Indicative relative level of ecosystem service importance of Natural Capital Asset category in the MH AONB

- High Positive
- Medium Positive
- Low Positive
- Negligible/Unclear
- Likely Negative

Indicative Natural Capital extent in ha

- 2,350-2,850 ha
- 700-1,350 ha
- 141 ha

Confidence in relative level of ecosystem service provision

- High
- Medium
- Low

The assessment is purely indicative and its purpose is to provide a general overview rather than giving a definite answer for each Natural Capital/ecosystem service combination. The figure indicates relative average levels of ecosystem services importance (marginal per ha) provided by different Natural Capital assets. It should be noted that comparison is only feasible within ecosystem services (across Natural Capital asset categories) but not across ecosystem services. It should be stressed that the assessment is indicative and based on incomplete evidence. A main evidence gap was information about the condition, quality and management of habitats. Often an indication was based on national trends rather than local evidence. For more information see the relevant sections of Chapter 2.

*Source: **Author assessment***

3. Towards a Monetary Natural Capital Assessment: Opportunities and Data Requirements

3.1   Introduction

One objective of this project was to assess the potential for valuing/monetising the Natural Capital assets in the AONB based on the datasets/valuation evidence available. A monetary Natural Capital assessment is an assessment of the value of ecosystem services provided by Natural Capital assets; expressed in monetary terms.

For some ecosystem services such as food and timber provision it is comparatively easy to work out the value because they are traded on markets and therefore have a market price which indicates the value. But many ecosystem services do not have a market price. We do not have to pay trees (or those who planted and manage them) for cleaning the air we breathe or an entrance fee for accessing a park for recreational purposes, for example. If others provide these services we can benefit as 'free-rider' without paying.

However, if no one pays for such ecosystem services there is also no incentive for others to provide such services in an unregulated market because they would not be paid for planting trees or managing a park. And because there is no payment there is also no market price which could indicate the value of such services.

But 'no price' does not mean 'no value'. This can be clarified using a simple example. The price for the air we breathe is zero but without air we would not be able to survive which means that clean air is clearly of high value to us.

"In considering the task of valuing ecosystem services an important distinction needs to be drawn between the terms 'value' and 'price'. That they are not, in fact, equivalent is easy to demonstrate. Consider a walk in a local park. The market price of such recreation is likely to be zero as there are no entrance fees

and anyone can simply walk in. However, the very fact that people do indeed spend their valuable time in parks shows that this is not a zero value good."[97]

Having no explicit monetary value for ecosystem services often results in the misjudgement that such ecosystem services are self-evident or without value. The high complexity of ecosystem interactions makes their value even more intangible and reinforces a tendency to neglect them.

"The full value of goods such as health, educational success, family and community stability, and environmental assets cannot simply be inferred from market prices, but we should not neglect such important social impacts in policy making."[98]

Economic valuation of ecosystem services serves to mitigate this information bias, and also makes the value of services provided by ecosystems more tangible for non-specialists which generates awareness for such benefits. This in turn supports more sustainable decision-making by better implementing formerly overlooked values into decision-making.

There are two main approaches to reveal the value of non-market ecosystem services. Sometimes the ecosystem value is contained within a market price (revealed preferences). This is for example the case for flood risk regulation. One can model the amount of water stored by a grassland patch in a flooding event. It can be calculated how much damage this amount of water would have caused e.g. to properties and infrastructure if that natural water storage capacity would not be available. These avoided damage costs reflect the value of the flood risk regulation service of the grassland patch.

The second approach method to reveal the value of ecosystem services is by simply asking people what they would be willing to pay if there was a market (stated preferences). One can for example ask people what they would be willing to pay to access a park if there was an entrance fee. This is the kind of research a monetary Natural Capital valuation is based on.

[97] UK NEA 2011b, 1072.
[98] HM Treasury 2003, 57.

To quantify ecosystem services values in monetary terms the so-called benefit transfer approach[99] can be applied. Valuation findings of primary valuation studies (revealed or stated preferences) studies carried out elsewhere can sometimes be transferred to the assessment area (in this case the Malvern Hills AONB) applying suitable precautions and assumptions. This approach allows transferring values from primary valuation studies to our specific context.

Carrying out original primary valuation studies demands extensive resources and lengthy timescales. The application of the benefit transfer approach can be seen as a practicable and cost-effective way for implementing the Ecosystem Approach in decision-making.[100] For further information about the benefit-transfer approach and how scientists calculate values for non-market ecosystem services see for example Defra's 'Introductory Guide to Valuing Ecosystem Services'.[101]

When quantifying Natural Capital, an important distinction needs to be made between Total Economic Valuation (TEV) assessments and Economic Impact Assessments. The TEV is a measure of the net value Natural Capital provides to society. The Economic Impact on the other hand is a measure of economic activity (such as is for example Gross Development Product (GDP)). The pay for a ranger to manage a greenspace, for example, is contributing positively to economic activity but in a TEV framework it is a cost factor because this pay is required to provide the economic value assuming that without that management the greenspace would not perform ecosystem services to the extent it does with management. Therefore, jobs are reducing the net TEV whilst increasing economic impact.

It should also be noted that economic activity is not necessarily contributing positively to society. If an asset would be destroyed and rebuilt exactly as it was then this would only contribute to economic activity but would not add economic value. Within the scope of this chapter, applying the TEV approach is discussed.

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[99] Sometimes also referred as 'value transfer approach'.
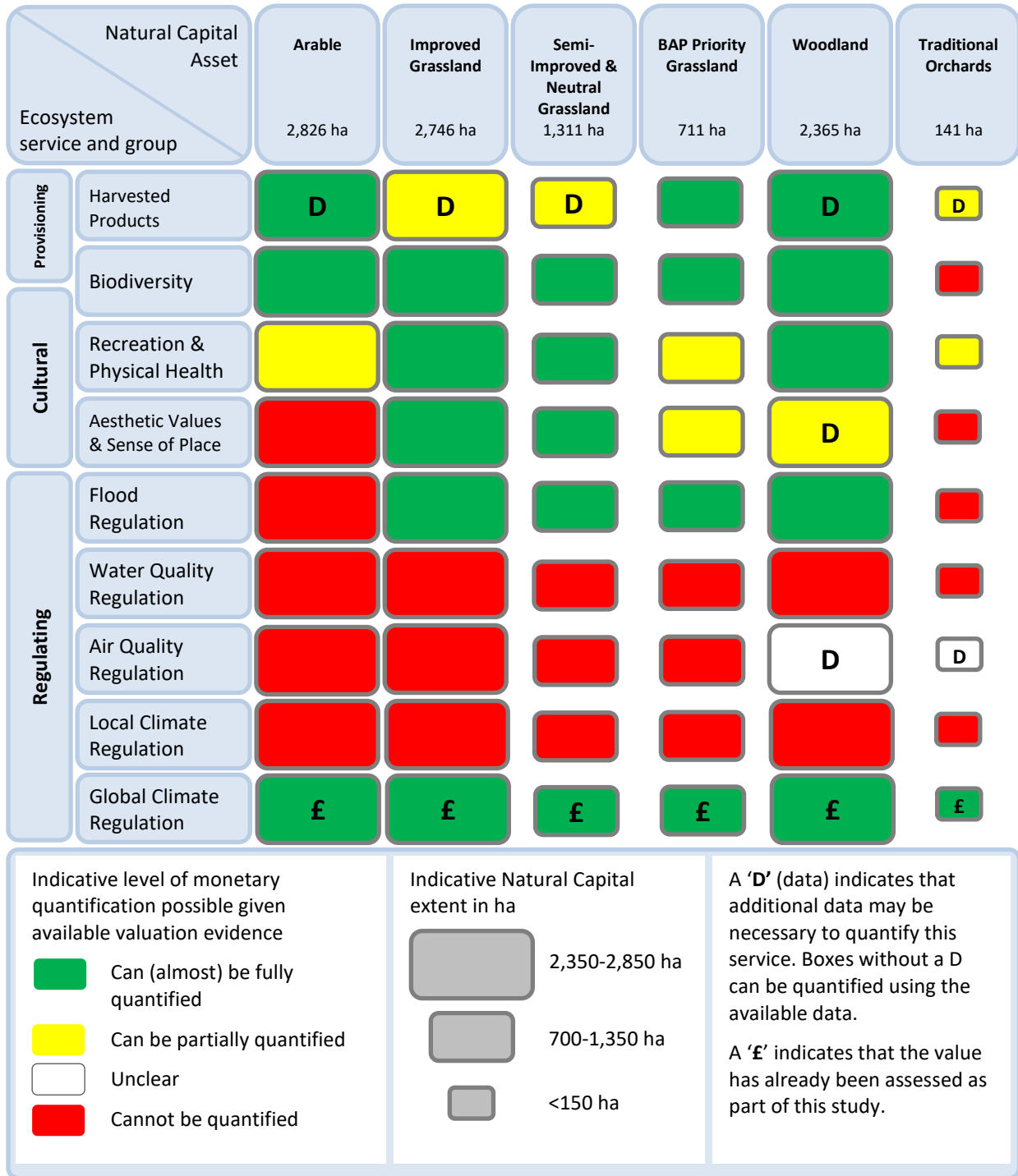[100] Defra 2007.
[101] Ibid.

3.2   Monetary Valuation Opportunities & Scope

In this section the scope of a monetary Natural Capital assessment for the Malvern Hills AONB is assessed, together with the ecosystem services which can be quantified in monetary terms, based on available data and research. For this purpose, Figure 2.8 from above has been adopted and modified as Figure 3.1. Information has been added on which Natural Capital/ecosystem services combinations can be quantified in monetary terms and if additional data is required to quantify the service in monetary terms. A more detailed analysis for each ecosystem service is provided in the following sections. This also includes details about data requirements.

Please note that, in addition to the main Natural Capital asset categories assessed in this figure, monetary values for other asset categories such as hedgerows and wetland can also be calculated. Details are given in the following sections. Certain aspects of other services such as physical health benefits may also be quantifiable.

Figure 3.1 Opportunities and Scope of Monetary Natural Capital Assessment

Ecosystem service and group	Natural Capital Asset	Arable 2,826 ha	Improved Grassland 2,746 ha	Semi-Improved & Neutral Grassland 1,311 ha	BAP Priority Grassland 711 ha	Woodland 2,365 ha	Traditional Orchards 141 ha
Provisioning	Harvested Products	D (green)	D (yellow)	D (yellow)	(green)	D (green)	D (yellow)
Cultural	Biodiversity	(green)	(green)	(green)	(green)	(green)	(red)
Cultural	Recreation & Physical Health	(yellow)	(green)	(green)	(yellow)	(green)	(yellow)
Cultural	Aesthetic Values & Sense of Place	(red)	(green)	(green)	(yellow)	D (yellow)	(red)
Regulating	Flood Regulation	(red)	(green)	(green)	(green)	(green)	(red)
Regulating	Water Quality Regulation	(red)	(red)	(red)	(red)	(red)	(red)
Regulating	Air Quality Regulation	(red)	(red)	(red)	(red)	D (white)	D (white)
Regulating	Local Climate Regulation	(red)	(red)	(red)	(red)	(red)	(red)
Regulating	Global Climate Regulation	£ (green)	£ (green)	£ (green)	£ (green)	£ (green)	£ (green)

Indicative level of monetary quantification possible given available valuation evidence: Green = Can (almost) be fully quantified; Yellow = Can be partially quantified; White = Unclear; Red = Cannot be quantified.

Indicative Natural Capital extent in ha: 2,350-2,850 ha; 700-1,350 ha; <150 ha.

A 'D' (data) indicates that additional data may be necessary to quantify this service. Boxes without a D can be quantified using the available data.

A '£' indicates that the value has already been assessed as part of this study.

*Source: **Author assessment***

3.2.1 Harvested products

To quantify commercial food production services from farming it would be necessary to get hold of actual figures about the arable crops harvested within the Malvern Hills AONB. Price statistics are available for most crops.

To quantify the food production of orchards it would be necessary to estimate the average yield and type of fruit in the AONB as well as average prices for fruits when harvested. Statistics for the average yield may not be available but it may be possible to estimate based on the area of traditional (commercial) orchards. Prices and average yield can potentially be informed by experts if statistics are not available. However, any assessment would be very indicative because of the diversity in management and productivity of traditional orchards in the AONB.

Calculating the value of livestock production could be estimated based on the type and annual number of sold livestock as well as market prices. However, it may be difficult to adjust for example for non-Natural Capital based inputs such as additionally bought fodder. A similar calculation may be possible for other products such as milk and wool.

To estimate the value of timber provision it would be necessary to estimate the tonnes of timber harvested in the AONB which may be challenging because relevant statistics are usually not available for AONBs. However, it may be possible to make assumptions based on the area of managed woodland and the area of felled woodland area which is known.

Other, less significant (but also usually neglected) services such as wild food (e.g. collecting of non-commercial mushrooms) and non-food resources (e.g. non-commercial flower picking) can be assessed for the following Natural Capital types using available data sources as they are approximated from the Natural Capital asset area:

- Native woodland
- Semi-natural & neutral grassland
- Lowland dry acid grassland
- Lowland meadows
- Lowland calcareous grassland

3.2.2   Biodiversity

Biodiversity values can generally be approximated based on national research as it is often based on habitat extent. The good spatial coverage of land-use information for the Malvern Hills AONB, even if often somewhat dated, provides reasonably robust data for a monetary assessment for each of the following Natural Capital asset types:

- Broadleaved woodland

- Ancient Semi-Natural Woodland (ASNW)

- Coniferous woodland

- Mixed woodland

- Scrub

- Improved grassland

- Calcareous grassland (partially)

- Lowland dry acid grassland (partially)

- Lowland meadows

- Neutral grassland

- Arable fields

If spatial data could be obtained relevant values could also be calculated for hedgerows and arable field margins. The author is not aware of studies for orchard biodiversity values.

3.2.3   Recreation & Physical Health

To calculate the recreational value of woodland, an estimate of visitor counts to woodland sites within the AONB would be required. Such statistics can usually be derived from Natural England's Monitoring the Engagement with the Natural Environment (MENE) survey.[102] But unfortunately reviewed data was not statistically robust enough to draw meaningful conclusions on the total count of visits to woodland within the AONB. This may change if new data gets released.[103] If new data does not provide more robust data either the visitor counts may be approximated from a higher level (in relation to woodland area) or estimates

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[102] http://publications.naturalengland.org.uk/publication/2248731?category=47018
[103] At the time when this report was written the MENE raw data was temporarily withdrawn. An older version has been reviewed.

could be made based on total visitor numbers and the area of accessible woodland. A stakeholder workshop could inform such an estimate (see also Chapter 4). Summarising, a monetary quantification of recreational values by woodland should be possible but the accuracy is unclear as this depends on the confidence in visitor statistics/estimates.

The calculation of the recreational value of other Natural Capital assets is based on a combination of land-use data and population statistics. Monetary valuation can be conducted for the following Natural Capital assets:

- Improved grassland
- Calcareous grassland
- Lowland meadows
- Neutral grassland

Land-use data is reasonably robust and local population statistics are also available. However, basing the valuation of recreational values for the Malvern Hills AONB on the local population alone would likely result in an underestimate as many beneficiaries come from outside the AONB. However, visitor survey data should allow for an adjustment for external visitors.

The author is not aware of valuation evidence for arable fields and (traditional) orchards. The value of hedgerows and arable margins could be assessed with relevant land-use data. If statistics are available also game bird shooting activities may be valued in monetary terms. This is a mix of recreation values (the experience) and harvested products values (the meat).

In addition to recreational values also the value of physical health related to 'green exercise' could be assessed. This is usually a very significant value and requires for example the number of walking/cycling trips within the AONB which should be able to approximate from the visitor survey 1999/2000, even if this is a bit dated now. Other relevant statistics such as the frequency of green exercise could be approximated from national statistics. The physical health value can be assessed for all Natural Capital types but a breakdown by Natural Capital asset is not possible.

3.2.4   Aesthetic Values, Sense of Place & Mental Health

The aesthetic value of woodland can only be assessed partially. In particular, the value of a free woodland view from urban (fringe) households can be assessed. About 60% of the AONB is classified as urban (fringe). To conduct this assessment, spatial information about each household in and close to the urban (fringe) areas of the Malvern Hills AONB is required. Such data can for example be derived from OS Address Point layers. Such layers are often held by local authorities. They are also provided by Natural England for free if Natural England is an official project partner (e.g. a funder).

The aesthetic and sense of place value for other habitats can be assessed for the same Natural Capital asset types as for recreation. The primary valuation study this calculation is based on calculated the value for cultural services collectively which is why the monetary valuation for the AONB would not allow to distinguish between the recreational value and the aesthetic and sense of place value. These values would be given collectively and may also include other cultural ecosystem services such as educational benefits.

It should also be possible to estimate the monetary value of mental health benefits. However, further analysis is required as part of a potential monetary valuation study to assess if the available scientific evidence allows a meaningful and sufficiently robust monetary valuation of such benefits. This would be calculated for the Malvern Hills AONB as a whole rather than as a break-down for each Natural Capital asset category.

3.2.5   Flood Regulation

The value of flood regulation services is mainly land-use based and can be calculated for the following Natural Capital types with no additional data requirements:

- Native woodland
- Improved grassland
- Lowland dry acid grassland
- Lowland meadows
- Neutral grassland
- Wetland

If spatial information becomes available it can also be assessed for hedgerows and arable margins. Primary valuation studies to quantify the monetary flood regulation value of arable fields and orchards are not known.

3.2.6   Water Quality Regulation

Unfortunately, primary valuation studies that would allow a monetary quantification of water quality services is only available for wetlands. Valuation evidence for other Natural Capital assets is lacking. There would be a potential to quantify the water quality in water bodies (as compared to poor water quality) but the relevant raw data is held by the Environment Agency and it is not clear if this study could be used for the purpose of quantifying water quality changes in the Malvern hills AONB.

3.2.7   Air Quality Regulation

Air quality regulation services provided by woodland, traditional orchards and other trees could be calculated by undertaking an iTree Eco assessment.[104] However, to do so groundwork would be required which for example includes measuring and identifying the species of all trees within a stratified sample of the AONB. Potentially, it may be possible to approximate the value from other iTree assessments in the UK but further investigation would be required to make a final judgement. An iTree assessment would also allow to calculate a structural aesthetic value of trees (based on hypothetical replacement costs) as well as a more accurate global climate regulation value. Valuation evidence for the air quality regulation services of other Natural Capital assets than woodland and trees is not available. However, this is generally limited anyway.

3.2.8   Local Climate Regulation (Climate Change Adaptation)

Climate regulation research is generally related to urban areas and the author is not aware of any monetary valuation evidence that would allow a quantification of local climate regulation services in the Malvern Hills AONB.

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[104] For more information visit https://www.itreetools.org/eco/

3.2.9 Global Climate Regulation (Climate Change Mitigation)

The monetary value of global climate regulation services has already been assessed in Section 2.2.9 of this report. This may be adjusted in a monetary valuation study based on the assessment timescale. Applying the approach outlined in Section 2.2.9, a breakdown by Natural Capital asset type is not possible. However, using a different approach it would be possible to estimate the carbon stock value for most Natural Capital assets within the Malvern Hills AONB. As mentioned before, an iTree Eco assessment would allow a more accurate assessment of the woodland resource in the Malvern hills AONB.

3.3   Data Requirements

Table 3.1 summarises which additional datasets would benefit a monetary Natural Capital assessment for the Malvern Hills AONB and which additional ecosystem services could be quantified based on the additional data.

Table 3.1 **Data Requirements for Monetary Natural Capital Assessment**

Data	Relevant for…	Notes
Harvested crop type and annual yield statistics/estimates (ideally over 5 years)	Harvested products: Arable	
Annual harvested fruits statistics/estimates for orchards and prices for at the point of harvesting	Harvested products: Orchards	Could potentially be based on orchard area and type. However, the area of commercial orchards is only known for some areas of the AONB.
Number and type of sold livestock	Harvested products: All grasslands that support livestock (meat & milk)	It would also be necessary to estimate the value of other non-Natural Capital elements (Malvern Hills AONB only) such as additionally bought fodder.
Timber statistics	Harvested products: Woodland	May be approximated based on (managed) woodland area.
Annual number of woodland visits within the AONB	Recreation: Woodland	Could potentially be based on stakeholder workshop or other estimates.
OS AddressBase Plus layer (or equivalent)	Aesthetic values: Woodland	This may be accessible through an OS public sector mapping agreement via Natural England[105]. Similar datasets may also be held by local authorities.
iTree Eco[106] assessment	Air quality regulation: Woodland and trees	
Hedgerow assessment (length/area)	Biodiversity/recreation/aesthetic values/flood regulation: Hedgerows	

*Source: **Author assessment***

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[105] Point of contact: Hannah Ross; NaturalEnglandGIDataManagers@naturalengland.org.uk
[106] For more information visit https://www.itreetools.org/eco/

4. Conclusions & Recommendations

This scoping study gives us a basic understanding of the value of the Natural Capital resource in the Malvern Hills AONB. We can see that the Natural Capital provides us humans with many services; way beyond food, timber and biodiversity. This is why it is important to protect and enhance this resource – for our own sake and for the sake of future generations. However, the assessment is indicative and based on incomplete and sometimes outdated data. It is also mainly a qualitative assessment. A monetary assessment makes Natural Capital values more accessible and tangible to audiences not usually engaged in environmental issues which could rise awareness and trigger new partnerships.

The assessment has shown that the Malvern Hills AONB faces a range of threats such as:

- overcrowding which can have negative effects on aesthetic values, recreation and biodiversity,
- development pressures, especially around the AONB which could impact on its tranquillity and landscape views,
- Climate change which leads to higher summer temperatures and can impact on water availability and biodiversity, and
- Agricultural intensification which can have negative effects on biodiversity, water quality, and potentially aesthetic values (e.g. polytunnels).

To mitigate/overcome these threats and to improve the evidence base for the Malvern Hills AONB a range of recommendations has been made throughout the report which are summarised below. Some more general recommendations were also added.

Short-term recommendations

- A workshop (series) could help to make better use of local knowledge. Stakeholder workshops including, for example, participatory ecosystem services mapping, could be used to:

  o Establish footfall maps to manage overcrowding and to inform a monetary assessment of recreational values.

o   Map which Natural Capital assets are most valuable for local communities in terms of their cultural services.

o   Map opportunities for Natural Capital enhancement and creation such as additional recreational areas to release pressures of overcrowding and to enhance the biological habitat network to allow better species migration in light of climate change.

o   To make the business case for enhancing Natural Capital in the AONB and to explore new funding opportunities such as visitor payback.

- A monetary valuation study would allow the value of the Natural Capital in the AONB to be communicated to new audiences and to make the business case for protecting/enhancing these valuable assets (see also Chapter 3). The available data allows a range of ecosystem services to be assessed (see Figure 3.1) although additional data would increase the range of ecosystem services that could be valued (see Table 3.1 for more details on data requirements).

Medium to long term recommendations

- Some of the land-use maps this assessment was based on were somewhat outdated (often based on 2007 data). A detailed Phase 1 assessment would help to better establish the actual circumstances on the ground which in turn would allow more detailed assessments. Such an assessment may also identify priority habitats that have been indicated by older datasets but were not recognised in the latest Priority Habitat Inventory (either because they were not there anymore or because they were simply not recorded). This would also allow to map and assess habitats which are not mapped so far such as hedgerows and to better identify/distinguish commercial and traditional orchards. An alternative would be to gain access to the latest Land Cover Map (2015)[107] although this only covers broad habitats and would therefore only do part of the job.

- A new visitor survey would provide up-to-date visitor statistics and could be designed to better estimate footfall and which Natural Capital assets are most valued by visitors. This could also inform future assessments or recreational and aesthetic values.

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[107] https://www.ceh.ac.uk/services/land-cover-map-2015

- Closer cross-boundary development control may be considered as development outside the AONB boundaries could still have a significant effect on the 'natural beauty' of the AONB; in particular views across the landscape from the elevated AONB areas. The Malvern Hills AONB cannot be managed in isolation to the surrounding and cross-boundary issues need to be addressed. New tools such as the Natural Capital Planning Tool (NCPT)[108] may be useful in this context.

- Bringing more traditional orchards into management, perhaps by local communities, would be an opportunity to increase both harvested products and biodiversity value.

- The promotion and branding of local food markets may be beneficial as it may allow farmers to achieve a price premium, increase the sense of local 'ownership', and reduces carbon due to short transport routes. However, this requires for example educating the local population as well as visitors about the benefits of localised, organic markets and supply chains.

- In light of the increasing demands for renewable energy sources such as woodfuel there is potential to increase woodland productivity. This increasing demand for woodfuel may bring woodland areas which were formally economically unviable for harvesting into active management which usually also supports other ecosystem services such as biodiversity. Collective management of smaller patches of woodland in diverse ownerships may be one way to increase management efficiency.

- Restoring coniferous PAWS to native species could further increase the biodiversity value and other services such as climate regulation and air quality regulation of woodland within the Malvern Hills AONB.

- Awareness rising and the promotion of low-intensity farming and the introduction of grass buffer strips and ponds could be effective in improving water quality and many other ecosystem services including biodiversity.

- The introduction of more trees along paths and tree islands at main visitor destinations where other shelter is scarce can provide efficient shelter opportunities for vulnerable visitors such as the elderly and young children from heat and UV radiation exposure which will increase due to climate change. Additional field/hedgerow trees can also provide new shelter opportunities for vulnerable livestock.

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[108] https://ecosystemsknowledge.net/natural-capital-planning-tool-ncpt

- Possible effects of climate change are more frequent and severe droughts as well as general water scarcity which could also trigger more frequent wildfires. Therefore, the Natural Capital infrastructure needs to be adapted to such risks, for example by providing more water storage capacities and perhaps by considering tree and grassland species that are more resilient to high temperatures and water scarcity. Providing a strong ecological network is also important because it allows species that are vulnerable to temperature changes to move freely from one area to another.

5. Abbreviations

ASNW	Ancient Semi-Natural Woodland
AONB	Area of Outstanding Natural Beauty
BAP	Biodiversity Action Plan
CEH	Centre for Ecology & Hydrology
GIS	Geographic Information System
GHG	Greenhouse Gas
GDP	Gross Development Product
NEAFO	National Ecosystem Assessment Follow-On
NEWP	Natural Environment White Paper
NCAC	Natural Capital Asset Check
NCPT	Natural Capital Planning Tool
NVZ	Nitrate Vulnerability Zone
PAWS	Plantations on Ancient Woodland Sites
PROW	Public Rights of Way
SSSI	Site of Special Scientific Interest
t CO2e	Tonnes of carbon dioxide equivalent
TEV	Total Economic Valuation
UHIE	Urban Heat Island Effect
WFD	Water Framework Directive
WIYBY	What's In Your Backyard

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Appendices

A.   *Spatial Natural Capital Asset Register Details*

Acronyms:
MHD - Malvern Hills District Land
MHT - Malvern Hills Trust Land
LCM – Land Cover Map 2007
PHI – Priority Habitat Inventory
AWI – Ancient Woodland Inventory
NFI – National Forest Inventory

Please note that the stated publicly accessible area includes a 50m buffer around PROW (see Section 2.2.3 for more details).

Asset Categories & Layers	Area in ha	Geographical coverage	Publicly Accessible (ha)	Publicly Accessible (%)
Total Malvern Hills AONB Area	10,663.8		3,511.0	
Coverage	10,437.9	98%		
Semi-natural	4,491.8	42%		
Arable				
AH_Arable_LCM	**2,825.9**	**27%**	**578.4**	
Traditional Orchards				
AH_TraditionalOrchards_PHI	**140.8**	**1.3%**	**48.7**	
Improved Grassland				
GL_Improved_MHD	144.0			
GL_Improved_MHT	40.0			
GL_Improved_Probably_MHD	736.9			
GL_Improved_LCM	1,825.2			
Total	**2,746.1**	**26%**	**786.5**	
Semi-Improved & Neutral Grassland				
GL_SemiImproved_PHI (good quality)	321.6			
GL_Neutral_MHD	31.6			
GL_Neutral_MHT	0.8			
GL_Neutral_Possibly_MHD	486.9			
GL_Neutral_LCM	29.6			
GL_RoughLowProductivity_LCM	440.1			
Total	**1,310.6**	**12%**	**332.8**	

Asset Categories & Layers	Area in ha	Geographical coverage	Publicly Accessible (ha)	Publicly Accessible (%)
BAP Grassland				
GL_LowlandDryAcid_PHI	590.0			
GL_LowlandCalcareous_PHI	11.7			
GL_LowlandMeadows_PHI	109.7			
Total	**711.3**	**7%**	**609.4**	
Wetlands (Basic assessment only as very low area)				
WE_InlandMarsh_PurpleMoorRushPasture_MHT	0.3			
WE_InlandMarsh_Swamp_MHD	0.1			
WE_InlandMarsh_Unspecified_MHT	3.2			
Total	**3.6**	**0.03%**		
Woodland				
WO_ASNW_AWI	799.7			
WO_Broadleaved_NFI	866.2			
WO_Coniferous_NFI	67.2			
WO_Felled_NFI	0.2			
WO_Mixed_NFI	94.1			
WO_PAWS_AWI	439.9			
WO_Shrub_NFI	16.1			
WO_UnspecifiedAssumedWoodland_NFI	4.5			
WO_UnspecifiedYoungTrees_NFI	76.7			
Total	**2,364.6**	**22%**	**874.7**	
Water (Basic assessment only as very low area and not suitable for economic valuation)				
WA_StandingOpenWaterAndCanals_MHD	14.2			
WA_Rivers_LCM	3.6			
WA_StandingOpenWaterLakes_LCM	10.3			
WA_Ponds_MHD	Count: 37			
Total	**28.1**	**0.3%**		
Other Landuses (not assessed)				
OT_Bracken_MHD	4.6			
OT_BuildUpAndGardens_MHD	6.6			
OT_BuildUpAndGardens_LCM	260.8			
OT_Quarry_MHD	0.7			
OT_Rock_MHD	4.1			
OT_Rock_LCM	0.3			
OT_IntensivelyManagedOrchards_MHD	17.8			
OT_UnspecifiedOrchards_MHD	11.8			
Total	**306.8**	**3%**		