The Wildlife Trust
for Birmingham and
The Black Country

The Value of Green Infrastructure in Birmingham and the Black Country

The Total Economic Value of Ecosystem Services provided by the Urban Green Infrastructure

2011

Oliver Hölzinger

Creating a **Living Landscape**

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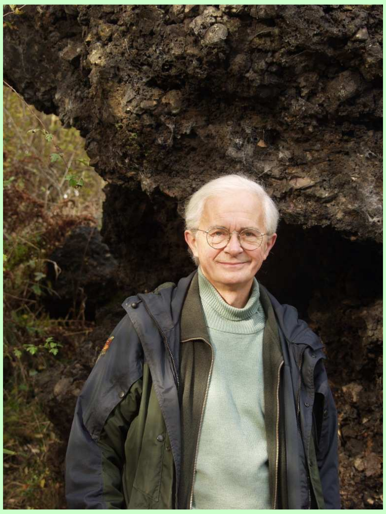

Foreword by Ian Trueman, emeritus Professor in Plant Ecology, University of Wolverhampton

This is a timely and impressive analysis of the natural assets of Birmingham and the Black Country! At a time when the value of nature has received attention at the national level, it is particularly appropriate that we examine the situation in one of its most densely populated areas.

Although many of us may see our wildlife sites as priceless, the Wildlife Trust has been fortunate to be able to host an environmental economist from Germany who has begun the process of setting them in a wider and more familiar context by calculating monetary values for some of our key ecosystems. This is a thorough, cautious and ingenious investigation which is a worthy defence of wildlife, and should be weighed against the monetary value to be associated with its destruction.

Prof Ian Trueman
BBCWT People & Wildlife Committee

I. Abstract

The pressure on the natural environment, especially in urban areas, is increasing. One main reason is that ecosystem services and the benefits they provide to human welfare are ignored or strongly undervalued and not adequately assessed in planning and policy. One reason is that most benefits are difficult to measure and not marketable. Economic valuation of ecosystems can help to mitigate this undervaluation and is receiving increasing attention by government and science. Monetarisation makes ecosystem services more tangible for decision makers and planners. One aim of this publication is to provide a decision aid whenever environmental issues are affected.

In this survey ecosystem services provided by woodland, heathland and wetland as part of the Green Infrastructure in Birmingham and the Black Country have been valued. A value transfer approach has been applied. Stating the best guess, the 2,422 ha of GI covered within this study provide an annual value of at least £20.78 million which results in £1.09 billion capitalised over 100 years., A wide range of ecosystem services have not been included in this sum because of incomplete scientific evidence. Therefore the findings can be interpreted as a baseline for the total value.

II. Acknowledgements

Many people provided valuable comments and statistical data for this study. In particular, I would like to thank Professor Ian Trueman and Sara Carvalho and Andy Slater from EcoRecord as well as Dr Rossa Donovan for a main data input. Further thank goes to Chris Parry representing the whole Wildlife Trust for Birmingham and the Black Country staff which provided assistance and support whenever necessary.

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V. List of Abbreviations

ANGSt	Natural England's Accessible Natural Greenspace Standard
ASNW	Ancient Semi-Natural Woodland
BAP	Biodiversity Action Plan
BG	Best Guess
CO_2	*Carbon dioxide*
CO_2e	*Carbon dioxide equivalent*
DECC	Department of Energy and Climate Change
Defra	Department for Environment, Food and Rural Affairs
ELF	Environmental Landscape Features
EMAS	European Environment Management and Audit
EU ETS	European Union Emission Trading System
GIS	Geographic Information System
GIVaN	Green Infrastructure Valuation Network
GI	Green Infrastructure
IMS	Integrated Management System
IPCC	Intergovernmental Panel on Climate Change
m	Million
PAWS	Planted Ancient Woodland Sites
PES	Payments for Ecosystem Services
SSSI	Site of Specific Scientific Interest
SUDS	Sustainable Urban Drainage Systems
TBT	Tributyl tin
TEEB	The Economics of Ecosystems and Biodiversity
TEV	Total Economic Value
UHIE	Urban Heat Island Effect
UHI	Urban Heat Island
UTAQS	Urban Tree Air Quality Score
WTA	Willingness-To-Accept
WTP	Willingness-To-Pay

1. Introduction and Background

1.1 Objectives of this Survey

In the UK, natural habitats are under pressure. Economic austerity in the course of profound changes in public administration is unlikely to mitigate the pressure on the natural environment. Especially within urban areas the stress on living landscapes is increasing. Facing depleted public coffers, every penny spent has to count and decisions are expected to be more frequently based on cost-benefit analyses. Because the services provided by Green Infrastructure (GI) are usually not marketable, they are generally undervalued. This can lead to wrong decisions concerning the natural environment.

This survey provides information about the magnitude of the economic value of the services provided by the Green Infrastructure of Birmingham and the Black Country, expressed in a measurement everyone is familiar with - money. This approach is called the Total Economic Value (see section 1.4).[1] Above all, the audiences for this survey are local authorities, members of the public administration, business and corresponding sectors in Birmingham and the Black Country. The survey aims to provide a decision aid whenever environmental issues are involved, e.g. in planning. It is not only the opinion of the Department for Environment, Food and Rural Affairs (Defra), that

> *"…the benefits the natural environment provides are not yet valued properly in policy and project appraisal across government."*[2]

Furthermore the survey is addressed to all interested people, e.g. from the environmental or science sectors, also from beyond Birmingham and the Black Country. The findings are not directly transferable, but can help others to grasp the dimension of benefits provided by the environment, especially in an urban context.

Another aim of this survey is to show an example of best practice when valuing ecosystem services within the United Kingdom. Most of the available literature and

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[1] For audiences who are not familiar with the ecological economics the introduction on http://www.ecosystemvaluation.org/ is recommended.
[2] Defra 2007, 2.

state of the art valuation methods have been applied within this survey. Therefore it has been possible to pay attention to comparability and transparency.

The objective of this survey is to point out the contribution of Green Infrastructure to human welfare, expressed in monetary values. In science there is no consistent definition for Green Infrastructure. In this survey, the following definition is used:

> *"Infrastructure is defined as the basic structures and facilities necessary for the efficient functioning of a given geographical area. Although there is no commonly accepted or authoritative definition in the UK, 'green infrastructure' refers to the combined structure, position, connectivity and types of green spaces which together enable delivery of multiple benefits as goods and services."*[3,4]

In addition to the accessible Green Infrastructure there are important environmental services provided by areas which are not accessible. Because of protection issues not all sites are publicly accessible but they still provide important services such as improving air quality. Consequently we have included these areas in the survey as well. This study covers woodland and the urban forest, heathland and wetland as well as a selection of environmentally important grassland habitats.[5]

Often enough an increase of economic welfare leads to a decline of non-economic welfare and mostly the environment suffers. A decline of total welfare in sum can be the consequence. The assumption is permissible, that an increase of environmental quality usually moves in parallel with an increase of non-economic welfare. For example: increasing health leads to a decline of healthcare costs on the one hand. On the other hand good health is a worth in itself. It is better to be healthy than to be ill, even if you have effective treatments. Therefore, we can take for granted that the

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[3] Forest Research 2010, 9.

[4] Natural England (2010) defines green infrastructure as "a strategically planned and delivered network comprising the broadest range of high quality green spaces and other environmental features. It should be designed and managed as a multifunctional resource capable of delivering those ecological services and quality of life benefits required by the communities it serves and needed to underpin sustainability. Its design and management should also respect and enhance the character and distinctiveness of an area with regard to habitats and landscape types.
Green infrastructure includes established green spaces and new sites and should thread through and surround the built environment and connect the urban area to its wider rural hinterland. Consequently it needs to be delivered at all spatial scales from sub-regional to local neighbourhood levels, accommodating both accessible natural green spaces within local communities and often much larger sites in the urban fringe and wider countryside."

[5] Because it was found possible to value only one ecosystem service provided by grassland, this habitat is not listed in the summary table.

economic welfare of the environment does not represent the total welfare. The consequence is a systematic under-estimation of the welfare overall.[6]

> *"Because ecosystem services are largely outside the market and uncertain, they are too often ignored or undervalued…"*[7]

The aspiration of this survey cannot be to provide a defensible monetary value that covers the whole economic welfare derived from the environmental infrastructure in Birmingham and the Black Country. One reason is a lack of available valid data. Many required statistics and baseline data are not available for the area examined. Even basic data about the extent of the Green Infrastructure is incomplete and inconsistent with reference to different resources. Matters are aggravated by a lack of scientific evidence. Especially in the United Kingdom actual valuation studies are very rare. Nevertheless, the findings are sufficiently defensible and valuation weaknesses are always noted and also recognised through a sensitivity analysis. Furthermore the values should be interpreted as the core for the total welfare provided by the Green Infrastructure in Birmingham and the Black Country. The total welfare value can be assumed to be a considerably in excess of this amount.

One field of application for the findings of this survey is as a decision aid whenever green spaces are affected. When it is necessary to compare environmental interests with other concerns such as providing space for a new warehouse or a new street this survey can help to weight the environmental issues improved.

> *"Green Infrastructure is not embedded as a priority agenda in the region [West Midlands] to the extent it should be and in the current recession we run the risk that hard-line economic views will be entrenched. This could result in the benefits of Green Infrastructure being left further behind, with a resulting diminishment of quality of life for us all, including for economic recovery and development."*[8]

This survey can help to provide a wider angle on the decision consequences and therefore lead to more well-founded decisions in which environmental issues are better reflected. However, as a general rule it should be noted that policy appraisals

[6] Mäler and Vincent 2005, 520.
[7] Costanza et al. 1997, 269.
[8] WMRO 2009, 2.

cannot be decided only on the basis of a monetary cost-benefit analysis. Not least because many ecosystem services are unquantifiable and such “soft” factors should also be recognised. Economic valuation is a decision aid not a decision substitute.

1.2 Ecosystem Services and Ecological Economic Theory

The ecosystem provides a manifold range of services to human wellbeing and is in fact the basis for our existence. This is often underestimated or simple ignored and accepted as self-evident. A good overview of the wide range of ecosystem services is provided by the recently published synthesis report of the international project “The Economics of Ecosystems and Biodiversity” (TEEB). Figure 1.1 provides an overview.

Within the limits of the present survey, not all relevant aspects can be covered. Furthermore not all ecosystem services can be transferred to the regional context with its high urbanisation. The importance of these services does however increase within this urbanised setting.[9] Other services such as “spiritual experience” or “sense of place” are very abstract and generally not quantifiable or even barely describable. The focus here is on the main ecosystem services to be expected to have the highest influences.

[9] CABE Space 2010, 40.

Fig. 1.1 Overview of ecosystem services

Provision services Describes the material outputs from ecosystems	**Food** Ecosystems provide the conditions for growing food
	Raw Materials for construction and fuel
	Fresh water Provision of surface and groundwater
	Medicinal resources Input for the pharmaceutical industry
Regulating services Describe services ecosystems provide by acting as regulators	**Local climate and air quality regulation** Trees and Woodland influence rainfall, pollination and provide shade
	Carbon sequestration and storage Plants remove carbon dioxide from the atmosphere and mitigate climate change
	Moderation of extreme events Ecosystems create buffers against natural hazards such as floods and storms
	Waste-water treatment Micro-organisms decompose pollutants
	Erosion prevention and maintenance of soil fertility Intact ecosystems protect against land degradation and desertification
	Pollination Most food crops depend upon animal pollination
	Biological control Regulation of pests and diseases
Habitat or supporting services Underpin almost all other services	**Habitat for species** Ecosystems provide everything that an individual plant or animal needs to survive
	Maintenance of generic diversity Ecosystem provide the basis for evolution as well as the gene pool for further developing crops
Cultural services Describe non-material benefits people obtain from contact with ecosystems	**Recreation and mental and physical health** Ecosystems provide space to relax, recover and for physical activity
	Tourism Nature tourism provides considerable economic benefits
	Aesthetic appreciation and inspiration for culture, art and design For instance as patterns for planes, vessels etc.
	Spiritual experience and sense of place For religion, identity…

Source: Referring to TEEB (2010a), p. 34

Many people still see a trade-off between environmental and economic goals. This is a misjudgement. The economic sector profits from an intact high quality environment in many cases as shown below. We should also keep in mind that the economy has no self-purpose and is meant to serve the social system. The social system for its part is embedded in the natural environment. By implication, a productive economy is not possible without the basis of an intact high quality environment. Additionally maximized social welfare is also unattainable without these two requirements. Finding the optimal mix of social, environmental and economic goals is another question and very difficult to answer. However, many facts suggest that the optimum level of using the environment has already been exceeded or, depending on resource and region, is well on the way to transcend the critical point.[10]

The perception that natural capital is overexploited automatically leads to the question of why this happens. A few economists still have the view that the “invisible hand of the market” will lead us to the welfare-optimum. They do not recognise that the market fails with respect to many environmental issues. The economic system as well as the social system always has an influence on the environment. This is basically irrefutable. From the anthropocentric point of view (see section 1.3), theoretically a most favourable amount of environmental consumption can be identified which leads to a long term welfare-optimum. However, many environmental goods and services have characteristics which lead to underestimation and give incentives for overexploitation.

Green Infrastructure and its services, which we are focussing on, can be located between a (half-)Common- and a Public Good, depending on the property relations and the service being considered. A Common Good is characterised by rivalry in utilization and non-excludability.[11] A few could theoretically be exclusive and thereby private. One might be able to build a wall around a site and charge visitors for accessing it. In this case it would have characteristics of a Private Good. Indeed, usually this is ineffective and socially inappropriate. Other services like the provision of wood or biomass can be organized privately. On the other hand, one is not able to exclude someone from other environmental services such as cleaning the air or

[10] See e.g. Meadows, Randers, and Meadows 2004; Weizsacker et al. 2009.
[11] Samuelson 1954.

implementing a carbon sink. These services can be characterised as a Public Good, because nobody can be excluded and there is no rivalry in their use.[12]

The crucial point is that many services provided by Green Infrastructure occur as positive external effects. The benefits from external effects or externalities do not have a market. They are not transmitted through prices. Nobody has to pay for the cleaner air which plants provide, the marginally lesser consequences of climate change through carbon sinks, nor even usually for recreation. Because there are no market prices, the unrestricted market is not able to allocate environmental goods in a satisfactory way. The market participants have great stimuli to overexploit these goods. In those cases where the market fails, politics necessitates action to prevent Public- and Common Goods from overexploitation. However, the public sector does not know the true price for these goods. This is where the present survey is aiming – to straighten the basis of decision-making for politics, public administration as well as the private and the third sector.

1.3 Ethical Embedding

Is it generally allowed to put a value on the environment? This is of course a reasonable question. The aim of this section is not to start an extensive environmental ethics discussion, but to show briefly why we do what we do and against which backdrop. It should be noted that it is not possible to appreciate environmental goods without value judgements.

We have adopted an anthropocentric approach, in other words we concentrate on human welfare and economic value to humans. We reflect the benefits and influences in general of the environment for humankind. This is the only practicable approach because *"non-anthropocentric value is, by definition, beyond any human knowledge."*[13] But it should be kept in mind that the anthropocentric approach can involve for example existence values (non-use values)[14], option values[15] or bequest values[16] as a matter of course. One can also benefit from the pure wellbeing of

[12] Ibid.
[13] Defra 2007, 12.
[14] You might never be able to see a whale in nature, but you can nevertheless benefit from the pure existence of whales.
[15] You might never see a whale in nature, but you can benefit from the ability to see whales in the future.
[16] You might never see a whale in nature, but you can benefit from the ability of coming generations to see whales in the future.

animals. A proof is the consumption of free-range organic eggs. The direct quality of these eggs is not better than the quality of a conventional egg. The buyer profits indirectly from the species-appropriate husbandry of the chickens and is willing to pay more for it.

Many proponents of other ethical perceptions might be able identify with this wider interpretation of anthropocentrism. Even if not, they might understand that this view is essential for examining the questions of this survey. To assign the environment a non-measurable value is neither practicable, nor does it mirror reality.

Many people have difficulty with a monetary value for environmental goods in general. The criticism is that you cannot or should not sell the environment. However, to make social, environmental and economical issues comparable, you need a common denominator, though not necessarily a monetary quantity. We could use something like “wellbeing credits”, but we have to accept that our whole economic system as well as constitutive parts of the social system operates in monetary terms. If we were to define a new rating system, we would have to convert everything into this system and can assume that no-one else could calculate with it or even understand it. According to this circumstance, it best serves the aims of the study to use a monetary value everyone is familiar with. The sacrifice of a monetary evaluation approach would probably impede environmental protection.

1.4 The Methodological Approach and its Limitations

First of all this is an economic valuation study. One main conceptual difference from economic impact studies is that they, unlike economic valuation studies treat government expenditures and employment as benefit.

> *“Economic impact studies are not designed to determine whether or not any of the uses of the resources are economically efficient and welfare enhancing.”*[17]

This contradicts the aims of the present survey. Because of the wide range of relevant data as well as the lack of valuation studies, especially in the United Kingdom, within the limits of this survey it was not possible to gather specific data or

[17] Forest Research 2010, 26.

records for each environmental impact. Therefore the benefit or value transfer approach has been applied. That means that findings from other primary valuation studies are transferred to our context, the Green Infrastructure of Birmingham and the Black Country. The focus on this comparatively small area makes it even more difficult to gather the relevant data, so a comprehensive valuation was not affordable.[18] As mentioned before, there has also been a focus on the main impacts of the Green Infrastructure.

Whenever possible, benefits from the environmental infrastructure have been valued in monetary terms.

> *"Placing accurate economic values on green infrastructure or its green space components is far from easy, but is vital to support the case for sustained investment."*[19]

To do this, the Total Economic Value (TEV) approach is used. This approach was developed to transfer all ecosystem benefits to quantitative monetised terms. As can be seen in table 1.1 below the TEV usually divides the welfare benefits from ecosystem services into four categories.[20] Within this setup, even the values in their own right, so called intrinsic values, can theoretically be captured.[21]

[18] Because of the complexity of the ecosystem and the difficulties of measuring environmental services for the economy and welfare, valuing the environmental services is very difficult in general.
[19] Forest Research 2010, 10.
[20] For reasons of clarity and comprehensibility we use a different structure in this survey.
[21] TEEB 2010b, 35.

Tab. 1.1 The Total Economic Value approach

Direct use value	The value derived from the direct extraction of resources from the ecosystem (fuelwood), or the direct interaction with the ecosystem (recreational use).
Indirect use values	Those values that support economic activity. For instance, the watershed protection function of a forest leads to improved water quality which might in turn affect a flower grower downstream.
Option use values	Preserving an ecosystem or biodiversity so that its direct and indirect use values can be potentially 'consumed' in the future. Such a value may be placed on avoiding species extinction in wild variants of commercially-grown crops as this genetic diversity may be valuable in the future.
Non-use values	These values differ fundamentally from the other value-types as they are not linked to economic activity, either directly or indirectly. Non-use values are also termed 'existence values' and refer to conservation for its own sake. For instance, we may value polar bears just because they are living creatures that we share the earth with and feel that we have a moral duty to preserve the habitats that support them.

Source: TEEB (2010b), p. 35

Direct-use values for marketable goods and services like wood production can often be directly derived from market statistics. However, within Birmingham and the Black Country these services only play a minor part. With every step towards non-use values it becomes more difficult to obtain convincing values.

For non-market goods and services the market price is zero. One does not have to pay for clean air, for example. So one needs other methods to reveal these human preferences for environmental goods and services. Usually two approaches can be distinguished: 'revealed' and 'stated' preference techniques. Applying the revealed preferences approach one derives the value from the marketable goods and services which the environmental attributes contain. One example is the 'hedonic price method' where differences between property prices dependent on environmental surroundings are used as indicators for the value of surrounding ecosystems. Furthermore one can derive values from damage or replacement costs such as those following flooding, or from travelling costs for example to visit a site for recreation. Stated preference techniques on the other hand elicit the value of ecosystem services by asking people their willingness-to-pay (WTP) for, or willingness-to-accept

(WTA) a change in environmental quality. These methods are very flexible and can also be applied to derive option and non-use values.[22]

Within the present study no original primary surveys were carried out. Other findings were transferred applying the benefit or value transfer approach. This approach allows the transfer of findings from other surveys to our context, the Green Infrastructure of Birmingham and the Black Country.

> *"A greater use of benefits transfer is seen to be the key to the more practical use of environmental values in policy-making. There are good examples in policy appraisal in the UK, where benefits transfer has been successfully applied…"*[23]

Consideration has also been given to the "Introductory Guide to Valuing Ecosystem Services", published by Defra as well as to the "Practical Guidelines for the Use of Value Transfer in Policy and Project Appraisal" provided by the Economics for the Environment Consultancy.[24] Using these guidelines it has been possible to ensure that the outcomes of the present survey achieve the state of the art as well as transparency and comparability with other studies.

In the present survey only valuation methods which comply with scientific standards as well as the available evidence are applied. Unfortunately during the literature analysis it was possible to find many publications referring to the topic which could not match this requirement. Nevertheless, the model implies some limitations. Related willingness-to-pay techniques have their own imperfections such as the social desirability bias (the interviewees may like to make out that they value an ecosystem service more than they actually do) or an inability to perceive hypothetical markets and goods. However, questioning techniques are sufficiently advanced to gather resilient outcomes.[25]

Another limitation may occur from applying the value transfer approach. Usually, the study site (the primary valuation study) and the policy site (Birmingham and the Black Country) are not entirely similar. Therefore, some socio-economic influencing

[22] For a more detailed overview of valuation techniques see Forrest Research (2010), p. 28
[23] Defra 2007, 38.
[24] Defra 2007; EFTEC 2010b.
[25] For more information see EFTEC and EFL 2006.

variables such as income or population density as well as the physical characteristics of the site and the context (availability of substitutes) need to be adjusted. Even if these adjustments are applied as thoroughly as possible, a benefit transfer error can never be ruled out. Some adjustments such as for cultural distinctions are not entirely possible. Further limitations are linked to general scientific uncertainties such as for future impacts of climate change. Further method-specific weaknesses and assumptions are discussed in particular sections, albeit in more depth whenever applied for the first time.

To take these circumstances into account within this investigation, a sensitivity analysis has been applied.

> *"Sensitivity analysis is core to any appraisal exercise and should be employed to compensate for the limitations and uncertainty concerning the data informing the assessment."*[26]

Using sensitivity analysis, every value is stated as "best guess" with a range, following best practice recommendations. If not noted otherwise, stated values in the different sections are best guesses for annual values. It should also be noted that the values produced in this study are gross rather than net values. Neither alternative land-use options nor the costs of land management etc. have been considered. This is a task within concrete policy appraisals.

Another mistake often made when valuing ecosystem services is double counting. The risk is even higher when valuing such a wide range of services as well as different habitats as in the present survey. The ecosystem interactions as well as the relations between different services are characterised by high complexity. Therefore, considerable attention has been paid to this issue. In case of doubt calculations are conservative to ensure validity. This principle has been applied to all issues.

However, in some cases a transfer of findings is only suggestive; in other cases it is not meaningful or ordinarily not achievable. If valuation is not possible the ecosystem service or influence is described qualitatively and, if available, valuation examples for related services which are not transferable are mentioned.

[26] EFTEC 2010a, 35.

The values of ecosystem services are not only stated as annual values; they are also stated as capitalised value over 100 years. To value an annual ecosystem benefit over time it is usual and reasonable to apply a discount rate. This discount rate is used to convert the benefits to present values. The main argument for the "Social Time Preference Rate" is that individuals as well as the society as a whole prefer current consumption more than consumption in the future. UK government recommends a discount rate of 3.5 percent for periods of up to 30 years. After 30 years this rate declines to 3.0 percent and after 75 years to 2.5 percent.[27]

The derivation for this rate, however, seems out-dated and the discount very high. HM Treasury (2003) argues for the use of the real interest rate for long term low risk investments.

> *"For individuals, time preference can be measured by the real interest rate on money lent or borrowed. Amongst other investments, people invest at fixed, low risk rates, hoping to receive more in the future (net of tax) to compensate for the deferral of consumption now. These real rates of return give some indication of their individual pure time preference rate."*[28]

With the phrase "hoping to receive" they appreciate that there is still a risk surcharge involved. Another crucial point is that especially long term cross-generational valuations always imply value judgements.[29]

> *"Society as a whole, also prefers to receive goods and services sooner rather than later, and to defer costs to future generations."*[30]

With this sentence the authors of HM Treasury (2003) implicitly imply that *"to defer costs to future generations"* is a law of nature or is socially deliberate and/or accepted. However, in consideration of the overall accepted concept of sustainable development and assuming that a government is not less responsible for future generations than for the current, even if future generations are not able to elect, any recommendation of this concept by government is at least highly questionable.

[27] HM Treasury 2003, 97.
[28] Ibid., 26.
[29] German Federal Environment Agency 2008, 30.
[30] HM Treasury 2003, 26.

In consideration of these weaknesses the decision has been made to apply another more actual and well derived approach for long-term discounting, recommended by the German Federal Environment Agency.[31] It is also recommend that the UK government re-evaluates this important issue. One underlying assumption or value judgement in this approach is that utilities across generations are attributed equal importance and therefore the pure time preference rate is zero.

> *"[…] the question to be answered is whether the individuals living today rate a certain event in a similar way as those living in the future would do. In the opinion of the Federal Environment Agency, utility discounting cannot be ethically justified in cross-generational considerations since it would contradict the cross-generational perspective of sustainable development. Therefore, both the utility for people living today and that for future generations should be attributed the same importance."*[32]

The German Federal Environment Agency recommends a discount rate of 1.5% for long term valuation over 20 years. This amount results from the estimated future economic growth and/or growth in efficiency. The assumption is implied that future generations need fewer resources to satisfy their needs because of technological progress.[33] This discount rate has been adopted for best-guess capitalisation over a time period of 100 years. However, to allow comparability within the UK literature, capitalised values are also calculated applying the discount rate recommended by HM Treasury (2003). This rate is also applied for the lower boundary of the sensitivity analysis. However, it is legitimate to bring into question the likelihood of further economic growth such as that which we have had in the past, especially if one considers the continuing loss of environmental resources and values. Therefore, the discount rate for the upper boundary is set to zero, which is also recommended by the German Federal Environment Agency.[34]

It is very important to know that the discount rate has a very strong influence on the capitalised value and the influence increases arise with the time span considered. For example, a present value of £1,000, in 100 years, applying a discount rate from

[31] German Federal Environment Agency 2008.
[32] The underlying assumption is that the utility or wellbeing does not grow proportional to consumption; Ibid., 32.
[33] Ibid.
[34] German Federal Environment Agency 2008.

HM Treasury (2003) of 3.5 percent (3.0 after 50 years and 2.5 after 2.5 years), is only £51. On the other hand a discount rate of 1.5 percent would result in a present value of £226. It is hardly necessary to state that a rate of 0 percent would result in £1,000.

It should be kept in mind that capitalised value projects a *ceteris paribus* future. If other variables change over time the capitalised value may change as well. If for example the amount of one habitat declines within the region, the relative value of the remaining extent will rise. Furthermore, neither the assumed population growth in Birmingham and the Black Country nor the additional pressure caused by climate change has been considered in the capitalised value. Both can be expected to increase their values over time. In a *ceteris paribus* scenario such influences are not considered.

1.5 The Regional Context: Birmingham and the Black Country

Outside London, within the UK Birmingham is the city with the highest population. It is located in the centre if the West Midlands. The Black Country adjoins Birmingham to the north and west practically seamlessly and the present study has included the Black Country boroughs of Dudley, Sandwell and Walsall and the City of Wolverhampton. Together, Birmingham and the Black Country cover 62,500 hectares and have a population of more than 2.1 million.[35] The area is highly urbanised with a population of nearly 3,400 people per km^2.

In the past, Birmingham and the Black Country were characterised by an early and strong industrialisation with rapid growth rates. The name "Black Country" relates to the massive extraction of coal. Even if the economy today is dominated by the service sector, the traces of the industrial revolution characterise broad areas of the region. One example is the extent of the canal network and another the amount of factory buildings. Overall, Birmingham and the Black Country is characterised by a high degree of surface sealing and comparatively slight and fragmented areas of green space, except for Sutton Park in the north of Birmingham. During the past years and decades, a continuing decline of Green Infrastructure could have been monitored. Between 1982 and 2001 alone, more than 1,000 ha (8.4%) of grassland

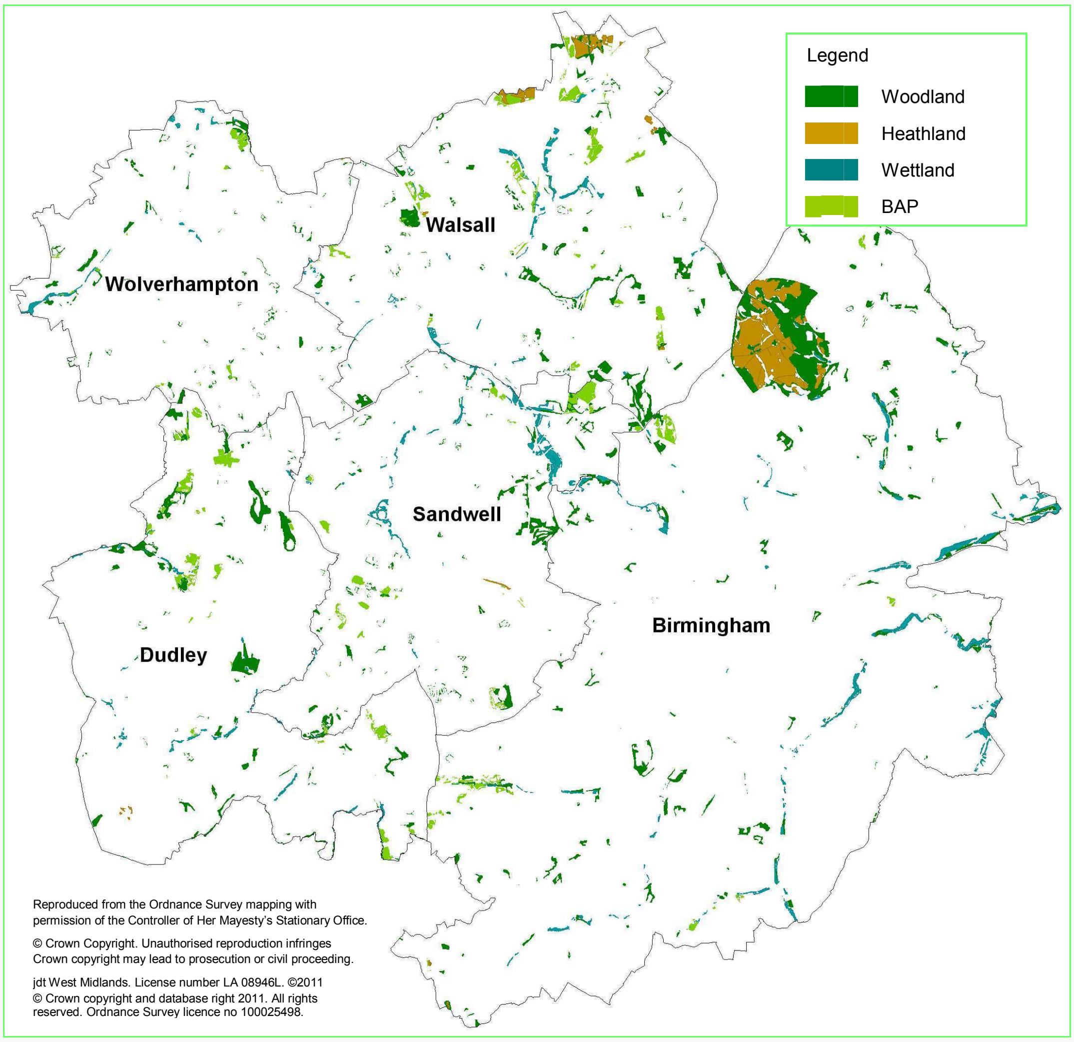
[35] In 2009; Resident Population Estimates by the Office of National Statistics

have been lost due to building development, to state only one example.[36] Facing further growth of population (estimates suggest an increase of about 10% in Birmingham and the Black Country before 2030,[37]) the pressure on Green Infrastructure is likely to increase.

At present, the Green Infrastructure considered in this study covers almost 3,000 ha. The major extent is woodland with 1,534 ha, followed by Biodiversity Action Plan (BAP) priority grasslands (551 ha), heathland (462 ha) and wetland (426 ha).[38] Map 1.1 below provides an overview. This schedule is not definitive. However, it is likely to be the best estimation to date.

[36] Not only BAP priority grassland; Pisilka, E. (2005), p. 120
[37] In 2030 = 2.34 million; 2006-based Subnational population projections by the Office of National Statistics
[38] Data provided by EcoRecord and the Forestry Commission. For more details see the referring chapters.

Map 1.1 Green Infrastructure (selection) in Birmingham and the Black Country



Source: GIS data by EcoRecord and the Forestry Commission

In recent years the understanding of the importance of Green Infrastructure for people and wildlife has increased among scientists, planners and policy-makers as well as within local authorities in general. This can already be seen by the green space strategies published by the different city councils. However, there is still no efficacious policy instrument established to mitigate land-use change and therefore the lost of Green Infrastructure. This is a clue to the circumstance that the whole importance of Green Infrastructure is still undervalued. The present study is an attempt to mitigate this knowledge-gap. With reference to section 6.4 it can also provide starting points to develop effective policy instruments.

2. Woodland and the Urban Forest

2.1 General Information

The starting point for identifying the area of woodland in Birmingham and the Black Country is the National Inventory of Woodland and Trees (NIWT) carried out by the Forest Commission between 1994 and 2000.[39] GIS (Geographic Information System) data indicates 1587 ha of woodland. However, some of the sites have changed over time in land-usage. To locate these areas, more up to date datasets for different habitats have been subtracted from the woodland dataset. On the other hand 310 ha of new woodland, planted during the Black Country Urban Forest Millennium Programme 1995 - 2001, have been added.[40]

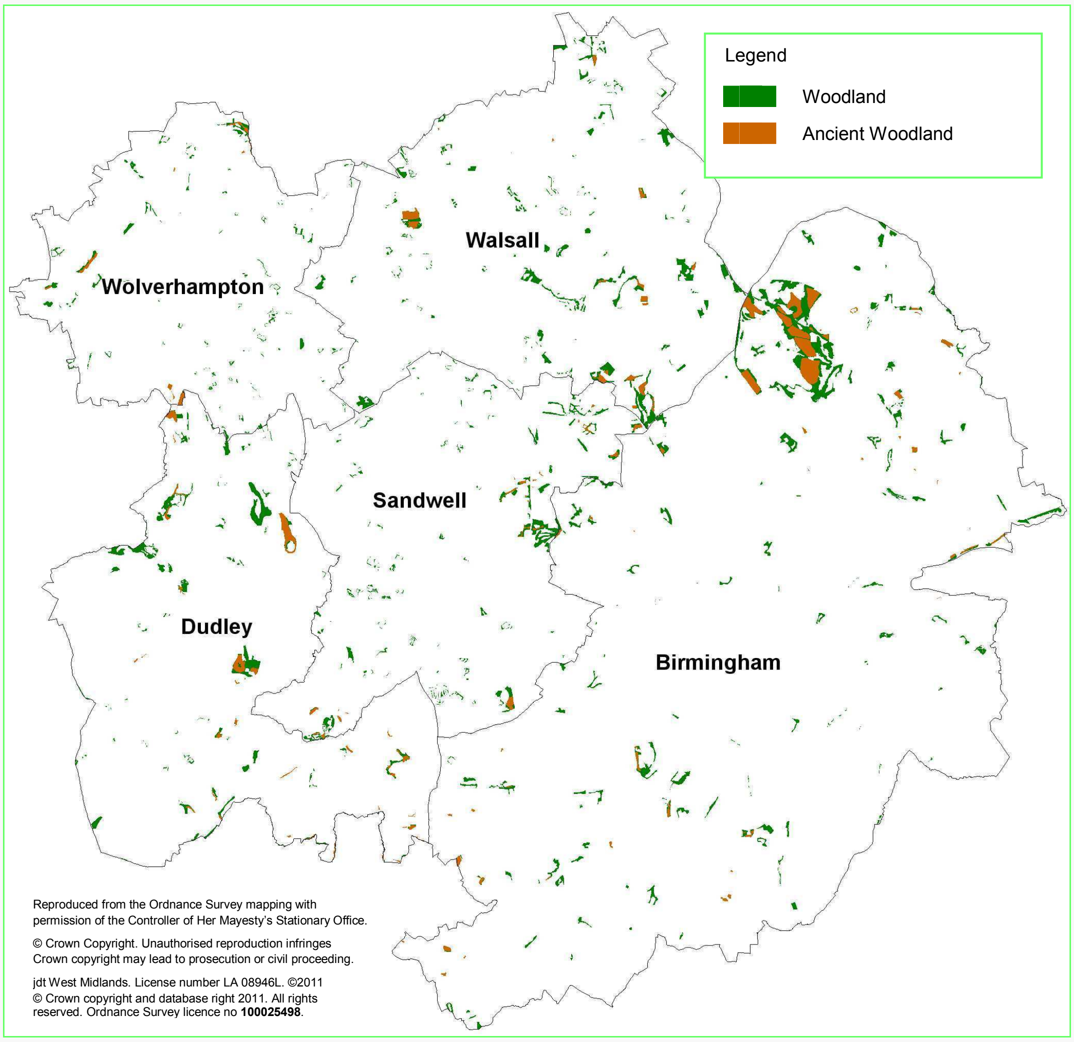
Therefore the area of actual woodland (woods >0.1 ha) in Birmingham and the Black Country is estimated to be 1,534 ha and covers about 3 percent of the land area. That is low compared with the over 8 percent for England as a whole.[41] This is attributable to the high urbanisation of the area. In England, woodland is defined as:

> *"Land under stands of trees with a canopy cover of at least 20% […], or having the potential to achieve this, including integral open space, and including felled areas that are awaiting restocking."*[42]

The definition of "at least 20 percent" sounds weak but the regional extent of open spaces within woodlands in Birmingham and the Black Country is less than ten percent.[43] The areas of woodland are pictured on map 2.1 below.[44] The woodland sites are very fragmented with the largest coherent areas in Dudley and Sutton Park in the north of Birmingham.

[39] Forestry Commission 2001.
[40] National Urban Forestry Unit 2001.
[41] WMRFF 2004, 11.
[42] Forestry Commission 2010, 165.
[43] Forestry Commission 2002. Derived from the West Midland county level.
[44] New planted woodland is not mapped.

Map 2.1 Woodland area in Birmingham and the Black Country



Source: GIS data by EcoRecord and the Forestry Commission

The dominant type is broadleaved woodland with 1,331 ha. The most common species are oak and birch.[45] Coniferous woodland represents only 1% of the woodland and 187 ha are covered with mixed woodland. Within the broadleaved woodland, 336 ha could be identified as ancient woodland.[46] An additional 73 ha may also be ancient woodland, but it has not been possible to finally clarify the status.[47] As a result, this area has been interpreted as belonging to the recent broadleaved woodland.

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[45] Forestry Commission 2002.
[46] Atkinson 2008.
[47] Ibid.

Ancient woodlands have been continuously wooded since at least 1600 and are classified as a local habitat of principal importance.

> *"Due to their longevity, they are very important for the conservation of genetic material, […] preservation of soils and as repositories of local species that can re-colonise other woodlands."*[48]

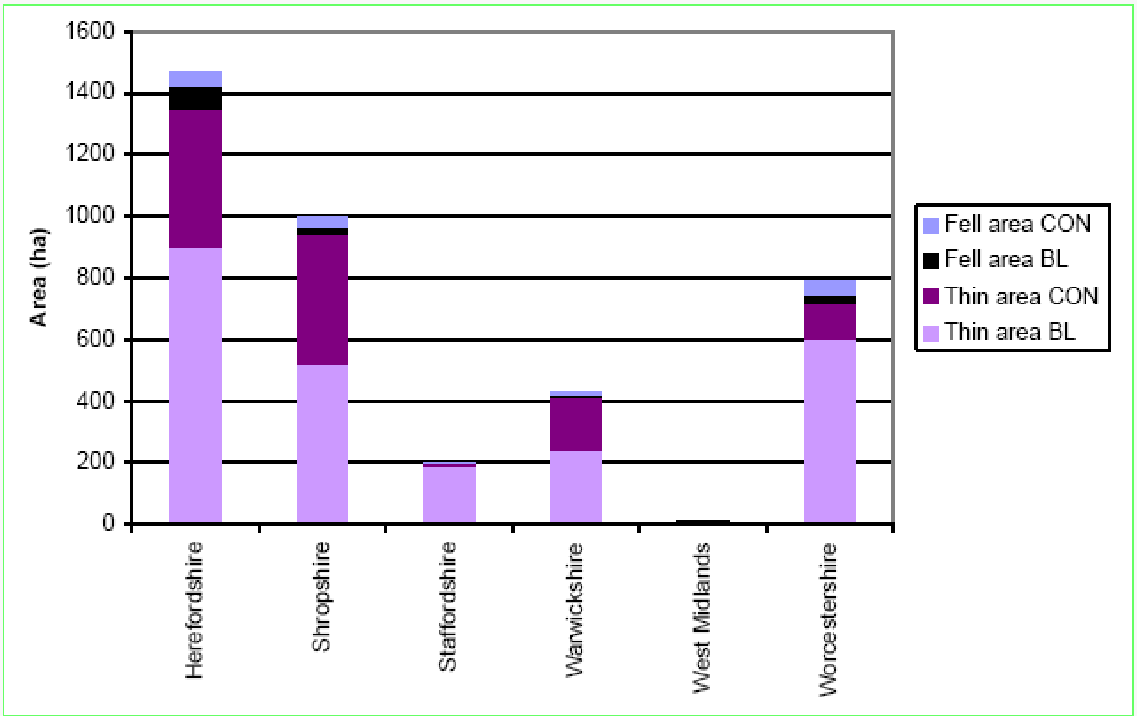
The definition of the urban forest is broader and includes woodland as well as stands of trees smaller than 0.1 ha and single trees.[49] Unfortunately, statistics of the extent of the urban forest are not readily available. The only estimation that can be made is a tree count of about 5.6 million.[50]

2.2 Harvesting

As timber is a marketable good, generally market prices can be used as an indicator of value. Unfortunately a value for the timber industry for Birmingham and the Black Country is not available. At the West Midlands Region the timber production of 2009 was estimated at 391.424 m^3 with a gross product of £11.3 million.[51] However, a direct approximation, e.g. by area of woodland, is not possible. The timber harvest in Birmingham and the Black Country is strongly under-represented. This can be clarified from Figure 2.1 which shows the area of approved felling licences for the West Midlands region. From this figure the value of harvesting in Birmingham and the Black Country can be ignored.

[48] B&BC LBAP Review Group 2010, 18.
[49] O'Brien, Williams, and Stewart 2010, 4.
[50] See section 2.5
[51] Ecogen and Lockhart Garratt 2009, 32.

Fig 2.1 Approved thinning and felling of broadleaves and Conifers 2003/04



Source: Lockhart Garratt Ltd with data provided by Forestry Commission, published in Ecogen (2009), p. 31

In future harvesting may play a bigger role. Referring to England's wood-fuel strategy it is planned to harvest about 6,000 m^3 of woodland annually to produce wood-fuel.[52]These developments will be monitored. The strategy provides a cost-benefit-analysis, but possible negative effects on other ecosystem benefits such as recreation or habitat for species are not adequately considered within this calculation. The work at hand can help to take these issues into account.

2.3 Air Pollution Absorption

Trees have an effect on the local air quality, especially in urban areas such as Birmingham and the Black Country where pollution emissions are comparatively high. They absorb, through deposition and chemical reactions, deleterious pollution such as carbon monoxide (CO), sulphur dioxide (SO_x), nitrogen dioxide (NO_2), ozone (0_3) and fine particulates (PM_{10}) which are responsible for dangerous illnesses e.g. respiratory ailments, heart disease and cancer.[53] The main sources for this pollution

[52] Forestry Commission.
[53] McPherson, Nowak, and Rowan 1994, 63.

are vehicle exhausts and conventional power stations. Generally, the benefit provided by trees could be valued by the avoided healthcare costs. Research carried out in New York suggests that a high tree density per square kilometre significantly reduces asthma prevalence in very young children, to note only one example.[54] On the other hand it is possible that specific tree species also have a negative impact on air quality by forming O_3 which can reduce the net air pollution absorption benefits.[55]

However, benefits provided by air pollution absorption are still largely uncertain and likely to be slight compared to other benefits such as recreation or habitat for species. In 2002 the annual health benefits from air pollution provided by woodland in the West Midlands Region was estimated to be only £30.000.[56] Therefore, a valuation is not reasonable until further research is undertaken.

> *"We note, however, that this role [valuing the role of forests in reducing air pollution] could be important, particularly in urban areas, and further research here may be justified."*[57]

To value the effect of woodland and the urban forest on air quality in Birmingham and the Black Country further research has to be carried out. Therefore it has been rejected from valuing this effect within this study.

2.4 Local Climate

Green Infrastructure, and in particular the Urban Forest, has a significant influence on the local climate. Urban areas are usually several degrees warmer than their surroundings. This urban heat island effect (UHIE) is caused by the massive use of materials retaining heat, which is released during the nights, as well as the concentration of waste heat from warming and cooling. In the future, the UHIE will combine with general global warming caused by climate change. In summer 2006 during a heatwave, for example, the UHIE caused more than 4 degrees of additional warmth within the central business district (most built up area) of Birmingham. Around Sutton Park the temperature was about 3 degrees lower.[58]

[54] Lovasi et al. 2008, 647.
[55] Donovan 2003, 233.
[56] Willis et al. 2003, 28.
[57] EFTEC 2010b, 85.
[58] Tomlinson 2009, 180.

The importance of Green Infrastructure can be clarified by this difference. Green Infrastructure and the urban forest in particular have a significant cooling effect. The temperature around vegetation is reduced by evapotranspiration. Furthermore, trees and shrubs provide shading and protection from heat and UV radiation.[59] Research in Manchester suggests that a 10% increase of Green Infrastructure in areas with the least greenery would reduce the UHIE by between 2.2% and 2.5%.[60] Many other studies validate this effect.[61] Therefore Green Infrastructure can play a vital importance in mitigating the negative effects of climate change.

Another positive effect on the local climate is the potential for reducing energy costs. On the one hand, trees provide shading which leads to reduced costs for air conditioning. On the other hand, trees can also act as a shelterbelt and reduce wind speed which results in lower heating costs. Kuppuswamy (2009) estimates that street trees provide a cooling effect of from 2% to 7%.[62] Research indicates that a medium-porosity green shelterbelt could reduce heating costs by about 4.5% for a typical two-story cellular office space in Scotland.[63] Computer simulations calculate maximum potential energy savings of 18% provided by tree shelter.[64] This in turn reduces carbon emissions and therefore mitigates climate change. Reducing the urban island heating effect also helps in reducing air pollution.[65] However, the maximum expression of this effect is highly related to the placement of the trees. Unfortunately the valuation of the effect on the local climate in Birmingham and the Black Country is not possible within the limits of this survey.

> *"There are no specific valuation toolkits to describe the value of GI as a means of ameliorating the effects of UHI and climate change."*[66]

However, Forest Research undertakes research of the effects of urban trees on the urban heat island effect. There are also planning tools such as i-Tree available to value the effect at the small scale level.[67]

[59] Forest Research 2010, 86.
[60] Gill et al. 2007, 122.
[61] Forest Research 2010, 87.
[62] Kuppuswamy 2009, 66.
[63] Wang et al. 8.
[64] Liu and Harris 2008, 115.
[65] Beckett, Freer-Smith, and Taylor 1998.
[66] Forest Research 2010, 90.
[67] Ibid.

2.5 Climate Change Mitigation

Woodland plays an important role in mitigating climate change and its negative influences by sequestrating and storing carbon. Trees, as well as green plants in general, use photosynthesis to take up carbon dioxide from the atmosphere.

> *"Woodlands and forests are a net sink of CO_2, i.e. they remove CO_2 from the atmosphere, except during tree harvesting and for a relatively short period thereafter (the duration depending on soil type and other site factors)."*[68]

The Forestry Commission estimates that UK woodland could contribute an emission abatement equivalent to 10% of the total UK greenhouse gas inventory in 2050. A requirement is the replanting of 4% of the land cover.[69] However, this potential is more related to rural areas than to urban areas.

The first step to value carbon sequestration of woodland in Birmingham and the Black Country is to estimate the actual carbon stock. Donovan (2002) surveyed the urban forest on the West Midlands unitary level which includes Birmingham, the Black Country as well as Solihull and Coventry. Based on a sample size of about 0.3% of the West Midlands unitary area, where more than 32,000 trees were surveyed, an estimation of tree count, biomass etc. is possible. These findings were categorised by different land classes. The count of trees is estimated to be 8.1 million. Applying a formula developed by Monteith (1979), the whole tree biomass was calculated as 978 kilo tonnes for the whole West Midlands unitary area.[70]

To calculate the amount of trees and biomass for Birmingham and the Black Country, the corresponding km-squares and urban land classifications were separated by analysing figure 3.2 in Donovan (2002). The statistics by urban land class were then recalculated for Birmingham and the Black Country which has a different land class structure. This results in an amount of about 5.6 million trees with a corresponding whole tree biomass of 635 kilo tonnes.

[68] Read et al. 2009, xii.
[69] Ibid., ix.
[70] Donovan 2003, 181.

The stored carbon is about 50% of the whole tree biomass.[71] Therefore, 317 kt carbon can be estimated to be held within the Birmingham and Black Country urban forest.[72] However, this covers only the carbon stored above ground. Roots and soil carbon are not embedded in the calculation, which leads to a severe underestimation of the role the urban forest plays in mitigating climate change.

> *"The carbon in [UK] forest soils accounts for most (around 80%) of total forest carbon…"*[73]

Because a separation between "usual" woodland and street trees etc. is not possible, estimation of the biomass in soil is difficult. The tree biomass from street trees, for example, often falls on tarmac and pavement and is removed afterwards. As a result, there is little accumulation of biomass. Taking these aspects into account, only the biomass from the known area of 1,534 ha woodland has been estimated here, calculating with an average of 217 tonnes carbon per ha.[74] This results in 333 kilo tonnes carbon sequestrated in woodland soils in Birmingham and the Black Country. If released, the 1,000 kt carbon would be emitted as about 3.5 million tonnes carbon dioxide.[75] However, it has to be noted that this is still an underestimation. Carbon stored in soil related to street trees and other single trees has not been considered.

To value the external costs of CO_2-equivalent we use the recommendation of the Department of Energy and Climate Change (DECC).[76] For a short term non-traded price in 2010 of carbon they suggest £52 per tonne of CO_2-equivalent with a 50%-range for sensitivity analysis.[77] The literature referring to this topic is anything but consistent. For example, it tallies vaguely with the suggestion of the uniform climate impact cost rate of €70 (best guess) by the German Federal Environmental Agency.[78] Multiplying the carbon captured in the Birmingham and the Black Country urban

[71] USDA Forest Products Laboratory 1952, 4.
[72] Land-use changes since 2001 are not considered.
[73] EFTEC 2010b, 80.
[74] Milne et al. 2004.
[75] The converting factor from carbon to carbon dioxide is 3.67
[76] DECC 2009.
[77] Ibid., 57.
[78] German Federal Environmental Agency 2007, 4.

forest and its woodland soils by the price recommended by DECC, it can be valued as at least **£185 million**.[79]

Nevertheless, it is not possible to conclude an annual or capitalised figure from this value. Most of the woodland was established at least 100 years ago. Therefore the assumption is reasonable that most areas of woodland are already in a natural balance between dying or cut down trees and new growing or planted trees. Because of safety issues, in urban areas very often trees are not allowed to grow until they die naturally. Therefore trees older than 100 years are not easy to find. Certainly, in this scenario mature woodland will not sequestrate additional carbon dioxide from the atmosphere.

The figure above is relevant more in case of a land-use change of afforested habitats rather than for future additional carbon sequestration. Within the years 2005 to 2008 land use change affecting woodland and other habitats in Birmingham and the Black Country was responsible for carbon dioxide emissions of about 86 kilo tonnes[80] with a value of £4.6 million.[81]

The only annual values for additional sequestration which can be calculated are for the 310 ha of known new planted woodland during the Black Country urban forestry millennium programme between 1995 and 2001. To estimate the actual and future carbon sequestration rates, look-up tables provided by the Forestry Commission have been applied.[82] They provide statistics with sequestration rates for tree biomass as well as corresponding soils for different periods of the tree lifetime. Annual sequestration rates are anything but constant over time.

The dominant planted species during the programme were silver birch and alder followed by ash and oak, the latter species comprising a smaller amount of about 10% each. The initial spacing was 2 metres and the yield class can be estimated to be between 4 and 6. The look-up table categories do not fit exactly with these figures. Therefore a lower and a higher scenario were calculated. Assumptions are summarised in table 2.1 below.

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[79] This figure is a best guess. We refrained from calculating a sensitivity analysis because the value is not part of the general calculation.
[80] AEA 2010.
[81] Price level 2010; DECC 2009 makes no recommendations for a carbon price before 2008 (£50/t CO_2). Therefore a decrease rate of £1 per annum is applied.
[82] West and Matthews 2010.

Tab. 2.1 Assumptions for the Forestry Commission look-up tables

	Effectively assumption	Low scenario	High scenario
Species	90% silver birch, alder & ash 10% oak	90% SAB (sycamore, ash, birch) 10% oak	
Spacing	2m	SAB: 1.5m; oak: 1.2m	2.5m
Yield class	4-6	4	6
Planted	1995 - 2001	1998	
Age when planted	2-3 years	2 years	
Management	Thinned (~10 year period)	Thinned (5 year period)	

Source: West, V., Matthews, R. (2010) and own assumptions

The carbon look-up tables have been used to calculate four time series. Two with 1.5m (1.2m) spacing and yield class 4 and two with 2.5m spacing and yield class 6, both applied for SAB and oak. Because carbon sequestration is not consistent over time, it is not possible to calculate an annual sequestration. For that reason the sequestration relating to the year 2010 is used.

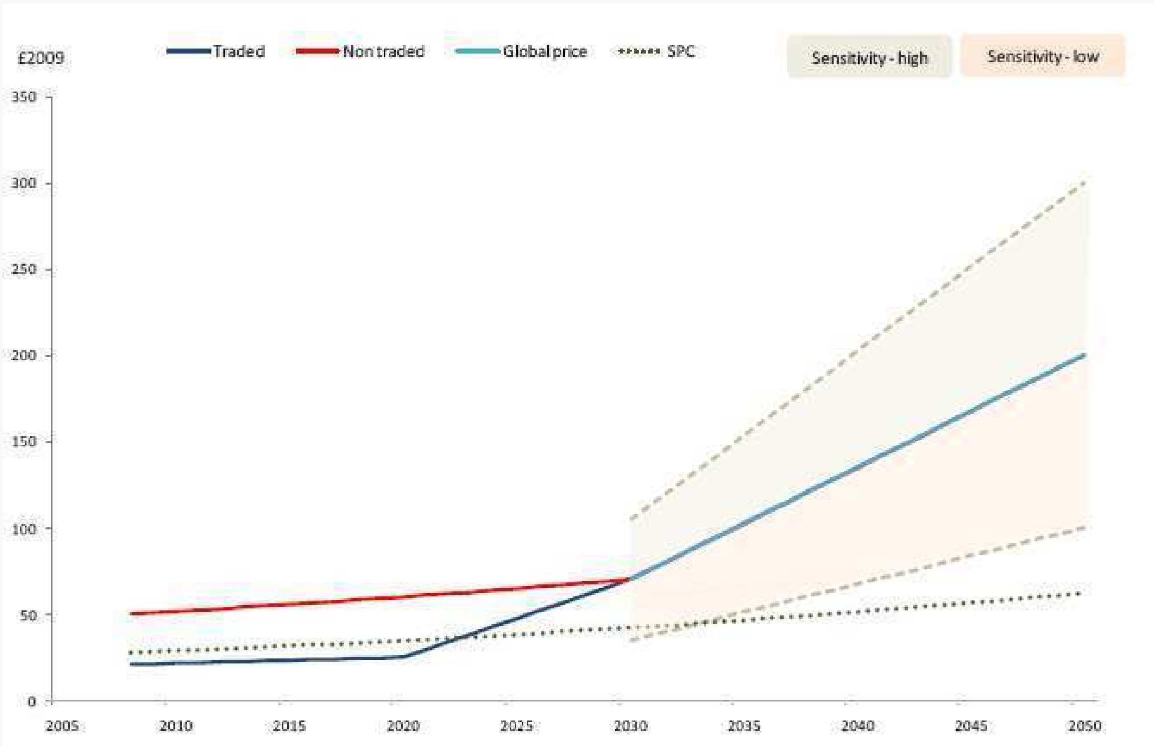
As an example, the calculation of SAB with 1.5m spacing and yield class 4 is explained below. If the trees were planted in 1998 (average) and were then 2 years old, in 2010 the trees were already 14 years. Finding the right category in the look-up table, an annual sequestration of 2.659 kilo tonnes CO_2 per hectare is expressed for 2010. Multiplied by the carbon price of £52 for 2010, 90% of 310 ha gives £138,000. The same calculation for oak (10% of plantings) gives £20,000. This leads to a lower scenario value of £158,000.

Repeated for the high-scenario calculation the result is £166,000. As a best guess a mean figure of **£162,000** is adopted to value the carbon sequestration of the 310 ha new-planted woodland between 1995 and 2001.

For the sensitivity analysis, the lower scenario calculation has been multiplied by the lower estimate for the carbon price and the higher scenario calculation has been multiplied by the higher estimate for the carbon price. Following these estimations, a range from £81,000 to £243,000 can be assumed.

Referring to the DECC calculations, the price for CO_2e will increase to £60 in 2020, £70 in 2030 and £200 in 2050.[83] A price for the period after 2050 is not reported. Therefore the constant increase rate of 1.0336, which is applied for the period between 2030 and 2050, has been adopted for the period 2050 to 2100. This would result in a price of about £1000 per tonne of CO_2 equivalent in 2100.

Fig 2.2 Traded, non-traded and previous shadow carbon price estimates



Source: DECC (2009), p. 79

Taking into account the discount rates and the sequestration rates, this results in a capitalised value of **£13.1 million**.

New street trees etc. may also play a significant role because of fast growth rates[84], but statistics are not available. On the other hand street trees usually do not reach ages of over 100 years because of safety issues. If felled, the vast amount of the stored carbon may be released and the trees are often not replaced. Usage as

[83] DECC 2009, 3.
[84] Nowak and Crane 2002, 385.

woodfuel in the future may be possible, but the cost-effectiveness of doing that, however, is uncertain.[85]

These findings show that carbon sequestration plays an underlying role compared with other ecosystem services. One can see that older woodlands should be protected, even if there are no additional benefits for climate mitigation. A complete release of the carbon stock in woodland and soils would cause external costs of about £185 million.

If planted properly, street and garden trees have a great potential to save energy in buildings. The shade and wind shelter created can reduce heating as well as cooling costs and therefore reduce carbon emissions.

> *"In general, it appears that for detached houses of conventional construction, trees in an optimum arrangement could save 20 to 25% of annual space conditioning energy use compared to the same house in an open field."*[86]

Nevertheless, especially within the urban environment, this effect is difficult to measure. One example is that the shelter belt effect from trees is also influenced by surrounding buildings.[87] However, mitigation of the urban heating island effect can also reduce cooling costs. Unfortunately a valuation is not possible, even though these effects on the climate are likely to be stronger than the direct carbon sequestration.[88]

2.6 Moderation of Extreme Weather Events & Wastewater Treatment

Woodland, as well as the Green Infrastructure in general, can help to mitigate extreme weather events. This especially includes flood risk reduction.

Flood Risk Reduction

[85] EFTEC 2010b, 84.
[86] Heisler 1986, 123.
[87] Donovan 2003, 30.
[88] Ibid., 69.

The costs to UK insurers, caused by the 2007 flooding, are expected to be around £3 billion.[89] If no additional action is taken, the costs caused by urban flooding in the UK could increase to between £1 billion and £10 billion annually.[90] Green Infrastructure can reduce the volume of water run-off through infiltration and absorption, as well as evapotranspiration.[91]

> *"For every 5% of tree cover area added to a community, run-off is reduced by approximately 2%."*[92]

Generally, the value provided by flood risk reduction can be derived from calculating the damage or replacement costs avoided. In the UK, by the 2080s, between £22 billion and £75 billion of new investments in engineering might be needed to ensure protection from higher flood risks caused by climate change.[93] A share of these "grey" infrastructure investments might be avoidable through creating new Green Infrastructure acting as Sustainable Urban Drainage Systems (SUDS). Often, this might be the cost-efficient alternative. However, this effect is not possible to value quantitatively for Birmingham and the Black Country.

Storm water entering combined sewers also causes additional energy costs. A valuation tool provided by the Green Infrastructure Valuation Network (GIVaN) can be applied to value this effect.[94] The tool bases its calculation on the annual evapotranspiration rates of different habitat types. For broadleaved woodland this value is about 4 million litres per hectare per year for an average annual rainfall of 754 mm.[95] Furthermore the estimation is made that in an urban area the run-off rate is estimated as 90%, which leads to an accountable evapotranspiration of 3.5 million l/ha/yr.

The energy usage for 1 megalitre waste water treatment is stated as 645 kWh, according to Water UK.[96] Applying a commercial electricity price of £0.04 per kWh, this results in annual avoided energy costs of £910 per ha of broadleaved woodland covered with mature trees. Younger trees are assumed to evapotranspirate less

[89] Pitt 2007, 64.
[90] Evans et al. 2004.
[91] GIVaN 2011, 27.
[92] Coder 1996, 4.
[93] Pitt 2007, 32.
[94] GIVaN 2011.
[95] Ibid.
[96] Ibid.

water. To take this factor into account, it is estimated that 80% of the trees are mature.[97] The rest is estimated to be 10 years old on average. For 10 year old trees the ability for evapotranspiration has been estimated as 40% for broadleaved species and 50% for conifers, compared with mature trees. This assumption takes the natural regeneration of woodland into account.

Furthermore the tool provides no data for mixed woodland. As a simple estimate, the area of mixed woodland can be split up equivalent to broadleaved woodland and conifer woodland. The underlying assumption is that mixed woodland evapotranspires the mean value of water between that transpired by broadleaves and conifers. Calculating the different scenarios results in a total annual value of £1.26 million for electricity costs avoided through evapotranspiration by 1,534 ha of woodland.

Unfortunately the tool is comparatively crude and may lead to an overestimation. A large amount of run-off water would go to rivers either directly, overland or via dedicated surface water sewers or highway drains and not directly into the combined sewers. However, the value may be realistic were the complete Green Infrastructure as well as the blue infrastructure (rivers, canals, etc.) to be removed.

Because of the insufficient scientific evidence the values from this section have not been made part of the main calculation and the total values.

2.7 Habitats for Species (Biodiversity)

In this section the non-use benefits of woodland as habitat for species are valued. Other authors often use the category “biodiversity benefits”. The task is to quantify people’s preferences or willingness-to-pay (WTP) for the existence of woodland as habitat for species and biodiversity in general.[98] To avoid overlaps, it is important to isolate the non-use value from recreation and landscape benefits. The main resource for this kind of valuation within the UK is a study provided by Hanley et al. (2002), which is considered appropriate even though the sample size was comparatively small and not representative for the whole population in the United Kingdom.[99] They valued the WTP for woodland habitats with different attributes, expressed by focus

[97] Regarding to the ability of maximum evatranspiration this means 25 years or older.
[98] See section 1.4 for more details.
[99] Willis et al. 2003, 15.

groups. This study was also applied to value the social and environmental benefits provided by woodland in Great Britain as a whole.[100]

To transfer the available statistics to the categories defined by Hanley et al. (2002), some assumptions are necessary. Mixed woodland is estimated to have a medial value between conifer and broadleaved woodland. Simplifying, the amount of 187 ha mixed woodland is divided equally between conifer and broadleaved woodland. The whole woodland is also categorised as lowland woodland, even though small fractions might be defined as upland woodland. Ancient woodland in the region fits well in the category of ancient semi-natural woodland (ASNW). The reason is that planted ancient woodland sites (PAWS) in the region are replanted with native broadleaves to the greatest extent. Therefore the characteristics are comparable. This leads to the following segmentation:

Tab. 2.2 Area of valuable woodland as habitat for species

Woodland Type	Lowland ancient semi-natural broadleaved	New lowland broadleaved native	Lowland conifer
Total area	336 ha	1,087 ha	109 ha

Source: Own calculations based on Forestry Commission (2001) and Atkinson (2008)

Handley et al. (2002) valued the benefits, based on the preferences expressed by focus groups. The mean WTP to protect and regenerate an area of 12,000 ha lowland ancient semi-natural broadleaved woodland was £1.13 per household (in 2002 prices).[101] With inflation adjusted to 2010 price levels, this results in £1.36 per household. Because this is a non-use value, the benefits are not restricted to local residents.

> *"There is no reason within standard economic theory why non-use values would also decrease with distance."*[102]

We calculate the benefits for UK households. However, because the non-use benefits do not end at the national border, this can be interpreted as underestimation. Multiplying the WTP by the number of UK households and breaking the result down

[100] Willis et al. 2003.
[101] Hanley et al. 2002, 18.
[102] Brander et al. 2008, 18.

to the regional area of ancient semi-natural woodland, an annual value of £770,000 for 336 ha can be calculated.

The valuation of the other woodland areas is more difficult because the focus group participants were asked explicitly for their WTP for an increase of woodland. However, the perception is permissible that keeping established woodland is worth the equivalent of, or more than planting new woodland. If the amount of woodland and therefore the habitat for species declines, the marginal value increases. Furthermore, the biodiversity in established woodlands is higher than in new planted woodlands. Following these arguments the valuation of the whole conifer and broadleaved woodland in Birmingham and the Black Country, applying the values for an expansion of woodland, seems to be justifiable. Nevertheless, for the lower boundary of the sensitivity analysis only the newly planted woodland is considered. Adopting the calculation for ancient semi-natural woodland above, the annual value of woodland in Birmingham and the Black Country adds up to **£2.71m**, representing the best guess. The details are presented in table 2.3 below.

Tab. 2.3 Valuation of woodland as habitat for species

Woodland Type	Lowland ancient semi-natural broadleaved	New lowland broadleaved native	Lowland conifer
Total area	336 ha	1,089 ha	109 ha
New planted (1995 to 2001)	*(not possible)*	310 ha	0 ha
Willingness to pay per household for 12,000 ha (price level 2010)	£1.36	£1.01	£0.38
Total annual WTP (in million £)	**£0.77**	**£1.87**	**£0.07**
Low estimation for total WTP (in million £)	*£0.77*	*£0.53*	*£0.00*

Source: Own calculations based on Forestry Commission (2001), Atkinson (2008) and National Urban Forestry Unit (2001)

Because these are passive- or non-use values, people often have problems in expressing their own preferences. On the one hand the topic is very abstract and hard to grasp. On the other, the WTP for this form of ecosystem service is a very small fraction of income which leads to a comparatively wide variation of expressed values. Furthermore, the form of moderation of focus groups and the information provided about the habitats can have a strong influence on the expressed WTP. Additionally, the comparatively small sample size makes the application of a wide range of 70% reasonable for the sensitivity analysis. This results in a range from £0.39m up to £4.61m, annually.

2.8 Recreation

Recreation and leisure such as walking, bicycling or relaxing within woodland generates numerous benefits. First, recreation raises individual wellbeing and is therefore a value in itself. Additionally, an increase of accessible woodland and Green Infrastructure in general close to home is estimated to improve people's health by providing space for physical activity such as jogging.[103] Street trees can also encourage people to walk or cycle to work more often[104] and about ¾ of the adults agree that green spaces are important for health.[105]

> *"Adults in the West Midlands are estimated to be the least physically active of the English regions."*[106]

Within the West Midlands, indicators of physical activity and for related diseases such as obesity, diabetes, heart diseases and strokes are significantly worse than the England average.[107] The annual costs of physical inactivity in England are estimated to be about £10.7 billion.[108] However, recreation has not only a positive effect on physical health. It also has restorative effects and contributes to mental health.[109]

The lack of accessible green space within a short distance from home is likely to be a key matter. Referring to a publication by the Woodland Trust, in Birmingham and Wolverhampton only 9% of the population has access to a woodland site of at least 2ha within 500m from home. Sandwell, Dudley and Walsall follow with 21%, 29% and 31%.[110] One opportunity to encourage people to improve their health could be to make previously restricted woodland sites accessible. This approach can be seen to

[103] Coombes, Jones, and Hillsdon 2010.
[104] van den Berg, Koole, and van der Wulp 2003.
[105] Kuppuswamy 2009, 64.
[106] APHO 2010, 1.
[107] Ibid., 6.
[108] Department of Health 2004, 9.
[109] Kaplan 1995.
[110] Woodland Trust Appendix I.

have great potential.[111] Estimated positive effects of more accessible Green Spaces are a healthier population linked with lower health service expenses and decreasing sickness absences.

To value the recreational benefits from woodland in Birmingham and the Black Country, a benefit transfer of the findings of Scarpa, R. (2003) is applied. This data is based on different primary contingent valuation studies from 1994 and 2002. Visitors of many woodland sites were asked how much they were willing to pay, if there were to be a charge for access. The results show that the willingness-to-pay for a visit differs by travelled distance as well as frequency of visits. People who visit woodland more than 50 times a year are willing to pay only an average of £0.60 (2002 prices) per visit. Furthermore, the WTP increases with the distance travelled to the site. The inflation adjusted WTP (price level 2010) per visit is summarised in table 2.4 below.

Tab. 2.4 Mean willingness-to-pay per woodland visit by distance travelled

	Mean WTP per visit (2010 prices)
Distance travelled <10 miles	£1.08
Distance travelled 11 - 25 miles	£1.80
Distance travelled 26 - 75 miles	£2.16
Distance travelled 76 - 100 miles	£2.52
Distance travelled 101 - 150 miles	£3.00
Distance travelled >150 miles	£2.88

Source: Scarpa (2003), p. 16

The latest available statistics about visits to woodland within Birmingham and the Black Country have been made available from “the national survey on people and the natural environment” provided by Natural England (2010b). These data are based on a survey undertaken between March 2009 and February 2010. The statistic for the area of Birmingham and the Black Country is based on a sample size of 560 questionnaires. The survey counted about 6.6 million visits to woodland, undertaken by Birmingham and the Black Country residents. It is implied that the number of visits by local residents is a reasonable indication of visits to local woodland sites. Because the vast amount of visits to woodland is within a travelled distance below 5 miles, this assumption is reasonable. The statistics are listed below.

[111] Ibid.

Tab. 2.5 Visits to woodland derived by distance travelled

	Visits in 2009/2010
Distance travelled <10 miles	6,266,000
Distance travelled <1 mile	2,367,000
Distance travelled 1-2 miles	1,874,000
Distance travelled 3-5 miles	1,485,000
Distance travelled 6-10 miles	540,000
Distance travelled 11 - 20 miles	198,000
Distance travelled 21 - 40 miles	109,000

Source: Natural England data from The national survey on people and the natural environment

The total value of the recreational benefits provided by woodland in Birmingham and the Black Country can be calculated by multiplying the visits with the mean WTP per visit. Because the distance categories do not fit exactly, for the 198,000 visits from between 11-20 miles, the WTP of £1.80 for the travelled distance of 11-25 miles has been applied. The WTP of £2.16 is applied for 109,000 visits from between 21 and 40 miles from home. This results in an annual value of **£7.4 million**.

With an eye toward the health benefits, these figures may still represent an underestimation. On the one hand, many respondents may not be aware or badly informed about the health benefits provided by woodland. Therefore, they may not take this component adequately into account when expressing their WTP. On the other, parts of the negative effects of poor health are mitigated by the social safety net. Therefore a healthy lifestyle may be undervalued by individuals in general. Furthermore, the respondents may neglect the visits to woodland within (country) parks. These destinations were collected as a separate category in the questionnaire.

To recognise uncertainties relating to the sample size, transfer errors and the general scientific uncertainties, a range of 50% has been applied for the sensitivity analysis, which leads to a value between £3.7m and £11.0m. With a view to the small amount of accessible woodland and the comparatively strong relationship between distance travelled and visits, the assumption is reasonable that creating access to more woodland would cause a significant increase of public welfare and therefore of the recreational value.

2.9 Aesthetic Appreciation

The visual amenity of environmental landscapes such as woodland is a value and can have significant influences, e.g. on property prices. Initially the focus in this report is on the private sector. The positive effect on businesses is covered later, even though overlaps cannot be avoided entirely.

In environmental landscapes with trees, property values can increase by an average of 7%. This also leads to increasing council taxes.[112] Another study in Berlin, Germany, found that street trees can increase land values by up to 17%.[113] Research in the USA suggests that a view of woodland can also improve mental health by breaking down stress.[114] Ulrich (1984) found that the view of woodland from hospitals has a positive effect on recovery times.

Calculations for park trees in Islington (Highbury Fields) and Liverpool (Sefton Park) resulted in average values per tree of £77,787 and £12,825 capitalised. Some mature plane trees were valued as £350,000.[115] Unfortunately, because the urban forest is not well statistically recorded in Birmingham and the Black Country, equivalent valuation was not possible within this survey.

Within this study, the best method to value the landscape benefits provided by woodland is to transfer the findings from Garrod (2002), who valued the willingness-to-pay for woodland views from home, applying a stated preference method. This represents the most actual primary study in Great Britain.[116] An additional advantage of this study is that overlaps with other benefits like recreation have been avoided.[117]

Referring to these findings, the annual WTP per household for a view of urban fringe broadleaved woodland from home is estimated to be £322.60 in 2010 (inflation adjusted by £268.79 in 2002).[118] We adopt this value for the dominantly urban area of Birmingham and the Black Country in common with Edwards et al. (2009), who applied the same data to value the social contribution of forests in Scotland. However, it should be noted that the sample size of completed questionnaires is

112 Forest Research 2010, 19.
113 Luther and Gruehn 2001, 23.
114 Ulrich and Simons 1986.
115 CABE Space 2009a, 37 & 40.
116 Forest Research 2010, 22.
117 Garrod 2002, 2.
118 Ibid., 12.

comparative small and no socio-economic adjustment is possible because corresponding information is not available.[119] Nevertheless, the findings for peri-urban broadleaved woodland are estimated to be sufficiently robust.[120] In view of the lack of alternatives this valuation is adopted for the whole broadleaved woodland in Birmingham and the Black Country. Only woodland sites bigger than 0.2 ha have been recognised. It is a reasonable assumption that smaller areas of woodland will not provide the same amenity benefit. Therefore, only 1,296 ha have been recognised for the calculation.

Unfortunately, a GIS viewshed-analysis was not feasible within this project to estimate the amount of households with an actual view of broadleaved woodland. Following the recommendation of Forest Research (2010), an estimation has been made concerning the households within 300m of a woodland site which have a direct view from home. In northern England, a viewshed analysis with the same assumptions has been carried out. The finding was that about 5% of the urban population had a view on broadleaved woodland. However, a direct transfer of this percentage to Birmingham and the Black Country is not feasible. The urban areas of north England have about double the cover of broadleaved woodland. On the other hand also woodland outside the urban areas within a 300m perimeter was considered in the northern England study.[121] The available data does not allow an exact calculation. Therefore the crude estimation is applied that 3% of the population in Birmingham and the Black Country has a free view of woodland. For the sensitivity analysis a range from 1% to 5% has been applied.

To calculate the annual amenity benefits provided by broadleaved woodland, the households of Birmingham and the Black Country were estimated to amount to about 884.000[122] of 2.1 million people.[123] For 3% or 26.500 of them, the amenity value has a total of **£8.55 million,** annually. However, it should be noted that this value neither covers amenity values while walking nor amenity benefits benefiting the economy or generally provided by street trees.

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[119] Ibid., 9 & 13.
[120] Forestry Commission 2010, 23.
[121] Forest Research.
[122] An average population per household of 2.4 people is applied (Census, Labour Force Survey, Office for National Statistics)
[123] Office for National Statistics: Resident Population Estimates

Garrod (2002) also found out that households are willing to pay £226 (2002 price level) per year for a broadleaved woodland view on journeys. Nevertheless, even though Garrod (2002) tried to aggregate this value for Great Britain as a whole, in the present study the transfer of these findings was rejected. In our opinion, assumptions to apply these values are not defensible enough to gather defensible results. However, it should be kept in mind that the amenity value could strongly increase if this factor were to be included.

Many studies also suggest that the urban forest and a green environment in general have manifold positive influences on the economy. Within a case study in Northumberland, respondents reported that they shop about one hour longer in retail areas landscaped with greenery and trees than in areas without. About ¾ reported that they prefer this setting.[124]

> *"Study results suggest that higher price valuations are mediated by psychological inferences of district character and product quality. Thus, creating and stewarding an urban forest canopy may enhance revenues for businesses in retail districts that offer diverse products at varied prices."*[125]

A well developed Green Infrastructure also attracts inward investments. The environmental surrounding is estimated to play a significant role for companies regarding to their location decision. It also attracts and retains especially high-skilled employees. However, the scientific evidence does not allow a quantitative analysis of these effects.[126]

The boost to economic competitiveness can be seen as a key factor in Birmingham and the Black Country to guarantee economic growth. The attraction of high-skilled workers by improving Green Infrastructure should be seen as a great opportunity to change the socio-economic structure in the region. The importance of green aesthetic amenity at work can also be clarified by the fact that employees without a view on a green environment often hang up pictures of natural scenes.[127]

[124] Rskensr 2003.
[125] Wolf 2003, 124.
[126] Regeneris 2009, 24.
[127] Heerwagen and Orians 1986, 623.

Another effect of a high-quality Green Infrastructure on workstations and the economy as a whole is increased productivity. Green spaces and a green view increases motivation and health which in turn decreases absent days. These findings show that the environment has a significant influence on the local economy, even if these effects are difficult to quantify, especially on a larger scale.

2.10 Summary

As shown above, woodland provides a wide range of ecosystem services. Within the urban setting, cultural services (recreation and aesthetic appreciation) represent the dominant amount with about 85% of the total values, followed by biodiversity (habitat for species) services. The provision of climate change mitigation plays a minor part and is more important in rural regions where the areas of woodland are considerably larger. The average value per hectare of woodland totals at over **£12,200** annually or £645,000 capitalised, even though a per-hectare value will vary strongly by location and accessibility.

Because many services are still undervalued or not possible to value at all, the summary table below shows the core of the Total Economic Value of woodland. The services provided by street trees etc. are virtually completely excluded.

Tab. 2.6 Valued ecosystem services provided by woodland

Ecosystem Service (all values in million, price level 2010)	**Annual value**		
	High	Best Guess	*Low*
Fresh Water Supply		Unvalued	
Air Pollution Control		Unvalued	
Local Climate		Unvalued	
Climate Change Mitigation	*£0.24**	**£0.16***	*£0.08**
Water Quality Improvement		Unvalued	
Habitat for Species	*£4.61*	**£2.71**	*£0.39*
Recreation	*£11.04*	**£7.36**	*£3.68*
Aesthetic Appreciation	*£14.25*	**£8.55**	*£2.85*
Σ	*£30.15*	**£18.79**	*£7.00*
	Capitalised values (discount rate 1,5%* over 100 years)**		
	High	Best Guess	*Low*
Climate Change Mitigation	*£44.94*	**£13.12**	*£3.18*
Habitat for Species	*£461.09*	**£142.12**	*£11.68*
Recreation	*£1,104.06*	**£385.68**	*£109.72*
Aesthetic Appreciation	*£1,425.31*	**£448.11**	*£84.98*
Σ	*£3,035.39*	**£989.03** (£564.26)**	*£209.56*

*) only for 310 ha new planted woodland
**) applying the HM Treasury (2003) discount rate
***) for the best guess

Source: Own calculations

Regarding these findings, it is recommended to plan new woodland sites as accessible, broader corridors. This maximises amenity values because the woodland sites can be seen from a lot of households and support space for recreation as well as habitat corridors. Furthermore accessibility to currently restricted-access woodland sites should be managed to maximise recreational values. Commercial harvesting should be avoided. A strong trade-off between timber production and other ecosystem benefits can be estimated. Within the urban setting, commercial harvesting is likely to reduce the total value of woodland ecosystem services. Woodfuel or timber production from old or dangerous trees, on the other hand, is recommended to mitigate climate change.

3. Heathland

3.1 General Information

Lowland heathland is one of the world's rarest habitats and a national and local BAP priority habitat. The heathland area in Britain has declined by more than two-thirds since the early 1800s.[128] This endangered habitat is characterised by vegetation dominated by dwarf ericaceous shrubs and usually occurs on acidic freely-drained soils with low nutrient content.

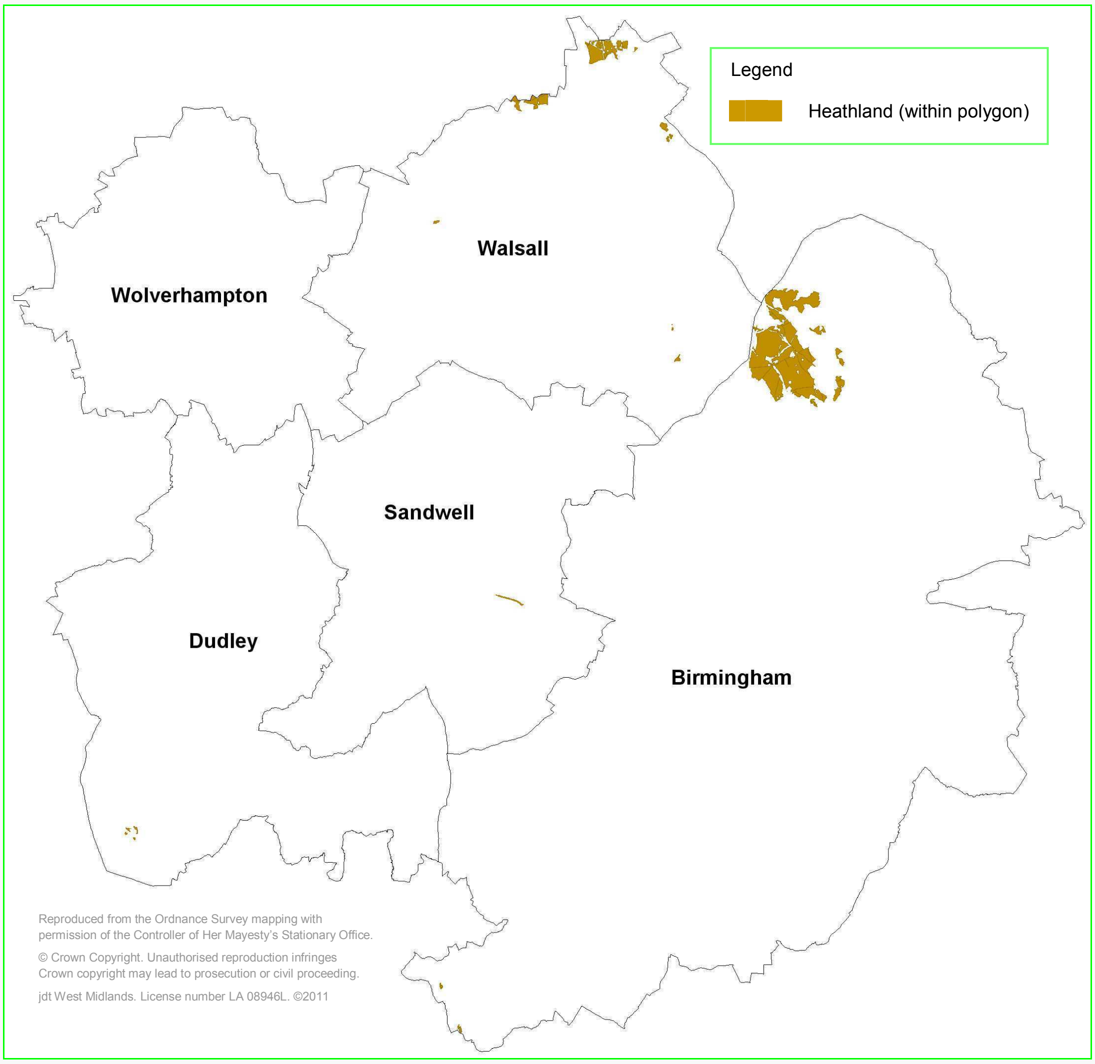
> *"The heaths of Birmingham and the Black Country are regionally important because they have a mixture of characteristics of the western wet heaths of Shropshire and the Welsh Borders, the upland heaths of the Peak District to the north and the dry heaths of southern England."*[129]

By definition, the vegetation coverage with plants typical of heathland is required to be at least 25%. And scrub and secondary woodland should covers less than 12%. The predominance of ericoids, *Ulex gallii* and (in southern England) *Ulex minor,* is a defining factor for this habitat.[130] It also usually occurs in combination with acid grassland and typical gradations between the two often makes a clear distinction difficult. Therefore the vast amount of the heathland in Birmingham and the Black Country is defined as "heathland present within polygon", following the recommendations of English Nature (2002).[131]

Data provided by EcoRecord maps 462 ha of heathland in Birmingham and the Black Country. As shown in map 3.1 below, the largest areas, about 83% of the total, can be found in Birmingham's Sutton Park. Further larger fragments occur in the Brownhills Common Local Nature Reserve in the north of Walsall.

[128] Hanley and Spash 1993, 211.
[129] B&BC LBAP Review Group 2010, 13.
[130] ERCCIS and EN 2002, 1.
[131] From now on whenever the term "heathland" is used, "heatland present within polygon" is also included.

Map 3.1 Heathland area in Birmingham and the Black Country



Source: GIS data by EcoRecord

3.2 Moderation of Extreme Weather Events

In this section energy costs avoided due to the presence of heathland are calculated. Storm water entering combined sewers causes additional energy costs. The benefit occurs through storm water absorbed and evapotranspired by heathland. For further information about the methods and assumptions see section 2.6.

The Green Infrastructure Valuation Network (GIVaN) toolkit[132] calculates the annual evapotranspiration rates of different habitat types. For heathland, about 3.3 million

[132] GIVaN 2011.

litres evapotranspired surface water per year per hectare are estimated. This results in avoided annual energy costs of £849 per ha. For 462 ha of heathland this gives **£390,000 annually**. Unlike woodland, for heathland the assumption is made that the ability of maximum evapotranspiration is reached within two years. Therefore, a separation by age of vegetation is not necessary. The assumptions are summarised in table 3.1 below.

Tab. 3.1 Assumptions for avoided energy costs through evapotranspiration by heathland

Average rainfall	754 mm/yr
Estimated run-off rates	90%
Annual Evapotranspiration	3,291,000 l/yr
Water industry energy use for wastewater treatment	645 kWh/megalitre
Energy saved	21,288 kWh/yr/ha
Commercial electricity price	£0.04/kWh
Private sector energy costs saved	£849/yr/ha
Annual energy cost savings	£0.39m

Source: GIVaN (2011), Met Office data and own assumptions

As can be seen above, the water evapotranspiration by heathland is not significantly inferior to woodland. This leads to comparable per-hectare values.

3.3 Recreation & Habitat for Species

Compared to woodland and wetland, the availability of primary valuation studies for heathland is even scarcer. This applies to the UK, where the amount of heathland is comparatively large, but also to global research. Following the literature review only the work of Hanley et al. (1991) in association with Hanley and Splash (1993) seems to be suitable for a value transfer. The basis is the derived willingness-to-pay for a lowland heath in the south of England.[133] The study site was the Avon Forest in Dorset.[134] The value was derived through an open ended questionnaire asking for the WTP for an entrance fee to the site. The mean expressed WTP for a daily fee to access the heathland site was expressed as £0.74 per visit equal to £1.19 at 2010

[133] Hanley, Munro, and Jamieson 1991.
[134] Despite the name would let suggest, the site is characterised by heathland.

prices.[135] Considering that the entrance fee to Sutton Park at weekends and on bank holidays is £1.50 strengthens this figure. However, in consideration of the other features Sutton Park provides this entrance fee has not been included in the calculation.

Because the WTP represents a hypothetical entrance fee, the assumption is reasonable that this value mainly covers recreational values. Because of the nature of the question[136], this value may cover other benefits as well. However, the assumption is reasonable that *de facto* basically recreational and habitat for species benefits have been covered by the respondents. The valuation of other ecosystem services such as air pollution control, and water quality improvement may not have been considered by respondents due to lack of information. Therefore value overlaps with “moderation of extreme weather events” are not to be expected.

The study from Hanley and Spash (1993) has already been used to develop a per-hectare valuation tool: the so-called Environmental Landscape Features (ELF) model.[137] The per-hectare-value of heathland within the West Midlands provided is expressed as £20.34 annually.[138] However, the adoption of this value for the heathland in Birmingham and the Black Country is not advisable. For one thing, the underlying assumptions and calculations are not completely comprehensible. For another, it is not possible to take the specific context of the high urbanised area of Birmingham and the Black Country with its high population into account. If adopted, the annual value of the heathland in Birmingham and the Black Country would total only £9,392 for the whole 462 ha which is lower than the average value of a single hectare of woodland in the area.

The ELF model[139] is applied in the “Environmental Accounts for Agriculture” reports.[140] However, the ELF values were not adopted for all heathland habitats. For

[135] Hanley and Spash 1993, 214.
[136] Question: “Avon Forest Park is currently owned and managed by Dorset County Council. Managing the site cost money: money to pay for wardening services, information displays, and monitoring the heathland. Suppose that the council, due to financial pressures, was faced with the decision of either introducing an entrance charge to the area, or else selling the site to developers. In such a situation, visitors such as yourselves could only retain the opportunity to visit the site by agreeing to pay such a charge. Clearly, the higher the charge that could be collected, the more likely it would be that the heathland would enjoy permanent protection. What is the most that you would be willing to pay as an entrance fee to save this heathland from development?” (Hanley, N. and Spash, C. (1993), pp. 213-214
[137] IERM and SAC 1999; IERM and SAC 2001; Oglethorpe 2005.
[138] Oglethorpe 2005, 10. the values are based on the avoidance of a 10% reduction in abundance and corrected to pricelevel 2010.
[139] IERM and SAC 1999; IERM and SAC 2001; Oglethorpe 2005.

heathland within a Site of Special Scientific Interest (SSSI) they adopt significant higher values. SSSIs are defined as the country's very best wildlife and geological sites. Referring to Willis (1990) who valued three sites with SSSI status, they calculate a value of £718 (price level 2003) per ha of SSSI-designated land.[141] It should be noted that in the view of the authors this value reflects only the "habitat for species" ecosystem service.[142] However, these values were adopted for all SSSI sites and not divided by habitat type. Therefore, as the authors also confirm, is it still a rough estimation.

> *"Although the approach to valuing SSSIs is somewhat crude, compared to the approach applied through the use of the ELF model, having the two sets of data is useful. The advantage of adopting a separate estimate for SSSI land is that the accounts can differentiate between the value of landscape, habitats and species provided on non-SSSI land and that provided by SSSI land."*[143]

Adopting these assumptions, the heathland in Birmingham and the Black Country would be valued at £326,302 and therefore almost 35 times the value provided by the ELF model. This is attributable to the fact that 83% of the heathland in Birmingham and the Black Country is designated as SSSI.[144]

In consideration of the findings above the validity of the ELF model should be questioned in general; especially because the limitations of the model and the strong tendency to underestimate the value were not adequately declared.[145]

Taking the literature review into account, the findings from Hanley and Spash (1993) seems to be the best method to value the ecosystem benefits provided by the heathland in Birmingham and the Black Country. In this case, an additional value transfer from Willis (1990) is not feasible. This would be very likely to involve overlaps.

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[140] Jacobs and SAC 2008; EFTEC and IEEP 2004.
[141] EFTEC and IEEP 2004, 67.
[142] Ibid., 77.
[143] Ibid., 67.
[144] GIS data provided by EcoRecord
[145] Especially in the most actual document provided by Oglethorpe 2005

For visits to the heathland habitats the WTP of £1.19 per visit provided by Hanley and Spash (1993) is adopted. Even though the study is comparatively old and therefore the valuation methods may not match the actual state of the art of ecosystem valuation, it is applicable for a value transfer. Nevertheless it should be noted that the uncertainties are comparatively high. Furthermore, the sample size with 177 respondents is comparatively small.[146] Neither was an adjustment by socio-economic variables possible.[147] These weaknesses are taken into account in the sensitivity analysis.

As mentioned before, with 382 ha the vast area of heathland can be found in Sutton Park. Referring to Birmingham City Council the annual visitors are estimated to be over 2 million. However, Sutton Park is not only characterised by heathland. Large areas of woodlands as well as wetlands, marshes and lakes can be found within the 970 hectares of park. Which visits are related especially or mainly to the heathland is not ascertainable. Often the mix of habitats might be crucial. To avoid overlaps especially with woodland benefits the visits related to the heathland have been estimated by the attributable area. 39% of the area of Sutton Park is covered with heathland. Following these assumptions, 787,000 visits are estimated to be related to the heathland area in Sutton Park. However, this must be admitted to be a very crude calculation.

Multiplying the 787,000 annual visits to Sutton Park related to heathland by the WTP of £1.19 results in an **annual value of £0.93 million**. As discussed above, this value can be related to the ecosystem services associated with recreation as well as with habitat for species. A relatively crude sensitivity analysis with a range of 80% has been applied to take uncertainties regarding visit counts, visits to heathland, transfer errors and general uncertainties especially taking into account the open-ended contingent valuation method which was applied in the primary valuation study. Unfortunately, a comparable calculation for other heathland sites, especially on Brownhills Common, is not possible. Visitor counts are not available. However, the vast proportion (83%) is covered.

[146] Hanley and Spash 1993, 214.
[147] Corresponding information are not stated in the study.

3.4 Summary

As stated in table 3.2 below, the value of ecosystem services provided by heathland totalise to **£0.93m**. However, these findings should be taken with due caution. On the one hand the valuation of recreational services and as habitat for species are derived from an old primary valuation study that does not match the current actual scientific state of the art. This fact is considered in the wide range applied in the sensitivity analysis. On the other hand the assumption is reasonable that many ecosystem services such as aesthetic appreciation or water quality improvement are not covered by the values. Other more appropriate primary valuation studies are not available at the moment. Furthermore "recreation" and "habitat for species" are only valued for heathland in Sutton Park. The avoidance of energy costs for wastewater treatment has also not been included. These circumstances suggest a more or less high undervaluation which has not been considered within the sensitivity analysis. As with the other habitats, the summary table shows a core for the TEV of heathland.

Tab. 3.2 Valued ecosystem services provided by heathland

Ecosystem Servise (all values in million, price level 2010)	**Annual value**		
	High	Best Guess	*Low*
Fresh Water Supply		Unvalued	
Air Pollution Control		Unvalued	
Local Climate		Unvalued	
Climate Change Mitigation		Unvalued	
Moderation of Extreme Weather Events		Unvalued	
Water Quality Improvement		Unvalued	
Habitat for Species Recreation	*£1.68*	**£0.93**	*£0.19*
Aesthetival Appreciation		Unvalued	
	Capitalised values (discount rate 1,5% over 100 years)**		
	High	Best Guess	*Low*
Habitat for Species & Recreation	*£167.91*	**£48.88** (£27.81)*	*£5.56*

*) applying the HM Treasury (2003) discount rate
**) for the best guess

Source: Own calculations

Broken down per hectare, the average annual benefit can be valued at about £2,000 or £105,000 capitalised over 100 years. This is comparatively slight compared to the values for woodland. However, at least parts of the difference are related to the circumstance that fewer ecosystem services have been evaluated for heathland. Further research is highly recommended to update previous studies and cover a wider range of ecosystem services provided by heathland.

4. Wetland

4.1 General Information

Using GIS (Geographic Information System) data provided by EcoRecord, within Birmingham and the Black Country it was possible to identify 426 ha of habitat that can be categorized as wetland.

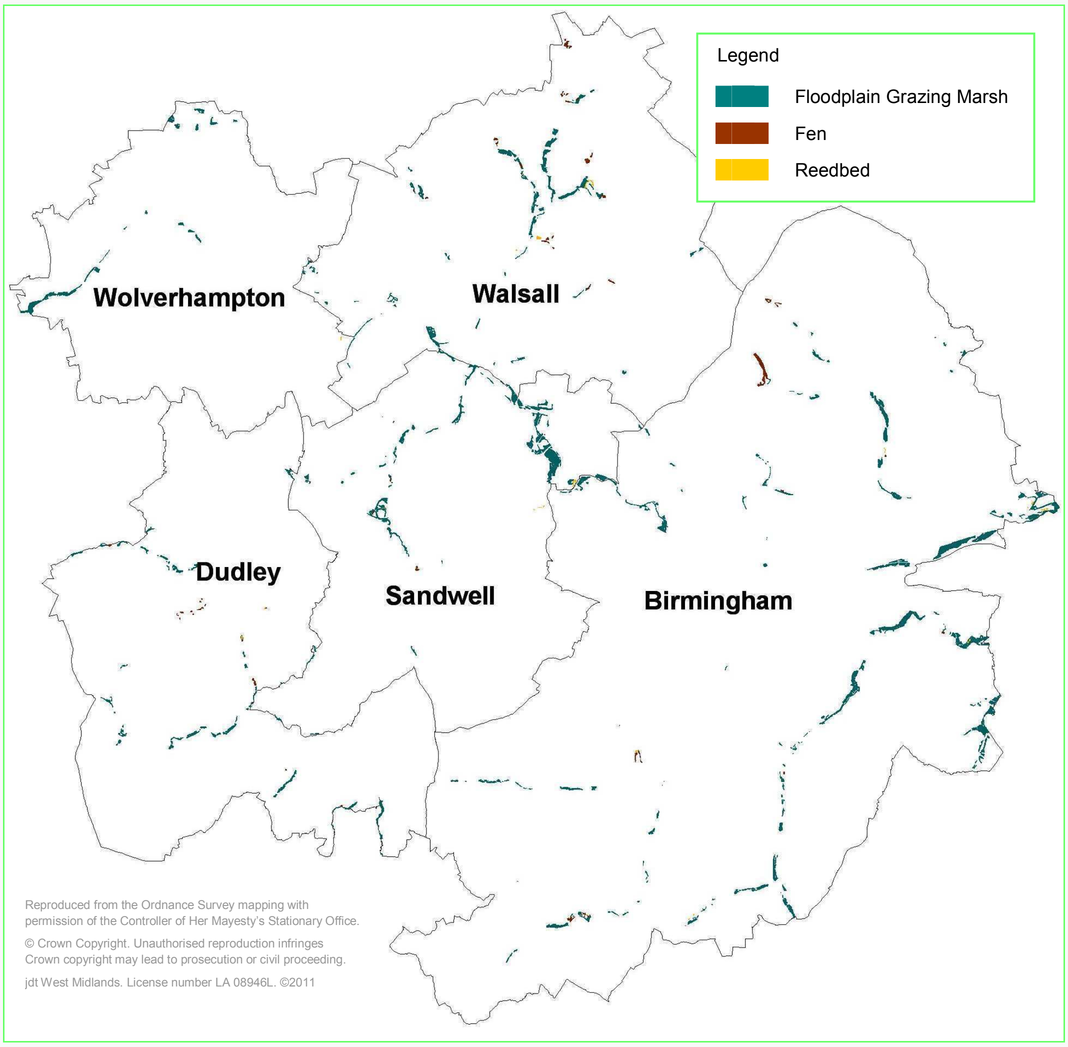
> *"While an inclusive definition of wetlands is difficult to state, they are generally characterized as being moist during an extended period each year with soils, plants and animals that are distinct from their aquatic and terrestrial neighbours."*[148]

With 401 ha the dominant amount of wetland in Birmingham and the Black Country is probably best described as floodplain grazing marsh. This habitat is described as periodically inundated pasture or ditches which maintain high water levels.[149] Further, 22 ha are fens which are characterized by the high mineral content contained within the water. Even scarcer than fens are reedbeds with an amount of only 4 ha within the study area. Reedbeds are dominated by stands of Common Reed *(Phragmites australis)* and a permanently high water level.[150] All three wetland types are "habitats of principal importance"[151] or BAP habitats.

Referring to map 4.1 below it can be seen that the areas of wetland are comparatively small and usually adjoin rivers. Good examples can be found at Sneyd Reservoir in Walsall or within Sutton Park National Nature Reserve in Birmingham.[152]

148 Woodward and Wui 2001, 258.
149 B&BC LBAP Review Group 2010, 12.
150 Ibid., 16.
151 Section 41 (S41) of the Natural Environment and Rural Communities (NERC) Act 2006
152 B&BC LBAP Review Group 2010, 12.

Map 4.1 Wetland area in Birmingham and the Black Country



Source: GIS data by EcoRecord

The different ecosystem services derived from wetland are outlined in the following sections. The valuation follows in section 4.7 using a different approach to that used above. The valuations for each ecosystem service in the following sections should be interpreted as a comparatively crude estimation. Crucial is the calculation in section 4.7.

4.2 Climate Change Mitigation

The benefits of wetland concerning climate change mitigation still remain uncertain.[153] On the one hand, wetland acts as a carbon sink. However, on the other, wetland micro-organisms emit other greenhouse gases, especially methane.

Within a comparatively short time horizon of 20 years wetlands in northern latitudes are estimated to have had net negative effects on climate change. This effect decreases over time and may lead to a balanced greenhouse gas effect over 100 years. After they have existed for 500 years northern wetlands are estimated to reduce the net greenhouse gas warming potential.[154] In respect of the poor scientific evidence, valuation of this ecosystem service from wetland is extremely difficult. Further research is necessary. However, the effect can be estimated as relatively low compared to other benefits.

The destruction of wetland can however have significant influence on climate change. Globally, wetland has the biggest carbon stock per ha. The Intergovernmental Panel on Climate Change (IPCC) estimates an average carbon stock of more than 120 tonnes per hectare.[155] Adopting this figure the total release of carbon captured in the Birmingham and the Black Country wetland could give rise to external costs of £10 million, or respectively £23,600 per ha.[156] Large former wetland areas in England are still emitting carbon dioxide although they were drained many years ago to provide agricultural land.[157]

4.3 Flood Risk Reduction & Storm Protection

The reduction of damage and other costs caused by flooding is certainly one of the main services provided by wetland. This is especially so in the highly urbanised area of Birmingham and the Black Country where floodplains are rare and the potential damage is great. Within the last twelve years alone Birmingham has faced eight large scale flooding events.[158] Along the River Tame, there are 3,100 properties at risk from flooding in Birmingham. Through climate change impacts this amount could rise

[153] EFTEC 2007, 12.
[154] Whiting and Chanton 2001, 521; O'Gorman and Bann 2008, 61.
[155] Gorte 2009, 5.
[156] Applying the carbon price of £52 in 2010 and assuming a total release. However, other land use options may also capture a lot of carbon.
[157] Natural England 2008, 9.
[158] Overview & Scrutiny 2010, 15.

to 5,400 in the future.[159] The formula provided by Brander et al. (2008) also includes flooding related to storm events.

> *"Many wetlands diminish the destructive nature of flooding, and the loss of these wetlands increases the risks of floods occurring."*[160]

To value this benefit we can approximate from the calculations in section 4.7. Therefore wetland services assigning flood and storm protection in Birmingham and the Black Country can be monetised as **£370,000** annually. These values are based on replacement costs.[161] However it should be noted that flood risk reduction services caused by wetland are very site-specific and should be valued case-by-case.[162] A more precise valuation is an assignment worthy of future policy appraisals. This could help to apply the best flood risk reduction management options.

For instance, the creation of new wetlands is one discussed option to mitigate the flood risk from River Tame.[163] The capitalised value can be interpreted as an underestimation. In the future, the quality and quantity of extreme weather events are estimated to rise. This effect is not included in the forecast.

4.4 Water Quality Improvement

Another significant benefit from wetlands is the improvement of freshwater quality, in particular the retention, removal and transformation of nutrients. Furthermore they can capture heavy metals such as TBT (tributyl tin) and complex organic pollutants.[164]

> *"Nitrate concentration has grown rapidly in the last 30 years. The capacity of ecosystems to purify such wastes is limited […] Loss of wetlands has further decreased the ability of ecosystems to filter and decompose wastes."*[165]

[159] EA 2009, 3.
[160] McInnes 2007, 13.
[161] Brander et al. 2008, 33.
[162] Land Use Consultants and GHK Consulting 2009, 132.
[163] EA 2009, 11.
[164] EFTEC 2010a, 12.
[165] Millennium Ecosystem Assessment 2005, 43.

Some fens and other wetlands fill rapidly during floods. The floodwater filters back out through the plants and soils.[166] These services lead to lower costs for technical percolation and/or a better health.

A review of Case Studies, mainly from the United States, show a relative constant willingness-to-pay with a mean annual value for water quality services of US$66.59 per acre (US$41.71 – US$101.81) in 2000 prices.[167] The per-hectare valuation used within this chapter results in a value of **£327,000** annually for the whole wetland in Birmingham and the Black Country.

4.5 Habitats for Species

The high importance of wetland as habitat for species can be expressed through the fact that all three habitats are categorized as BAP habitats of principal importance.[168] One example is the especially high diversity in plant and invertebrate species within floodplain grazing marsh.[169]

> *"The degradation and loss of wetlands is more rapid than that for other ecosystems. Similarly, the status of both freshwater and, to a lesser extent, coastal species is deteriorating faster than that of species in other ecosystems. Wetland-dependent biodiversity in many parts of the world is in continuing and accelerating decline."*[170]

The diversity of species in wetlands can also have pharmaceutical relevance. Some plants like bog myrtle (or sweet gale) can be used producing medicines and cosmetics. This gene pool is seen as a potential for the future.[171]

Because non-use values are explicitly excluded in the meta-analysis provided by Brander et al. (2008)[172] we have to imply that accessibility to the habitat is necessary to profit from this benefit. However, this does not stringently mean that physical accessibility is necessary. Experiencing access or views of the site from other open spaces might be adequate.

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166 Scottish Natural Heritage 4.
167 Kazmierczak 2001, 1.
168 See section 4.1
169 B&BC LBAP Review Group 2010, 12.
170 McInnes 2007, 8.
171 Scottish Natural Heritage 4.
172 Brander et al. 2008, 33.

To make an estimation of the area of land which is physically accessible, as well as accessible for amenity is a difficult task. We assume that only a fraction of wetland, about 15 percent, is physically accessible. The viewable wetland is estimated to be about one third of the total area. In the absence of other statistical data these estimations are used within our model. Therefore the value of “habitat for species”-benefits of 30 percent of the wetland can be calculated. These uncertainties are considered in the sensitivity analysis. However, it has to be clarified that the other wetland areas also provide a habitat for species as a matter of course. Only the economic valuation within this study is not possible.

Following these estimations and the calculation in section 4.7 the habitat for species or biodiversity ecosystem service provided by wetland in Birmingham and the Black Country is valued at **£185,000** annually.

4.6 Recreation & Aesthetic Appreciation

The calculation from Brander et al. (2008) involves consumptive services like recreational hunting and fishing as well as non-consumptive recreation, amenity and aesthetic services being separated. An assumption has been made that no permitted recreational hunting (other than fishing) is occurring in the region. Non-consumptive recreation like hiking as well as amenity and aesthetic services play a significant role. Because definitions for the different categories are not explicit as explained in Brander et al. (2008), the separation between recreation and landscape benefits is not possible.

Following the implications from section 4.5 we calculate the recreational and landscape benefits only for 30 percent of the wetland in Birmingham and the Black Country. This is the estimated amount which can be experienced. Recreational fishing is more related to the “blue infrastructure”. However, this category has a negative influence on some other recreational benefits and on the total value. Because wetland in Birmingham and the Black Country usually adjoins rivers and canals where fishing occurs we include it in the calculation, but also only for the accessible amount of 30 percent. The calculation in section 4.7 below results in an annual value of **£170,000**.

4.7 Benefit Valuation

To value the benefits provided by the wetland in Birmingham and the Black Country we use a different valuation method than that for the previous habitat types. A value transfer function based on the findings of Brander et al. (2008) who calculated on the base of a meta-analysis involving more than 260 studies has been applied.

> *"From the perspective of the policy good, Brander et al. (2008) provides the most appropriate match, being limited to temperate European wetlands."*[173]

The calculation is based on a per-hectare basis. The valuation techniques involved in the surveys reviewed are hedonic pricing, the travel cost method, contingent valuation, choice experiments, market prices, net factor incomes, production functions, replacement costs as well as opportunity costs.[174] The applied meta-regression model was prepared to value wetland in Europe.[175]

For the purpose of this part of the valuation we have categorized the whole area of wetland in Birmingham and the Black Country as inland marsh. The definition submitted by EFTEC[176] does not match 100 percent with floodplain grazing marsh, but EFTEC categorizes that habitat as inland marsh in their case study "Valuing Environmental Benefits of a Flood Risk Management Scheme."[177] This study can be seen as a good practice example within the United Kingdom. EFTEC uses the same valuation technique. To ensure best practice this method is also used here.

Brander et al. (2008) provide a value function which can be viewed in figure 4.1 below. This function allows adjusting the average value of wetland by a range of site-specific variables.

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[173] EFTEC 2010d, 7.
[174] EFTEC 2010a, 125.
[175] Brander et al. 2008, 30.
[176] Inland marsh: Low-lying land usually flooded in winter, and more or less saturated by water year round. This includes non-forested areas of low-lying land flooded or liable to flooding by fresh, stagnant or circulating water. Covered by specific low ligneous, semi-ligneous or herbaceous vegetation. Including: Fens and transitional bogs without peat deposition or on peaty ground (peat layer is less than 30 cm thick) with specific vegetation composed of reeds, bulrushes, rushes, willows, sedges and tall herbs, sphagnum hummocks, often with alder or willows and other water plants; Marsh vegetation located in margin zones of raised bogs; Water-fringe vegetation of reed beds, sedge communities, fen-sedge beds, tall rush swamps, riparian cane formations; High floating vegetation; and Inland saline (alkali) marshes (prevailing arheic). EFTEC 2010, 52-53
[177] EFTEC 2010d.

Fig. 4.1 Meta-analysis value function for wetland

The per-hectare function used for the value transfer can be expressed as:

$$y_i = a + b_S X_{Si} + b_E X_{Ei} + b_C X_{Ci}$$

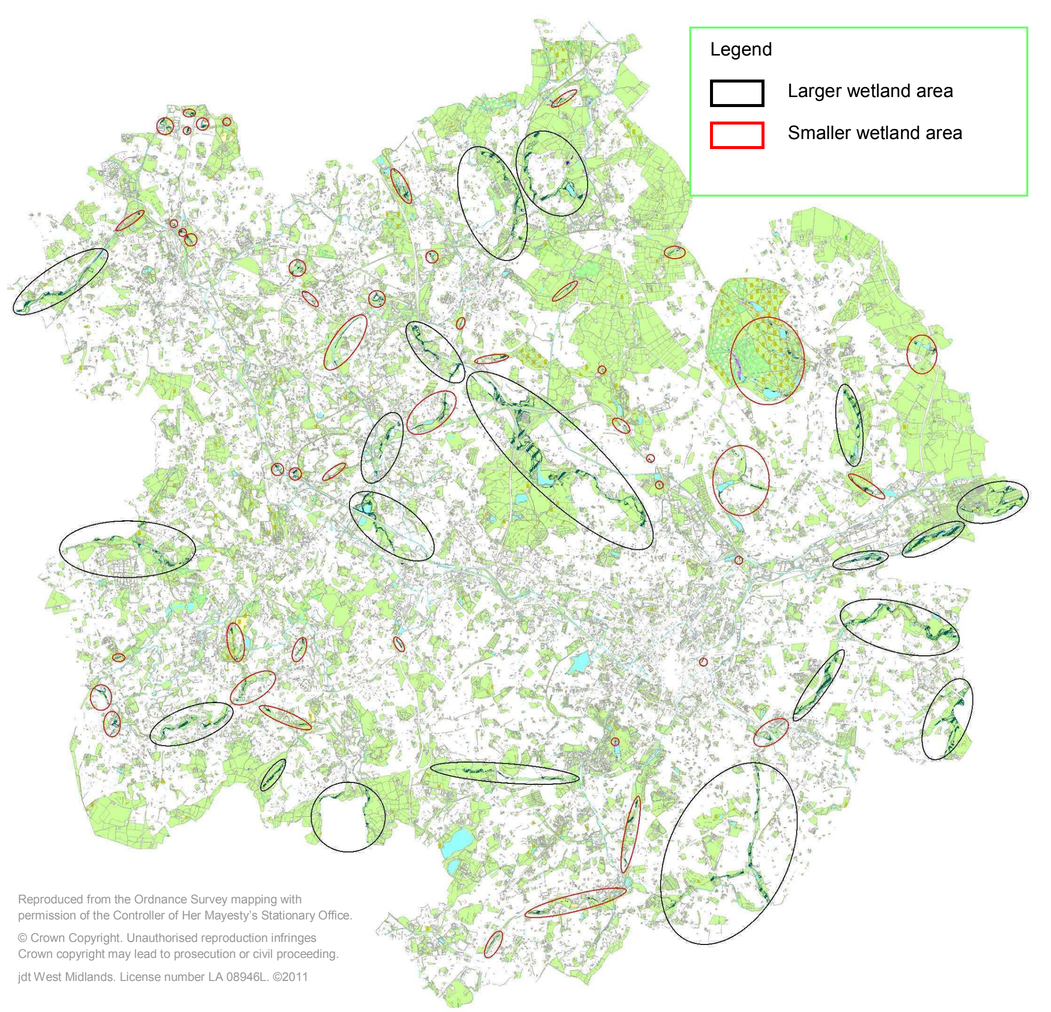
- y_i measures the value of ecosystem site i, based on three vectors of explanatory variables:
    - the valuation study X_S
    - the valued ecosystem X_E
    - the socio-economic and geographical context X_C.
- The coefficients b_s, b_E and b_C are the vectors containing the coefficients of the explanatory variables, and
- a is a constant.

Source: Brander et al. (2008), p. 16

The applications for the wetland in Birmingham and the Black Country as well as its assumptions are presented in table 4.1. To avoid an over-simplification, four different scenarios have been calculated.

One problem is to estimate the size of the different wetland habitats. In the area within Birmingham and the Black Country wetland habitats are highly fragmented. This can be illustrated by the GIS analysis which provides more than 750 different polygons. On the other hand the size of a wetland has a significant influence on its value. To avoid over-estimation, habitats are pooled within a close area, for example alongside a river. Map 4.2 below shows how the wetland sites were pooled. A comparatively crude map analysis regarding the connectivity between the sites results in 20 bigger and 47 smaller areas of wetland in this definition. Imputing that it appears that the larger wetland areas are covering 2/3 of the whole wetland giving an average size for the larger wetland areas of 14.2 ha and 3.0 ha for the smaller habitats.

Map 4.2 Wetland area categorisation



Source: GIS data by EcoRecord

The next step is to separate these two categories each by the provision of recreational, landscape and biodiversity benefits (hereafter called additional benefits) which are only provided by 30 percent of the wetland as explained in section 4.5 and 4.6. Following this approach we get the following matrix.

Tab. 4.1 Classification of wetland in four categories

<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="2">Provision of additional benefits (30% of total area)</td></tr>
<tr><td>Yes</td><td>No</td></tr>
<tr><td rowspan="2">Size</td><td>Smaller</td><td>Total size: 42.6 ha
Average size: 3.0 ha</td><td>Total size: 99.4 ha
Average size: 3.0 ha</td></tr>
<tr><td>Larger</td><td>Total size: 85.2 ha
Average size: 14.2 ha</td><td>Total size: 198.7 ha
Average size: 14.2 ha</td></tr>
</table>

Source: Own calculations based on GIS data from EcoRecord

Based on these estimations and statistical data the function from Brander et al. (2008) for a valuation via benefit transfer can be applied. Table 4.2 provides the calculation for larger wetland with recreational benefits applying the value function from figure 4.1. In this calculation variables which are not relevant for the wetland in Birmingham and the Black Country, like commercial hunting or harvesting, are not used.

Tab. 4.2 Sample value function for a bigger wetland with recreational benefits

Variable	Coefficient value	Value of explanatory variable	
Constant a	-3.078	1	
Wetland Type: Inland marsh	0.114	1	As discused above we categorize the whole wetland as inland marsh
Wetland size:	-0.297	*ln* 14.2	Average size of bigger wetland areas (see table 4.3)
Flood control:	1.102	1	See section 4.3
Water quality improvement:	0.893	1	See section 4.4
Surface and ground water supply:	0.009	1	The supply and surface of groundwater is expected to play a role in Birmingham and the Black Country. Because of the comparatively small influence on the result we have avoided an extensive explanation.
Biodiversity:	0.917	1	See section 4.5
Recreational fishing:	-0.288	1	Pooled in section 4.6
Non-consumptive recreation:	0.340	1	
Amenity and aesthetic services:	0.452	1	
GDP per capita (2003 US$):	0.468	*ln* 30,206	GDP is aproximated from the West Midlands Unitaries level with €26,400 (Pricelevel 2003; Source Eurostat NUTS 2). Converted to 2003 US$ using OECD purchasing power parity (PPP) exchange rates (factor 0.87) this results in US$30,206. This is necessary for the application in this function.
Population density per km^2 within 50 km:	0.579	*ln* 1,305	The population density within 50 km of each wetland site is approximated from the average population density within Birmingham, the Black Country and adjouing districts (South Staffordshire, Cannock Chase, Lichtfield, North Warwickshire, Soilhull and Bromsgrove). Referring to the Office of National Statistics (ONS) in 2008 about 2.8 million people lived in this area covering 2120 km^2 which gives an average population of 1,305 per km^2. The assumption underlies that a wider radius would not match with the specific context of an highly urbanised ares.
Wetland area within 50 km:	-0.023	*ln* 3,000	Considering the marginal influence on the result we have allowed a generous wetland area of 3,000 ha within 50 km radius of each wetland site.

Source: Adopting the calculation in table 4 in EFTEC (2010d), p. 10-12 referring to Brander et al. (2008)

To calculate the annual benefit per hectare for this setting we use the formula from figure 4.1 applying the parameters from table 4.2 above. This results in the following natural logarithm term:

$$\$/ha/yr = -3.078 + 0.114 - (0.297 \times \ln(14.2)) + 1.102 + 0.009 + 0.893 - 0.288 + 0.340 + 0.752 + 0.917 + (0.468 \times \ln(30206)) + (0.579 \times \ln(1305)) - (0.023 \times \ln(3000))$$

$$\$/ha/yr = \ln 8.771$$

To transform this natural log term we raise the exponential to the power of 8.771:

$$e^{8.771} = \text{US\$6,442 (price level 2003)}$$

Applying PPP exchange rate again and convert to GB£ (2010 prices) we arrive at an annual value per ha of £4,890. For larger wetland areas providing additional benefits multiplying the attributable area of 85.2 ha results in £416,516. Repeating this for calculation for the other three wetland classifications we obtain a total annual value of **£1.06 million**. A summary can be found in table 4.3 below.

Tab. 4.3 Valuation of wetland in four categories

(in 2009 prices)		Provision of recreational benefits (15% of total area)			
		Yes		No	
Size	Smaller	Total area: Average size: Annual value/ha: Annual value:	42.6 ha 3.0 ha £7,744 **£329,773**	Total area: Average size: Annual value/ha: Annual value:	99.4 ha 3.0 ha £1,385 **£137,648**
	Larger	Total area: Average size: Annual value/ha: Annual value:	85.2 ha 14.2 ha £4,890 **£416,516**	Total area: Average size: Annual value/ha: Annual value:	198.7 ha 14.2 ha £875 **£173,855**

Source: Own calculations based on GIS data from EcoRecord and EFTEC (2010d) Brander et al. (2008)

One can see that the accessibility to experience additional benefits has a very large influence on the value and therefore a high priority for further planning.

In the next step the amount attributable for each ecosystem service can be approximated. This step is not necessary but to maintain consistency within this survey it is important. By setting every variable standing for an ecosystem service to equal zero[178] and viewing the difference in the sum, an estimation can be made of the attributable value for each benefit. Following this approach amounts of about 27.6% for flood protection, 0.4% for surface and ground water supply, 24.4% for water quality improvement, 22.8% for recreation and 24.8% for biodiversity in terms of habitat for species, are produced. If recreation is excluded then the other amounts will rise proportionately. The table below summarises the findings.

Tab. 4.4 Summary of ecosystem services provided by wetland

In thousand £	Larger wetlands		Smaller wetlands		**Σ**
	With recreation	Without recreation	With recreation	Without recreation	
Fresh water supply	£1.5	£1.2	£1.2	£1.0	**£5.0**
Flood risk reduction & Storm Protection	£114.9	£91.6	£91.0	£72.5	**£370.1**
Water quality improvement	£101.6	£81.0	£80.5	£64.1	**£327.3**
Habitat for Species	£103.3		£81.8		**£185.1**
Recreation & landscape	£95.1		£75.3		**£170.4**
Σ	£416.5	£173.9	£329.8	£137.6	**£1,057.8**

Source: Own calculations based on GIS data from EcoRecord and EFTEC (2010d) Brander et al.

The annual average value per hectare is £2,484. However, it should be noted that the per-hectare value for smaller wetland sites is higher than for larger wetland sites and that accessible sites have generally a significant higher value. That is related to the additional provided services.

The applied approach pools the different habitats (floodplain grazing marsh, fens and reedbeds) in one category. However the literature suggests that fens and reedbeds may have a comparatively higher value than floodplain grazing marsh with respect to services excluding flood risk reduction and storm protection.[179]

[178] To avoid contortions recreational fishing is never excluded.
[179] EFTEC 2007, 16 - 23.

4.8 Sensitivity Analysis and Summary

For the sensitivity analysis, uncertainties regarding the estimations taken, as well as the scientific evidence, are considered. For the upper boundary a value using half average wetland sizes can be re-calculated and also the uncertain negative effects of recreational fishing can be excluded. For the lower boundary, the average wetland size can be doubled and the additional benefits can be restricted to 15% of the physically-accessible wetland. Additionally, a 50% range has been applied to take account of the scientific uncertainties as well as possible transfer errors. A summary can be seen in the table below.

Tab. 4.5 Valued ecosystem services provided by wetland

Ecosystem Servise (all values in £ million, price level 2010)	**Annual values**		
	High	Best Guess	*Low*
Fresh Water Supply		£0.00	
Climate Change Mitigation		Unvalued	
Moderation of Extreme Weather Events		£0.37	
Water Quality Improvement		£0.33	
Habitat for Species (Biodiversity)		£0.19	
Recreation & Aesthetical Appreciation		£0.17	
Σ	*£2.41*	**£1.06**	*£0.38*
	Capitalised value (discount rate 1,5%over 100 years)		
	High	Best Guess	*Low*
Σ	*£240.84*	**£55.43** (£31.54)*	*£11.20*

*) applying the HM Treasury (2003) discount rate

Source: Own calculations

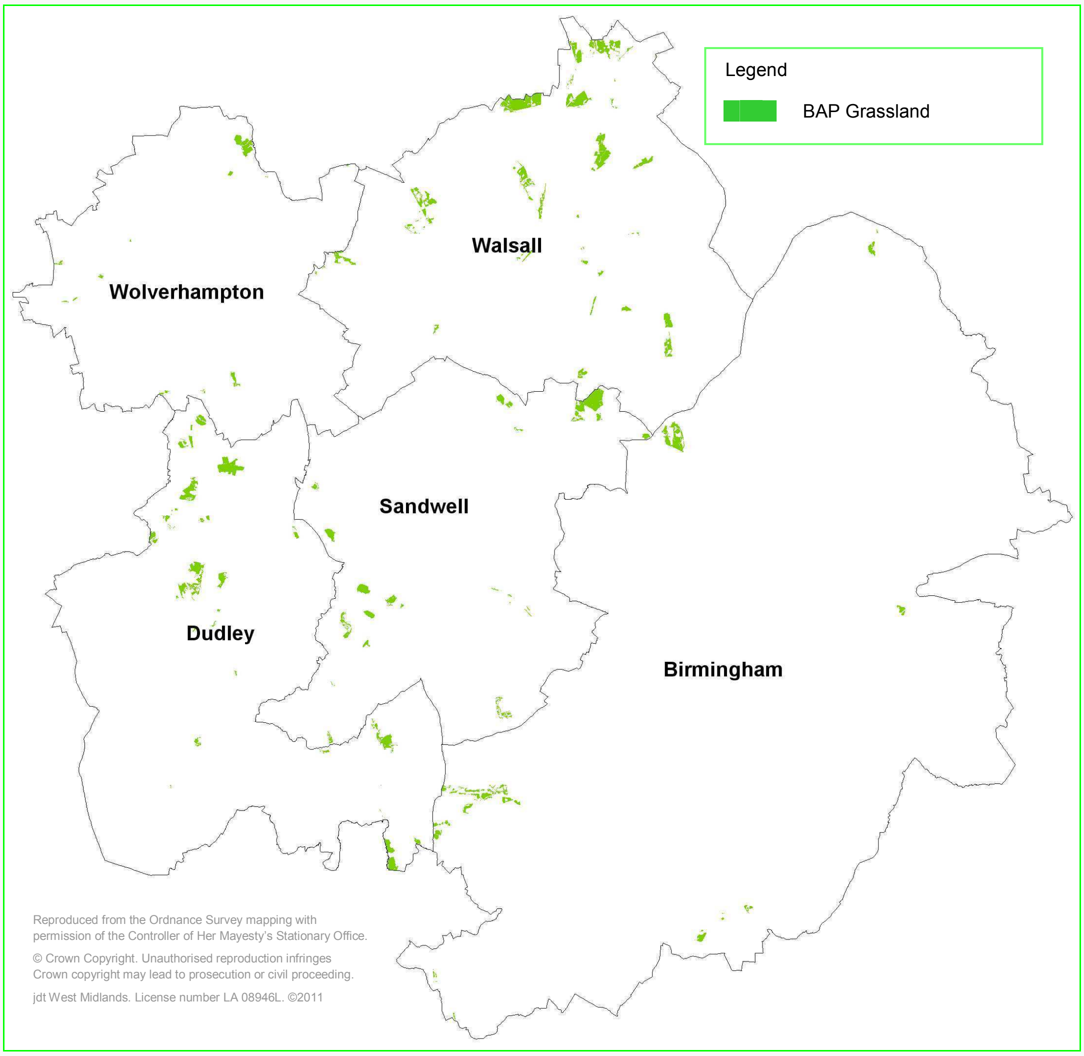
To ensure an effective preservation of existing wetland, as well as to develop new or recover wetland, pooling resources and knowledge is recommended. A closer project-based collaboration could help to maximise the total ecosystem benefits and would avoid sub-optimisation. Greater cooperation between sections of the Environment Agency which is responsible for flood risk management, the local authority leisure services departments as well as the Biodiversity Partnership could be very productive in developing best practice wetland projects, aiming to maximise the delivery of ecosystem services as described here.

5. Grassland

5.1 General Information

Within this chapter, only BAP priority grassland habitats are considered. One reason is the data availability. EcoRecord provides only statistics about lowland meadows, lowland dry acid grassland, lowland calcareous grassland, and purple moor-grass and rush pasture. Nevertheless these grassland habitats are considered to have the most importance as ecosystem service providers and therefore the highest values. In Birmingham and the Black Country, 551 ha of BAP priority grassland have been identifiable.

Map 5.1 BAP priority grassland area in Birmingham and the Black Country



Source: GIS data by EcoRecord

With nearly 400 ha, the vast proportion of grassland can be categorised as lowland meadow. This habitat type covers grasslands cut for hay as well as unimproved neutral pastures. Often, horse grazing is the main land use. Some characteristic species include Black Knapweed, Greater Burnet, Pignut, Yellow Rattle and Crested Dog's-tail. Examples can be found in Park Lime Pits in Walsall or Dudley's Illey Pastures.[180]

Lowland dry acid grassland covers about 130 ha and usually occurs on lime deficient soil. To avoid overlaps, the stated extent does not include acid grassland associated

180 B&BC LBAP Review Group 2010, 13 - 14.

with heathland sites. It contains species such as Wavy Hair-grass, Mat Grass, and Harebell as well as fescue grass species and can be found for example at Barr Beacon in Walsall.[181]

Less common are areas of calcareous grassland, amounting to 21 ha, and purple moor grass and rush pasture with an extent of only 5 ha. Calcareous grassland usually occurs on soils with high base status and can be found on former limestone working areas in Dudley and Walsall. Purple moor grass and rush pastures occur on poorly drained acidic soils. This habitat is usually fragmented and can be found within other grassland or heathland habitats.[182]

5.2 Scientific Basis

Unfortunately, conclusive values could not be calculated for these specific grassland habitats or for grassland in general. The literature review reveals only some initial values which are not appropriate for a value transfer.

Troy and Bagstad (2009) state per-hectare values for grassland, based on a meta-analysis. This includes a range of ecosystem services. They value the benefits provided by each ha of grassland at 353.36 Canadian dollars (~£230) annually. However, the calculation is elusive and at least some values involved in the meta-analysis are based on crude estimates rather than on testable primary valuation studies.[183]

The estimates provided by TEEB (2009) are assumed to be more valid. The report values grassland with US$1,010 (~£620) per ha and year.[184] However, this value represents grasslands from all over the world. A transfer to the specific context of the urban area in a highly developed country is not reasonable. The fact that an average hectare of forest is only valued at £1,620 in the TEEB report[185] allows the conclusion that the value of grassland in Birmingham and the Black Country is very much higher.

[181] Ibid., 14.
[182] Ibid.
[183] Troy and Bagstad 2009, 15 - 16; Olewiler 2004, 16.
[184] TEEB 2009, 20.
[185] Ibid.

Open spaces and parks were also valued in the past.[186] However, the derived values cannot be separated by habitat type and are very site-specific, even if grassland may represent a big area of the surface. This takes effect especially if particular features such as swimming pools are provided or the amount of mature trees is very high.[187] A value transfer is not feasible. As discussed in section 3.3, the values provided by the ELF model[188] are also ineligible for a value transfer to the urban context. The only benefit that it is possible to value is the moderation of extreme weather events.

5.3 Moderation of Extreme Weather Events

Analogous to woodland and heathland, the avoided energy costs for managing combined sewers can be valued. The benefit occurs through the avoidance of storm water flooding by its absorbance and evapotranspiration by grassland. For a full explanation of the methodology see section 2.6.

The applied Green Infrastructure Valuation Network (GIVaN) toolkit[189] calculates with the annual evapotranspiration rates by different habitat types. For grassland, the estimate is about 3.4 million litres evapotranspirated surface water per year per hectare. This results in annual avoided energy costs of £875 per ha which gives **£480,000 annually** for 551 ha of grassland. The supposition has been made that the ability of maximum evapotranspiration is reached within two years. The assumptions are summarised in table 5.1 below.

186 CABE Space 2009a.
187 Forest Research 2010, 135.
188 IERM and SAC 1999; IERM and SAC 2001; Oglethorpe 2005.
189 GIVaN 2011.

Tab. 5.1 Assumptions for avoided energy costs through evapotranspiration by grassland	
Average rainfall	754 mm/yr
Estimated run-off rates	90%
Annual Evapotranspiration	3,770,000 l/yr
Water industry energy use for wastewater treatment	645 kWh/megalitre
Energy saved	21,885 kWh/yr/ha
Commercial electricity price	£0.04/kWh
Private sector energy costs saved	£875/yr/ha
Annual energy cost savings	£0.48m

Source: GIVaN (2011), Met Office data and own assumptions

As can be seen above, evapotranspiration by grassland is similar to that for woodland and heathland. However, as mentioned before, the scientific evidence is not strong enough to include this value into the main calculation.

5.4 Summary

It is clear that further research is necessary to value ecosystem services provided by grassland. Actual research is in progress to value different ecosystems, e.g. different grassland habitats including the BAP priority grasslands within the river Frome Catchment in the south of England.[190] However, at this stage it is not possible to assess if the findings will be suitable for a value transfer. It may be difficult in general to value ecosystem services provided by grassland separate from the surrounding environment.

[190] http://www.fromesurvey.com/

6. Conclusion and guidance

6.1 Key Findings and Interpretation

The main findings of this study are summarised in table 6.1. The structure of the summary table is based on the overview of ecosystem services presented in figure 1.1. In total, the Green Infrastructure in Birmingham and the Black Country covered in the survey can be valued at **£20.78 million annually** or **£1.09 billion capitalised**.[191] As mentioned previously, the scientific basis is very incomplete which leads to a likely undervaluation. Furthermore, most of the ecosystem services which have been given a value are still likely to be undervalued.

The summary table covers only ecosystem services that it has been possible to value for at least one habitat. However, the unvalued services are considered to provide benefits as well. Some of these benefits are described qualitatively in the relevant chapters. All quantitative values are presented as best guess (BG) figures. This reflects the best scientific evidence available. Furthermore, a sensitivity analysis with a high and a low estimate is applied. This range considers for example scientific uncertainties or possible value transfer errors. Therefore, values should be read as for example: 'recreational benefits provided by woodland in Birmingham and the Black Country are estimated to have an annual value of between £3.68 million and £11.04 million with a best guess of £7.36 million.' Generally, where figures are quoted the specific valuation methods and assumptions should be stated as well. For more information see section 1.4.

Values are calculated as annual benefits and also as capitalised values. For both, a *ceteris paribus* scenario is implicit. This means that other influencing quantities such as population growth, extent of habitats etc. are assumed to be constant over time. The capitalised values reflect the total annual benefits over the next 100 years. Technological progress has been taken into account by applying a discount rate of 1.5% to the best guess value.[192] Average values per hectare are also presented. However, the value for one particular hectare may differ very strongly in relation to accessibility etc. For calculation-specific limitations see the relevant chapters.

[191] Best Guess
[192] For the sensitivity analysis and the (only stated) HM Treasury value other discount rates are applied. For more information see section 1.4.

Tab. 6.1 Green Infrastructure valuation summary table

Ecosystem Service		Woodland							Heathland							Wetland						
in million £ Pricelevel 2010		Annual			Capitalised (100 yrs.)				Annual			Capitalised (100 yrs.)				Annual			Capitalised (100 yrs.)			
		High	**BG**	*Low*	*High*	**BG**	BG HM	*Low*	*High*	**BG**	*Low*	*High*	**BG**	BG HM	*Low*	*High*	**BG**	*Low*	*High*	**BG**	BG HM	*Low*
Providing Services	**Fresh Water Supply**		Unv.							Unv.							**£0.005**					
Regulating Services	**Climate Change Mitigation**	*£0.24*	**£0.16**	*£0.08*	*£44.94*	**£13.12**	£9.01	*£3.18*		Unv.							Unv.					
	Moderation of Extreme Weather Events		Unv.							Unv.							**£0.37**					
	Water Quality Improvement		Unv.							Unv.							**£0.33**					
Habitat or Supporting Services	**Habitat for Species (Biodiversity)**	*£4.61*	**£2.71**	*£0.39*	*£461.09*	**£142.12**	£80.86	*£11.68*	*£1.68*	**£0.93**	*£0.19*	*£167.91*	**£48.88**	£27.81	*£5.56*		**£0.19**					
Cultural Services	**Recreation**	*£11.04*	**£7.36**	*£3.68*	*£1,104.06*	**£385.68**	£219.43	*£109.72*									**£0.17**					
	Aesthetic Appreciation	*£14.25*	**£8.55**	*£2.85*	*£1,425.31*	**£448.11**	£254.95	*£84.98*		Unv.												
∑		*£30.15*	**£18.79**	*£7.00*					*£1.68*	**£0.93**	*£0.19*					*£2.41*	**£1.06**	*£0.38*				
∑					*£3,035.39*	**£989.03**	£564.26	*£209.56*				*£167.91*	**£48.88**	£27.81	*£5.56*				*£240.84*	**£55.43**	£31.54	*£11.20*

	Woodland							Heathland							Wetland						
Ø/ha p. a. (in £)	*£19,649*	**£12,244**	*£4,565*					*£3,637*	**£2,020**	*£404*					*£5,655*	**£2,484**	*£882*				
Ø/ha capitalised (in £)				*£1,978,318*	**£644,599**	£367,754	*£136,580*				*£363,651*	**£105,861**	£60,230	*£12,046*				*£565,540*	**£130,154**	£74,051	*£26,301*
Area (in ha)	1,534							462							426						

Notes:

BG Best Guess

BG HM Best Guess HM Treasury (Only stated for comparability) - discount rate recommended by HM Treasury is applied (see chapter 1.4)

Unv. This ecosystem service is not able to be valued at present. This does not mean that the benefit does not exist at all.

Ø/ha p. a. Average annual value per hectare

For the underlying assumptions, limitations and valuation methods see the relevant chapters.

Source: Own calculations based on primary valuation studies and market prices

Because only one benefit provided by BAP priority grassland could be monetarised, the value is not appropriate for application in practice. Therefore, grassland has not been included in the summary table. The relatively low value is likely to lead to general underestimation of the true value of that particular habitat. Because benefits provided by grassland are often ignored, this is very unsatisfactory. The interpretation that grassland only provides minor benefits would be a misjudgement. Acid grassland for example provides 18 different ecosystem services.[193]

It should be noted that it is possible to support estimates of the real values of some ecosystem services which are higher than the stated values. Sometimes, as for the moderation of extreme weather events, only elements of the total ecosystem service have been valued. In this case the real value may also exceed the high value presented in the sensitivity analysis.

It has to be clarified again that the high average per-hectare values for woodland compared to wetland and heathland must not be interpreted in the way that woodland is worth more than the other habitats in general. Different approaches have been used and different ecosystem services have been valued. If all ecosystem services would have been valuable economically heathland might have equivalent or higher values than woodland. The lower values for wetland are basically related to the poor accessibility and the unvalued non-use benefits.

Apart from the ecosystem services listed, Green Infrastructure in Birmingham and the Black Country provides a wide range of further benefits which are widely considered to be of value. Based on questionnaire survey results, literature review and expert workshop assessments, Haines-Young and Potschin (2008) tried to compile a complete list of ecosystem services provided by different habitats. With 22, the highest number of services is provided by broadleaved woodland and heathland.[194] For comparison, in this survey only 4 services are valued for woodland and 2 for heathland.[195] In the following section, some examples of insufficiently- or un-valued benefits are given.

[193] Haines-Young and Potschin 2008, 25.
[194] Ibid.
[195] Even if some services might be pooled in the categories of this survey. Furthermore, especially some provision services are not occurring in Birmingham and the Black Country.

6.2 Further Benefits provided by the Green Infrastructure

Green Infrastructure can provide significant water quality benefits. During a Project in the City of Aalborg in Denmark, 900 ha of intensive agricultural land were converted to woodland and pasture. The drinking water benefits by filtering of nitrates (NO_3) have been estimated to be at least €489 per hectare per year.[196] Green Infrastructure can also act as a buffer to mitigate noise pollution which has a significant influence on human welfare. Research undertaken in Birmingham showed that a noise reduction of 1dB has an average welfare benefit per household of between £77 and £130 annually.[197] Vegetation cover also protects against soil erosion. This, in turn, mitigates some natural hazards, e.g. landslides.[198]

Especially in urbanised areas woodland is capable of playing an important role in education. Children who have grown up in cities do not have the same relationship with nature as their counterparts living in the countryside. Therefore, practical education is all the more important for these children. Unfortunately, research about the educational benefits from woodland is scarce. In England, Land Use Consultants (2002) made estimations about the economic value of benefits from woodland for education. Based on these assumptions the educational benefits in the West Midlands are estimated to be about £2 million annually.[199] However, the assumptions made are very crude. For additional information about further benefits provided by Green Infrastructure see TEEB (2010c) or Forest Research (2010).

These circumstances make a comparison between the different habitats in this study problematic. The values are calculated for different services and based on different studies and methods. It is not acceptable to come to the conclusion that woodland is generally of more value than heathland, because of its higher per-hectare values. Under consistent methods and the coverage of all ecosystem benefits, it cannot be ruled out that heathland could have a higher value than woodland. Furthermore, many other components of the Green Infrastructure such as hedgerows or the whole blue infrastructure (rivers, ponds, canals etc.) have not been covered at all.

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[196] Forest Research 2010, 163.
[197] Bateman, Day, and Lake 2004, 34.
[198] O'Gorman and Bann 2008, 71.
[199] ERM and Willis 2004, 26.

This underpins the assumption that the calculated values only represent the core of the real values of the Green Infrastructure in Birmingham and the Black Country. However, as long as these limitations are considered, the value can give a useful impression of the role Green Infrastructure plays in our life and how it contributes to people's welfare.

6.3 Application of Economic Valuation

The valuation of ecosystem services has generally a wide range of potential fields of application. In this section, a collection of examples are considered. Relevance for regional and local decision makers refers particularly to structural planning. The literature review shows that "green" solutions often can represent a cost-effective alternative to "grey" engineering options in satisfying public needs.

> *"Considering ecosystem services in policy making can save on future municipal costs, boost local economies, enhance quality of life and secure livelihoods."*[200]

Examples are protection from flooding or the purification of drinking water. Another advantage is that beneath the main service provided, manifold additional benefits such as space for recreation or habitat for species arise. The "green" option should always been considered when facing new planning tasks.

The same argument applies where Green Infrastructure is under pressure. On the one hand a growing city is in need of space for new residents and infrastructure as well as enterprises. On the other, these residents and employees are in need of sufficient green spaces for recreation etc. Finding the right balance between these valid needs is a hard task. The economic valuation of ecosystem services provides in outline a decision aid when comparing "green" and "grey" solutions, for instance in the assessment of planning applications. Another field of application is the establishment or redevelopment of Green Infrastructure.

> *"The valuation of ecosystem services can provide input for decisions at many different levels. This ranges from national and international policy*

[200] TEEB 2010a, 3.

decisions to regional and sub-regional decisions and local planning decisions.”[201]

For more general information and arguments for environmental economics in urban areas see chapter 4 in TEEB (2010b).

Private sector enterprises

These applications apply as much to private as to public sector enterprises. Possible decisions may emerge in making choices between the implementation of air conditioning or green shelterbelts and paying higher salaries or providing a more pleasant (greener) workstation to attract high-skilled employers. Even if not all benefits provided by “green” solutions can be internalised (a range of services benefit the public as a whole and not just the company which establishes it), this option may still be cost-effective.

And whether internally cost-effective or not, the “green” solution offers another opportunity. More than ever before, consumers are considering the sustainability of products and businesses. Arguably, this factor has risen to being a major factor in purchase decisions. Therefore, the implementation of “green” solutions as well as environmental friendly projects in general offers a great opportunity for sustainability marketing which can attract completely new categories of buyers. This, in turn, leads to higher business success which can be interpreted as another form of internalisation.

A key role can fall to planning officers and consultants to inform about and develop “green” solutions. The cooperation with third sector organisations and other stakeholders may also involve opportunities regarding synergy effects caused by pooling knowledge and manpower. Naturally, this relates also to the public sector.

Application

To involve economic valuation as a decision aid for explicit planning projects, the “Introductory guide to valuing ecosystem services” published by Defra (2007) provides a systematic guideline. This document is applicable for policy appraisals but

[201] Defra 2007, 21.

also suitable as a decision aid for enterprises and consultancies. However, some supplements have been made to the guide provided by Defra by the present author. Therefore, the following notes should be read in combination with the guidelines.[202]

As mentioned before, the economic valuation of ecosystems is a decision aid, not a decision substitute. The following approach can help decision makers to consider and evaluate all aspects which might be affected. On this basis a justifiable decision is possible. Economic valuation can be an important and helpful stage in process. The recommended key steps are outlined in figure 6.1 below.

[202] For additional information see also Defra 2010.

Fig. 6.1 Key steps in involving economic valuation in decision making

1. Baseline: Identify the “starting point”

1.1 Describe the affected ecosystems: Area, habitat types, protection level, context (part of green corridor, substitutes, urban/rural, change over time)…

1.2 Identify the ecosystem services provided: What categories/services are occurring and who/what is affected (area, population, other ecosystems…)?

1.3 Describe other management options: What other policy options are possible. Repeat step 1.1 and 1.2 for these potential options.

2. Qualitative assessment: Rate the potential impact of each management option on each ecosystem service.

3. Quantitative assessment: Value the (potential) impacts, when possible.

3.1 Select the most important services: What services are likely to be most important?

3.2 Identify valuable services: Which valuation methods are possible? Is the data available? What effort will be necessary? What is reasonable within the project?

4. Assess welfare effects: Identify the links (the logical chain) between ecosystem services, impacts and the welfare effects. This includes management costs as well as possible trade-offs and avoidance of double counting.

5. Value the effects on welfare: Monetarise the effects on welfare of each policy option.

5.1 Decide what is reasonable: What effects on human welfare can be valued within reasonable effort and which valuation method shall be applied?

5.2 Value the effects on welfare: Apply valuation methods within the framework of best practice guidelines.

5.3 Calculate the costs: Compare e.g. planting and management costs.

6. Decision: Compare the options under consideration with respect to values and the qualitative analysis. Other factors such as public acceptance should also be included.

Source: Based on Defra (2007), p. 22-27; supplemented by own recommendations.

A general key factor is the degree of the (possible) change in human welfare. Naturally, the extent of affected land as well as the context plays an important role. It should be noted that many small projects can also have a significant effect. In this case a pooling of such projects can be a sensible approach. This also affects keeping the effort involved in the analysis reasonable. Depending on the extent of the project, external consultation as well as the involvement of stakeholders may be advisable or necessary. Environmental economics can be a very complex topic with many opportunities for mistakes and misjudgements. Furthermore the literature provides a considerable range of tools and case studies to value ecosystem services. Unfortunately, many of them cannot be classified as best or good practice.[203] Maximum transparency is recommended to allow an external review.

The first step is to describe the actual situation and the possible policy options. This involves for example the extent of the affected area, possible protected sites, the availability of (equivalent) substitutes, the degree of urbanisation and the legal basis for a land-use change. Then the affected ecosystem services have to be identified. The description of “grey” management options can also be included, if applicable. It should also be considered, that for example a relocation of habitats or the course of a road can also be an option.

In the next step a first qualitative assessment is necessary. This involves positive, negative, uncertain and absent or negligible effects on ecosystem services. An initial rating might be helpful at this stage.

Quantitative assessment in the third step allows making first estimations about the value by a rough calculation. Initial per-hectare values may be applied. Furthermore it is necessary to research which valuation methods are applicable, which data is necessary to perform the evaluation and whether this is reasonable considering the extent of the project and the budget.

In a fourth step the causal chain between ecosystem service and human welfare has to be identified. The attention should be shifted to trade-offs (e.g. harvesting/recreation) and double counting (e.g. totalling benefits from hedonic price and WTP for the same service). On the other hand costs of development, establishment and management of habitats should be estimated.

[203] See Forest Research 2010 for more information.

The next step includes the precise valuation of the ecosystem services and the welfare benefits for each policy option in line with best practice guidelines. Opposing the costs, a total net benefit can be calculated. The outcome is a cost-benefit-analysis. Depending on reasonable effort, this can also include primary valuation studies. Naturally, the more effects that can be valued, the better the decision aid it provides.

These values are involved in the final multi-criteria decision weighting and scoring. Not all welfare effects can be valued. Ignoring the unvalued effects, however, can result in serious misjudgement. A transparent process that involves public participation is likely to generate the best results. It also creates public acceptance for the project.

Possibly it is necessary to repeat the whole process if a decision on this basis is not possible or the outcome is unsatisfactory. In this case new policy options should be considered and it might be necessary to improve the quality of the analysis.

Even though public welfare should have priority, especially for the public sector, a parallel analysis of the direct and indirect effects on the corporate success or public coffers can also be helpful. In this case external effects without return on investment would not be considered. However, this separation may be very difficult because of complicated cause-and-effect coherence. Indirect effects for example related to fiscal revenues also have to be considered.

Fields of application

The present study can provide support at almost all stages of this process. This applies especially to policy appraisals in Birmingham and the Black Country. The findings are also partially transferable. However, validity declines with increasing divergence from the particular context.

Apart of its applications at the local planning scale, the valuation of ecosystem services can also be applied in strategic policy. The most obvious outcome would be a general increasing consideration of ecosystem services and their benefit to human welfare. As a next step a more strategic approach could be developed. Integrating ecosystem considerations into local policy as well as in the activities of private organisations could for example be implemented by developing an Integrated Management System (IMS). An IMS can be audited by EMAS (European Environment Management and Audit) or via the ISO 14000 family standards.

Such IMS were developed to integrate environmental issues into strategic planning (corporate governance). The objective is to improve the environmental performance in an ongoing process. Essential for the implementation is to collect information about and to report on the environmental "footprint" of the organisation. This helps to identify the potential to ameliorate environmental impacts. The standards of EMAS and ISO 14000 provide flexible instruments which can be applied to small businesses as well as civilian authorities and whole cities. The auditing system monitors the ongoing improvement. Economic valuation can be implemented e.g. in the quantitative environmental information (ISO 14033, in development).

Another opportunity is the integration of economic valuation into economics-based land-use mitigation planning instruments. The basic idea would be to mitigate land-use by reducing tradable certificates over time. The model would be the European Emissions Trading System (EU ETS). This could be a cost- and resource-efficient way to reduce the pressure on the Green Infrastructure. The new created "artificial" market could encourage the location of new planning projects on sites without nature conservation value or to establish and recultivate compensation sites (biodiversity offsets). Delinking urban development from resource consumption is necessary and possible.[204] Applying economic valuation could help to ensure that such compensation sites provide at least the same benefit to the public. Such a policy instrument could implement quantitative land-use strategies at the local, regional and national level.

6.4 Recommendations and Conclusion

In the service of public welfare, local authorities need to take ecosystems more into account than before. The advantages could be increasing long-term resilience of policy as well as reduced risks and costs from failing and degrading natural systems.[205]

[204] TEEB 2010b, 69.
[205] Defra 2010, 13.

"Taking the value of our natural services into account isn't an 'optional extra', it's part of good policy making."[206]

The present publication is intended to provide a useful impression of the dimension of the benefits provided by the Green Infrastructure. It also provides examples of how and why to implement the ecosystem approach into policy making.

Accessibility

In the short term the findings of this study suggest that the opening of already existing, but so far restricted public access green spaces could provide quick and cost-effective additional benefits. However, the protection of especially sensitive habitats has to be considered. When creating new green spaces or protecting Green Infrastructure under pressure, the focus should fall on areas with a relatively limited extent of high quality green space. Natural England's Accessible Natural Greenspace Standard (ANGSt) may be a good indicator. If possible, such areas should be planned as green corridors. Their visibility from a wide range of vantage points in combination with the additional biodiversity benefits is likely to provide the greatest benefits. This is likely to provide the highest values in terms of ecosystem services. Because their recreational and amenity benefits are negligible, green roofs may only be a second-best solution.

Best practice

Generally, all actions to create or improve Green Infrastructure should follow best practice guidelines. Bentrup (2008)[207] for example provides vivid guidance to maximise different ecosystem services, planting trees as wind buffer for example to reduce heating and cooling. Even though derived for the United States, a range of these guiding principles are transferable. Trees for Cities (2008)[208] provides best practice guidelines to plan and implement the planting of street trees. CABE Space (2005)[209] provides tips to improve the quality of parks.

Planning applications

[206] Ibid., 9.
[207] Bentrup 2008.
[208] Trees for Cities 2008.
[209] CABE Space 2005.

The giving of permission for new planning applications affecting Green Infrastructure could also be adjusted. One way would be for applicants (for bigger applications) to be required to demonstrate that their projects are unrealisable on brownfields or comparable spaces. If they are able to demonstrate this satisfactorily there should be a condition, which should be considered to mandatory, to create an ecological compensation area of at least equal quantity and quality (biodiversity offsets). The quality criterion should also specify that the compensation area should occur in an area with comparable population density to avoid the drift of green spaces to the borders of the city.

Information basis and mapping

Another task is to inform corresponding stakeholders and the general public about the importance of Green Infrastructure and the range and value of services it provides. Even if the general awareness of environmental problems and the importance of green spaces already exist[210], there is still a requirement for further information about the complexity and variety of the interactions involved. Such information is likely to generate general acceptance for policy instruments benefiting Green Infrastructure. It also can mobilise volunteers and increase the pressure on private enterprises to take environmental issues more into account. On the other hand cooperation between local authorities, private enterprises and the third sector can help to pool resources and decrease costs when creating new green spaces. Involving the third sector decreased the unit costs of planting 10,000 trees around London significantly.[211] The involvement of enterprises in planning and funding of environmental improvements could particularly apply to shopping centres or dense business districts. One aim should be to ensure that the private sector contributes to the costs of such projects. This concept is called Payments for Ecosystem Services (PES) and is one way to internalise the positive external effects provided by Green Infrastructure.

A further main task for the future is to improve the general information basis of Green Infrastructure and ecosystem services. This affects local authorities and the scientific sector equally. On the local and regional level a more precise assessment and mapping of the Green Infrastructure is necessary.

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[210] May 2010, 34.
[211] Forest Research 2010, 129.

"There is a major gap in the information that is publicly available about England's green spaces. Nobody knows how many green spaces there are, where they are, who owns them or what their quality is."[212]

The available statistics and maps are not detailed enough to allow an overall valuation of the Green Infrastructure. Some of the required data sets are either non-existent or are out of date. The lack of comprehensive information as well as the sometimes poor communication and cooperation between organisations responsible for information gathering are key obstacles to the wider valuation of Green Infrastructure. Examples are the mapping of features in parks, the assessment of tree counts, age and species, the accessibility of green spaces, attendance figures etc. These recommendations are consistent with the West Midlands technical paper on the mapping and assessment of Green Infrastructure.[213] The central database could be established within EcoRecord, the Ecological database for Birmingham and the Black Country, which already holds the most comprehensive catalogue. The database could also be part of a national dataset which is a recommended outcome.[214]

In the medium term, these records could also include the determination of economic values. Green Infrastructure is not valued adequately on authorities' asset registers and balance sheets. Often, only a symbolic value of £1 is given in the accounts. This should be changed over time to match realities.[215] The mapping of brownfield sites and other potential sites to (re)develop Green Infrastructure is also recommended. Furthermore, a strategy to mitigate land-use should be developed. Such a strategy would be more potent if quantitative targets were involved. This is true at the regional level as well as the national level.

<u>Research</u>

To improve the economic valuation of ecosystem services, additional action from the academic and scientific sector is necessary. To ensure maximum practice relevance, future primary valuation studies should be optimised for value transfer. With such studies, the knowledge gaps for example regarding grassland could be closed. Good

[212] CABE Space 2009b, 2.
[213] TEP 2007, 5.
[214] CABE Space 2009b, 2.
[215] CABE Space 2009a, 4.

coordination of such research projects is recommended to avoid overlaps. National authorities are now recommending the application of the value transfer approach.[216] Consequently, funding has to be provided for primary valuation studies to allow the wide implementation of this recommendation.

The implementation of the ecosystem approach and valuation techniques is only just beginning. Additional efforts are necessary to improve the approach and make it applicable on a wide base. However, the scientific evidence already allows the application of this approach in practice, even if only fragments of the total ecosystem services are able to be valued at the moment. The findings of the present survey reveal the dimension to which the public benefits from Green Infrastructure. Current developments in policy and science suggest that the ecosystem approach will achieve increasing importance in the future.

[216] Defra 2007.

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