Building natural value for sustainable economic development

The green infrastructure valuation toolkit user guide

Contents

Cover image: Cheonggyecheon, Seoul, Korea. © Nepal Asatthawasi.

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Many people and organisations have been involved in the development of this green infrastructure valuation toolkit.

The project was initiated in December 2008 by a consortium of organisations with remits for economic development, place-making and protection of the natural environment in England. The consortium steering group was chaired by Natural Economy Northwest, managed by Tees Valley Unlimited and comprised representatives from The Northern Way, Natural England, Design for London and the Commission for Architecture and the Built Environment (CABE), with support from the Department for Environment, Food and Rural Affairs (Defra) and five economic development agencies: One North East, Yorkshire Forward Advantage West Midlands, the Northwest Development Agency, and the London Development Agency.

The green infrastructure valuation toolkit was predominantly prepared by Genecon LLP, the consultant appointed for this work. The present User Guide and associated Calculator were brought to their current prototype form by CABE and Natural England between September and December 2010 in consultation with the consortium steering group.

This project wouldn't have come to fruition without the hard work, dedication and good will of a much wider range of individuals. The consortium would like to thank all those who have contributed their time and expertise to the project in different ways: including by enabling a workshop, providing expert input and feedback on draft materials, approving funding or by providing data from real-life project examples that could be used as case studies to test the toolkit.

The consortium has established the Green Infrastructure Valuation Network (GIVaN) to facilitate further collaboration. See www.bit.ly/givaluationtoolkit

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Overview

This work is being published at a time of concern for England's economy, environment and society, as the country faces up to a series of profound and interlinked long term challenges.

In the immediate future, economic austerity means that the rationale for every investment is being examined as never before and localism is the defining scale for policy delivery. Every penny spent has to count. Local organisations, local people and local leaderships will be in the driving seat to address global challenges in their own area. There is a thirst for practical approaches that can foster economic growth and improve the places in which we live.

Well designed, planned and managed green infrastructure can bring a wide range of benefits to local communities and places – and can underpin sustainable economic growth. But those who want to make the most of this untapped potential face a number of challenges. Identifying the key benefits associated with a green asset, demonstrating how a green infrastructure proposal can add value to a broader developmental project or choosing between different green infrastructure approaches are not easily done.

The green infrastructure valuation toolkit has been developed in response to these challenges to help local stakeholders make good decisions about the value of different options for change:

- It provides a simple framework that can help identify and broadly assess the benefits of proposed green investments and existing green assets – whether those benefits directly contribute to a local economy, or provide wider non-market returns for society and the environment.
- It provides insight in key evidence and concepts from a wide range of sectors, including economic development and regeneration, public health, nature conservation – providing a strong platform for improved mutual understanding and cooperation.

Compiling the evidence base and valuation methodologies supporting *The green infrastructure valuation toolkit* has been a vast undertaking. As the project developed, it became clear that there were a number of methodological and data challenges which were beyond the scope of the project to address. Some limitations to be aware of include:

- The mixed nature of the categories used to group green infrastructure benefits that can result in risks of double counting.
- The limited distinctions made between benefits that might result in economic growth and those leading to non-market return.
- The use of benefit transfer values that are difficult to apply to a UK context.

Full details on the strengths and limitations of the work can be found on pp. 12-13 and should be fully taken into consideration.

Despite these challenges, the development of *The green infrastructure valuation toolkit* has inspired a great deal of interest and support. The present version of the toolkit is being released as **a prototype**, rather than as finalised product, to allow those organisations and individuals who have shown interest to experiment with and benefit from the progress that has been made.

It is important that work on the economic valuation of green infrastructure continues and complements ongoing efforts being taken forward at national level. Defra's guidance on economic valuation provides an important point of reference. The link below provides access to key documents, including An Introductory Guide to Valuing Ecosystem Services and links to official value transfer guidelines.

http://www.defra.gov.uk/environment/policy/natural-environ/using/valuation.htm

The consortium who led the development of this toolkit has established the Green Infrastructure Value Network (GIVaN) to maintain the good working collaborations that the project has inspired. Based in the north of England, the GIVaN welcomes input from practitioners, policy makers and academics with an interest in open source learning and technical exchange on green infrastructure valuation. Further detail on how to take part can be found p. 13.

What is green infrastructure?

Green infrastructure is a term which has grown in use in recent years. Definitions vary, but most agree that green infrastructure should be seen as a collection of **natural assets** which provide multiple functions and services to people, the economy and the environment. These natural assets span spatial scales and types of land use. For example, they include:

- woodland
- water courses
- coastal habitats
- highway verges
- parks
- urban trees
- private gardens
- the grounds of hospitals, schools and business parks.

This network of natural assets and 'green' and 'blue' spaces that lies in and around towns and cities provides raw materials for our economy. Like other infrastructure, it sets the scene for recreation, tourism and investment and underpins physical and mental health and wellbeing. It provides balance to our urban centres and links them the countryside. Crucially, it is also our life-support system, regulating the quality of our air, water and soil.

Why invest in green infrastructure?

There is a growing interest in **integrated development** models. How can we simultaneously achieve economic, environmental and social goals? Can we include and capitalise on the promotion of biodiversity, the services that our ecological assets provide to our economy and society?

Well designed, planned and managed green infrastructure can offer multi-functional approaches to achieving sustainable economic development and **address genuine practical challenges**. For example:

- **Supporting growth**: investment in green infrastructure – for example enhancing a river corridor with paths, an improved river edge and opportunities for water-based activities – provides opportunities for tourism, attracting visitors, increasing income and employment. As well as providing opportunities for recreation, it can also enhance health and boost productivity for users and onlookers.
- **Stimulating investment**: green spaces and landscaping can enhance the urban environment, influencing business location decisions and leading to new inward investment and employment – as well as increasing land and property values and improving quality of life.
- **Mitigating climate change impacts**: open spaces used both as playing fields and flood plains can provide effective temporary stores of flood water, protecting residential and business property – as well as providing resources for exercise and health benefits.
- **Improving health**: green lungs in urban environments, like public parks, green routes and trees close to offices, can provide resources for healthy lifestyles for employees and residents alike - as well as helping to reduce summer urban temperatures and supporting biodiversity.

Green infrastructure is increasingly being embraced across the country. There is particular interest in the north of England and other areas facing ongoing economic change, as they seek to develop sustainable approaches to regeneration and improve the quality of life for people living in old industrial centres.

As new thinking develops about how to achieve sustainable models of development, there are opportunities to embed green infrastructure firmly within local plans and economic development initiatives.

There is also an opportunity to secure better value for money by joining up investment priorities from a number of agencies to address multiple issues through approaches that have not traditionally been encouraged. Partly this is because understanding of green infrastructure's many benefits is not yet widespread - and the tools for valuing these benefits are under-developed.

How can the toolkit help?

The toolkit is intended to help bridge the current gap between evidence and practice when it comes to environmental investments. It uses practical methods to value the benefits of green infrastructure projects, making it easier to:

- understand and make the case for investment across a broad suite of partners
- compare the benefits from green infrastructure with other developments
- prioritise between the different opportunities that are available.

The toolkit is a self-contained, single resource, based on and including the best available valuation approaches – although, inevitably, necessary simplification has required some compromises.

Who is the toolkit aimed at?

The toolkit can help land managers, developers and other organisations investing in local sustainable development – whether local authorities, city regions, local enterprise partnerships, economic development agencies or community and voluntary sector organisations.

It gives those involved in the management or planning of urban centres and other large land assets ready access to hard numbers on the unique economic returns of their greening projects. This will be helpful for:

- informing audits of land
- reviewing development proposals
- making the case for funding or improving green spaces.

Board members, councillors and other investors on the receiving end of funding requests could equally use the toolkit to compare proposals, and select the projects that perform best against their own priorities. For instance, an economic development partnership might want evidence of how a project is likely to

stimulate inward investment, while local health authorities might be interested in increasing physical activity.

The toolkit can also sit alongside other appraisal mechanisms used to identify and assess the impact of resources.

Why was it developed?

Over the past two decades, considerable research efforts have been made to show how trees and high quality green and blue spaces provide environmental, social and economic benefits.

The Millennium Ecosystem Assessment (2005),[i] which assessed the consequences of ecosystem change for human wellbeing at a global scale, provided the impetus and the conceptual framework for much of the recent work at a more local level. The partners in this project – notably The Northern Way, Natural Economy Northwest, Natural England and the Commission for Architecture and the Built Environment - have also all been active in taking forward research on the green infrastructure agenda.

However, despite the progress made, much of this work has yet to be considered in current policy and funding decisions. And in a context where public funding resources are tight and low-carbon development models are taking centre stage, decision-makers and practitioners need to assess and understand returns from green investment – so as to get the balance between 'grey' and 'green' right.

A key problem has been a lack of readily accessible information. Case studies and research materials on the benefits of green infrastructure are often scattered across academic or specialist literature, and findings are often presented in a language that does not speak to those outside the environmental sector. The partners were keen to address this.

In addition, discussions held with Defra have also confirmed that a usable, practical guide would complement their ongoing work on **ecosystems services***[1]

The aspiration is for the toolkit to develop over time, as new evidence and valuation approaches are developed. It should be seen as a 'living' set of tools, which can be used alongside, or incorporated into other appraisal mechanisms, and to help point the way to further research.

What does the toolkit do?

The toolkit provides a set of calculator tools, to help assess an existing green asset or proposed green investment and translate findings into a business case.

It looks at how the range of green infrastructure benefits deriving from an asset or investment can be valued:

- in **monetary terms** - applying economic valuation techniques where possible
- **quantitatively** - for example with reference to jobs, hectares of land, visitors
- **qualitatively** – referencing case studies or important research where there appears to be a link between green infrastructure and economic, societal or environmental benefit, but where the scientific basis for quantification and/or monetisation is not yet sufficiently robust.

The toolkit does not assess the quality of the design or detailed management requirements of green infrastructure.

This guide describes the evidence base and rationale supporting each of the calculator tools, and provides advice on how to use them.

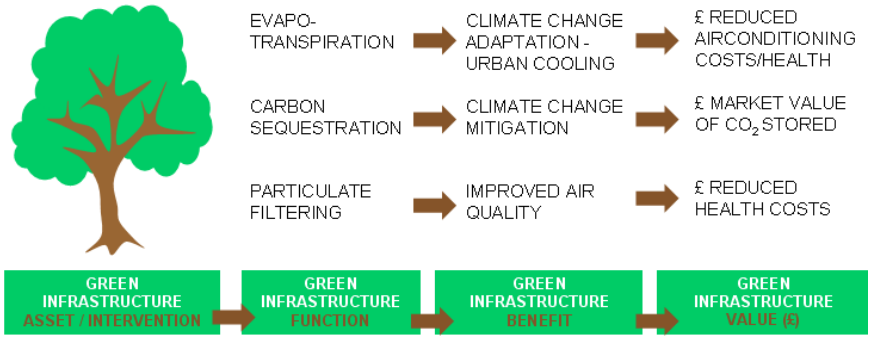
Assessing the benefits

The toolkit uses standard valuation techniques to assess the potential benefits provided by green infrastructure within a defined project area. These benefits are assessed in terms of the functions the green infrastructure may **perform, support or encourage**, depending upon the type of project. For example, figure 1 shows how an urban tree planting scheme can result in improved air quality, carbon sequestration and reduced health costs, thereby illustrating green infrastructure function, resultant benefit and potential monetisation.

However, not all benefits can be given a monetary value. A rich body of evidence illustrates and demonstrates the different types of benefits deriving from quality green spaces. But for many, robust valuation techniques do not yet exist. For others, proving a direct causal link between green infrastructure and the potential benefits is not yet possible.

[1] * All terms followed by a star are defined in the **Glossary**

Figure 1: Translating green infrastructure intervention into monetised benefit values



New versus existing green infrastructure

Local strategies have different priorities for green infrastructure. Some aim to create new green spaces and assets, including green roofs and street trees, linked to programmes of economic or spatial development. Others aim to consider the impact of changing or shaping existing green assets in light of local public health priorities.

This is an important consideration when valuing projects. Take, for example, a proposal to improve access to green space, perhaps a public park or community forest. Adding new footpaths and cycleways might increase the functionality of the green space, encouraging more people to use the area.

The toolkit will help to identify the **marginal benefits*** associated with greater use. However, it is often useful to have a more complete view of the value of the asset, including the *existing, baseline* benefits. These might include the contribution the green space makes to water management or local temperature control, or in storing carbon or supporting biodiversity.

Most of the tools in the toolkit can be used to measure the benefits of existing green spaces. One of the case studies - Ropner Park, Stockton-on-Tees - shows its application to an existing urban park.

This is also very relevant for projects which envisage a potential reduction in green space, or those that aim to secure/protect the long-term future of existing green infrastructure - an assessment can be made of the value that might otherwise be lost.

How do I use the toolkit?

The toolkit uses a three-stage approach to assessing the value of an existing green asset or proposed green investment:

1. **Preparation** gather data about the physical character of the site or proposal and about the populations that might benefit from it.
2. **Assessment**: identify the benefits involved and apply the relevant benefits calculator tools
3. **Reporting**: compile the results from the assessment into a compelling 'return on investment' argument highlighting all qualitative, quantitative and monetary findings.

A more detailed breakdown can be found in the 'Using the toolkit' section.

Three case study examples presenting results from applying the toolkit are included in Appendix 1:

1. **Ropner Park, Stockton-on-Tees** - an existing, traditional Victorian urban park.
2. **Liverpool Knowledge Quarter** - a proposed investment plan to enhance public spaces and green infrastructure in a fast-changing area of east Liverpool.
3. **Belvedere Employment Area Green Links, London Borough of Bexley** – a proposed investment plan to improve access and environmental quality of the Belvedere Employment Are

The calculator is available online at online at www.bit.ly/givaluationtoolkit

[i] www.millenniumassessment.org

Developing the toolkit

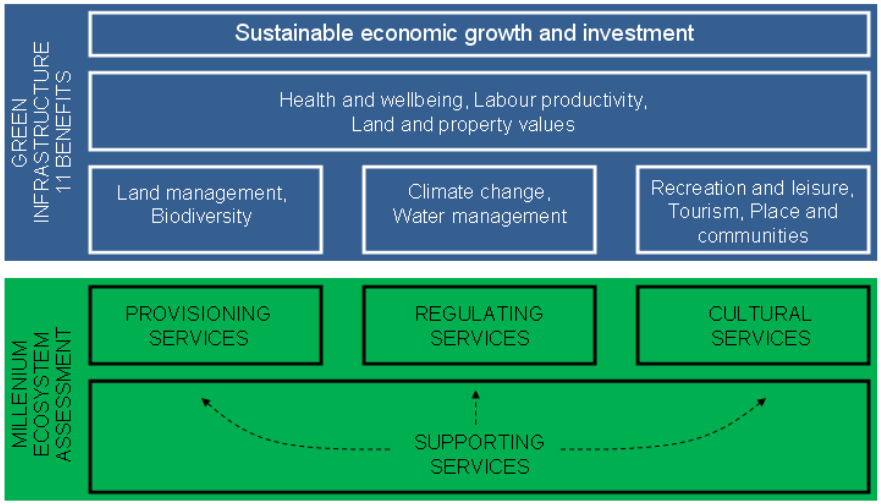
This section provides an overview of the approach taken to developing a practical framework for assessing green infrastructure benefits. It introduces some of the core economic concepts and reference studies used to create the present toolkit proto-type. It sets out the strength and weaknesses of this work and proposed next steps for future improvements.

The 11 benefits framework

The benefit estimation tools are grouped into 11 categories. These are based on work done by Ecotec with **Natural Economy Northwest*** (NENW) in 2008, which proposed 11 benefit groups.

1. Climate change adaptation and mitigation
2. Water and flood management
3. Place and communities
4. Health and wellbeing
5. Land and property values
6. Investment
7. Labour productivity
8. Tourism
9. Recreation and leisure
10. Biodiversity
11. Land management

Figure 2: Mapping green infrastructure benefit groups to the ecosystem services approach



The framework complements other approaches to grouping the benefits of green infrastructure, including the **ecosystem services*** approach. The ecosystem services approach looks at the services provided by ecosystems and their components: water, soil, nutrients and organisms.

Ecosystem services can be defined in various ways. The Millennium Ecosystem Assessment provided the most comprehensive assessment of the state of the global environment to date, and it classified ecosystem services as follows:

Supporting services - the services that are necessary for the production of all other ecosystem services, including:

- soil formation
- photosynthesis
- primary production
- nutrient cycling
- water cycling.

Provisioning services - the products obtained from ecosystems, including:

- food
- fibre
- fuel
- genetic resources
- biochemicals
- natural medicines
- pharmaceuticals
- ornamental resources
- fresh water.

Regulating services - the benefits obtained from the regulation of ecosystem processes, including:

- air quality regulation
- climate regulation
- water regulation
- erosion regulation
- water purification
- disease regulation
- pest regulation
- pollination
- natural hazard regulation.

Cultural services - non-material benefits such as:

- spiritual enrichment
- cognitive development
- reflection
- recreation
- aesthetic experiences.

Identifying functions, benefits and underlying logic chains

An important step in deriving the valuation tools in this document was to identify the functions, benefits and impacts of green infrastructure.

To assess their value, the toolkit needed to gather and assess evidence of how provision or protection of a green asset delivers a particular output or influences an outcome.

This progression is known as the logic chain. The use of logic chains is recognised as a fundamental approach for assessing the value of investments, and in recent years this approach has been embedded in project appraisal methodology.

Central to the logic chain approach is understanding the 'evidence base' for a particular green project – and using it to demonstrate the causal connections between the proposed activities, the outputs and outcomes, and how they lead to impacts, including their impact on goals such as economic development and human wellbeing. The logic chain approach is also a systematic method for identifying evidence gaps and strategic areas for evidence development.

This is a particularly important issue for green infrastructure investment. The evidence available to date can take us part of the way to the goals of this project. Case studies show that the environmental quality of an area has a positive influence on inward investment. However, the evidence base to enable the calibration of impacts is less clear and there is more work to do. In other areas such as climate change adaptation, scientific understanding of the impact of green infrastructure is still evolving.

As part of this work a series of logic chains, based on key green infrastructure functions - for example providing opportunities for exercise, offering shelter from wind, and so on - have been developed for each of the 11 categories, with associated benefits.

Appendix 3 provides an overview of the tools offered by the toolkit, based on the green infrastructure functions captured in the 11 benefit groups. The table details the outputs from each tools and a recommended timeframe for appraising value and returns.

These timeframes are based on judgements of a green infrastructure asset's lifespan - assuming between 30-50 years - or an appropriate accrual period of 20-25 years, allowing for growth to maturity. A lower 10 or five-year timescale is indicated for a number of the tools – this timescale is more usually associated with monetary benefits affecting gross value added.

Capturing the 'total economic value'

While there is good qualitative evidence for the benefits of green infrastructure, it is not currently possible to put figures on some potential impacts.

One example is economic growth and investment. A number of studies have shown a positive correlation between environmental quality and businesses' decisions to relocate, but have not been able to quantify the relationship:

- How much green infrastructure is enough?
- What about other factors such as transport links, a skilled workforce and so on?

The complex nature of the relationships at play here mean that a simple tool cannot provide meaningful results - more detailed, specialist and bespoke techniques will be needed.

The toolkit cannot count everything. What it does count is designed to be robust enough for **initial, indicative project appraisal**, providing a range of figures indicating the potential impact of a green infrastructure intervention or even an existing green asset.

Given the multi-functional benefits from green assets, there is also a need to capture the wide range of benefits that contribute to the overall welfare of society. This can be done by assessing the **total economic value*** (TEV) of the green investment.

This includes:

Use value* - relating to current or future uses of a good or service. These include:

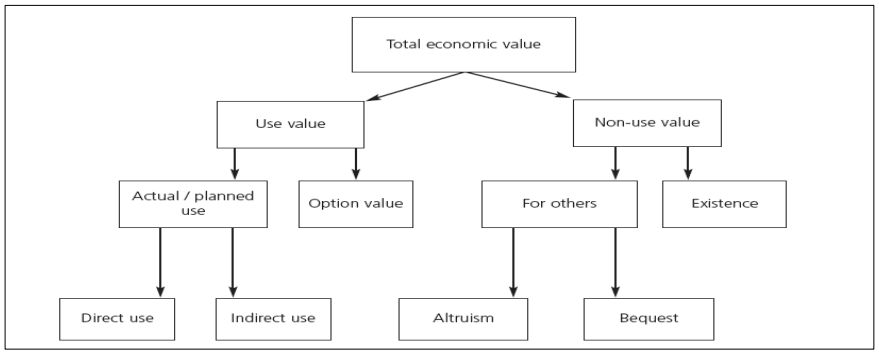
- *Direct use values*. These may be consumptive – such as timber - or non-consumptive – such as recreational activities.
- *Indirect use values*, including key ecosystem services like flood protection.
- **Option value*** is associated with retaining the option to use a resource in the future.

Non-use values derive from:

- *Existence value* - the knowledge that environmental resources continue to exist
- *Altruistic value* – are available to others to use now
- *Bequest value* – are available for use in the future.

Figure 3 demonstrates the total economic value approach.

Figure 3: Total economic value schematic



Source: Defra, 2007

The toolkit provides guidance on estimating the total economic value. However, a **proportionate approach needs to be adopted at appraisal stage**.

While there is often a focus on direct and indirect use values, it may be important to understand the **option and non-use values** associated with any green investment. Where a project is shown to make a significant impact or contribution to a particular policy objective, for example tourism or flood alleviation, there may be a need for more detailed studies to underpin the toolkit results. The toolkit can help to identify the major impact areas of a green infrastructure investment.

The HM Treasury *Green Book - Appraisal and Evaluation in Central Government* provides overall guidance on the appraisal and evaluation of public sector investment. It states that

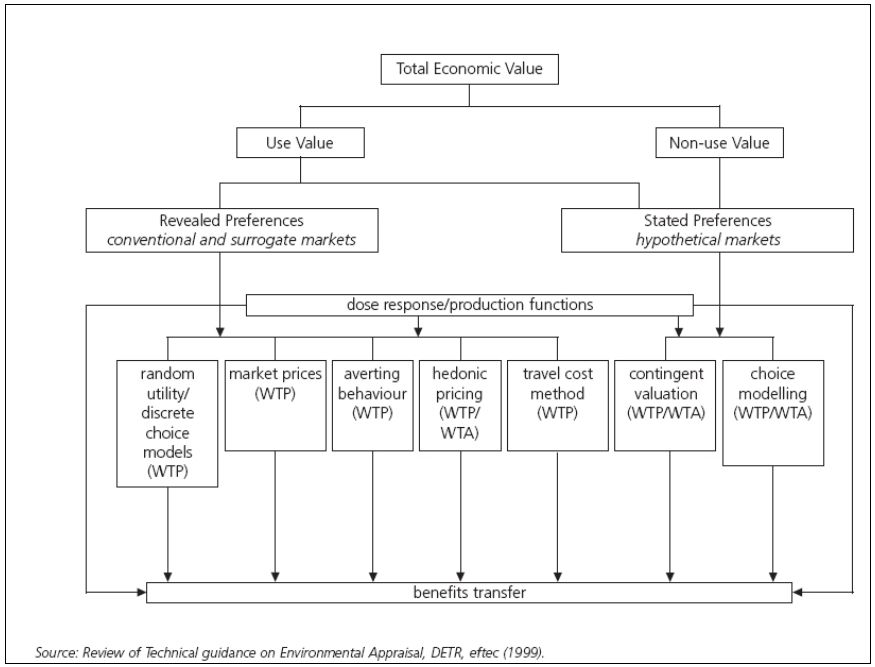
- public sector investment should be subjected to a comprehensive, but proportionate, assessment
- the assessment should consider the impact on society as a whole.

Central to this are the estimates of the total benefits and full costs to society and, where feasible, that all relevant costs and benefits are expressed in **monetary terms** to arrive at a net benefit or cost.

Costs and benefits related to market goods and services are estimated using market prices. For wider social and environmental costs and benefits for which no market price is available, specialised non-market valuation techniques may be applied.

Figure 4 shows where these techniques are commonly used to estimate the value of the different components of total economic value.

Figure 4: Approaches to the valuation of green infrastructure and environmental goods



Some of the key methods include:

- **Contingent valuation (CV):** a survey method which aims to capture individual preferences for a change in the provision of a good or service through assessing their **willingness to pay*** (WTP) or **willingness to accept** (WTA) compensation. These changes are hypothetical, and it is important to ensure surveys are well designed to minimise this and other sources of bias. The contingent valuation approach is widely used for generating option and existence values - for example in protecting biodiversity.
- **Hedonic pricing:** this method relates the price of a marketed good to a non-marketed good, the most common of which are property and labour. The property value (PV) approach is the most common use. It consists of observing differences in the values of property between locations, and

isolating the effect of ambient environmental quality on those values. The approach has been used to assess the impact of green infrastructure on residential property prices[2].

- **Travel cost method:** this takes the cost of getting to a site as the value attributed to the good or service. So the value people place on a good environmental space is inferred from the time and cost they incur in travelling to it. This method is applied mainly to public recreation sites with free or minimal admission charges - for example coastal footpaths or a nature reserve - where it is argued that the cost of travel is a good proxy for the entry price.
- **Effect on production:** this measures the effect a project may have on the output, cost or profitability of producers through its effect on their environment and the welfare of consumers. An example might be reservoirs creating new fisheries, or bee keepers benefiting neighbouring gardens. This method is often used to assess negative impacts associated with an investment.
- **Preventative expenditure**: this is typically used when comparing the benefits provided by green infrastructure to the costs of providing engineering solutions – for example protection from flood risk - and/or replacement cost approaches.
- **Benefit transfer:** effectively adopts or adapts information from valuation studies undertaken elsewhere - using a variety of the above techniques - and applies them in a new context. There are many examples across a range of benefit streams - a scan of the EVRI (Environmental Valuation Reference Inventory) database is a useful introduction to the range of topics covered. A more sophisticated use of benefit transfer is called the **transfer function approach**. This adapts the results from one study to make it more suitable to another context – for example adjusting for the socio-economic context or the location.
- **Specific values**: are incorporated in the toolkit, the most significant being the 'social cost of carbon' or 'shadow price of carbon'. This value is effectively a shadow price set by government - it is a requirement to adopt the value in public sector cost-benefit analysis.

The use of the **benefit transfer** approach is a central feature of this toolkit. It is an approach supported by Defra as a cost-effective way of undertaking appraisal. The other methods outlined can be complex, and resource and time-intensive - where existing *transferable* values can be applied to provide an economic valuation, this will generally be more efficient and preferable.

However, **the benefit transfer method is only as good as the initial study from which the values are taken**.

Since valuations are often context and time-specific, care needs to be taken in their use and interpretation. Defra has developed guidance on the use of benefit transfer and is currently providing a more detailed set of guidelines on the use of value transfer in valuing environmental impacts[3].

Demonstrating value for money

Economic appraisal methodologies used to make decisions on public sector funding are increasingly adopting a benefits framework approach, considering the full range of impacts from a project and the total public sector benefit value created – rather than focusing solely on the direct economic impact on employment.

This approach has been adapted for this toolkit. It fits well, given the growing recognition of the wide range of benefits that green infrastructure can provide. The approach also fits with the total economic value concept promoted by Defra for assessing the value of environmental outcomes of a project - whether costs or benefits.

Key supporting studies

The toolkit draws on a substantial body of evidence from a large number of sources in the UK and overseas over the last 30 years.

Some studies and reports have been especially useful, providing the core information on which this toolkit is based:

- Northern Way/Ecotec, *City region green infrastructure strategic planning: raising the quality of the north's city regions*, 2006
- Ecotec, *The economic benefits of green infrastructure*, sponsored by Natural Economy Northwest, 2008
- Jacobs for Defra, *Valuing England's terrestrial ecosystem services*, 2008
- AMION, *The economic benefits of green infrastructure* – an assessment framework for the NWDA, 2008
- Defra, *An introductory guide to valuing ecosystem services*, 2007
- Natural England, *No charge? Valuing the natural environment*, 2009.

These reports have provided a wealth of background evidence and frameworks for appraisal. Many of the approaches and values used in this toolkit are drawn from this work. Other sources are listed in the text.

Some specific studies have been used for key elements of valuation:

- Forestry Commission research (*The social and environmental benefits of forests in Great Britain*, Wills, Garrod et al, 2003) for average values for forestry and woodlands.

- Work by Eftec for Communities and Local Government (*Valuing the external benefits of undeveloped land*) gives a useful indication of the scale of external - non-use - benefits which green infrastructure can give. Careful application is required to avoid double counting if other tools are used for these benefits, and to be sensitive to context. However, the values do provide an initial estimate of the likely scale of benefits, and are used in tools on recreation, quality of place and biodiversity.

Other sources are listed in the dedicated chapters associated with each of the 11 benefits.

Strength and limitations of the toolkit

Before releasing the toolkit in its current prototype form a wide range of feedback has been solicited from peer economists, potential users and specialists in the various subject areas covered by the project. Summarised below are the findings from this wide consultation exercise.

The peer review was conducted in March 2010 with expert economists:

- Andy McNab and Petrina Rowcroft from Scott Wilson, commissioned by CABE
- Simon Kyte, Senior Economist, Greater London Authority

Field testing of the toolkit with a variety of potential users currently managing large green infrastructure projects included the Red Rose Forest team, the Newlands Project Team (Forestry Commission), Cheshire West and Chester Council, Trafford Council and Rochdale Council.

Consultation with specialists involved Professor John Handley and Dr Susannah Gill on climate change issues, Dr William Bird on health issues, Eleanor Lucas and Richard Copas from the Environment Agency on water management issues Professor Edward Maltby on the economics of biodiversity, and many others.

Strengths

The toolkit provides a very helpful introduction to the evidence demonstrating the benefits of green infrastructure interventions. It offers a structured argument that speaks the language of regeneration and economic developments.

The 11 economic benefits structure provides a relatively simple high level means of presenting and communicating the benefits of green infrastructure projects in economic contexts, although it also brings some risks of double-counting (see Limitations below).

The toolkit provides a structured approach to value green infrastructure benefits in monetary, quantitative and qualitative terms, with equal weight being applied to each of these three ways to present existing evidence. It can add value to and inform the decision-making process, particularly when used at an early stage to get broad brush figures and weigh pros and cons.

The toolkit relies on current state-of-the-art evidence and valuation techniques for green infrastructure benefits. However, the toolkit also highlights the need for considerable improvement and expansion of the evidence base to enable future iterations to provide improved valuations.

The toolkit helps make green infrastructure benefits ‘visible’ to potential funders. The inclusion of environmental benefits in cost benefit analysis is currently very difficult, often requiring professional assistance. Such assistance is frequently beyond the means of many groups seeking project funding. The toolkit is aimed at filling this gap, providing a means of scoping out the indicative benefits of green infrastructure using tools and approaches accessible to many projects and groups.

However, whilst the toolkit provides a means of undertaking a broad Value for Money assessment, it must but emphasised that this is only indicative and cannot replace more rigorous formal project appraisal techniques.

Limitations

Whilst the 11 benefits framework is easy to communicate, the benefit groups tend to overlap. Although guidance is provided throughout the Calculator, extra caution must be exercised to ensure that double counting is avoided when undertaking a valuation exercise.

Some of the benefit groups such as ‘Place and Communities’ are large concepts in their own right and and the toolkit presents a selection of proxy indicators which can be measured to seek to give an indication of the benefit in these areas.. Some areas of benefits such as ‘Transport’ or ‘Education’ are not captured in the 11 benefits framework and should be included in further developments of the toolkit.

The toolkit does not provide guidance on dealing with uncertainties. Uncertainties exist in science (i.e. in our understanding of green infrastructure functions and associated total economic value) and in our knowledge of what the future holds (e.g. in relation to climate change). Any quantitative appraisal should recognise such uncertainties. This could be achieved through providing lower and higher bound estimates where the evidence base suggests ranges in values and/or through conducting sensitivity analyses to demonstrate how the benefit estimates vary as a result of changes in any underlying assumptions. Whilst the Calculator contains a "Values Library" that was originally intended to document upper and lower bound ranges, the project was unable to complete it before the present proto-type release.

The toolkit does not distinguish between economic impacts, which relate to economic growth, and economic value, which expresses welfare benefits to people in monetised terms. Nor does it distinguish between absolute and relative impacts.

However, the toolkit does attempt to identify those benefits that can relate to gross value added, those which have a broader economic context and the residual benefits that cannot be monetised but can be either quantified or described. The toolkit enables projects to do a best estimate of the total benefits to make an indicative comparison with project capital and projected maintenance costs.

The toolkit does not provide guidance on separating out project benefits from other benefits that might have happened anyway. When the toolkit is used to assess the impact of a green infrastructure investment, the user needs to be clear that these benefits should be treated a gross benefits and do not necessarily demonstrate additionality..

The toolkit calculator makes extensive use of the value transfer approach, which is the process of inferring one economic valuation from another. This is complex and requires close attention to differences between the two contexts. Whilst it is right to caution that to achieve value transfer to standards acceptable for a 'Treasury acceptable Cost Benefit Analysis' nearly always requires the support of an economist, because cost benefit analysis should be proportionate to the evidence, cruder value transfers may be appropriate provided the assumptions underpinning them are clearly stated and it is made clear that the end result is an indicative value, as advised throughout the toolkit calculator. Further assistance is available from Defra's value transfer guidelines[2].

The toolkit has attempted to use the "best available" evidence, but the work done has demonstrated how there needs to be significant work done to improve the evidence base. In some instances where little evidence was available, calculation factors were adopted based on a "reasonable rules of thumb" approach. Whilst underscores the need to consider toolkit outputs as strictly indicative, the Calculator does provide clear warning and guidance where such assumption-based factors are being used. When good local data is available, the toolkit can be tailored by replacing these assumption-based factors with parameters specific to the project. This would improve the robustness of the valuation, but it is unlikely that data will exist of sufficient rigour to permit anything more than indicative valuation results. Toolkit outputs will thus invariably be broad scale and contextual.

Some of the potential benefit streams have proved impossible to provide simple tools for. This has resulted in the necessary recommendation of the use of bespoke studies. Whilst these will invariably be complex and potentially costly, the toolkit provides a means of identifying which areas of valuation, if relevant to the specific project would require professional input.

How can I help improve the toolkit?

The present version of the toolkit is being released as a prototype.

Developing the toolkit's next iteration will require wide and sustained collaboration. To facilitate this process, interested parties are invited to pass the toolkit to others who might be able to incorporate it into their work and to provide feedback on:

- Their experience in using the toolkit, good and bad!
- Sources of improved evidence
- Suggestions for improving the tools
- Ideas for new tools

The consortium who led the development of this toolkit has handed over the responsibilities for co-ordinating future work to the Green Infrastructure Value Network (GIVaN). Further information on the network can be found at:

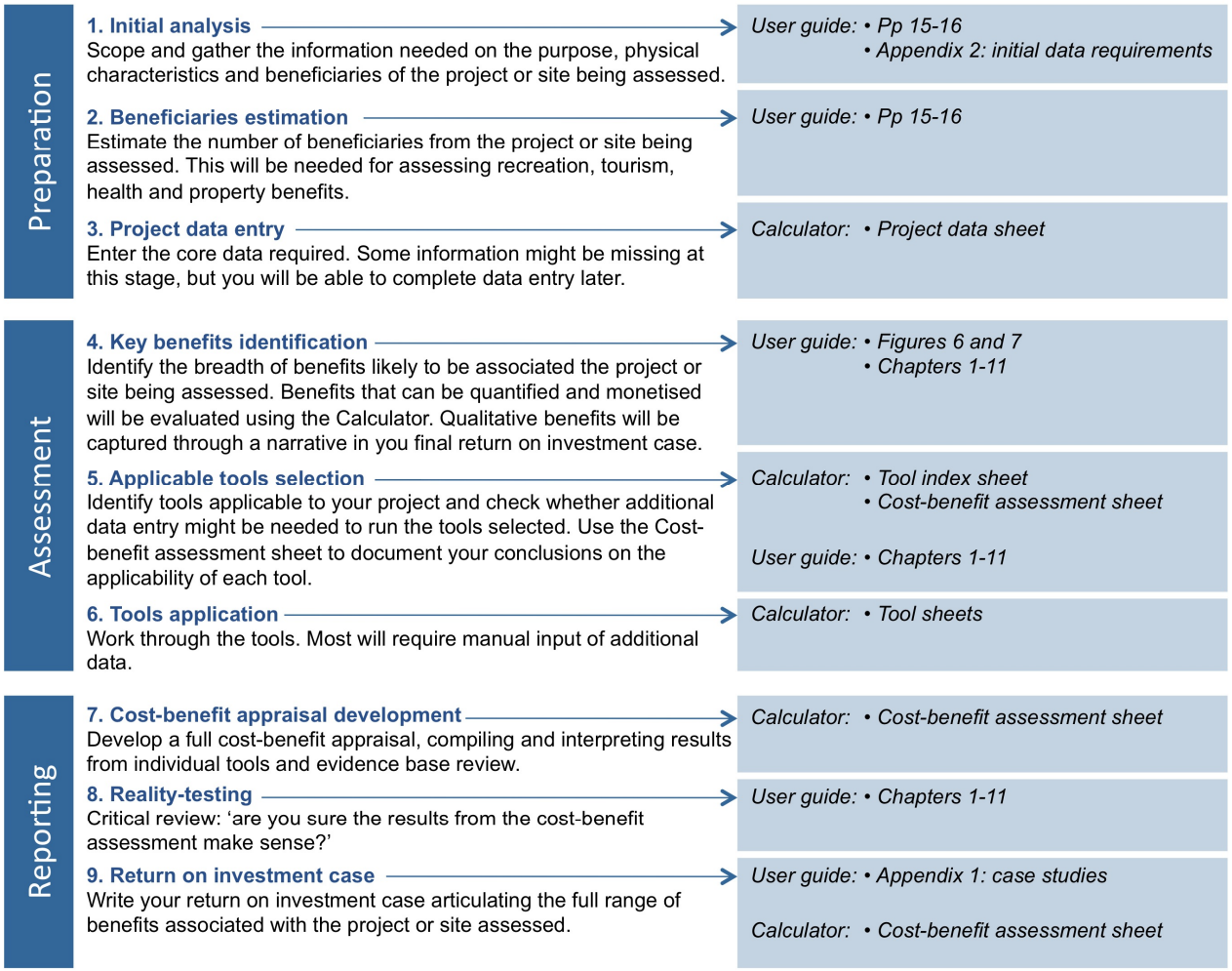
www.bit.ly/givaluationtoolkit

[2] http://www.defra.gov.uk/environment/policy/natural-environ/using/valuation/index.htm

Using the toolkit

This section provides an overview of the approach to estimating the value of green infrastructure investments. It introduces some of the core economic valuation concepts and provides guidance on to how to use the toolkit.

Figure 5: Step-by-step guide to using the toolkit



Preparation

Step 1: Initial analysis

Scope and gather the information needed on the purpose, physical characteristics and beneficiaries of the project or site being assessed.

Good information about the project or asset to be valued is essential. **The better the information, the greater the accuracy of the valuation.** A checklist of the initial data requirements is provided in Appendix 2.

Core information such as the type, quantity and location of a green asset, its current and future use and so on, should be readily available from the project developers or asset owners.

Step 2: Identifying beneficiaries

Estimate the number of beneficiaries from the project or site being assessed. This will be needed for assessing recreation, tourism, health and property benefits.

Many of the benefits of green infrastructure come from its use by humans – for recreation or tourism. Baseline figures for current use are therefore important to help assess the **net additionality*** of the green infrastructure investment – the net positive difference resulting from the investment.

The affected population will be an estimate of the relevant 'user' and 'non-user' population – the beneficiaries of the investment.

- '**Users**' benefit directly, by using the new or improved green infrastructure - think of people using a park, or a new cycle path.
- '**Non-users**' may also derive a benefit - for example, a city dweller may value investment to safeguard a rural habitat even if they have no intention to visit the site.

In many cases, the most appropriate approach to identifying beneficiaries will be some form of **population** or **household density** or **catchment analysis**. Understanding this is important, as the value given to a green infrastructure investment - and in particular non-marketed goods - is sensitive to distance. There is a reduction in value further away from the green asset.

Some methods commonly used to estimate the number of potential beneficiaries include:

Method 1: Density of use. Where the proposed investment involves the provision of a cycleway or footway it is possible to estimate the likely level of use based on density values from other sites or areas.

- British Waterways' economic impact model uses national data on density of use for walking and cycling per kilometre
- local authority leisure services departments may also have local leisure use data to draw upon.

Method 2: Population penetration analysis. This approach estimates the likely use of the green asset by local residents or visitors, based on taking a percentage of the relevant population. It draws on household population data. The percentage penetration can be based on evidence from other areas or green infrastructure-type projects or a bespoke leisure use study.

Method 3: Catchment analysis. This method is useful to determine the relevant beneficiaries of green infrastructure investment - for example the number of residential or commercial properties within a certain visual range or travel-time distance.

This type of analysis is also useful for estimating non-user benefits. Here the aim is to identify the relevant household population that may value the green asset for its **option use*** or existence. This may be based on a geographical area or drive time, depending on the findings from the evidence base.

Method 4: Site transfer
This estimates the likely total number of visits based on the experience of other similar sites. For example, a woodland of 50 hectares with 25,000 visits per year has a density of use of 500 people per hectare per year. This can be applied to your project, based on the scale of your site.

Calculating catchments

The Greater London Authority (GLA) publishes guidance on the preparation of open space strategies, which includes a series of catchment areas:

- regional parks, of up to 400 hectares in size and catchment area of 3.2 to 8 kilometres
- district parks of up to 20 hectares and catchment area of 1.2 kilometres
- local parks of 2 hectares serving the local population within 400 metres.

Other councils have drawn on the GLA's guidance when working up their own strategies. For example, Kirklees 2007 open space assessment modified the

GLA's guidance to include major parks - specialised parks capable of holding events – with a catchment of 2.4 kilometres.

In the UK, local green space standards are increasingly being included in supplementary planning documents. The standard is often set that all households should be within 800 to 1,200 metres' walking distance of large, neighbourhood green space (around 2 hectares).

For the purpose of simplifying data collection for the toolkit, use by the local resident population living within 400 metres and 1,200 metres of a proposed green space asset is recommended.

Calculating usage

A significant gap currently exists in the research around the usage of green assets – especially after investment to improve an existing asset.

Depending upon the level of works done, there could be an increase in visitation reported by 30 per cent of users (Glasgow Green 2007), through to 2.5 times the original level of park usage (Ladywell Fields, Lewisham).

Other research includes:

- The *Park Life Report* by GreenSpace was published in 2007 as the 'first ever public satisfaction survey of Britain's parks and green spaces'. Almost 20,000 people commented on the quality of parks and green spaces, how they used them and how well they felt they were managed and maintained.
- Grahn and Stigsdotter's 2003 study *Landscape planning and stress* found that the distance to public urban green spaces appears to be critically important - average use varied from 3.2 times per week for residents within 300 metres to 1.5 times per week for residents between 300 metres and 1,000 metres.
- The 2003 *Use of public parks in England* report was based on the findings of a national survey commissioned by English Heritage, Sport England, and the Countryside Agency.

Step 3: Project data entry

Enter the core data required in the Calculator. Some information might be missing at this stage, but you will be able to complete data entry later.

Before starting to use the Calculator, 'save as' the version of the Excel workbook that will be used with the project name and a version number. As you complete critical steps throughout the project assessment, remember to regularly 'save as' the work completed with a new version number. This will save time by allowing to go back to an earlier version without starting again from the beginning, in case an error is made and some of the formulas performing the calculation embedded within each tool gets in advertently corrupted or erased.

As a rule of thumb, in the Calculator:

- Cells with grey, green or blue backgrounds contain critical information or formulas and should not be altered;
- Cells with a yellow background are for data entry or require review; Red comments in the right margin will always specify which action should be taken.

Assessment

Step 4: Key benefits identification

Identify the breadth of benefits likely to be associated with the project or site being assessed. Benefits that can be quantified and monetised will be evaluated using the Calculator. Qualitative benefits will be captured through a narrative in your final return on investment case

This will help identify which benefits and calculation tools from the toolkit apply to a particular green space, asset or proposed intervention.

For example, when assessing a traditional park, it is obvious that the estimation tools related to recreation and leisure benefits would apply. However, there are other benefits – such as climate change, health and wellbeing, land and property values, tourism – which should not be overlooked.

Figures 6 and 7 show the potential benefits provided by different green spaces and assets:

- green shows the biggest impact
- amber shows that the space or asset will provide some benefit
- white shows that the benefit is small or not relevant.

Figures 6 and 7 are designed to signpost which benefits should be considered. Depending on the type of green infrastructure asset or improvement, it might be easier to first consider the type of space involved, using Figure 6. This allows the identification of the range of benefits which should be considered. A more detailed approach based on assets - using figure 7 - will allow this initial selection of applicable benefit areas to be refined, and confirm which calculation tools can be used.

Judgement needs to be exercised throughout, based on the background information provided within each of the thematic chapters.

Figure 6: Green spaces and green infrastructure benefits

Types of green spaces	Climate change adaptation and mitigation	Flood alleviation and management	Place and communities	Health and wellbeing	Land and property values	Investment	Labour productivity	Tourism	Recreation and leisure	Biodiversity	Land management
	1	2	3	4	5	6	7	8	9	10	11
Parks and formal gardens	■	■	■	■	■	■	■	■	■	■	■
Natural and semi-natural green spaces	■	■	■	■	■	■	■	■	■	■	■
Green corridors – including river and canal banks, cycleways and right-of-way	■	■	■	■	■	■	■	■	■	■	■
Outdoor sports facilities	■	■	■	■	■	■	■	■	■		■
Amenity green space – including private gardens and landscape areas for business settings	■	■	■	■	■	■	■		■	■	■
Provision for children and teenagers	■		■	■	■				■		■
Allotments, community gardens and city farms	■	■	■	■						■	■
Cemeteries and churchyards	■	■	■	■						■	■
Civic spaces	■		■		■	■	■	■	■		■
Woodland (*)	■	■	■		■	■	■	■	■		■
Post-industrial land/brownfield land (*)	■	■				■					■
Agricultural land (*)	■	■									■

Based on Planning Policy Guidance 17 (PPG17) typology and associated definitions with some additions (*).

Figure 7: Green infrastructure assets and benefits

Green infrastructure features (non-exhaustive list)	Climate change adaptation an mitigation	Flood alleviation and management	Place and communities	Health and wellbeing	Land and property values	Investment	Labour productivity	Tourism	Recreation and leisure	Biodiversity	Land management
	1	2	3	4	5	6	7	8	9	10	11
Allotments			■	■			■			■	■
Open and running water – canal, river, stream, marsh, wetland, pond	■	■		■	■	■	■	■	■	■	
Riverbank	■	■	■	■	■	■	■	■	■	■	■
Path – footpath, cycle path, bridleway			■	■	■		■	■	■		
SUDS – swales, ditches, filter drain, infiltration trenches	■	■			■	■				■	
Green roofs and walls	■	■	■	■	■	■	■			■	
Trees	■	■	■	■	■	■	■	■	■	■	■
Verges and hedges	■		■		■	■	■			■	
Woodland	■	■	■	■	■	■	■	■	■	■	■
Grassland – meadow, rough, heath	■	■	■	■	■	■	■	■	■	■	■
Grassland – lawn	■	■	■	■	■	■	■	■	■		
Playing fields	■	■	■	■	■	■	■		■		■

Step 5: Applicable tools selection

Identify tools applicable to your project and check whether additional data entry might be needed to run the tools selected. Use the Cost-benefit assessment sheet in the Calculator to document your conclusions on the applicability of each tool.

It is important to note that there is interconnection and overlap between the 11 benefit categories. This reflects the multiple benefits that green assets can deliver – but means that **some care is needed to avoid double counting**.

For example:

- land and property values might be expected to reflect the opportunities for recreation and leisure in local parks
- labour productivity is influenced by health and wellbeing
- economic growth and investment, and quality of place, are influenced by a number of other benefit streams.

On the other hand, identifying discrete, measurable benefit streams can lead to the wider, 'holistic' benefits of green infrastructure being overlooked.

Step 6: Tools application

Work through the tools. Most will require manual input of additional data.

Remember to regularly save your work with a new version number each time you have completed one tool.

Reporting

Step 7: Cost-benefit appraisal development

Develop a full cost-benefit appraisal, compiling and interpreting results from individual tools and evidence base review.

The toolkit is structured around assessing both the qualitative, quantitative and monetisable value of green infrastructure investment, acknowledging that not all benefits can be expressed in monetary terms.

Whilst there is good qualitative evidence for the benefits of green infrastructure, it is not always currently possible to put figures on some potential impacts, still less to assign an economic value.

One example is economic growth and investment, where a number of studies have shown a positive correlation between environmental quality and businesses' decisions to relocate, but have not been able to quantify the relationship. The complex nature of the relationships at play – including other factors such as transport links or a skilled workforce – mean that a simple estimation tool cannot provide meaningful results. More detailed specialist and bespoke techniques will be needed.

In short, the toolkit cannot count everything. What it does count is designed to be robust enough for **initial project appraisal**, providing a range of figures indicating the potential impact of a green infrastructure intervention or even an existing green infrastructure asset

In applying the tools, it is important to understand:

- the **strategic contribution of the investment** - how the investment contributes to a local plan and strategic objectives
- the **context and scale of outputs** - the proximity to business or households.

Step 8: Reality-testing

Critical review: 'are you sure the results from the cost-benefit assessment make sense?'

Uncertainties exist in the science, as well in our knowledge of what the future holds - for example, in relation to climate change and the relative scarcity of resources. Any quantitative appraisal of green infrastructure benefits should account for such uncertainties, for example by providing lower and higher estimates.

Whenever the evidence base suggests ranges in values, the calculation tools should be used with **both the low and high value** to present the results as ranges.

The summary of evidence associated with each benefit category also highlights any sensitivity issues that should be taken into account – for example where the occurrence or extent to which a benefit occurs is highly dependent on specific factors.

Step 9: Return on investment case

Write your return on investment case articulating the full range of benefits associated with the project or site assessed.

The cost-benefit appraisal sheet in the Calculator features at the bottom a 'value for money test' to help report results on value and compare to costs. The test compares an **indicative assessment** of the present value (PV) of those **benefits**

that can be monetised to the **costs of implementation** - both initial capital and long-term maintenance. The cost benefit appraisal also describes the project benefits in non monetised terms through compiling indicative non-monetary **quantitative outputs** and short **qualitative descriptions** of applicable benefits.

Comparing the PVs of the benefits from green infrastructure assets or improvements against associated capital and revenue costs and discounting on a common basis, is particularly relevant given that the benefits of green infrastructure investment can be long term. For example, a canal-side improvement may create the setting for investment over a period of five to 10 years. Some of the benefit groups, such as carbon storage and flood protection, may deliver benefits for periods of 50 years or longer.

'Discounting' is based on the premise that people prefer to receive benefits in the present rather than in the future. The toolkit is designed to help its users express the **net present value*** (NPV) of green infrastructure assets – that is their value in present terms, accounting for all the net benefits the assets will bring over their lifetime. In technical terms, the NPV is the sum of the present and discounted future flows of net benefits associated with a green infrastructure asset. The **discount rate*** is used to reduce future benefits and costs to their present-time equivalent.

The challenge in arguing the value for money case of any public sector investment is that usually the test is for the value of the benefits to equal at least the value of the costs. Preferably, it should exceed this by some margin, although not always, depending upon the wider case.

For green infrastructure projects, however, it is generally accepted that **it is not possible to monetise all their benefits**. This means a compromise position is needed. The judgement made within the toolkit is that three components are required - reflecting the principle that the range of benefits resonate with different parts of the public sector.

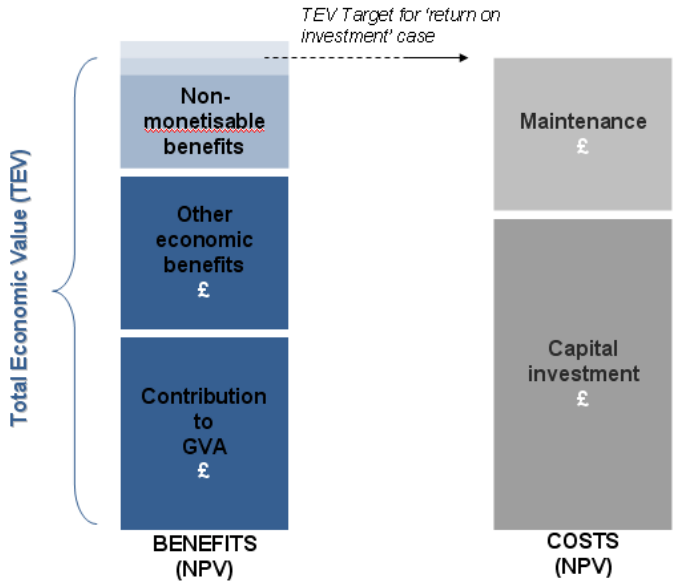
- **Contribution to gross value added (GVA)**: 'GVA' or 'market' style benefits are those that relate best to the contribution that green infrastructure can make to a local economy in terms of the value of goods, services, employment, measured either as production, income – for example through jobs - or expenditure. 'GVA' benefits will be of particular interest for economic development agencies, private investors and so on.

- **Other economic benefits,** additional or alternative to the 'GVA' benefits and including 'non-market', but nevertheless monetisable benefits perhaps more closely associated with social, environmental and welfare economics. Examples include willingness to pay values associated with recreation or leisure opportunities, habitat protection, the social value of carbon reduction, or health benefits calculated using the statistical value of a life, where it is perhaps not yet possible to directly relate green infrastructure investment to health sector savings.

- **Non-monetiseable -** at least at this point - typically environmental and social benefits likely to result from a given green infrastructure investment. In some instances those can still be expressed in quantitative terms.

Figure 8 illustrates these components, which considered altogether build up an estimate of **total economic value*** (TEV) to be used to write a return on investment case.

Figure 8: Return on investment case: investment costs v. monetised and non-monetised benefits



2 Impact of Oakland County's Green Infrastructure on the Local Economy, Oakland County Planning and Economic Development Services, August 2009

3 Defra, *An introductory guide to valuing ecosystem services*, 2007 and Eftec for Defra, *Valuing environmental impacts: guidelines for the use of value transfer*, 2010.

1 Climate change adaptation and mitigation

Trees and other plants provide natural air conditioning and shelter, modifying the storage and exchange of heat in urban areas - improving the liveability of towns and cities and reducing the need for energy for heating and cooling.

Trees and other plants also absorb carbon as they grow, and soils store carbon.

Relevant types of green spaces and features – all green infrastructure:

- trees provide particular benefits for local climate control, including cooling and sheltering
- green space in cities is effective in reducing surface temperatures
- investment in green roofs offers great potential for urban cooling.

For carbon sequestration and storage, the key factor is the volume of biomass. While all plants store carbon, the amount of carbon stored by individual street trees, or small areas of groundcover, is negligible in isolation. Unless considering these as components of a larger-scale green infrastructure intervention, or where carbon sequestration figures are particularly needed, it will not generally be worth trying to measure this impact, compared to other benefits of green space.

WHAT THE EVIDENCE SHOWS

Temperature regulation

Trees, climbing plants, hedges, green space and other elements of green infrastructure modify climate locally - and globally. Increasing the proportion of green infrastructure can help urban areas adapt to rising temperatures - reducing the urban heat island effect where buildings and streets absorb, store and radiate solar energy.

The impact of green infrastructure on the built environment has been widely researched. Positive benefits are achieved through:

- the dissipation of incoming solar heat on building structures through shading
- the reduction of long-wave radiation exchange between buildings due to the low surface temperatures created by shading of plants
- the reduction in ambient air temperature through evapo-transpiration[4].

A number of studies in the UK and overseas have looked at these effects. Work in Chicago[5] by Nowak and McPherson modelled the impact of tree planting on air temperature and wind, looking at the impact of tree planting on urban temperatures.

- At a local scale, large numbers of trees and green spaces were found to reduce local air temperatures by 0.5℃ to 5℃ – whi ch can help lessen the need for air conditioning in buildings nearby.
- At the city scale, increasing urban tree cover by 10 per cent was estimated to reduce average air temperatures by 1℃ .

Similar, more recent work in the UK modelled the impact of increasing green cover - including trees, green space and green roofs - in Greater Manchester as a strategy for adapting to climate change[6]. It found that a 10 per cent increase of green cover in areas with little green - urban centre and high density residential areas - keeps maximum surface temperatures below 1961-1990 levels until 2080.

Green roofs have significant potential to make the biggest difference, given practical constraints on increasing green cover in urban areas.

This would maintain city centre 'liveability' – reducing stress and ill-health, and maintaining the ability of cities to function as centres of trade and employment. **The economic scale of this impact could be very significant. Further work is needed to correlate temperature and economic activity.**

At a local level, green infrastructure can conserve building energy use:

- **shading** reduces the amount of heat absorbed and stored by buildings
- **evapo-transpiration** converts liquid water to water vapour, thus cooling the air by using solar energy that would otherwise heat the air and the buildings
- in winter, the **shelterbelt effect** of trees and other green infrastructure can slow winds, thereby reducing the amount of heat lost from buildings.

The Chicago study found that increasing tree cover by 10 per cent - or about three trees per building - could reduce total heating and cooling energy use by 5 to 10 per cent. Care is needed in applying these figures in the UK where domestic air-conditioning is uncommon. Looking at heating costs alone, **a single, mature tree sheltering a building from wind could save around 1.3 per cent in energy costs**. A 'rule-of-thumb' used in the UK[7] suggests 3 to 9 per cent energy savings from tree screening.

Other green infrastructure adaptation benefits

Green infrastructure can also help with adaptation to changing patterns of rainfall and wind. Increasing green cover by 10 per cent can reduce surface run-off by 5 per cent - though climate change scenarios still predict that higher winter rainfall

means that overall run-off increases, requiring additional storage capacity[8]. This is considered separately within water management and flood alleviation (below).

By reducing wind speeds and turbulence, trees can also reduce risk of property damage.

Carbon sequestration and storage

Trees and other plants sequester carbon as they grow. The carbon is released again naturally when the plants die and decompose. Carbon is also stored long-term in wood products, buildings, furniture and so on. More carbon is stored in soils, fixed over time from dead trees and plants. Peat bogs, where plants decay anaerobically, are particularly significant carbon stores, though they are also sources of methane - a more potent greenhouse gas.

In their work on valuing the UK's **ecosystem services***, Jacobs[9] pooled findings from a wide range of sources, estimating the total annual value of carbon sequestration benefits in England for the three most significant land uses:

Land use	Annual value of carbon sequestration
Woodland	£998 million
Peatland	£4,979 million
Wetlands	£4,583 million

These figures should be treated as estimates, but they do give an indication of the importance of green infrastructure in sequestering carbon. Different estimates are reported elsewhere in the literature, reflecting different assumptions, different **discount rates*** and values of sequestered carbon.

National figures are useful, but to estimate the carbon benefits of green infrastructure at a project and local level we need to look at **unit values, per hectare**. It is also possible to estimate the carbon stored by street trees using average figures, but the accuracy and value will be low.

Woodland and forestry

With sustainable planting and felling - where new trees take the place of old - woods and forests can provide long-term carbon sequestration benefits. Community forestry, reclamation and reforestation of derelict and unproductive land provide new opportunities for carbon sequestration. A net total of 15.11 million tons (Mt) CO_2 was sequestered by forestry in 2006, equivalent to around 3 per cent of UK CO_2 emissions.[10]

A 2003 study on behalf of the Forestry Commission[11] looked at carbon sequestration by different trees in commercial forestry and woodland.

Size matters

Large urban trees can store up to 1,000 times the amount of carbon as small trees, with sequestration rates up to 90 times greater. Shrubs store only around 4 per cent of the carbon of trees[12].

Soils

Soils store carbon, and their protection is important. Defra recognises the need to prevent the loss of soil carbon to the atmosphere, and is exploring the potential for increasing existing carbon stores as a contribution to meeting the Government's climate change targets[13]. **It is estimated that more carbon is stored in the UK's soils - around 10 billion tonnes - than in all the forests in Europe**. Over half of this is in peatland habitats.

In the US Cicahek and Macha[14], looked at the amount of carbon stored in grassland to a depth of 60 cm. Most – around 75 per cent - of the 10-16 tC/ha measured was in the soil. However, in order to make an estimate of the carbon stored within a given area of land, more data is required, particularly for urban soils and green space uses. The supporting scientific evidence is developing in this field.

ASSESSING THE BENEFITS

Scale is important in measuring the benefit of green infrastructure. Planting a few trees on a new business park or around a residential development will have localised impacts on temperature regulation, specific to nearby buildings.

- Chang's study of 61 parks (2007) showed that parks of at least 3 hectares in size are on average 0.81ºC cooler - noon, summer - than their surrounding urban areas[15].
- Parks have also been found to reduce temperature around their boundary up to 200 to 500 metres away, with larger parks having a greater impact[16].
- Looking at two parks in Singapore - 12 hectares and 36 hectares - Chen Yu's study (2006) concluded that large urban parks can extend the positive effects to the surrounding built environment during both day and night. The modelling work also pointed to energy savings of 10 per cent on reduced cooling load when buildings are built near to parks. Other studies have reported savings as high as 25 per cent.

Clearly, care is needed in transferring this research to the UK, given the less widespread use of air conditioning.

To affect urban temperatures more widely, a city-wide greening strategy is needed. Modelling has shown that changing the proportion of 'green' to 'grey' can significantly change peak summer temperatures.

The rate at which trees and other plants absorb carbon varies. Likewise, the quantity of carbon stored in different soil types varies greatly.

For most project appraisals, variations in carbon storage and sequestration will be too small to count meaningfully. The **exceptions** are:

- large-scale proposals for tree planting
- enhancement, reinstatement or loss of moorland, peat bog or wetland.

For other projects, it may be useful to have an estimate of the amount of carbon stored *as a whole* – for example in parkland and other green space across a city. However, the change from any given urban green infrastructure enhancement will be low.

QUANTIFYING

Temperature moderation

The Chicago study model took account of factors including:

- local climate
- type and maturity of the trees
- distance from the building
- type of building
- levels of insulation.

It then considered the impact on building temperatures, and the potential for energy saving for heating and cooling.

Undertaking similar modelling would be possible for sites in the UK, and would yield the most accurate figures. However, the level of data required is significant, so a simplified version based on the outputs of the Chicago modelling is preferred. Though the Chicago climate is subject to greater extremes, average seasonal temperatures are similar to those in the UK.

Note that:

- The study looked only at residential properties. The toolkit uses figures for the largest property size to extrapolate for commercial property (see further work, below).
- The UK 'rule-of-thumb' for energy savings is in the order of 3 per cent to 9 per cent of total energy. This is a higher figure than that derived from the Chicago work. Other research indicates that the sheltering impact of a belt of urban woodland can cut energy costs by 10 per cent[17].

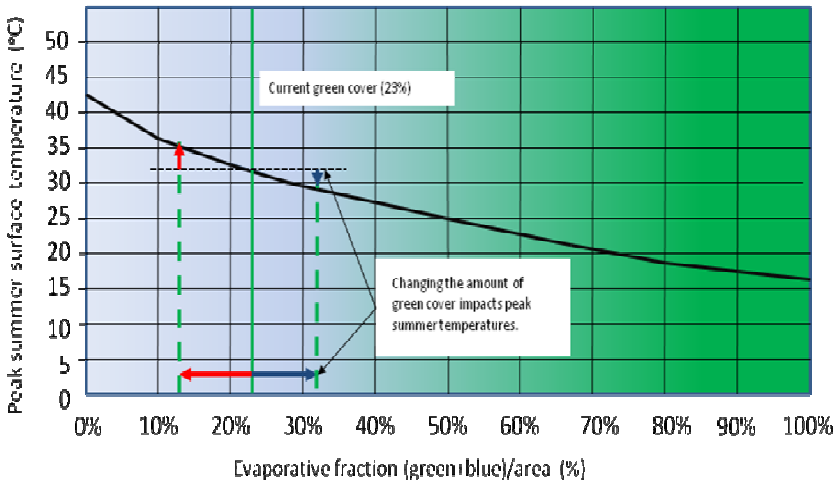
As an average, the toolkit uses 3 per cent savings for domestic - heat - and 8 per cent - heat and cooling - for commercial from the presence of trees.

At a larger scale, a city-wide greening strategy can impact on city temperatures, and estimates can be made of the degree of cooling against different climate change scenarios. Modelling in Manchester suggested an increase of 10 per cent in green cover could keep maximum surface temperatures in high density residential areas and town centres at or below 1961-1990 levels until the 2080s.

Figure 9 illustrates this effect.. With 23 per cent green cover peak surface temperatures are 32^{o}C. Creating 10 per cent new green cover - for example with a green roof programme, or increased canopy from street trees - reduces peak summer temperatures to 29^{o}C.

Reducing green space by 10 per cent - through development - will reduce cooling, and peak surface temperatures rise to 35 ^{o}C. Note that these are estimates based on modelling for Manchester, but give a good indication of potential impacts for other urban areas. A better estimate could be made with more detailed modelling.

Figure 9: Variation in peak surface temperature as a function of the evaporative fraction (source: Gill et al, 2007)



(Evaporative fraction is the fraction of ground cover which evapo-transpires – vegetation and water – within an area.)

Carbon sequestration

Key factors affecting rates of carbon sequestration include:

- species
- climate
- how the asset is managed – planting and felling.

In most cases, it will be appropriate to use average values which take account of these factors.

For **managed coniferous forest** over a full lifecycle - from planting to harvesting - around **2.5 tonnes of carbon** is sequestered per hectare per year[18].

Urban green space, street trees and green roofs also store and sequester carbon. In principle, it would be possible to estimate both the carbon stored and the amount sequestered every year. However, there are two main problems:

- detailed knowledge of the type and quantity of green infrastructure is generally lacking – although the extent of green space cover can be relatively easily assessed from aerial photographs
- relevant values for carbon sequestration are not available for all green infrastructure types – for example public parks.

It is clear that the annual carbon *sequestration* value will be small for grass cover, compared to woodlands and forestry.

Protection of carbon stores

Protection of *stored* carbon in the soil is important. Carbon storage in soil depends on a number of factors, including soil type, condition and use.

Knowledge of the carbon stored should be an important consideration where **land use change** is proposed. However, the evidence base does not yet allow robust estimates to be made of the carbon storage capacity of different types of green infrastructure.

MONETISING

Gross value added impact – urban cooling

In principle, an estimate can be made of the economic impact of a city-wide greening strategy as a measure to adapt to climate change.

This could be a very significant figure, sufficient in itself to justify a city-wide, urban greening strategy. However, further work is first needed on the sensitivity of economic activity to temperature (see below).

Building energy saving – cooling

Using work from the US and UK, an estimate is made of the energy saved by having trees around buildings – the benefits include energy, fuel cost, CO_2. The benefits will largely be for public and commercial premises given the limited use of air-conditioning in homes in the UK. Estimates can be made for reduced energy use, cost and also carbon reductions.

Building energy saving – heating

Using work from the US and UK, an estimate is made of the energy saved in having trees sheltering buildings, reducing the heat loss by slowing wind – the benefits include energy, cost, CO_2. This is dependent on the location of the tree(s) and local climatic conditions, so care is needed in applying the tool.

Where the quantity of carbon sequestered is known, a monetary value can be found using an appropriate price of carbon.

In 2009, the Department of Energy and Climate Change (DECC) issued new advice on carbon valuation[19].

For assessing projects that reduce or increase emissions in sectors **not** covered by the EU Emission Trading System - the 'non-Traded Sector' **which includes most green infrastructure projects** - a '**non-traded price of carbon**' will be used. This is based on estimates of the **marginal abatement cost*** (MAC) required to meet a specific emission reduction target.

For example, this gives a short-term non-traded price of carbon of **£60 per tonne CO_2e in 2020, with a range of +/- 50 per cent -** so a **central value of £60, £90 high estimate and £30 low estimate.**

In the longer term - 2030 onwards - consistent with the development of a more comprehensive global carbon market, the traded and non-traded prices of carbon will converge into a single traded price of carbon.

- for **2030**, the value is **£70 per tonne of CO_2e, with a range of +/- 50 per cent** – so a **£70 central estimate, £105 high estimate and £35 low estimate**
- for **2050**, the value is **£200 per tonne of CO_2e, with a range of +/- 50 per cent** – so a **£200 central estimate, £300 high estimate and £100 low estimate**.

Note that for assessing policies that reduce or increase emissions in sectors which *are* covered by the EU Emission Trading System, and in the future other trading schemes, a '**traded price of carbon'** will be used. **Most green infrastructure schemes will not fall into this category.**

TOOLS AVAILABLE IN THE CALCULATOR

Tools	Input data	Tool basis
Tool 1.1: Building energy saving – heating. [■ Quantification and Monetisation functional for only residential properties] Estimates the energy saved in having trees sheltering residential and commercial buildings thereby reducing the heat loss.	Tree cover and types planted within 10m of buildings. Size of trees. Residential building numbers and types. Commercial building numbers and types.	Application of Chicago 1994 study. For estimation, use 3% energy savings for each residential property <10m from trees.
Tool 1.2: Reduction in carbon emissions from building energy saving – heating. [■Quantification and Monetisation functional for only residential properties] Estimates reduction in carbon emissions associated with energy savings for heating by multiplying energy reduction (in kWh) by 0.203		Derived from carbon intensity for natural gas: 0.203 kg/kWh (Defra/Carbon Trust)
Tool 1.3: Avoided damage from wind and storm [■ Quantification and monetisation require further research]		
Tool 1.4: Reduced peak summer temperature [■ Functional] Estimates reduction in peak temperature, a key factor in improving the liveability of urban areas during summer months.	Base case level of green cover. Increase in green cover.	Application of Gill, Handley et al. research.
Tool 1.5: Building energy saving – cooling [■ Quantification and monetisation functional only for green roofs. Further work required to also factor in the cooling effect of trees surrounding the buildings] Estimates reductions in air conditioning cost associated with having green roofs on buildings.	Green roof cover	As a rough estimate, assuming an air conditioning system efficiency of 10Btu/h(3W) per Watt, including fan power and distribution losses (Jeffrey Sonne); Assume green roofs dissipate heat energy at 150W/m2 (source, University of Manchester workshop w/ Handley, Gill et al, April 2010)
Tool 1.6: Reduction in carbon emissions from building energy saving – cooling. [■ Functional] Estimates the reduction in carbon emissions associated with energy savings for cooling by multiplying the reduction in energy consumption (in kWh) by 0.537		Derived from carbon intensity for grid electricity: 0.537 kg/kWh (Defra/Carbon Trust)
Tool 1.7: Market value of carbon stored and sequestered in woodland and forest (including soils). [■ Quantification and monetisation functional only for broadleaf trees]	Area (ha) of woodland. Type of tree (species, or split between broadleaf and coniferous).	Application of Forestry Commission estimate. Conversion to non-traded price of carbon.
Tool 1.8: Market value of carbon storage and sequestration for other land-use types (agricultural, peatlands, wetlands, urban green space). [■ Quantification and monetisation require]		

KEY EVIDENCE AND SOURCES

Market Values	
Energy prices (gas and electricity)	£/kWh, electricity £/kWh, gas
Non-traded price of carbon	£27/tC in 2010, DECC, *Carbon Valuation in UK Policy Appraisal*, 2009
Trade price of carbon	As above, but applicable only to sectors covered by ETS (unlikely to include most green infrastructure interventions)
Scientific research and modelling	
Chicago's urban forest ecosystem: results of the Chicago urban forest climate project. Nowak, McPherson, Rowntree, 1994	

Adapting cities for climate change: the role of green infrastructure. Gill, Handley et al, 2007	
Evaluating Green Roof Energy Performance. Jeffrey Sonne, Ashrae Journal 2006	
Carbon stored and sequestered in woodland and forest (including soils)	Further research needed
Carbon storage and sequestration in soils	c.10tC/ha for grassland - further research needed
Key benefit transfer values	
Average heating energy savings per tree	1.3% (Chicago) 3-9% (UK)

KNOWLEDGE GAPS

The main area for further work is clarification of the current research - to bring together a consistent view on the science - and work to link temperature rises on economic activity, measured by gross value added. Coupled with work cited here on using green infrastructure to adapt to climate change, this would allow an estimate to be made of the gross value added impact of urban greening strategies, influencing green roofs, tree planting and green space protection/enhancement.

Further work is also desirable to model local impacts of green infrastructure on local temperature regulation in the UK, to inform tree planting strategies in relation to species type, location, scale of planting and so on.

UK based evidence on the cooling impact of trees on buildings could help complete tool 1.5. A number of bespoke academic studies have also been undertaken in the UK and elsewhere assessing the cooling impact of trees on particular buildings, however it is difficult to generalise findings:

The Centre for Urban Forestry Research (part of the US Forest Service, a USDA agency) reports that well placed, mature trees can save consumers up to 30% of annual cooling costs and save 10-25% of energy used for heating[20].

Royal Institute of Chartered Surveyors sponsored research[21] finds that based on the typical UK climate, the savings on energy costs from green roof installation are negligible, with the energy savings possible with a 10cm deep green roof capable of being delivered with just 3mm extra insulation.

Another study[22] predicted 4.45% annual heating energy savings for a typical office building in Scotland, equivalent to a reduction of 400 kg of annual CO2 emissions if natural gas was the heating fuel. This study also suggests that the benefit would be more significant in buildings with curtain walls of which U-value is much lower than a standard wall and in residential buildings.

Further work is needed to provide useable values for the carbon stored in different land use types, including soils. This is very complex and context-specific – there is great variety in soil type and usage, and hydrology, climate and ecology are important factors. It is unrealistic to expect highly accurate estimates to be possible for all land-use types, but it should be possible to obtain better 'ball park' figures for broad groups.

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[4] Wong N. et al, 2003. Investigation of thermal benefits of rooftop gardens in the tropical environment. *Building and Environment* 38: 267-270.

[5] Nowak, McPherson and Rowntree, *Chicago's urban forest ecosystem: results of the Chicago urban forest climate project,* USDA,1994

[6] Gill, Handley et al, *Adapting cities for climate change: the role of green infrastructure,* 2007

[7] Rawlings for DETR, *Environmental rules of thumb*, 1999

[8] Gill, Handley et al, *Adapting cities for climate change: the role of green infrastructure,* 2007

[9] Jacobs, *Valuing England's terrestrial ecosystems services*, 2008

[10] Natural England, Research report NERR026: *Carbon management by land and marine managers*, 2008

[11] Brainard, Lovett and Bateman, *Carbon sequestration benefits of woodland*, 2003

[12] Nowak, McPherson and Rowntree, *Chicago's urban forest ecosystem: results of the Chicago urban forest climate project,* USDA,1994

[13] Defra, *Safeguarding our soils*, 2009

[14] Macha, D., and L. Cihacek.. *Carbon storage in plant and soil components of selected grass monocultures*. AnMtgsAbsts2009.53321. ASA, CSSA, SSSA, Madison WI, 2009

[15] Chang et al, 2007 "A preliminary study on the local cool-island intensity of Taipei city parks." *Landscape and Urban Planning* **80**(4): 386-395.

[16] Yu and Hien, 2006, Thermal benefits of city parks. *Energy and Buildings* **38**, 105-120.

[17] Heisler, *Energy savings with trees*, 1986 and Jones (2003) cited in *Landscape consultants* (2004)

[18] Forestry Commission

[19] Department of Energy and Climate Change, Carbon valuation in UK policy appraisal: a revised approach, *Climate Change Economics*, July 2009

[20] Cited in http://www.nmenvirothon.com/Forestry/Ch.9_urban%20forestry.pdf

[21] Can greenery make commercial buildings more green? *Built and Rural Environments*, Aug 2007

[22] Wang et al, Heriot Watt University, December 2006. Reducing Space Heating in Office Buildings Through Shelter Trees, *Energy and Buildings* 38,

2 Flood alleviation and water management

Green infrastructure can help store and intercept rainwater and facilitate natural drainage.

Relevant types of green spaces and features – all trees, plants and green infrastructure, but particular functional benefits from:

- elements of sustainable urban drainage systems (SUDS)
- green roofs in urban areas.

WHAT THE EVIDENCE SHOWS

Creating, reinstating or protecting natural drainage systems can reduce flood risk as well as demand on sewers and the wastewater treatment network:

- trees and other plants process rainwater, through interception, evaporation and transpiration
- green space allows natural infiltration of surface water
- Sustainable Urban Drainage Systems (SUDs) include elements of green infrastructure - culverts, ditches and swales
- reed beds can be used to treat wastewater
- washlands and wetlands can store water and provide a buffer against flooding
- woodland and forests can help regulate watersheds, reducing river flow speeds, the frequency and severity of flooding and soil erosion, and conserving nutrients.

Flooding

The summer of 2007 was the wettest on record, causing substantial flooding in areas around York and Humberside, as well as the Midlands, Gloucestershire and South East. Flooding claimed the lives of several people and over 55,000 homes and businesses were flooded across England and Wales. Insured losses totalled approximately £3 billion[23] alone, and key critical utilities were affected. Water supplies to 140,000 homes in Gloucestershire were cut off for up to two weeks, and almost 300 schools in Yorkshire and Humberside suffered damage.

Climate change brings with it increased risk of surface water flooding in the future. Land-use planning is an important tool in managing that risk[24].

Surface water

Protecting and enhancing green space within urban areas is important for managing rainwater. A study in Manchester showed that a 10 per cent increase in green cover resulted in a 5 per cent reduction in surface water run off[25]. Green space reduces the total volume of run-off through infiltration, absorption and evapotranspiration. It also flattens out the peaks in run-off by holding back the water, acting as temporary storage. The need for increased sewer capacity is reduced on both counts.

Water companies offer reduced bills for customers who handle their own surface water, avoiding discharging to the combined sewer network.

Sustainable Urban Drainage Systems (SUDS)

These are increasingly specified as a requirement for new developments[26]. SUDS reduce the need for hard engineering solutions – so can be compared with these to estimate the value of benefits. SUDS can also create high quality environments which encourage biodiversity.

The uptake of SUDS in the UK has been slow, partly because of the lack of a clear framework on responsibility for their maintenance and upkeep. However, the Flood and Water Management Act 2010 includes a requirement for developers to build new surface water drainage systems to standards that reduce flood damage and improve water quality. It also gives local authorities responsibility for approving, adopting and maintaining new SUDS, where they affect more than one property[27].

River catchment management

River flows can be moderated by careful planning of green infrastructure, including restoring natural vegetation, and creating or protecting washlands. This can slow river flows and allow venting to undeveloped floodplains, reducing the incidence and severity of flooding in urban areas.

Rising sea levels will increase the risk of coastal flooding. **Rewetting schemes*** and **managed realignment*** can reduce coastal flood risk and reduce drainage costs:

- rewetting schemes refer to the deliberate process of elevating the average annual water table in an area by partially or completely removing the drainage controls previously in place
- managed realignment refers to the deliberate process of altering the line of river, estuary or coastal defences – this can include widening a flood plain or lowering or moving flood defences

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These are promoted by the Environment Agency as a cost-effective approach to coastal defence.

ASSESSING THE BENEFITS

Measuring the impact of green infrastructure on improved water management and reduced flood requires detailed knowledge of:

- the hydrology of an area
- existing water infrastructure
- the area and permeability of surfaces (natural and built)
- climatic conditions.

For most schemes, detailed appraisal by the Environment Agency and statutory drainage authorities - water companies and local authorities - will be needed.

This toolkit provides a guide to assess the type and potential level of benefits likely to be achievable. The evidence highlighted above shows that the **potential benefits are significant**. For example, reinstatement of catchment ecosystems can improve water quality and attenuate river flows, reducing flood risk. Reduced flood risk can reduce losses from property damage - avoided loss - and reduce insurance premiums. Green infrastructure can also substitute for more costly hard engineering/flood prevention solutions.

QUANTIFYING

Quantifying and valuing water management benefits accurately requires detailed modelling of water catchments, including surface water sewer systems.

Major flood risk management schemes

Bespoke appraisal by the Environment Agency will usually be required, where natural drainage options will be considered alongside other flood risk management interventions. The Environment Agency uses a number of 'Outcome Measures (OM)'[28] to assess schemes, including:

OM1: Economic benefits
OM2: Households at risk
OM3: Deprived households at risk

Other output measures include:

- nationally important wildlife sites
- UK Biodiversity Action Plan habitats
- flood warning
- contingency planning
- inappropriate development
- long-term policies and action plans.

SUDS schemes

An indication of the scale of benefit can be derived from their **capacity**, measured in cubic metres (m^3). An indirect valuation (see below) can then be made, comparing the scheme to the cost of creating equivalent capacity via a hard engineering solution.

Green space

Partial estimates of the water management value can be made using data for evaporation, transpiration and interception of rainwater for different land cover types. This effectively **estimates reduced surface water run off** - where this run off would otherwise enter the sewer network, there are resulting cost reductions in treatment and provision of the sewer capacity.

Water companies recognise the benefit of reducing surface water flows into their combined sewers and offer reduced tariffs to customers who implement sustainable drainage schemes.

All these valuation approaches will significantly underestimate the cumulative impact of local green infrastructure schemes. Reducing surface water run off will reduce failure of combined sewer overflows (CSO) and over-topping of flood defences in extreme flows - this is where there are significant cost savings through avoided infrastructure costs and avoided cost of property damage.

MONETISING

Three valuation tools are included in the toolkit.

Tool 2.1 – Energy and CO2 emissions savings from reduced volume of stormwater entering combined sewers

-!- This tool is only appropriate in urban areas with a combined sewer network.

This tool is designed to help assess the impact of vegetation on the amount of rainfall entering combined sewers. It uses Forestry Commission values for evapotranspiration and interception for different land cover - coniferous trees, deciduous trees, grassland.

It does not take account of water retention within soils, which is highly dependent on soil types and their storage capacity - which itself varies according to how much water they are already holding.

Reductions in surface water entering combined sewers lower operational costs for water treatment, including energy consumption - water companies use an average of 645 kWh/megalitre of wastewater treated.

Tool 2.2 - Savings in wastewater treatment costs to domestic and commercial water customers

This tool uses published water industry figures for surface water drainage charges to assess cost savings to residential and commercial customers who are not draining rain water into combined sewers. Where property holders – residential and commercial – avoid discharging surface water from their property into the combined sewer network, water companies provide a discount to wastewater bills. For domestic properties in north-west England, the discount is £35.33 per year[29]. For commercial properties the discount varies with 'chargeable area' - the area of the premises, discounting and permeable areas - in bands. For example:

- for a site of 0.15-0.3 hectares, the discount is £918 per year
- for a site of 2.5-5 hectares the discount is £15,313 per year.

Potential: tool 2.3 - Avoided infrastructure costs

This tool is designed to help assess cost savings from managing stormwater with SUDS and avoiding the need for hard engineering solutions. SUDS can bring savings by reducing or avoiding the need for investment in new storage and treatment capacity, and also avoids ongoing operating costs.

TOOLS AVAILABLE IN THE CALCULATOR

Tools	Data input	Tool basis
Tool 2.1: Energy and CO2 emissions savings from reduced volume of stormwater entering combined sewers [■ Functional] Estimates the energy savings associated with the impact of vegetation on reducing the amount of stormwater entering combined sewers.	Land use - coniferous trees, deciduous trees, grassland. Average rainfall (or 800mm pa default) Water treatment costs (energy and other inputs)	Application of Forestry Commission data on the use of water by trees and other land cover to estimate reduction in surface water to sewers.
Tool 2.2: Savings in wastewater treatment costs to domestic and commercial water customers [■ Functional] Uses published water industry figures for surface water drainage charges, to estimate the actual cost savings to residential and commercial customers who are not draining rainwater into combined sewers.	Number of domestic properties avoiding discharging to combined sewers. Area of commercial property.	Water company information on site area charges for surface water drainage.
Tool 2.3: Avoided costs of traditional water drainage infrastructure [■Quantification and monetisation require further research] Estimates cost saving from managing stormwater through SUDS rather than through traditional engineering solutions.	Requires average cost data for construction of new rainwater storage tank capacity	

KEY EVIDENCE AND SOURCES

Market Values	
£35.33 – surface water drainage charge for residential properties £35.33-£58,000 – surface water drainage charge for commercial properties, dependent on area	United Utilities, 2009/10 www.unitedutilities.com/siteareacharges.htm
Average cost of additional water storage capacity.	Figure from water industry
Scientific values/research	
Evaporation losses by land cover types eg conifers – 550mm-800mm for 1m annual average rainfall.	*Water use by trees*, Forestry Commission, April 2005
Benefit transfer values	
Conversion factors	
645kWh / megalitre	Average energy use in wastewater treatment (Water UK)

KNOWLEDGE GAPS

A key gap is in relating small-scale interventions – for example the creation of a green roof or new green space – to wider surface water management. Modelling work has been carried out for Manchester showing a 5 per cent reduction in surface water run off from a 10 per cent increase in green cover[30]. It would be helpful to be able to derive a monetary value for this impact (in terms of cost avoidance) and to be able to commoditise this for local schemes.

The estimates for the reduction in **wastewater treatment costs** are solely based on energy savings, not on wider inputs - including other operating costs, chemicals and so on. Estimates also do not take account of the capital costs of providing the sewer network, including the wastewater treatment works. To capture these costs in full, it might be best to use the **long run marginal cost*** for wastewater treatment, with average values obtained from the water companies.

The toolkit does not include any quantification of the benefits of improved **water quality** resulting from improved catchment management. It is hoped that the evidence base will be strengthened in this area as the results of major upland catchment management schemes begin to emerge. Recent work by EFTEC[31] on upland moorland ecosystem management did not include **potential flood risk** reduction benefits due to lack of data. Likewise, no data was available on the impact of green infrastructure interventions on **drinking water quality**, where investment to improve upland blanket bog can reduce peat erosion and colouration.

Developing the evidence base is essential. Further research work into the impacts of green infrastructure intervention on attenuation of river flows is needed, for example, to model the impact of tree planting or land restoration.

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[23] Pitt, *Learning lessons from the 2007 floods*, Cabinet Office

[24] *Foresight: Future flooding study,* 2004

[25] Gill, *Adapting cities for climate change*, ASSCUE, 2006

[26] Communities and Local Government, *Eco towns planning guidance*, 2009

[27] *Flood and Water Management Act 2010*

[28] Environment Agency's flood and coastal erosion risk management appraisal guidance (FCERM-AG): www.environment-agency.gov.uk/research/planning/116705.aspx

[29] United Utilities, 2009/10, www.unitedutilities.com/siteareacharges.htm

[30] Gill, *Adapting cities for climate change*, ASSCUE, 2006

[31] EFTEC for Natural England, *Economic valuation of upland ecosystem services*, 2009

3 Place and communities

Green infrastructure can improve the environment, providing opportunities for recreation, community cohesion, improved visual amenity, and attracting inward investment.

Relevant types of green spaces and features – primarily planned urban green infrastructure aimed at enhancing the urban environment, providing a setting for investment and improving quality of life.

Green infrastructure types include:

- amenity greenspace
- civic squares and spaces
- allotments
- community gardens and urban farms
- parks and public gardens
- community woodland.

WHAT THE EVIDENCE SHOWS

Green infrastructure is one of the key components of quality of place, together with other factors such as transport links, the range and mix of homes, services and amenities, the design and upkeep of buildings and streets and so on. Work done on behalf of the Northern Way[32] defines quality of place as *'...the sum of those factors – culture, local environment, public realm, housing, community safety, access, health – which together make somewhere – whether a town, city or region – an attractive place to live'.*

Green infrastructure is part of a mix of factors contributing to quality of place helping to position a place or location as economically attractive, and therefore meriting investment.

Research conducted by CABE based on statistical analysis of the Best Value Performance Indicators data (2006/07) has shown that there is a strong link between people's satisfaction with their local parks and open spaces and their satisfaction with their neighbourhood. People do value and use their local green spaces: three out of four people visit a public green space at least once a month – and more than a quarter do so at least three times a week.[33]

ECOTEC[34] describe how the debate surrounding green space has evolved rapidly, in part '*forced in the UK by the emergence of the concept of sustainable communities, with quality of place and quality of life as key drivers of regeneration and economic renewal*'. ECOTEC highlighted the case for green infrastructure as a key element of sustainable communities, linking the value that people place upon green space - opportunity for recreation, improved image of place, attractiveness to visitors, increased community cohesion and civic pride - with additional land and property value and desirable business location that well planned, high quality green infrastructure brings.

The scale of the impact is likely to vary: additional investment in an already good quality public park may have less impact on quality of place than creating a new local park in an area with little green space.

Isolating the contribution of green infrastructure is problematic, as is identifying an indicator or set of indicators which adequately cover all aspects of quality of place – the **full** range of benefits considered in the toolkit contribute to making green infrastructure one of the quality of place's key components. Much of the literature focuses on land and property prices as a proxy for quality of place – see section 5, Land and property. Section 9 considers recreation and leisure benefits to people using green space. This chapter focuses on the benefits of green space for community cohesion, and visual amenity.

Community cohesion

Various surveys have shown that green infrastructure has the ability to bring people together and to promote social cohesion.

A 2004 literature review by the Health Council of the Netherlands[35] found three papers addressing the social impact of shared green space. The presence of green space correlated positively with social ties within a neighbourhood.

Communal/shared activities such as community gardening and allotments are also seen as a means of improving local neighbourhoods, enhancing community attractions and improving attitudes of residents towards their neighbourhood.

Useful studies include:

- *The value of public space*, Cabe Space 2005
- *Greenspaces, better places*, Urban Green Spaces Taskforce, 2002

QUANTIFYING

Landscape/visual amenity

This is the approach used by the toolkit. It is generally expressed as a **willingness to pay*** for a view, and varies according to landscape type.

The simplest tool for valuing landscape and visual amenity is provided in Eftec's work on valuing the external benefits of undeveloped land - see below. The values provided include a basket of benefits, including recreation. It does not take account of local context - including green space nearby, the quality of the asset,

the accessibility of the asset and so on. It can, however, provide a ballpark estimate of the level of benefits. More detailed studies are needed.

A 2003 Garrod/Macmillan study for the Forestry Commission – see below - estimated the value of woodland views from properties. It focused on the number of urban fringe households with a woodland view, which was found using 1991 Census classification of wards.

The willingness to pay figures generated by the study can be used together with the number of households within 450 metres of the green asset.

Community cohesion

Attempts at quantification appear to be limited to the number of volunteer hours committed by individuals to shared or communal green infrastructure projects and activities. Greenspace Scotland is embarking upon a two-year research programme '*Greenspace is good – so prove it!'* funded by the Big Lottery Research Programme. Recruitment of participating groups was targeted for January 2010 – so it is possible that a potential tool may evolve through this research.

MONETISING

Landscape/visual amenity

Work by Eftec for the Department of Communities and Local Government[36] brought together 47 studies on the **externalities*** associated with undeveloped land. The study does not systematically isolate landscape from other benefits - such as recreation, ecology and tranquillity - for each of the land types considered, but it does have some useful values:

- £54,000 per hectare per year for an urban park
- £2,700 per hectare per year for urban fringe forestry
- £889 per hectare per year for urban fringe - greenbelt.

These figures include recreation benefits, but explicitly exclude 'functional' benefits – climate control, water management and so on.

A study[37] for the Forestry Commission looked at a range of 'non-market' benefits including recreation, landscape amenity, biodiversity, carbon sequestration, pollution absorption, water supply and quality.

For landscape amenity, a survey of over 400 residents was done across England, Scotland and Wales to estimate the value of woodland views from properties and on journeys - based on willingness to pay. It explored the value of woodlands and forests in different landscape contexts – such as mountain, hilly/rolling, urban fringe - and found that clear preferences for woodland/forest views were really only to be found in urban fringe settings.

The study estimated an annual willingness to pay of £268.79 amounting to a capitalised (note: in perpetuity) value of £7,680 per urban fringe property with a woodland view. This approach provides values significantly higher than the Eftec work.

Community cohesion

Very little data is currently available for monetising the economic value of green infrastructure. It does point to some evidence linking increased community cohesion to reduced levels of crime.

Monetising community cohesion and promoting the social inclusion benefits that good quality green infrastructure can offer is problematic, with the evidence base largely qualitative.

TOOLS AVAILABLE IN THE CALCULATOR

Benefit valued	Input data	Tool basis
Tool 3.1: Willingness to pay for view of urban green space [■ Quantification and monetisation require further research]		
Tool 3.2: Increase in volunteering [■/■ Quantification and monetisation require bespoke appraisal]	Volunteering hours/organisations formed	Qualitative benefit, no generally applicable monetisation tool other than monetisation of volunteer input (accepted by some funders)

KEY EVIDENCE AND SOURCES

Market Values	
N/A	
Scientific research	
N/A	
Benefit transfer values	
Urban core (public space, city park) £54,000/ha/yr Urban fringe (green belt) £889/ha/yr Urban fringe (forested land) £2,700 /ha/yr Rural (forested, amenity) £6,626 /ha/yr Natural and semi-natural land (wetlands) £6,616 ha/yr Agricultural land (extensive) £3,150 /ha/yr; Agricultural land (intensive), £103 /ha/yr	Eftec (2005)
£268.79 per household with a view of green space including woodland per year (2003 price base). Updating by Consumer Price Index uplift to 2010 prices, this would equal £308.03 Capitalised per household: £7,680 (2003) (in perpetuity), updated to 2010 prices £8,800. Note: Capitalised benefit over 10-year period = £2,557, over 20-year period = £4,374	*The social and environmental benefits of forests in Great Britain*, Kenneth G. Willis, Guy Garrod, Riccardo Scarpa, Neil Powe, Andrew Lovett, Ian J. Bateman, Nick Hanley, and Douglas C. Macmillan, 2003

KNOWLEDGE GAPS

There is some evidence, from CABE and others, linking investment in public realm generally to overall quality of place, but no attempts have been made to do a similar task for green infrastructure.

There is much work to be done to value to the community cohesion benefits from green infrastructure investment. Research being commissioned by Greenspace Scotland '*Greenspace is good – so prove it!'* appears to offer potential. This will be based on case study evidence, but is a two-year research program

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[32] *Residential futures*, 2009

[33] CABE, *Urban green nation*, 2009

[34] ECOTEC, The public and business case for investing in green infrastructure and a review of the underpinning evidence, 2008

[35] Health Council of the Netherlands and Dutch Advisory Council for Research on Spatial Planning Nature and the Environment. *Nature and health: the influence of nature on social, psychological and physical well-being*, 2004.

[36] Eftec, *Valuing the external benefits of undeveloped land*, 2005

[37] Willis, Garrod et al, *The social and environmental benefits of forests in Great Britain*, 2003

4 Health and wellbeing

Green infrastructure improves air quality, reduces stress levels and provides opportunities for formal and informal physical activity and recreation.

Relevant types of green spaces and features – potentially all green infrastructure, including:

- amenity green space
- cycling routes
- grasslands and heathlands
- open countryside
- outdoor sports facilities
- parks
- woodland.

WHAT THE EVIDENCE SHOWS

Green infrastructure provides health and wellbeing benefits. These can be broadly classified into three areas:

- providing opportunities for exercise
- helping to reduce stress levels and improving mental health
- contributing to improved air quality, and as such to the reduced incidence of respiratory illness.

A fourth benefit area, with studies dating back to the 1980s is the impact of green space on shortening patient recovery time and therefore reducing costs associated with long hospital stays[62].

There is a growing recognition amongst health authorities of the links between increased opportunities for exercise and health benefits. Significant recent changes include:

- policy changes within the Department of Health to further promote the benefits of increased exercise[63]
- local primary care trusts (PCTs) actively promoting programmes such as health walks and green/blue gyms.

Physical activity and reducing obesity are now PCT priorities[64], though only a minority of PCTs are actively considering investment in green infrastructure projects. For the majority, the benefit of green space investment remains unfamiliar territory which will require cultural change, although there is confidence that this is slowly changing.

There is much work in the UK and overseas on the impact of green space on general health and specific health conditions, and the evidence base is building. This should lead to new valuation approaches and tools.

Opportunities for exercise

Local, accessible green space provides opportunities for exercise, increasing overall levels of fitness and reducing obesity.

- work by Giles-Corti[65] suggests that open spaces with a range of attractive attributes - such as trees, lakes, landscaped features - encourage higher levels of walking
- the National Institute for Health and Clinical Excellence (NICE) has published formal guidance on promoting and creating both built and natural environments that encourage and support physical activity.[66]

Benefits of exercise

Regular physical activity reduces the risk of:

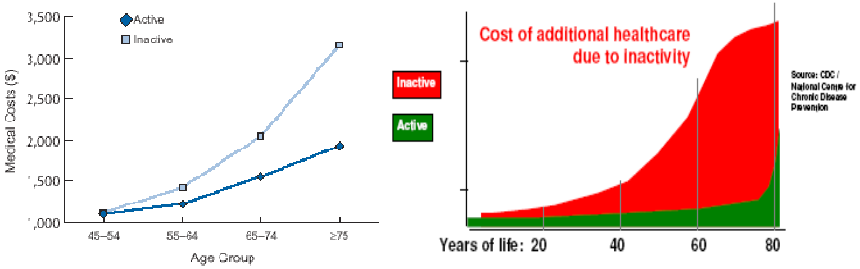
- cardiovascular disease
- non-insulin dependent diabetes mellitus
- osteoarthritis
- some forms of cancer - 2,500 colon cancer deaths are attributed to inactivity[67]
- obesity.

Despite the well-recognised benefits of regular physical activity, in 2008 only 39 per cent of men and 29 per cent of women in England met the public health recommendation of at least 30 minutes of moderate intensity physical activity for five days per week. That amount of activity – which can take place in short bursts or by walking two miles relatively briskly – is enough to expend 200 calories per day. This means 27 million people in England are not active enough to benefit their health.

Costs of physical inactivity

Considerable research has been done in the US by the Center for Disease Control and Prevention (CDC) on the cost of additional healthcare needs due to inactivity. The graphs show the difference in the annual medical costs between active and inactive women - aged 45 or older - and how this gap escalates with increasing age. The second shows a representation of this for all population groups.

Figure 10: Healthcare cost and physical inactivity



Source: Centers for Disease Control and Prevention. *Promoting active lifestyles among older adults*. National Center for Chronic Disease Prevention and Health Promotion. Nutrition and Physical Activity

Research[68] has found an estimated 35,000 deaths every year in the UK are directly related to physical inactivity. Two-thirds of these deaths are due to cardiovascular disease - around 100 deaths a day.

The Department of Health's 2009 *Let's get moving* study and various NHS studies reported the cost of physical inactivity in England at £8.2 billion a year (2002)[69]. This calculation added the **direct costs of healthcare** and the **indirect costs**, such as earnings lost due to inability to work and premature death. This model excluded the additional contribution of physical inactivity to obesity, whose overall cost has been estimated to be £6.6 to £7.4 billion per year.

The *Let's get moving* report estimated that:

- a 10 per cent increase in physical activity in adults would benefit England, both directly and indirectly, by at least £500 million per year and would save around 6,000 lives
- of this £500 million saving, 17 per cent was attributable to direct health costs
- the direct health saving for a 10 per cent increase in physical activity would be £85 million per year.

Let's get moving also estimated direct costs to the UK healthcare system for

- **Coronary heart disease (CHD).** This is the single most common cause of death in the UK, costing the healthcare system around £3.5 billion in 2003. Studies show that regular exercise halves the risk of heart disease.
- **Stroke care.** This costs the NHS about £2.8 billion per year. For each individual who has a stroke in the UK, the cost to the NHS is £15,000 over five years.
- **Diabetes.** There are currently around 2.1 million people in the UK diagnosed with diabetes. The treatment of diabetes and its complications costs the NHS 5 per cent of its budget - £3.5 billion per year, equating to £1,666 per person. The concern is that if current trends in obesity levels are not reversed then diabetes health costs will escalate – by an estimated 15 per cent over the next 20 years.

Benefits of green space

Current goals set by government focus on increasing physical activity by helping two million more adults to be more physically active by the year 2012.[70]

An important step in developing a tool to assess the health benefits of investing in green space is to understand the relationship between green assets and participation in physical activity. The difficulty is that the evidence to quantify relationship between access to green space and increased levels of physical activity is limited..

US-based evidence by Cohen et al (2007) suggests that park use is positively associated with people living within 1 mile of the park[71]. People living within 1 mile were four times more likely to visit the park once a week or more, and to take 38 per cent more exercise on average in a week than those living further away.

During 2009, Natural England commissioned two studies by the Universities of Bristol and East Anglia looking at the association between access to green space, frequency of use, physical activity levels, and the probability of being overweight or obese[72]. Key findings were:

- 55 per cent of people within Bristol live with 300 metres of some form of green space
- a third of respondents used green spaces at least weekly
- frequency of green space use declined with increasing age and worsening levels of deprivation.

The researchers controlled for neighbourhood deprivation, and concluded that people who perceive easy access to safe green spaces report higher green space use, more regular physical activity and lower risk of obesity - whatever the quality of the local area.

However, the research does **not** provide a mechanism for extrapolating the impact of creating or improving green space on the level of physical activity in the local population.

Research in Holland has struggled to find support for a positive relationship between the amount of local green space and levels of physical activity[73], although this contrasts with the bulk of studies done in the US and Australia. Further work appears to be needed in this area to obtain a valuation tool.

Reducing stress levels and improving mental health

Regular, physical activity is also associated with reduced risk of depression and improved mental wellbeing. A number of theories link the presence of nature to good mental health and wellbeing – relating to the ability of natural and green spaces to foster relaxation, reduction of stress and restoration. Some refer to the 'Biophilia effect' originally proposed by Wilson (1984) which linked human wellbeing to close contact with nature.[74]

Professor Jules Pretty, Centre for Environment and Society at the University of Essex analysed responses from 1,252 people - of different ages, genders and mental health status - drawn from 10 existing studies in the UK. The analysis showed that activity in the presence of nature led to mental and physical health improvements, concluding that as little as five minutes' exercise in a park, working in a backyard garden, on a nature trail, or other green space will benefit mental health[75].

The results of a Swedish study[76] indicate that city landscape planning may affect the health of town-dwellers, concluding that the more time people spend in outdoor green spaces, the less stressed they feel:

- statistically significant relationships were found between the use of urban open green spaces and self-reported experiences of stress – regardless of the informant's age, sex and socio-economic status.
- the more often a person visits urban open green spaces, the less often he or she will report stress-related illnesses.
- the same pattern was shown when time spent per week in urban open green spaces was measured
- distance to urban green spaces is associated with amount of use - see research on green space usage.

Costs of stress

Research undertaken by the Kings Fund in 2008 assessed the direct NHS service costs and total costs - including lost earnings - of mental health disorders – excluding dementia. The results showed direct costs to the NHS of £7.65 billion and lost earnings of £26.1 billion, with projections to increase to £8.71 billion and £28.1 billion - 2007 prices - by 2026.

Figures published by the Health & Safety Executive claim that 6.7 million working days are lost each year due to the effects of stress. The cost to society is estimated to be in the region of £3.8 billion per year.

However, further work is needed in this area to obtain a valuation tool.

Improved air quality

Green infrastructure, particularly trees, can filter, trap and lock in airborne pollutants.

Increased levels of fine particles in the air are increasingly being linked to health hazards such as heart disease, respiratory illnesses like asthma and the incidence of lung cancer. Much research focuses on particulate matter of less than 10 micrometres (PM_{10}) which presents the greatest health risk, and is the subject of European Air Quality targets.

However, trees remove a wide range of pollutants including ozone, nitrogen dioxide, carbon monoxide and sulphur dioxide as well as PM_{10} particulates and of course carbon dioxide.

Research led by Professor Nick Hewitt at the Department of Environmental Science, University of Lancaster differentiated those species with the greatest capacity to improve air quality - ash, larch, Scots pine, silver birch - from those species with the potential to worsen air quality - English oak, willow and poplar. The research looked at a regional level at the potential to reduce mortality rates. It concluded that doubling the tree cover across the West Midlands - currently 8.1 million trees - could reduce premature deaths due to particulates in the air by up to 140 people per year.

In a smaller study area, Tiwary et al (2009) have modelled PM_{10} reduction by green space establishment across a 10 kilometre by 10 kilometre area of the East London Green Grid.[77] This was based on a scenario of 75 per cent grassland, 20 per cent sycamore maple and 5 per cent Douglas fir. The study looked at the impact on premature mortality and respiratory hospital admissions, estimating that two deaths and two hospital admissions would be averted each year.

Most of the research has been at the large spatial scale. It does not model the impact of a smaller number of urban street trees, although Professor Hewitt's forthcoming work will look at the effects of city greening on air quality. At the current time, design of a generally applicable valuation tool - other than one designed at large scale – looks problematic.

QUANTIFYING

Opportunities for exercise and Improving mental health

Benefits can be measured in terms of:

- increased participation in regular exercise as a result of local green infrastructure investment
- ward/output area population in close proximity to the green asset.

The weight of evidence is beginning to build around the cost savings that can be derived from investment in physical activity[78]. For example, 2006 NICE research suggests "brief interventions for physical activity cost between £20 and £440 per **Quality Adjusted Life Year*** – significantly below the £30,000 cost-effective threshold and therefore represent exceptional value for money".

The closest currently available valuation methods appears to be the calculation tools included in the Department for Transport's WebTag Guidance Note 3.14.1[79] on the appraisal of walking and cycling projects. This models the number of preventable deaths using the 2007 World Health Organisation's Health Economic Assessment Tool for cycling (HEAT).

This is based on research undertaken by Andersen et al (2000) for the Copenhagen Heart Study.[80] This found that individuals who cycle for three hours per week reduce their risk of all-cause mortality – relative risk of death - to 72 per cent of that of non-cyclists, controlled for other types of physical activity.

Improved air quality

Benefits are measurable at relatively large spatial scales - for example, county, district, or metropolitan area level. This requires mapping or estimating either the canopy cover or the number of trees within this spatial area.

It is possible to design a valuation tool from established US research - if the principle of transferring US data to the UK is accepted. This looks at the impact of improved air quality in a different way - in terms of the **cost savings of other pollutant control measures**.

The key research in this area is the *Chicago Urban Forest Climate Study* by the USDA Forest Service[81] which concluded that the 4.1 million trees across the metropolitan area of Chicago in 1991 removed:

- 15 tonnes of carbon monoxide
- 84 tonnes of sulphur dioxide
- 89 tonnes of nitrogen dioxide
- 191 tonnes of ozone
- 212 tonnes of PM_{10}.

MONETISING

Two out of six potential tools are currently functional to monetise some of the health benefits of green infrastructure.

Tool 4.2 Reduced mortality from increased walking and cycling

This is based on reductions in all-cause mortality, using the Department for Transport's statistical value of a life. The tool requires:

- an assessment of the green infrastructure scheme on journey distance
- an assumption that 90 per cent of users make a return trip
- an assessment of how many trips per year will be made.

Assumptions can also be taken from Sustrans' 2009 evaluation of Cycling England's Cycling Demonstration Towns[82] (CDTs) programme. This found a mean time per week cycled by new cyclists of 60 minutes, based on an average of 20 minutes per day and 2.9 days per week per person.

The study found that cycling rates did not rise immediately, but took a period of three years to increase. The six towns showed an increase of between 10 per cent and 57 per cent - an average of 27 per cent, or 6.2 per cent each year.

A 1 kilometre journey, being made by an individual 2.9 times per week on average, would be calculated as follows:

Step 1: Calculate mean distance travelled per year
Mean distance travelled: 1 km
% of users making return trip: 90%
Average days travelled per year 150 days (2.9 average trips per week)
Mean distance travelled per year per cyclist = 1km x (1+90%) x 150 days = 285 km

Step 2: Calculate relative risk for green infrastructure scheme
Mean distance travelled per year by cyclist in Copenhagen study = 1,620 km
Relative risk of death for cyclists found in Copenhagen study = 72% of that of non-cyclists
[Note for walking: WebTag advises use of 85%]
Therefore reduction in relative risk of death found in Copenhagen = 1 - 0.72 = 0.28

Therefore, estimated reduction in relative risk of death for green infrastructure scheme = 285/1620 x 0.28 = 0.049

Step 3: Calculate reduced mortality benefit
Mean % of England & Wales population aged 15-64 who die each year from all causes = 0.00235
Extra cyclists encouraged by green asset scheme relative to no intervention case = Y
(calculated from population within 1,200 m of green asset, and in absence of local survey information, for Ready Reckoner, use finding from Cycling Demonstration Town (CDT) programme that improved infrastructure will increase use by 27%)
Expected deaths in this population = 0.00235 x Y = 0.00235Y
Lives saved per year = 0.00235Y x 0.049
Cost of life (source DFT, 2007 cost) = £1.6m
Reduced mortality benefits (2007 prices) = 0.00235Y x 0.049 x £1.6m

The WebTag Guidance indicates that there is currently no specifically applicable guidance available for walking, although the World Health Organisation intends to develop a walking-specific model. The WebTag Guidance indicates that walking should provide greater benefits to the average individual over the same distance travelled, and therefore at least for the time being, the HEAT tool for cycling can also be applied for walking.

Tool 4.6: Avoided costs for air pollution control measures

The *Chicago Urban Forest Climate Study* by the USDA Forest Service[83] gave dollar values per metric tonne for preventing the emission of pollutants, based on 'current control strategies'. It calculated pollution absorption capacity and typical monetary values down at the level of the individual tree. This ranged from $0.04 per year for small trees to more than $2 per year for large trees. Tool 4.7 is based on these figures.

CASE STUDY: ERITH MARSHES & BELVEDERE LINKS, LONDON THAMES GATEWAY

The Erith Marshes & Belvedere Links will provide major investment in public space and will include new access opportunities. Using benefit tool 4.2 it has been estimated that walking benefits provide NPV of £1.4m over 5 years and cycling benefits of £0.6m over a similar period.

See Appendix 1 for case study details.

TOOLS AVAILABLE IN THE CALCULATOR

Tools	Input data	Tool basis
Tool 4.1: Direct savings to the NHS from improved health of the local population/reduced obesity levels from increased levels of physical activity [■ Quantification and monetisation require further research]		
Tool 4.2: Reduced mortality from increased walking and cycling Estimates the reduction in mortality rates from take-up of moderate physical exercise through walking or cycling [■ Functional]	Estimate of extra numbers of the local population who have taken up physical exercise (walking or cycling)	Webtag Guidance note 3.14.1 outlines the methodology for calculating the number of preventable deaths
Tool 4.3: Health cost savings from reduction in mental health disorders [■Quantification and monetisation require further research]		
Tool 4.4: Health cost savings from reduced in-patient stays [■Quantification and monetisation require further research]		
Tool 4.5: Reduced mortality from respiratory illnesses Estimates the reduction in mortality rates from illnesses associated with particulates in the air [■Quantification and monetisation require further research]		
Tool 4.4 Avoided costs for air pollution control measures Estimates savings from not having to implement other pollution control measures to prevent emissions or		USDA Forest Service: *Chicago Urban Forest Climate Study*

remove from the air sulphur dioxide, carbon monoxide, PM10 captured by trees [■ Functional]		

KEY EVIDENCE AND SOURCES

Market values	
Cost of life (reduced mortality)	DfT: £1.215m – statistical value of a life (2002 prices) Webtag 3.14.1 Guidance note (April 2009)
Net cost saved per Quality Adjusted Life Year gained	Between £750 - £3,150 (NICE)
Scientific research	
University of Lancaster, Professor Nick Hewitt	
USDA Forest Service: *Chicago urban forest climate study*	
Benefit transfer values	
Tool 4.2	Statistical value of life as above.
Tool 4.4	Pollutant control strategies calculating pollution absorption capacity at typical monetary values down at the level of the individual tree (ranging between $0.04/year for small trees to more than $2/year for large trees).

KNOWLEDGE GAPS

Opportunities for increased exercise and mental health

Further work with some input from a specialist health economist could allow the development of tools calculating:

- net cost saved to the NHS per Quality Adjusted Life Year
- direct savings to the NHS from improved health of the local population from reduction in mental health disorders
- direct savings to the NHS from reduced in-patient stays.

Discussions held with Natural England's specialist health advisor suggest it will also be important that the toolkit uses appropriate language in the final version of the tools – for example Quality Adjusted Life Year (QUALY) - so that its credibility holds with primary care trusts.

Distance to green infrastructure

A significant gap in the research evidence base appears to be the mapping of increased participation in exercise as a result of local green infrastructure enhancement, for use within a valuation tool.

Grahn and Stigsdotter's 2003 research review[84] is helpful as it provides usage data within a local population in terms of distance bands to green infrastructure. This is based upon research across nine Swedish cities. It shows that distance to urban green spaces is associated with amount of use, as well as a statistically significant relationship between the use of urban open green space and self-reported experiences of stress.

Improved air quality

Most of the research that has been undertaken in this area is at large scale, and for example, does not model the impact of a smaller number of urban street trees. Professor Hewitt at Lancaster University has indicated that work is soon to get underway using EPSRC funding by a consortium - 'Urban Futures' - to look at the effects of city greening on air quality. This could potentially offer a project-level valuation tool.

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[62]Ulrich, View through a window may influence recovery from surgery,

Science 27 April 1984: Vol. 224. no. 4647, pp. 420 – 421

[63] Department of Health, *Let's Get Moving,* September 2009

[64] Department of Health, *Vital signs, operational planning guidance* 2008/09-2010/11

[65] Giles-Corti, B., Broomhall, M. H., Knuiman, M., Collins, C., Douglas, K., Ng, K., Lange, A. and Donovan, R. J. (2005) Increasing walking: how important is distance to, attractiveness, and size of public open space? *American Journal of Preventative Medicine* 28 (2 Suppl 2), 169-176.

[66] National Institute for Health & Clinical Excellence, *Public health guidance note 8*, January 2008

[67] Cabinet Office Strategy Unit, *Health economics model for Game Plan*, 2002

[68] Allender S, Foster C, Scarborough P & Rayner M, The burden of physical activity-related ill health in the UK. *Journal Epidemiology & Community Health*, 61:344-8, 2007

[69] Department of Culture Media and Sports Strategy Unit, *Game Plan: a strategy for delivering government's sport and physical activity objectives*, 2002

[70] DCMS, *Before, during and after: making the most of the London 2012 Games* (Legacy Action Plan), June 2008

[71] Cohen, D. A., Mckenzie, T. L., Sehgal, A., Williamson, S., Golinelli, D. and Lurie, N. (2007). Contribution of public parks to physical activity. *American Journal of Public Health* 97 (3), 509-514.

[72] The relationship of physical activity and overweight to objectively measured green space accessibility and use, Emma Coombes, Andrew P. Jones, Melvyn Hillsdon, *Social Science & Medicine,* Volume 70, Issue 6, March 2010, 816-822

[73] Maas, J. Verheij, R. A., Groenewegen, P. P., de Vries, S. and Spreeuwenberg, P. (2006). Green space, urbanity and health: how strong is the relation? *Journal of Epidemiology and Community Health* 60 (7), 587-592.

[74] Edward O. Wilson, *Biophilia*, 1984

[75] Barton, J and Pretty, J, What is the best dose of nature and green exercise for improving mental health? A multi-study analysis. *Environmental Science & Technology*, 2010

[76] Grahn P and Stigsdotter UA. Landscape planning and stress. *Urban forestry and urban greening*, 2003

[77] Tiwary, A., Sinnett, D., Peachey, C.J., Chalabi, Z., Vardoulakis, S., Fletcher, T., Leonardi, G., Grundy, C., Azapagic, A. and Hutchings, T.R. (2009). An integrated tool to assess the role of new planting in PM10 capture and the human health benefits: a case study in London. *Environmental pollution* **157**, 2645-2653.

[78] Matrix Insight on behalf of Health England, *Prioritising investments preventative health*, 2009 www.healthengland.org/publications/HealthEnglandReportNo5.pdf

[79] *Guidance on the appraisal of walking and cycling schemes*, TAG Unit 3.14.1, January 2010, Department for Transport, Transport Analysis Guidance (TAG) http://www.dft.gov.uk/webtag/documents/expert/pdf/unit3.14.1.pdf

[80] Andersen, L B, Schnohr, P, Schroll, M, Hein, H O, (2000) All-cause mortality associated with physical activity during leisure time, work, sports, and cycling to work, *Archives of Internal Medicine*, Vol. 160, pp1621-1628

[81] Nowak, McPherson and Rowntree, *Chicago's urban forest ecosystem: results of the Chicago urban forest climate project,* USDA,1994

[82] Aylesbury, Brighton and Hove, Darlington, Derby, Exeter and Lancaster

[83] Nowak, McPherson and Rowntree, *Chicago's urban forest ecosystem: results of the Chicago urban forest climate project,* USDA,1994

[84] Grahn P and Stigsdotter UA. Landscape planning and stress. *Urban forestry and urban greening*, 2003

5 Land and property values

The existence of trees and green spaces within urban and semi-urban areas can increase land and property values.

Relevant types of green spaces and features – primarily planned urban green infrastructure aimed at enhancing the urban environment, providing a setting for investment and improving quality of life.

This includes:

- amenity green space
- civic squares and spaces
- allotments
- community gardens and urban farms
- parks and public gardens
- community woodland.

WHAT THE EVIDENCE SHOWS

Land and property values are a useful proxy measure for the relative prosperity and attractiveness of a community, neighbourhood or place. Property values reflect a basket of factors – for example transport links, proximity to employment and local services, as well as environmental quality.

A number of studies have tried to isolate the impact of green infrastructure, including trees, parks and community woodland on neighbouring property prices, particularly in a **residential** context. The magnitude of the suggested impact on value varies significantly between the studies.

CABE Space's study[105] on the impact of park improvements on residential values found that:

- properties near a park were on average 5 to 7 per cent more expensive than comparable houses further away
- the highest value increase was 34 per cent
- 'off-park' impacts - on properties 'within the vicinity of a park' - achieved an average of 7.3 per cent
- 'on-park' impacts – on properties overlooking a high quality park – saw an 11.3 per cent increase.

Work undertaken by Dunse for the Royal Institution of Chartered Surveyors (RICS)[106] used Aberdeen as a case study area. It found that the overall premium for a property next to a park, relative to a similar property 450 metres away, is positive across all house types.

The price premium ranges between 0.44 per cent and 19.97 per cent depending on house and park type. The study even suggests that park shape matters - rectangular or oblong (long/narrow) parks being preferable to square or circular (short/wide) parks. A rectangular park, for example, would potentially offer greater opportunities for access – suggesting that accessibility as well as proximity is important to households. The findings are attractive in that they provide a relationship between house type and park type:

	Detached	**Flat**	**Non-detached**
City park	19.97%	7.54%	2.93%
Local park	9.62%	7.92%	9.44%
Open space	2.71%	4.7%	0.44%

US-based research also suggests that distance from the park or open space is valued as important[107]. Interestingly however, immediate adjacency - within 30 metres - of the park or open space can in some instances attract its own relative disadvantages. Lutzenhiser and Netusil's study suggested the largest premiums lie in the 61-120, 121-180 and 301-365 metre distance bands, respectively.

Relationship between property value and distance from a park:

Distance from park (m.)	**%Change**
< or = 30 meters	ns
31 - 120	4.09
121 - 210	2.96
211 - 300	2.28
301 - 400	2.18
401 - 450	1.51

Source: Bolitzer & Netusil, 2000[108]

Inter-relationship between property value, park distance and park type:

% Change: Distance from park (m.)	Urban park	Natural park	Specialised park
< or = 60 meters	2.9	16.9	11
61 - 120	3.1	15.4	8..6
121 - 180	1.8	19.1	15.4
180 - 240	ns	16.9	8.5
241 - 300	ns	13.5	7.4
301 - 365	2.5	12.2	6.9
366 - 450	ns	15	5.8

Source: Lutzenhiser & Netusil, 2001[109]

Commercial property values can also benefit from the presence of green infrastructure. In principle, higher landscape quality will help to make sites and premises easier to sell or let and help retain occupants.

Some studies suggest that some occupants value landscape quality more highly than others, to the extent that they are prepared to pay a higher than average rent for premises located in an area of high landscape quality[110]. This, however appears to vary from occupant to occupant. A review of the evidence base suggests that the link between high quality green infrastructure and up-lifts in commercial property value is much less clear cut than for residential.

Much appears to depend upon the **type of business**. High value businesses that have a choice of location tend to put a higher premium on quality of place than lower-value businesses.

A good quality public realm can increase the attractiveness of retail centres, leading to higher commercial retail rents and increased occupancy. Trees, verges and green space can be central to improved public realm, although few studies have sought to isolate the contribution that this green infrastructure makes from other 'grey' aspects of public realm enhancement.

QUANTIFYING

Residential land and property uplift

Benefits can be measured in terms of household type and numbers within 450 metres of park/open space.

UpMyStreet.com can be used as a quick reference to define the volume of sales – for flats, terraced, semi-detached, detached and so on - and the average sale prices achieved. Depending on whether an existing green infrastructure asset – such as a park - is being valued, or whether a new green infrastructure asset is being proposed, the findings above can be used to derive:

- the **value premium** incorporated within the average property price, attributable to the existing asset
- the **uplift premium** that could be expected as a result of implementing the green infrastructure investment.

Commercial land and property

Extrapolating figures for the economic benefit of green infrastructure on commercial land and property values does not appear straightforward. It is likely that a detailed, bespoke study, consulting prospective investors/developers, purchasers, tenants or occupiers on their **willingness to pay*** for green enhancements will offer a more robust and meaningful approach.

Note: Where property value uplift can be estimated, **it is important to avoid double counting**. To varying degrees, particularly for residential property, property prices will reflect other green infrastructure benefit streams - health/air quality, visual amenity, recreation, quality of place and so on. Care must therefore be taken in presenting these other benefits alongside potential property price increases.

MONETISING

Two tools are currently included in the toolkit:

Tool 5.1 Residential land and property uplift

This either values the impact of an existing green infrastructure asset, or assesses the impact of a proposed green infrastructure investment

(Potential) Tool 5.2 Commercial land and property uplift

The toolkit evidence review suggests that the link between high quality green infrastructure and uplifts in commercial property value is much less clear than for residential. No generally applicable monetisable tool has emerged at this point. The tool is, however, being retained on the basis that future evidence or studies may be undertaken in the future.

CASE STUDY: ERITH MARSHES & BELVEDERE LINKS, LONDON THAMES GATEWAY

The Erith Marshes and Belvedere Links project is seeking to deliver improved access and environmental quality at the interface of open space and a major employment area. The Toolkit has shown that if environmental enhancements improved land value by only 5%, this would be £75-100k per hectare, based on current values. Households are expected to benefit from a combined £9.5m uplift in value.

See Appendix 1 for full details.

TOOLS AVAILABLE IN THE CALCULATOR

Tools	Input data	Tool basis
Tool 5.1: Residential land and property uplift [■ Functional] Estimates residential land and property uplift within 450 metres of park/open space	No. of units and property types within 450m of enhanced green infrastructure asset	Various studies – Dunse (2007) for the RICS, and work by Lutzenhiser and Netusil (2001)
Tool 5.2: Commercial land and property uplift [■Quantification and monetisation require further research] Commercial land and property uplift - requires bespoke willingness to pay surveys with prospective investors/developers, purchasers, tenants or occupiers		

KEY EVIDENCE AND SOURCES

Market values	
Properties near the park were on average 5-7% more expensive than comparable houses further away, with the highest value increase seen at 34%	CABE Space
Price premium ranges between 0.44% and 19.97% depending on house and park type	Dunse on behalf of RICS
Price premium ranges between 1.8% and 19.1% depending on distance and type of green space	Lutzenhiser and Netusil (2001)
Benefit transfer values	

KNOWLEDGE GAPS

Further work is needed to explore whether a generally applicable tool can be devised for commercial development values associated with green assets.

Meta-analysis of existing studies using a **regression model*** could help determine how important green infrastructure is in businesses' decisions regarding location.

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[105] CABE Space, *Does money grow on trees*, 2005

[106] Neil Dunse for RICS, *Urban parks, open space and residential property values*, 2007

[107] Lutzenhiser, M., & Netusil, N.R. (2001). The effect of open spaces on a home's sale price. *Contemporary Economic Policy*, 19(3), 291-298

[108] Bolitzer, B. and Netusil, N (2000) The impact of open space on property values In Portland, Oregon, *Journal of Environmental Management* 59, pp 185-193.

[109] Lutzenhiser, M., & Netusil, N.R. (2001). The effect of open spaces on a home's sale price. *Contemporary Economic Policy*, 19(3), 291-298.

[110] South Yorkshire Forest et al, *Creating a setting for investment - economic landscapes*, 2008

6 Investment

High environmental quality and the creation and development of green spaces and landscaping can encourage and attract high value industry to a locality or region. Including green infrastructure in and around a new estate and buildings can improve functionality, reducing cost and improving outcomes.

Relevant types of green spaces and features – these include:

- all trees, plants and green spaces
- green infrastructure within, in close proximity to, or providing gateways to, investment sites
- green roofs and SUDS
- investment in the public estate, including hospitals and schools.

WHAT THE EVIDENCE SHOWS

Economic growth is influenced by many factors, including:

- skills
- health
- education
- transport networks
- access to capital
- proximity to markets
- environmental quality.

There is anecdotal and qualitative evidence that high environmental quality is an important factor to some businesses. Investing in green infrastructure can both improve the quality and the image of an area or site - leading to new investment and employment.

The presence of trees and green spaces has also been shown to improve outcomes, for example improving labour productivity [see section 7] or reducing patient recovery time - and hence length of stay in hospitals. Well-designed green infrastructure can reduce running costs, through sustainable water management [see section 2] and reduced energy costs [see section 1a].

For the purpose of valuation, green infrastructure affects **private sector investment** - helping to drive economic growth - in two main ways.

At a wider scale

Green infrastructure provides a context for inward investment, enhancing an area's image.

Poor perceptions of an area can be a barrier to inward investment and to recruitment - especially of highly skilled workers[109]. Investment in environmental improvements has the potential to help improve perceptions:

- 33 per cent of new investors in the West Midlands region cited the attractiveness of the region as an important factor in location decisions[110]
- in the South West, over 35 per cent of companies quoted environmental attractiveness as a key reason for their move[111].

At the site level

The public realm and green infrastructure in and around particular investment sites can help attract and retain companies.

A high quality public realm can create the impression of a prosperous area which businesses are keen to buy into. The fluidity and footloose nature of many business sectors means that they can relocate if the circumstances are not right.

Typical green investments might include tree planting, landscaping and provision of green space. Functional green infrastructure – like SUDS and green roofs – can be attractive to firms concerned with their environmental impact.

Current research

A literature review by Greenspace Scotland concluded that while there was likely to be a positive relationship for some investors, there was a need to enhance the evidence base[112].

A number of studies however do show a positive relationship between environmental quality and investment, particularly for high-value, mobile businesses:

- Research on the benefits of environmental enhancements to investment showed that the quality of the location had a direct impact on investment – see the Riverside and Speke Garston investment projects below.
- A CABE and DETR (2001) study[113] examining the value of urban design found that 'evidence was offered that the better designed environments beneficially impacted on the productivity and the health and satisfaction of the workforce'.

- A Groundwork and CLES report[114] found that the environmental interventions 'in all the case study areas enhanced the ability of businesses to attract staff'.

Environmental improvements have been shown to beneficially affect the image of employment areas:

- CABE (2005) suggests that there is recognition that high quality green spaces can help businesses build a good image and reputation, which will encourage inward investment and employment into an area.[115]
- CABE (2001) found that prestige and image were important factors for occupiers in choosing a place to locate, particularly among UK-based businesses whose clients visited frequently.

Other research also highlights the positive role of a high quality environment in image making and urban regeneration.

ASSESSING THE BENEFITS

While available evidence points to a strong relationship between high environmental quality and inward investment, valuing this impact in isolation from other factors is difficult.

At a wider scale, interventions intended to attract inward investment are likely to focus on tackling poor perception of an area, that might be associated with its industrial legacy and deteriorated environmental condition, for example.

- Where the need to address poor environmental quality is assessed as significant - for example as evidenced through baseline quality of life surveys or inward investor surveys - comprehensive green infrastructure interventions have the potential to make a high impact.
- Where the survey evidence is less supportive of the need for investment and/or partial limited green infrastructure improvements are being proposed, the likelihood of influencing inward investment decisions will be lower.

At the site level, where the green infrastructure intervention is comprehensive and the end users are in sectors and product areas known to value the surrounding environmental quality, the impact is likely to be high.

Table 1 summarises the conditions and factors to consider, in order to assess the level of impact (high / medium / low) that green infrastructure improvements are likely to have on inward investment.

Table 1: Impact of green infrastructure improvements on inward investment

Impact of improvements / Scale of improvements	**High**	**Medium**	**Low**
Area-wide	High relative assessment of need Comprehensive range of green infrastructure	Medium relative assessment of need Broader mix of green infrastructure solutions	Low relative assessment of need. Smaller area and partial green infrastructure intervention
Site-based	Target sectors in high value, knowledge industries and with strong environmental market linkages Comprehensive range of green infrastructure	Higher value added activities (professional services etc) Broader mix of green infrastructure solutions	General business and industry use Partial green infrastructure intervention

QUANTIFYING

The first step in assessing the economic value of green infrastructure in relation to inward investment is to identify whether the investment context is:

- a general investment at a wide scale, or
- an area-based project focused on a particular development site.

Wider scale investment

The objective for investing in green infrastructure is likely to be to **influence perceptions** – with the aim of over the longer term changing behaviours - for example attracting higher value-added jobs and skills.

The benefits can be assessed through **perception surveys** - a baseline can be set and changes examined over time.

Area-based projects

Where green infrastructure is integrated into an area master plan or a strategic investment site, the approach to measuring the benefit can be more specific.

At the outset of the project, public realm - including green infrastructure investment - will be looked at in the context of:

- the target end-user requirements
- best practice or minimum standards.

This process implicitly makes a judgement about the importance of, and **willingness to pay*** for, a high quality environment.

This can be supported through **investor and end-user interviews** or **expert opinion** to gauge the relative importance of the green infrastructure proposed for the site to the inward investment. The value may include:

- whether the target firms were achieved
- higher rental premiums
- occupancy levels.

For example, a review by Whitehead[116] found that in response to urban quality improvements, office rents increased by 15 to 35 per cent, with a mean uplift of 24 per cent.

Some examples of developments where the quality of the environment was viewed as central to the success of the development include:

- **Riverside Park Industrial Estate Middlesbrough**: investment in the green infrastructure of the park created a setting for stimulating business growth and investment. The redeveloped site attracted new, high profile, occupants, and saw occupancy grow from 40 per cent to 78 per cent. It levered over £1 million of private investment[117].
- **Speke–Garston redevelopment**: this study examined the importance of the £8 million environmental programme within the £100 million Speke–Garston redevelopment to the decision of companies to invest in the area. Five out of seven investors interviewed stated that the improvements were an important element in their overall location assessment[118].

MONETISING

It is not currently possible to provide a tool which can value the impact of green infrastructure on attracting investment. However, further analysis from existing case study material could provide the basis for a monetising tool (See Knowledge Gaps below).

CASE STUDY: LIVERPOOL KNOWLEDGE QUARTER

Liverpool Knowledge Quarter is comprises the area of the City Centre where Liverpool's knowledge economy is focused, and includes three Universities, both Cathedrals, Lime Street Station and a major teaching hospital. Partners are seeking to increase the number of high value jobs in conjunction with a programme of enhance green infrastructure and improved public realm. Application of the toolkit has shown that investment and enhancement of green space could help secure 3.5% - 4.6% annual GVA growth rate over the next 10 years – or 5,600-8,000 jobs

See Appendix 1 for full details of the case study

TOOLS AVAILABLE IN THE CALCULATOR

Tools	Input data	Tool basis
Tool 6.1: Private sector investment levered [■Quantification and monetisation require further research] Estimate of the level of private sector investment levered	Number of companies expected to occupy a site where a green infrastructure investment is being made Estimates of the site's capital and/or rental value with and without the green infrastructure investment	Ex-ante survey of importance of green infrastructure investment to development of the site (to inform attribution) Development appraisals (expert opinion on impact of green infrastructure on values)
Tool 6.2: Employment creation [■Quantification and monetisation require further research] Estimates site employment capacity and employment based gross value added (GVA) that can be attributed to the presence of high quality green infrastructure	Projected employment numbers and associated GVA	Attribution factor (zero to 1) based on relative importance of green infrastructure investment. It is very unlikely that attribution of 1 would be applied except where the development site concept was being led by green infrastructure as an attraction theme. The upper level of attribution is likely to be in the order of 0.2 (where it is assessed as being one of 5 key business location factors). However, the weighting of the key location factors should also be explored to ensure a best estimate is applied
Tool 6.3: Image enhancement [■Quantification and monetisation require further research] No generally applicable monetisable tool, but anecdotally, high quality environment has been reported to influence location decision-making	Scale of green infrastructure proposed Views of investors and/or opinion formers through a baseline perceptions survey	.

KEY EVIDENCE AND SOURCES

Market values	
Property market values	Property agents and developers
Occupancy rates	Property agents and developers
Research	
Regional development agency ongoing evaluation of similar investments – for example public realm	Regional development agencies and Homes and Communities Agency
Benefit transfer values	
Premium uplifts	**Environmental Valuation Reference Inventory*** (EVRI) database for studies (in particular British Waterways) elsewhere and expert opinion (Delphi techniques)
Conversion factors	
Employment/Gross value added	Office for National Statistics (ONS) & Regional Observatories

KNOWLEDGE GAPS

This benefit could be strengthened further with reference to good case studies which support a link between green infrastructure investment and inward investment – for example where investment has been made in business parks and other inward investment sites.

Care will be needed in extrapolating from other areas, but **an indication of potential investment, types of business attracted and occupancy rates should be possible** to help support outline project proposals.

For example, an evaluation of the impact of public realm investment in Torbay found that the public investment was recognised by businesses as important in influencing their investment decisions and increased trade[119]. The analysis, based on waterfront business surveys and interviews, was able to attribute on average some 20 per cent of private sector investment to the waterfront public investment. Key retailers had noticed increased footfall as a benefit and some **10 per cent of investment** was attributed by the evaluators.

It should be possible to provide indicative ranges of benefits from green interventions. However, providing a predictive tool is not likely to be possible without:

- specific research to develop the evidence base for green infrastructure projects
- a robust mechanism for isolating the impact of green infrastructure from other contributing variables [see section 6].

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[109] Northern Way/Llewelyn Davies Yeang, *Quality of place: the North's residential offer*, 2006

[110] Advantage West Midlands, 2001 cited in Amion, *Economic value of green infrastructure*, 2008

[111] Advantage West Midlands, 2001 cited in Amion, *Economic value of green infrastructure*, 2008

[112] Greenspace Scotland, *Greenspace and quality of life: a critical literature review*, 2008

[113] CABE/DETR, *The value of urban design*, 2001

[114] CLES and Groundwork, *The contribution of the local environment to the local economy*, 2007

[115] CABE, *Does money grow on trees?*, 2005

[116] Whitehead, T., Simmonds, D. and Preston, J. (2006). The link between urban quality improvements and economic development. *Journal of Environmental Management*, 80/1:1-12.

[117] CLES/Groundwork, 2007

[118] NWDA, Speke-Garston evaluation

[119] SWRDA, 2006

7 Labour productivity

High quality accessible green infrastructure can support a more productive workforce for employers through improved health, stress alleviation and enhancing motivation or attracting and retaining motivated people.

Relevant types of green spaces and features – green space, trees and so on in and around public and commercial premises, including business parks.

WHAT THE EVIDENCE SHOWS

Research suggests that well planned, accessible green infrastructure can be expected to have an impact on labour productivity. The impacts include:

- **physical health improvements** – resulting principally from increased exercise and improved air quality
- **mental health improvements** – from the calming effects of the presence of trees and green spaces, and also from physical exercise
- **improvements at work** - psychologists have noted that when workers have access to plants and green spaces they can be more patient, better at problem-solving and more productive
- **a reduction in short-term absenteeism**.

The first two effects are part of health benefits [see section 4] and are qualitative benefits. The third effect – improvements at work - is a localised benefit derived by employers who choose to invest in greening the workplace.

US studies show the influence that green space can have on people's effectiveness and productivity:

- A 2004 study by The Centre for Health Design saw reduced staff turnover to below 12 per cent – from around 30 per cent - and a 6 per cent increase in a case study hospital's market share following green infrastructure investment.
- A 2003 report by The California Energy Commission found that workers in a call centre in Sacramento performed 10 to 25 per cent better on tests of memory function and recall when they had a view of vegetation, as opposed to no view.

More recently, research undertaken in the US has shown a link between improved green space and problem-solving/labour productivity.

ASSESSING THE BENEFITS

An assessment can be developed considering:

- how many individuals in the workplace benefit from the green infrastructure investment or the existing green provisions - **scale considered**
- how comprehensive the planned green investment is or how extensive the existing green infrastructure provision is - **levels of green infrastructure**.

This enables a qualitative assessment using high, medium and low impact scores, as proposed in table 2.

The scale is more likely to be a spectrum - for example, where a site-level investment delivers a comprehensive programme, the impact will be higher than medium. Moreover, working with an individual organisation on a demonstration project would ultimately have important wider benefits when rolled out across a number of companies.

Table 2: Impact of green infrastructure improvements on labour productivity

	High	**Medium**	**Low**
Scale considered	Several sites Several organisations	One site Several organisations	One site One organisation
Levels of green infrastructure	Comprehensive	Partial	Limited or absent

QUANTIFYING

The key output is **the number of workplace individuals that will benefit from the proposed green infrastructure investment**. This will require:

- an **assessment of the number of employees** in the company, on the site or across the programme
- **surveys of workers** to build up the evidence base on the perceived impact of the green investment.

MONETISING

In order to estimate the labour productivity benefit of a green infrastructure investment or asset, two impacts need to be considered:

- the impact on labour productivity - workers' effectiveness on the job
- the increased profit - as a result of reduced costs of recruitment.

Both impacts enhance overall gross value added (GVA) per firm. However, the key limitation is the evidence to calibrate both effects:

- the evidence shows that the impact on productivity is generally positive, but it needs to be estimated in terms of higher output per employee and thus a reduced requirement for labour
- the cost-saving benefit needs to be expressed in terms of a percentage of profit.

Better evidence for these two indicators would enable a GVA estimate to be made.

It does, however, seem possible at this time to assess the **reduction in short-term absence from work** that can result from the improved levels of health of those who take up physical activity as a result of a walking or cycling intervention.

2003 research by the World Health Organisation (WHO) in the US showed that physical activity programmes involving 30 minutes of exercise a day reduced short-term sick leave by between 6 per cent and 32 per cent.[120]

In the UK, the average absence of employees is 6.8 days, of which 95 per cent is accounted for by short-term sick leave.[121] For each employee who takes up physical exercise for 30 minutes a day, five days a week as a result of a walking or cycling intervention, the annual benefit to employers is likely to be - on average - at least 0.4 days gross salary costs (6 per cent of 95 per cent of 6.8 days).

These benefits can be monetised, though it should be noted that these are **business benefits** rather than the consumer benefits of improved health.

In order to calculate the benefits, this figure needs to be combined with the **average gross salary costs** and the **number of affected working people**. This can then be combined with average hours worked per day to generate a gross salary figure.

CASE STUDY: ROPNER PARK, STOCKTON-ON-TEES

Ropner Park is an existing urban park that has recently undergone extensive refurbishment and improvement. Use of the recreational value tool has demonstrated that park users are willing to pay an average of £0.96 per visit. This is worth £98.8k per annum, or £822k PV (3.5%, 10 years).

See Appendix 1 for full details of the case study.

TOOLS AVAILABLE IN THE CALCULATOR

Tools	Input data	Tool basis
Tool 7.1: Savings from reduced employee turnover [■Quantification and monetisation require further research]		
Tool 7.2: Increase in labour productivity [■Quantification and monetisation require further research]		
Tool 7.1: Savings from reduced short-term absenteeism from work [■ Quantification and monetisation functional only for the amount of work days loss avoided] Estimates the reduction in working days lost and associated employment-based GVA	Estimate number of workforce within a local population, and proportion that are likely to take up moderate exercise through walking and cycling	DfT Webtag 3.14.1

KEY EVIDENCE AND SOURCES

Market Values	
Reduction in sick days per year – average short-term sick leave= 6.8 days (UK)	CBI, 2004, *The lost billions: 2003 CBI absence and labour turnover survey*
Average gross salary costs	
Research	
Take-up of moderate physical activity reducing short-term sick leave by between 6% and 32% per annum.	WHO, 2003
Benefit transfer values	

KNOWLEDGE GAPS

While the available evidence suggests a link between green space and increased productivity, further work is needed to provide the basis for a predictive tool.

The various studies quoted show improvements in aspects of performance, but not a direct impact of productivity over a sustained period. Nor do they control for other external factors. To achieve a usable tool, a study would need to be designed that:

- considered different types of workplace with differing levels of green space
- controlled for other factors – for example views of cityscapes, other local amenities/opportunities for recreation
- looked at whether the benefits are maintained long-term.

[120] World Health Organisation, *Effectiveness and economic impact of worksite interventions to promote physical activity and healthy diet*, 2008.

[121] CBI, *The lost billions: 2003 CBI absence and labour turnover survey*, 2004

8 Tourism

Green infrastructure provides opportunities for tourism

Relevant types of green spaces and features - the types of green infrastructure assets or projects that give rise to tourism benefits include:

- woodlands
- access to mountain or moorland
- water courses
- green corridors.

WHAT THE EVIDENCE SHOWS

The protection and enhancement of green infrastructure can help an area maintain its existing tourism economy and attract new visitors. The establishment or development of a site offering a range of tourist activities can be a significant attractor of economic activity.

- the National Trust has estimated that 40 per cent of tourism-related employment is dependent on a high quality environment[122]
- the environmental economy sustains 26 per cent - or £2.8 billion - of the North West region's tourism sector with rural tourism supporting £0.7 billion
- across England over 33 million people make over 2.5 billion trips to urban green spaces[123]
- US research highlights that parks play an important part in a city's tourism economy, although often the number of tourists is not recorded.[124]

Investing in quality green space is vital to the health of a sustainable tourism industry. Green space adds value to tourism destinations and services, improving the quality of the experience for tourists and increasing income and employment[125].

This part of the toolkit focuses on the impact of proposed investment on **attracting visitors to an area**. By definition, this means attracting people from outside the target area – whether a local authority area, sub region or region - who will spend in this area, thus helping grow the local tourism economy. Visits by local people are considered under recreation and leisure [see section 9].

The types of green infrastructure projects likely to contribute most to the growth of the tourism economy are those:

- with a unique appeal in terms of the quality of the environment
- that provide a range or critical mass of activities on site, increasing value-added and on-site expenditure

Projects that attract people from outside the region and overnight visitors will generate greater off-site expenditure in the local economy.

Examples of sites that have developed strong tourism offerings based around the quality of their green infrastructure include:

Yorkshire Dales National Park

A study into the economic benefits of the Yorkshire Dales National Park found that the tourism economy was worth £235 million - 2004 prices - and that the landscape, cultural and human heritage were key factors underpinning the tourism sector[126].

The study quotes the results of a contingent valuation exercise which found that on average households were willing to pay £47 per year - 2004 prices - to enjoy the public benefits associated with upland areas across the UK[127].

A study by Eftec in 2006 found that cultural heritage - taken to mean the visual presence in the landscape of traditional farm buildings - is highly valued. The study found a **willingness to pay*** of between £3 and £11 by households in the region for a 1 per cent improvement in the attributes of the area's cultural heritage.

South West

A National Trust study examined the value of tourism associated with the conserved landscape in the South West. A survey of visitors leaving the area asked them to score the extent to which conserved landscape motivated their trip away from home. The average score given was 7.8 out of 10, which was directly translated into a motivation proportion of 78 per cent. Applying this factor to the region's tourism economy volume and value gave 12.6 million trips and £2.3 billion of expenditure motivated by the landscape[128].

New Forest

The New Forest attracts 30 million visitors per year and contributes some £60-70 million annually to the local economy as a result of its use as a recreational resource.

Oakland County

Oakland County in the US developed a green infrastructure strategy based around an interconnected network of open spaces, natural areas and watercourses. A study of the economic impact found that the county attracted 1.3 million people staying an average of 3.5 nights, generating $177 million of tourism

revenue. Over 40 per cent of the trips involved outdoor recreation and 20 per cent were water-based activities.[129]

ASSESSING THE BENEFITS

Qualitative assessment is based on the overall impact of the proposed investment on tourism, on a scale of low, medium and high:

- **low impact** - improves the setting for existing tourism use
- **medium impact** - improves access to public space for tourism use
- **high impact** - provides a new tourism resource and/or an integrated approach to access and enhance an existing resource.

QUANTIFYING

The starting point for quantifying the benefit is to understand the demand. In case the valuation is applied to an existing green infrastructure asset, visitor figures will most likely be available. If this is not the case, or for assessing the impact of a proposed green infrastructure intervention, an estimate of visitors will be needed:

- often a project sponsor will already have a baseline estimate of visitors and the potential increase in use
- where the project is new, a specific market study may have been done, looking at the tourism potential.

The toolkit provides guidance on a number of demand estimate methods, including:

- using a **density** factor based on the size of the infrastructure – for example the kilometres of footpaths
- **penetration rates** based on population drive-time catchment areas
- **benefit transfer** using tourism density from a similar site.

In estimating the number of visitors, there is a need to make a distinction between local leisure use by residents, and use by a visitor from outside the area. This will partly depend on the area of impact for the project – for example regeneration area, sub-region, or region.

Method 1: Density of use

Where the proposed green investment involves a cycleway or footway, it is possible to estimate the likely level of use based on density values from other sites or areas.

- British Waterways' economic impact model uses national data on density of use for walking and cycling per kilometre
- local authority leisure services departments may also have leisure use data to draw upon

An estimate of visitors is needed - so a deduction for local resident use is required.

Method 2: Population penetration analysis

This approach estimates the likely use of the green infrastructure by local residents, based on taking a percentage of the relevant population - drawing on household population data. The percentage penetration is based on evidence from other areas or green infrastructure projects, or a specific leisure use study.

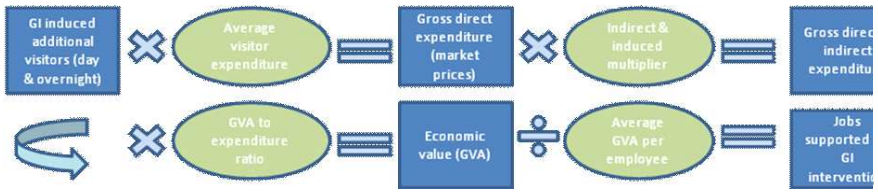
Method 3: Site transfer

This estimates the likely total number of visits based on the experience of other similar sites. For example, if a particular woodland of 50 hectares is known to have 25,000 visits per year, the density of use is 500 people per hectare. This can be applied to your project, based on the scale of the site after adjustment for the proportion of users from the local area.

MONETISING

In the majority of cases, the economic value of tourism can be estimated by using **market prices** based on visitor expenditure surveys or tourism economic models. This allows estimates of **visitor expenditure**, **gross value added** and **associated employment supported** to be made.
Figure 11 summarises the steps in estimating the tourism value of a green infrastructure investment.

Figure 11: Estimating the tourism value of a green infrastructure investment or asset



The key issue in tourism impact assessments is being able to estimate the **additional** number of visitors drawn to an area as a result of the green investment and the associated value.

Estimating the additional impact requires a judgement to be made about the primary purpose of the visit, and the extent to which the visit to the proposed project displaces activity from somewhere else. Where a project provides a unique offer to an area, displacement would be expected to be low. If there are alternative similar activities in the area, it could be that the proposed investment will simply displace existing tourism expenditure.

Average expenditure per visitor varies depending on the type of visitor, origin and in particular whether they stay overnight. Using the most appropriate daily expenditure is therefore important in estimating economic value and impact.

TOOLS AVAILABLE IN THE CALCULATOR

Tools	Input data	Tool basis
Tool 8.1: Tourism expenditure [■ Functional] Estimates the volume and value of tourism-related expenditure	Number of tourist visitors (defined as people from outside the target area) Average expenditure per day	Local expenditure surveys or tourism data sets such as the Scarborough Tourism Economic Activity Monitor (STEAM)
Tool 8.2: Employment supported by tourism [■Quantification and monetisation require good project data] Estimates the number of jobs supported by tourism activity and GVA associated with employment	Total additional expenditure Average expenditure required to support one full-time job in the tourism economy Number of jobs supported in the tourism economy Average GVA per employee in the tourism sector	The tool provides employment conversion factors to be applied to expenditure estimates

KEY EVIDENCE AND SOURCES

Market Values	
Visitor expenditure profiles	Survey data such as the England Leisure Visits Survey provides estimate of expenditure by type of use. Scarborough Tourism Economic Activity Monitor (STEAM) data provides information on day and staying visitor expenditure for a variety of spatial areas. Local economic partnerships and tourism bodies also conduct regular visitor expenditure surveys.
Benefit transfer values	
Density of visitors	It is possible to gather information directly from similar sites, or use the England Leisure Visits Survey which provides information on the use of open spaces. Also several studies in EVRI (**Environmental Valuation Reference Inventory***) on valuing benefits of national parks. Various tourism studies that quantify the economic value of national parks/attractions are available for the UK, e.g. through local/regional tourism authorities and/or local authorities.
Conversion factors	
Job conversion factors - the tourism expenditure required to support one job	STEAM data is available for many areas at the regional, sub-regional and local authority level.
Gross value added (GVA) per employee	The Annual Business Inquiry (ABI) data, the Office for National Statistics' survey of employment and financial information provides information on average GVA per employee by sub-sector. The figure for the hotels and restaurants sector is a reasonable approximation.
Gross to net conversion factor – enables the conversion of gross to net additional impact	BIS Occasional Paper Number 1 (Research to improve the assessment of additionality, October 2008) provides information on deadweight, displacement, and multipliers by types of projects. For regeneration-type projects (including tourism projects) the average gross to net ratio was 50%. This is used as a default value in the tourism tool. Project appraisers can select alternative gross to net factors where they have project-specific evidence.

KNOWLEDGE GAPS

There is a considerable amount of research on the economic impact of tourism and key attractions. This includes work on the tourism value of the environment.

A **library** of this information would be useful to help make impact estimates more specific to a green infrastructure context - by providing better information on additionality, density of use and average expenditure made by the types of visitors to green infrastructure-intensive projects.

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[122] National Trust, 2004 cited in Amion, *Economic value of green infrastructure*, 2008

[123] Amion, *Economic value of green infrastructure*, 2008

[124] Harnik, P and Welle, B *Measuring the impact of a city park system*, The Trust for Public Land, 2009

[125] Sustainable Tourism Partnership quoted in *Greenspace for a more successful and sustainable Scotland*, Green Space Scotland, 2009

[126] Courtney, P, Gaskell, P, Mills, J, Edwards, R A socio-economic study of grant funded dry stone walls and farm building restoration in the Yorkshire Dales National Park, CCRU and ADAS, 2007

[127] McVitie, 2005 cited in Courtney, P, Gaskell, P, Mills, J, Edwards, R *A socio-economic study of grant funded dry stone walls and farm building restoration in the Yorkshire Dales National Park*, CCRU and ADAS, 2007

[128] National Trust, *Valuing our environment: A study on the economic impact of the conserved landscapes and the National Trust in the South West*, 1998

[129] Oakland County Planning and Economic Development Services, Impact of Oakland County's green infrastructure on the local economy, 2009

9 Recreation and leisure

Green infrastructure provides opportunities for recreation

Relevant types of green spaces and features - assets or projects that give rise to recreational benefits include:

- parks and public gardens
- general amenity space
- outdoor sports facilities
- woodlands
- access to mountain or moorland
- water courses
- green corridors.

WHAT THE EVIDENCE SHOWS

Publicly accessible green space provides recreational and leisure opportunities for local residents.

Investment in green infrastructure can enhance access to natural green space and provide opportunities for various forms of formal and informal recreational activity. These include:

- hill walking
- casual walking
- freshwater angling
- bird watching
- game shooting
- cycling
- horse riding
- golf
- gardening
- water sports.

In addition, green infrastructure can be seen as a cultural asset that helps to give an area a sense of identity[130].

Each recreational activity has a different degree of reliance upon natural ecosystems – for example bird watching has a higher reliance than say hill walking. However, it is likely that enjoyment would decline markedly following any degradation of the natural environment.

Studies have shown that the value attached to such investment by the public will vary across different forms of recreation and will be area-specific[131]**.** It is therefore important that consideration is given to the applicability of **benefit transfer values**.

The approach to estimating the monetary value is based on an understanding of:

- the **scale** of the intervention or existing asset - for example kilometres of cycleways or footpaths provided
- its **contextual setting** - urban or rural
- recreational use - for example walking, cycling, or fishing.

An impact has been noted in the following case studies – but these may not be generally applicable.

National Ridgeway Trail

As with other public rights of way, the public do not pay for the use of national trails, but they do have an economic value. A survey of users of the National Ridgeway Trail found that on average walkers were willing to pay £1.85 per visit - based on an average visit lasting six hours and visiting the trail six times a year[132]. A similar study found that birdwatchers visiting forests were willing to pay £8.64 per visit[133].

Forests

A study into the economic and environmental benefits of forests estimated the **marginal benefit*** of visits in the range of £1.66 to £2.75 per recreational visit[134]. The study was based on recreational surveys across seven forests in England and Wales. The total recreational value of the forest system was estimated at £393 million (2002 prices).

The report highlighted that marginal recreational benefits varied according to the attributes of the forests. These attributes included:

- the size of forest
- percentage coverage of broadleaves, larch
- the presence of a site of special scientific interest (SSSI).

The recreational **willingness to pay*** estimates ranged from £1.10 for Epping Forest to £3 for Delamere Forest.

Parks

The park system of Boston in the US was designed to provide a series of open places accessible to all. Today across Boston there are 5,040 acres of parkland space, supporting a wide range of recreational activities.

In a study on the economic benefits of Boston's parks by the Trust for Public Land[135], residents were asked to value their direct use of the open green space for:

- general use – such as walking
- sports – for example cycling
- special uses – for example golf.

The study found an average value attributed to each use of $1.9, $3 and $9 respectively (2006 prices).

ASSESSING THE BENEFITS

Qualitative assessment is based on the overall impact of the proposed investment on recreation, on a scale of low, medium and high:

- **low impact** - improves the setting for existing recreational use
- **medium impact** - improves access to public space for recreational use
- **high impact** - provides an integrated approach to access and the enhancement of recreational space.

QUANTIFYING

In order to measure the benefit, the starting point is understanding the relationship between the green infrastructure investment and the direct leisure use that it enables. For example, the introduction of a new path or cycleway will enable recreational use. The protection of wildlife or rivers will support uses such as bird watching or angling.

There are a number of ways to estimate use by residents – two are outlined here. If a user demand assessment has already been done, this can be used to underpin the benefit assessment tool.

The estimate of the total number of users can either estimate an overall number of users, or break the number down by different types of activity – for example walking, cycling. Which approach is used will depend on the type of green asset and the level of understanding of the end users.

Method 1

This involves analysis of the **number of people in a catchment area** - based on varying distances from the green infrastructure - and the **average frequency of use**.

total demand = total population in catchment x average frequency of use for the type of activity

Census and other leisure surveys can be used to set an appropriate frequency of use.

Method 2

An alternative approach is to estimate the **population in a catchment area** and apply a **participation factor** and a **frequency factor**.

total demand = total population in catchment x participation in recreational activity x frequency of use

MONETISING

The approach to estimating the recreational economic value of a particular green project involves:

- assessing the expected change in visitors as a result of the project - based on a visitor demand estimate
- assessing the 'associated consumer surplus value' – the willingness to pay.

As there is often no market price for the recreational service - for example an entrance fee or permit fee - an appropriate **benefit transfer monetary value** is needed to provide a proxy for a persons' willingness to pay.

A more sophisticated approach is the **transfer function method**. This enables the transfer value to take account of the specific context – for example the socio-economic characteristics of an area. However, this requires that the study being drawn upon has provided details on the willingness to pay. Alternatively, for major green investments, a willingness to pay study could be done.

There are a number of key sources that summarise the results of benefit transfer studies:

- the most significant database is EVRI (**Environmental Valuation Reference Inventory***) – however it is not always up-to-date
- new evidence may come from academic studies and evaluations by Defra, the National Trust and British Waterways

- guidance on the application of benefit transfer is available from Defra[136].

Figure 12 summarises the steps involved in estimating the economic value of recreational activity enabled through green infrastructure investment.

Figure 12: Estimating the economic value of recreational activity induced by green infrastructure

TOOLS AVAILABLE IN THE CALCULATOR

Benefit valued	Input data	Tool basis
Tool 9.1: Recreational value [■ Functional] Estimates the willingness to pay for various types of outdoor recreation	Number of local people using green infrastructure for recreational purposes. Profile of types of activity enabled by the green infrastructure asset	A quantitative approach based primarily on a non-marketed valuation methodology

KEY EVIDENCE AND SOURCES

Market values/recreational use	
Leisure use surveys provide details on population penetration rates and average expenditure for different leisure uses.	England Leisure Visits Survey
Census data provides estimates of the frequency that people take part in different leisure activities and participation rates.	Results from the Sports and Leisure Module *General Household Survey 2002*, National Statistics, 2004
Benefit transfer values	
Department for Transport (DfT) provides an estimate of the value of leisure time to be employed in transport economic appraisal.	2009 DfT Web Tag guidance sets an average value of £4.46 per trip.
The tool uses a selection of values drawn from EVRI applicable to different leisure uses.. Examples include (per trip): Hill walking = £1.85 Casual walking = £5.59 Freshwater angling = £2.21 Bird watching = £8.64 Game shooting = £1.11 Cycling = £16.37 Horse riding = £15.53 Woodland visit (local up to 10 miles) = £0.90 Rutland Water Nature Preserve (multiple uses) = £25.50 General park use = £0.96 Use of green space = £4.46 **-!- Where a general use value* is used** - for example the value for general use of park space - **it is important not to double count a specific leisure use** - such as cycling.	Environmental Value Reference Inventory (EVRI) provides a database of studies. See also recent work by Jacobs on behalf of Defra and British Waterways (2009) on valuing the benefits of Britain's inland waterways. This includes recreational value. Earlier work by Sheffield Hallam University on this topic might also be useful.

KNOWLEDGE GAPS

The primary issue for estimating recreational values is keeping abreast of new studies providing up-to-date information or a wider variety of activity and context-specific benefit transfer values. The **Environmental Value Reference Inventory (EVRI) database** is the key repository for studies and is the first port of call. However, it could be worthwhile for a green infrastructure-specific **filter** to be developed, to aid the identification of relevant information and values.

The collection of **density information** across a range of green infrastructure projects would be helpful to enable rapid and more robust demand assessments for a project. The frequency of participation in leisure uses is also an area requiring simplification.

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[130] AMION, *Economic benefits of green infrastructure,* 2008

[131] O'Gorman and Bann, Valuing England's terrestrial ecosystem services, a report to Defra, 2008

[132] Bennet, 2003 cited in O'Gorman and Bann, *Valuing England's terrestrial ecosystem services*, a report to Defra, 2008

[133] Christie, 2006 cited in O'Gorman and Bann, *Valuing England's terrestrial ecosystem services*, a report to Defra, 2008

[134] Forestry Commission, 2003

[135] Harnik, P and Welle, B *Measuring the impact of a city park system,* The Trust for Public Land, 2009

[136] Eftec, *Valuing environmental impacts: guidelines for the use of value transfer*, 2010

10 Biodiversity

Investment in green infrastructure can improve and protect habitats, provide ecosystem services such as pollination, and support biodiversity

Relevant types of green spaces and features – all green infrastructure supports biodiversity, but the conservation, enhancement and restoration of biodiversity should be a key output of green infrastructure investment:

- green space in towns and cities provides habitat and migration routes, making the urban area more permeable
- designated sites – SSSIs, NNRs, SACs and so on [see table] – are recognised as having high biodiversity value.

WHAT THE EVIDENCE SHOWS

Investment in green infrastructure can lead to better management of land, supporting **ecosystem services*** and biodiversity.

Biodiversity[137] provides non-use values to individuals within society. These reflect peoples' cultural concerns, or concerns about the preservation of particular habitats or species. These form the main pillar of the valuation approach in the toolkit.

Investment in green infrastructure also contributes to maintaining critical supporting ecosystem services such as the carbon and water cycles. From these, direct and indirect benefits are realised, and these are covered in sections 1 and 2 of this guide.

Investment in green infrastructure can help reverse habitat fragmentation and increase biodiversity. In urban areas, larger sites – urban parks and community woodland – are most valuable, but smaller sites play a vital role as part of a patchwork of green space through which species can move[138]. Urban trees are important, offering a range of habitats for insects and birds.

Key factors influencing the value of green infrastructure for biodiversity are:

- the typology - the woodlands, urban forests, ponds, rivers and riverbanks, parks and gardens, allotments and cemeteries
- the quantity/area
- proximity of other sites.

A small, isolated site is likely to have lower value than a larger site which forms part of a mosaic of green space.

A study of four urban areas on Merseyside revealed that the greatest influence on their ecology was the proportion of green space, particularly trees.[139] Other studies[140] have shown the importance of **networks** of sites, allowing species to move between and through urbanised areas: this will be increasingly important for species' adaptation to climate change.

ASSESSING THE BENEFITS

Many areas in the UK are subject to international, national or local habitat and biodiversity designations. Investment which improves these sites is likely to have high value. Designations include:

SAC (Special Area of Conservation)	International statutory designation - Natural England
NNR (National Nature Reserve)	National statutory designation - Natural England
SSSI (Site of Special Scientific Interest)	National statutory designation - Natural England
LWS (Local Wildlife Site)/ BNS (Biological Notification site)	Local non-statutory designation
RIGS (Regionally Important Geological/Geomorphological Sites)	Local non-statutory designation
LNR (Local Nature Reserve)	Local statutory designation

Other important strategies and targets for biodiversity improvements include:

Ancient Woodlands	National, non-statutory – Natural England and Forestry Commission
UK Biodiversity Action Plan (BAP) Priority Habitats and Species	National – Natural England. Translated into local action through the local BAP
BOA (Biodiversity Opportunity Areas)	Non-statutory, local/regional
Important networks of habitats	Under national planning policy statement 9, biodiversity and geological conservation (PPS9)

Even where they are not specially designated, some types of habitat always have special biodiversity value, including wetlands and lowland forest. Likewise, in urban areas, street trees and green space can be very important locally.

QUANTIFYING

Some quantification of benefits can be linked to national biodiversity targets within the UK Biodiversity Action Plan, translated into local BAP Plans.

- **Status** – Designation: European site (SAC/SPA), SSSI, Local Wildlife Site, LNR, Identified Biodiversity Opportunity (from biodiversity opportunities map). With Local Wildlife sites there is a link to NI197 and DCLG guidance for local authority monitoring
- **BAP Habitat** - contribution to National BAP target (and potentially regional BAP target). Some targets area based on area (Ha) which gives a quantitative measure
- **BAP Species contribution** – potential for supporting a species from the BAP list, located within
- **Support for protected species** – as above for protected species.
- **Ecological network contribution** – contribution to an identified Ecological Network/Framework area
- **Broad (local) ecological value** – potential to develop ways of recognising the broader ecological value of a proposal in supporting local biodiversity, including improving access to nature, contact with wildlife and support for local species.

MONETISING

Biodiversity is generally treated as a non-use value, based on research studies into individuals' **willingness to pay*** to protect and maintain particular habitats or species - which they may never themselves see.

The evidence base is stronger for designated areas – for example national parks, Natura 2000 sites, SSSIs - than for non-designated sites such as parkland and other green space.

Values for designated areas vary greatly:

- Jacobs cites a willingness to pay value of £0.41 to £1.14 per household per year for preserving or creating individual SSSIs[141]
- another study estimates a value of £12.29 per person per year for preservation of the Norfolk Broads.[142]

There is less valuation evidence for other, non-designated sites:

- research on woodland and forestry gives biodiversity values of £0.33 (lowland conifer) to £0.90 (upland native broadleaf) per household per year for an increase in 12,000 hectares of commercial woodland[143]
- Eftec's study on undeveloped land[144] includes figures for 'ecology' which may be applicable (but care is needed to avoid double-counting the other benefits included)
- research undertaken to inform agri-environment policy[145] places a monetary figure of £906 (1999 prices) per hectare on biodiversity, an average estimated willingness to pay from a variety of studies.

However, these values depend on how biodiversity is defined.. Values elicited by respondents to willingness to pay surveys will also strongly reflect the extent to which they believe the particular habitat being valued is under threat. If they perceive little or no threat, the value they offer is likely to be low. If they are aware of a real or present danger, then the value is likely to be significantly higher.

TOOLS AVAILABLE IN THE CALCULATOR

Benefit valued	Input data	Tool basis
Tool 10.1: Willingness to pay for protection or enhancement of biodiversity [■ Functional]	Type and area of site. Accessibility.	Application of benefit transfer values from appropriate studies. (area X appropriate benefit transfer figure = value) – but care needed on application

KEY EVIDENCE AND SOURCES

Benefit transfer values	
There are a wide range of possible transfer values which could be cited from the literature. However, there does not appear to be widespread support for the use of willingness to pay values as a mechanism for valuing biodiversity.	

KNOWLEDGE GAPS

The main challenge for future work is to extend valuation to urban areas. While there has been research in rural areas to inform national policy on agriculture and water management, there is little evidence which can be readily applied to urban biodiversity values.

There is significant ongoing work on trying to understand the relationship between biodiversity, ecosystem functioning and human wellbeing. As this work evolves, the toolkit should take account of the findings and best practice valuation approaches.

[137] Jacobs, *Valuing England's terrestrial ecosystem services*, 2008

[138] Landuse Consultants, *The environment, economic growth and competitiveness. The environment as an economic driver*, 2006

[139] Cabe Space, *Does money grow on trees*?, 2005

[140] Cabe Space, *Does money grow on trees*?, 2005

[141] Jacobs, *Valuing England's terrestrial ecosystem services*, 2008

[142] Bateman and Langford, *Non-users' willingness to pay for a national park,* 1997

[143] Garrod and Willis, *The social and environmental benefits of forestry*, Forestry Commission, 2003

[144] Eftec, *Valuing the external benefits of undeveloped land*, 2009

[145] MAFF/Defra, *Estimating the value of environmental features*, 1999

11 Land management

Green infrastructure includes land in productive use in the countryside. Managing this land provides employment opportunities, and investment to reinstate degraded land - in both urban and rural environments - can restore ecosystems and reduce land management costs.

Relevant types of green spaces and features – all land types, including:

- agricultural land
- commercial forestry and woodland
- moorland
- allotments and community orchards in urban settings
- urban green space
- parkland
- country parks and nature reserves.

WHAT THE EVIDENCE SHOWS

The green infrastructure 'sector' is a major employer nationally. Agriculture, hunting, forestry and fishing[146] alone employ some 247,000 people in the UK.

Investment can provide new opportunities for agricultural diversification for food and non-food crops, as well as providing the resource to generate renewable sources of energy, including growth of biomass and biofuels. Diversification of agricultural production can also be encouraged to meet local market demand, and produce added-value, regionally distinctive food and drink.

In an urban context, community assets such as allotments and community orchards provide opportunities for communities to come together, as well as providing fresh, locally-sourced produce.

Green infrastructure such as urban and country parks and community forest require ongoing operation and maintenance which supports jobs. A study commissioned by CABE in 2009[147] estimated that some 122,000 people were employed in the green space sector, including:

- public parks departments
- nature reserves
- botanical/zoological gardens
- landscape services
- architects.

The level of employment supported by green infrastructure can vary greatly according the **land type and use**. Maintaining the quality of urban public space will require greater resource than open moorland. The **level of public access** is likely to be an important determinant, as will the **attitude of the landowner**.

Reducing management costs

Green infrastructure investment can itself have an impact on long-term management costs. For example, investment in derelict industrial sites can be an efficient and effective land remediation strategy. The Land Trust has been managing a number of remediated sites in this way since its establishment of the Land Restoration Trust in 2005.

Trees can absorb pollutants as part of natural biological processes. Through repeated felling and removal of the timber the level of contamination can be reduced, and leaching of pollutants to groundwater lessened[148]. Creation of new green space can provide new habitat, enhancing the value to local wildlife - and where sites are also publicly accessible, there is new green amenity space for the local community.

Reinstating ecosystems has the potential to reduce management costs. For example, traditional intensive management strategies can require significant and costly inputs in the form of nutrients, herbicides and pesticides. Restoring ecological balance and making land more self-sustaining can reduce the need for these inputs[149], though overall production may fall. Likewise, investment to reinstate natural hydrological systems in upland moorland, through blocking of drainage channels - 'grips'[150] - can deliver downstream benefits. [See also section 2].

QUANTIFYING

A market valuation of produce – for example wood, biomass, crops - could be carried out using current market prices. Sources for this data could be built into the toolkit, but the maintenance task to keep them up-to-date would be demanding. Likewise, it is possible to view productive land as a commodity itself - which provides the opportunity for productive use and an income stream, measured by market value.

A proxy for the value of a particular land use is the **employment it sustains**. This is a similar approach to that taken by project assessors in looking at traditional economic investments, where employment impacts can be an important output.

Based on data from Land Restoration Trust project appraisals for various site end uses, table 3 gives an indication of the potential direct employment per hectare for different land uses. The figures vary greatly – an urban nature reserve can require intensive management.

Table 3: Employment supported by green infrastructure assets

Employment in different land uses	Jobs/hectare
Urban core (public space, city park)	0.026
Urban allotments, community gardens, orchards	Volunteers
Urban fringe (forested land)	No data
Urban fringe (country park/mixed amenity)	0.011
Urban nature reserve	1.53

MONETISING

For productive land, an assessment can be made of the market value of the products. Again, no market values are provided in the toolkit because they would very quickly become out of date.

Valuing the employment supported by green infrastructure can be undertaken by multiplying jobs to average sectoral gross value added values - around £20-£30,000 per year[151]. For many projects, employment figures will be an integral part of the project plan, and included in maintenance costs.

TOOLS AVAILABLE IN THE CALCULATOR

Benefit valued	Input data	Tool
Tool 11.1: Market value of products [■Quantification and monetisation require bespoke appraisal]	Quantity and type of product (for exmple crops, biomass, wood etc) Market value of products	Quantity x market value
Tool 11.2: Employment –based GVA generated by land management [■ Functional]	Actual employment figures (where known). Estimated employment figures (based on table above). Gross value added (GVA) value for jobs by sector	Jobs (no) x sectoral GVA value

KEY EVIDENCE AND SOURCES

Market Values	
Market value of products from the land	Not included here. Current values should be sourced by project developers.
Benefit transfer values	
Employment/hectare of land for different land uses, including commercial and publicly-owned.	
GVA values for employment in relevant sectors	

KNOWLEDGE GAPS

Further work to develop the range of employment figures by land type/use would be useful.

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[146] ONS, *Employment in agriculture, hunting, forestry and fishing*, 2009

[147] CABE, *Green space skills 2009: National employer survey findings*

[148] National Urban Forestry Unit, *Trees matter*, 2005

[149] Town and Country Planning Association, 2004

[150] United Utilities Sustainable Catchment Management Programme (SCAMP)

[151] Bridge Economics, *Environmental economy report for the North West*, Environment Agency, 2006.

The environmental economy of the North West was valued at £2.6 billion annual gross value added, supporting 109,000 jobs, equivalent to gross value added/job of £23,853

Glossary

Mt – million tons

tC – tons of carbon

CO_2e - equivalent carbon dioxide

Discounted cash flow analysis: a way of estimating the value of an investment in today's money by adjusting future returns to get their present value.

Discount rate: (*) the rate used to reduce future benefits and costs to their present-time equivalent.

Ecosystem approach: (*) a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. An ecosystem approach is based on the application of appropriate scientific methodologies focused on levels of biological organization, which encompass the essential structure, processes, functions and interactions among organisms and their environment.

Ecosystem services: (*) the goods or services provided by the ecosystem to society. In order for an ecosystem to provide services to humans, some interaction with, or demand from, people for the good or service concerned is required.

Environmental Valuation Reference Inventory (EVRI): a comprehensive storehouse of over 2,000 international studies providing values, methodologies, techniques and theories on environmental valuation. https://www.evri.ca/Global/Splash.aspx

Externalities: (*) uncompensated side effects of human actions. For example, if a stream is polluted by runoff from agricultural land, the people downstream experience a negative externality.

Indices of Multiple Deprivation (IMD): composite indices developed by the Office of National Statistics to identify areas of multiple deprivation. Levels of deprivation are measured for a number of separate dimensions or 'domains' such as income, employment, education and health. These dimensions, sometimes referred to as 'domains' are then aggregated to provide an overall measure of multiple deprivation and each individual area is allocated a deprivation rank and score. The indices are used to help target policies and funding, and reinforce a common goal to improve the quality of life in disadvantaged communities.

Long run marginal cost: this refers to the cost of providing an additional unit of service or commodity under the assumption that this requires investment in capacity expansion. A long run marginal cost for a wastewater treatment company is to have to build a bigger plant. The costs will vary from how fast the demand for water treatment is growing, how far are existing plants from being at capacity, and so on.

Managed realignment: this is the deliberate process of altering the line of river, estuary or coastal defences. This can include widening a flood plain, lowering or moving flood defences, often to create or recreate natural habitats such as salt marshes and mudflats, which then act as a natural form of flood and storm defence. A key aspect of this is the goal of establishing more sustainable estuarine, riverine or coastal forms, better able to deal with natural processes, surge tides and heavy rainfall. The creation of these natural areas also has nature conservation benefits.

Marginal abatement cost: carbon emission reductions usually involve some costs, often the cost of investing in new technologies or processes. The total cost of reducing emissions is known as the abatement cost. The marginal abatement cost refers to the cost at a given time of eliminating an additional unit of emissions.

Marginal benefit: this is a way to measure change in benefits over the change in quantity. For example, it could refer to the value of the benefits of an additional recreational visit for a tourist site.

Natural Economy Northwest (NENW): The Natural Economy Northwest £3million, 3 year programme ended in December 2009 – a partnership led by Natural England, the Northwest Regional Development Agency and SITA Trust. The Natural Economy Northwest team worked with a wide range of partners and stakeholders to reposition the natural environment within sustainable futures, and to encourage proper investment in the natural environment by developing a framework for establishing the economic value of such investment. For further information please see: www.naturaleconomynorthwest.co.uk

Net additionality: this is the net positive difference that results from economic development intervention, or any other type of investment.

Net present value (NPV): (**) a calculation used to estimate the value – or net benefit – over the lifetime of a particular project, often longer-term investments. NPV allows decision-makers to compare various alternatives on a similar timescale by converting all options to current pound figures. A project is deemed acceptable if the net present value is positive over the expected lifetime of the project.

(*) the sum of the present and discounted future flows of net benefits. A discount rate is used to reduce future benefits and costs to their present time equivalent.

Option value: (*) the value that people place on having the option to enjoy something in the future, although they may not currently use it.

Quality Adjusted Life Year (QUALY): this provides a way to measure the outcomes from treatments and other health-influencing activities not only in terms of life expectancy (increase in length of life) but also in terms of quality of life.

Regression analysis: in statistics, this refers to the techniques for modelling and analysing several variables and identifying their relationships.

Regression models: are used to predict one variable from one or more other variables.

Rewetting scheme: this is the deliberate process of elevating the average annual water table in an area by partially or completely removing the drainage controls previously put in place.

Total economic value: (*) the sum of the direct use, indirect use, option and non-use values for a good or service.

Use value: (*) value derived from actual use of a good or service. Uses may include indirect uses. For example, the buffering impact of upstream forests on downstream water flows provides an indirect use value of the forest for downstream water users.

Willingness to pay: (*) the amount of money (or goods or services) that a person is willing to give up to obtain a particular good or service.

Sources:
(*)Environmental Economics Toolkit, United Nations Development Programme – Global Environment Facility, 2006
(**) Environmental Economics, The Essentials, Environmental Literacy Council, 2007

Appendix 1: Case studies

ERITH MARSHES & BELVEDERE LINKS, BELVEDERE, London Thames Gateway

"***We watch with interest the evolving concept of the valuation toolkit for its potential to help in attracting future investment in green infrastructure.***" London Borough of Bexley

Belvedere and the nearby towns of Erith and Thamesmead [in the boroughs of Bexley and Greenwich] lie in the London Thames Gateway growth area. They are characterised by a low skill, low wage economy that struggles to sustain a retail and wider amenity offer. The area's main employment location of Belvedere is blighted by 70ha of vacant or derelict land. In order to attract new businesses a new link road has been planned, with the intention of opening up the area.

The site enjoys a unique environmental setting. It is immediately adjacent to the Erith Marshes, a site of regional importance for nature conservation. Underinvestment in the environment of the area needed to be addressed in order improve access, flood prevention, recreation and biodiversity as a way of maximising the functionality of the green infrastructure. The local network of drainage dykes has received little or no maintenance in recent years and its restoration is considered vital in preventing the flooding of low-lying residential areas. Pedestrian and cycleway improvements (green links) are also planned.

The Erith Marshes and Belvedere Links project aims to enhance the environmental quality of the marshland and to improve its accessibility from the surrounding area. In turn, this is expected significantly to increase the attractiveness of the Belvedere employment site to higher value businesses.

The green infrastructure valuation toolkit has been used to evaluate the benefits of this significant investment in the marshes and adjacent area. As recommended in this guide, a three stage process was applied.

Preparation: Understanding physical characteristics and beneficiaries

The project would be focused on 156ha of existing marshland, including 15km of drainage dykes, and the redevelopment of 12.5ha of derelict land, which would be made possible by the construction of the new link road.

The works will greatly improve access, security and sustainability in Belvedere, with a range of long term benefits for local employers, staff and residents. The main direct beneficiaries of the new access and enhanced greenspace are expected to be local residents. Based on an analysis of the number of households, the number of residents living within 300m and 1200m of the project were estimated to be over 5,000 and around 47,500, respectively. [Actual figures are 5,164 and 47,518, but this sounds too precise!]

The number of recreational users is predicted to be 237,600 (based upon a likely 10 visits each year, 50% of which are assumed additional to the existing baseline figure).

Assessment: Identifying potential benefit areas and applying relevant tools

As a natural greenspace area, the marshes are considered likely to have a positive impact on climate change adaptation, flood alleviation and general quality of place. The green corridor element of the project (paths and cycleways) is likely to have tourism, transport [it seems obvious we that we should mention it, although Genecon haven't costed transport benefits] and public health and well-being benefits.

The different elements of green infrastructure within the project (exact area of canal, wetland, different types of grassland, woodland and length of footpaths and cycleways) have been analysed in the context of the likely beneficiaries.

The relevant tools were applied to assess the value of the benefits identified in monetary terms (for those benefits that could be costed) quantitative terms or qualitative terms. Some valuations were expressed as a precise figure, whereas others were expressed as falling within a range of figures. For valuation purpose, most benefits were deemed to last for 10 years, although some were deemed to last for longer periods. In each case, the valuations were discounted to give a present value (PV) figure, so that benefits which accrued for different lengths of time could be easily and directly compared.

Reporting: Articulating a strong return on investment case

The benefits were calculated as follows:

- Climate change adaptation and mitigation

  The marshes and other areas of greenspace exhibit a significant urban cooling effect. This benefit, though uncosted, is recognised as having an impact on 2,000 to 2,500 households within 300-450m of the marshes.

- Water management and flood alleviation

  Energy costs and carbon emissions relating to water treatment will be reduced through improvement of the natural drainage system on the marshes. The value of these benefits were calculated to be £0.6 million and £0.3 million, respectively, at present value (PV).

- Health and wellbeing

  The calculation of reduction in mortality rates from increased take-up of moderate exercise (walking and cycling) was estimated to be £7.4million (PV) for walking and £1.5 million (PV) for cycling.

- Land and property values

  Residential land and property uplift within a 450m radius of the site was estimated to be £9.5 million (PV).

- Investment

  An earlier study considered employment and environmental outputs from the Belvedere Link road on its own, from the marshland improvement and green links on their own and from a combination of the two. For employment, by 2016 the link road alone might provide an additional 2,200 jobs, and the green links 650, but together the increase is predicted to be a net 8,700. Adjusted for the relative importance of the green infrastructure, the estimation of site employment capacity and employment based GVA assessment was £31 million (PV).

- Labour productivity

  Reduced absenteeism was calculated to be worth between £0.1 million and £0.5 million (PV).

- Recreation and leisure

  Based on a "willingness to pay" measure, the recreational benefits were estimated to be £1.64 million (PV).

- Biodiversity

  Erith Marshes are some of the last remnants of grazing marshes in south London. It is recognised that their enhancement through this project will bring increased qualitative biodiversity benefit, especially the promotion of rare and specially protected species such as the water vole.

- Land management

  Direct management of the land was estimated to generate employment for three people, calculated at a benefit value of £0.6 million (PV).

Summary

The total value of the benefits generated by the improvements was estimated to be £53.1 million - £55.8 million (PV). Just over half of this (56%) was accounted for by that aspect of the site's increased employment potential which was considered attributable to the green infrastructure. The other significant benefits included land and property uplift, improved labour productivity from fewer working days lost, enhanced health and well-being, recreation and flood alleviation.

The capital investment is to be made by regeneration and economic development agencies. The total cost of £10.54 million includes the road construction and just £1.84 million of this relates to the landscape improvements. This case study illustrates the challenge of how best to capture the relative impacts of green and grey infrastructure. Without the link road, the number of jobs attracted would be low, but with improved access, the importance of improved environment becomes much greater.

This project therefore shows a very good rate of return on investment in the natural environment.

KNOWLEDGE QUARTER, Liverpool

"The toolkit enabled us to provide a robust figure that showed the value of investing in green infrastructure in the heart of Liverpool. In this case street trees and green roofs were the predominant types. Retaining green infrastructure in the projects to regenerate the area from the design stage to implementation will require this strong economic evidence." The Mersey Forest

Liverpool's Knowledge Quarter (LKQ) is a diverse inner city neighbourhood which includes three universities, the two cathedrals, a large teaching hospital, a concert hall, theatres, restaurants and bars. It also contains a residential district which includes some attractive Georgian streets and squares. LKQ is within easy reach of the M62 motorway, main railway links and the Mersey Tunnels. However, the physical setting is fragmented, both environmentally and socially, by piecemeal planning, poor pedestrian access, inappropriate highways schemes and general neglect of the public realm.

LKQ is identified as a strategic employment site within the north-west of England. An Urban Design and Public Realm Framework was produced in 2007. The framework set out a long term vision to reconnect the area with a strong network of enhanced spaces and connecting routes. A programme of street improvements (projects estimated at £15 million) and place improvements (projects estimated at £7.25 million) was proposed.

As a follow-up to the public realm framework, a Green Infrastructure Enhancement Plan was commissioned. This maps existing green infrastructure and identifies opportunities for its extension. The plan proposes a net gain in green cover of 7.7ha, increasing it from 37.7ha (22% of the area) to 45.4ha (27% of the area). This increase is planned to be primarily in the form of street trees and green roofs, with some additional green spaces.

The green infrastructure valuation toolkit was used to evaluate the benefits of this proposed investment in the LKQ. A three stage process was applied.

Preparation: Understanding physical characteristics and beneficiaries

The main new contribution to the planned green infrastructure is from the inclusion of a significant area of green roofs in the new hospital and university buildings and the planting of an additional 3,300 trees. Existing parks, private gardens and smaller spaces are also included.

The direct beneficiaries of the proposed GI enhancement plan will be residents and visitors to the LKQ, including employees, students and patients at the hospital. These are as follows:

university staff	11,250
other employees	15,000
students	45,200
residents	7,500
patients	unknown
visitors	unknown

Assessment: Identifying potential benefit areas and applying relevant tools

Street trees and green roofs are considered likely to confer a range of benefits, including climate change adaptation, flood alleviation, property value enhancement and general employment uplift.

The relevant tools were applied to assess the value of the benefits identified in monetary terms for those benefits that could be costed, as well as other quantitative terms and qualitative terms. Some valuations were expressed as a precise figure, whereas others were expressed as falling within a range of figures. For valuation purpose, some benefits were deemed to last for 10 years and some for 25 years. In each case, the valuations were discounted to give a present value (PV) figure, so that benefits which accrued for different lengths of time could be easily and directly compared.

Reporting: Articulating a strong return on investment case

The benefits were calculated as follows:

- Climate change adaptation and mitigation

  Savings in energy costs from the reduction in heating of buildings and savings in carbon emissions through increased shelter were estimated to be £3.4 million - £4.7 million, present value (PV).

  A small benefit from the value of stored carbon in trees was calculated at £6K - £18K (PV).

- Water management and flood alleviation

  Avoided surface water charges and reduced carbon emissions from reduced water treatment (primarily due to green roofs) were calculated to be worth £1.6 million – £2.0 million (PV).

- Place and communities

Clearly, one of the major benefits of such a substantial investment in the public realm is the improvement to quality of place, though placing a monetary value on this was not possible.

- Health and wellbeing

  Calculation of savings from pollution control benefits amounted to £14K - £112K (PV).

- Land and property values

  Over 2,000 houses within the LKQ and over 4,000 just outside (within 450m) were deemed to benefit from property value uplift amounting to £1.7 million - £6.7 million (PV). [Not sure this compares with property uplift for Erith Marshes, which is much more.]

- Investment

  Assuming a 3.5% - 4.6% annual GVA growth rate over the next decade, 5,600 – 8,000 additional jobs are expected be created in the LKQ. Assuming that 20% of this is attributable to overall public realm improvements and one third of this, 7%, is attributable to the green infrastructure, this equates to £23 million - £32 million (PV).

- Land management

  Employment directly supported by the additional greenspace is calculated to be 1.5 full-time equivalent posts, which is calculated to be £40K (PV).

Summary

Use of the toolkit demonstrated that the value of the green infrastructure benefits would amount to between £29.3 million and £45.6 million (present value). 70%–78% of this return is accounted for by increased employment benefits and 10%-12% by climate change adaptation benefits. The value for money test shows that, on a proposed landscape capital investment of £29.7 million, at the lower estimate of value, the benefits almost cover the cost of investment and at the higher end of the range there is a definite positive return. The benefit value is likely to have been understated, since there are considerable benefits to both hospital patients and visitors to the area, neither of which have been quantified.

ROPNER PARK, Stockton-on-Tees

"The toolkit provides some really useful data to demonstrate the multi-functional nature of the park and its social, environmental and economic value. For a site like Ropner Park this helps to justify previous capital investment, and can be used to support the case for maintaining high-standards of management in the future in order to maximise the benefits to local people and the Borough as a whole"

Stockton-on-Tees Borough Council

Stockton-on-Tees is one of five boroughs within the Tees Valley in the north-east of England. It is an area of traditionally heavy industry. Stockton's population is around 178,000, and that of the wider metropolitan region is around 651,000.

Ropner Park is a Victorian urban park, established in 1893 as Stockton's principal park. It covers an area of 15.5ha. The park is laid out in a classical style, with grassed areas, formal bedding, bowling greens, a fountain, a bandstand and an ornamental lake. In 2006 Ropner Park underwent a major refurbishment, with substantial landscape restoration, construction of a pavilion, tennis courts, a play area and the installation of an art feature. The total cost of this work was nearly £3.5 million, 69% of which was funded by the Heritage Lottery Fund, with the balance funded by Stockton-on-Tees Borough Council.

The green infrastructure valuation toolkit was used to evaluate the benefits of this significant investment in the park.

Preparation: Understanding physical characteristics and beneficiaries

The physical characteristics of the park were analysed to establish the extent of each green infrastructure asset, such as area of woodland, rough grassland, lawn and open water.

Then the likely beneficiaries were identified. These were deemed to be visitors to the park (103,500 per annum) and also the people who live within its range (over 4,500 within 300m and over 22,000 within 1200m) and those businesses which are located nearby (over 70 within 300m and over 1000 within 1200m).

Assessment: Identifying potential benefit areas and applying relevant tools

The next stage was to consider which of the 11 green infrastructure benefits were likely to be significant. Parks and formal gardens are likely to have a good climate change adaptation impact, particularly for temperature regulation. This type of space is also likely to contribute to quality of place, improved health and well-being, uplift of land and property value as well as tourism and recreation and leisure. Information on beneficiaries and maintenance levels (both in terms of density of population and level of park use) both point to a good likelihood of those benefits occurring.

Looking into the green infrastructure assets in greater details confirmed this initial assessment, but it allowed the evaluation to be further refined.

The relevant tools were applied in order to assess the benefits. These were valued in monetary terms for those benefits that could be costed, as well as other quantitative terms and qualitative terms. Some valuations were expressed as a precise figure, whereas others were expressed as falling within a range of figures. Some benefits were deemed to last for 20, 30 or even 50 years. In each case, the valuations were discounted to give a present value (PV) figure, so that benefits which accrued for different lengths of time could be easily and directly compared.

Reporting: Articulating a strong return on investment case

The benefits were calculated as follows:

- Climate change adaptation and mitigation

  The park, as a large green space, has an impact on urban temperatures and consequently on city liveability. The cooling effect was calculated to be 1℃ and this benefited an estimated 2000 households and 74 businesses. This benefit was not monetised.

  The value of stored and sequestered carbon in trees and woodland was calculated to be £30,200 (PV).

- Water management and flood alleviation

  The park provides natural evapo-transpiration of c5iMl of rainfall/annum. Within an urban context this is a benefit as it reduces volumes entering combined sewers. The value of avoided energy costs and carbon emissions from the reduced need for water treatment was calculated to be £215,000 (PV).

- Health and wellbeing

  The park provides good opportunities for walking and cycling. Take-up of such moderate physical exercise helps to reduce mortality rates and this was calculated at PV of £0.35m over 5 years, £0.65m over 10 years. Annual mortality reduction benefit was calculated at £75,000 p.a.

  Various green infrastructure elements within the park have an impact on improving air quality. The savings from avoiding other pollution control measures was calculated to be between £21,000 and £165,000 (PV).

- Land and property values

Well kept parks and green spaces enhance property values in the neighbourhood, with uplift ranging from 3% - 20%. Properties within 450m were considered to have their value increased. The total value of this was £18.8 million (PV).

- Investment

  The positive perception of the area created by the park may have an impact on private sector investment decision making, but further analysis would be required to make a quantitative estimate.

- Tourism

  Increased visitor numbers bring additional expenditure, supporting local employment. This was calculated to have a value of £979,000 (PV).

- Recreation

  The park clearly provides extensive opportunities for recreation. 103,500 users per annum were estimated and, based on a "willingness to pay" measure, the recreational value was calculated to be £822,000 (PV).

Summary

The results showed that the overall benefits were valued at £20.81 million - £21.01 million. 90% of this benefit was associated with the impact on adjacent residential property values. The other monetisable benefits amounted to £2.07 million - £2.21 million per annum at net present value.

Appendix 2: Initial data requirements

The table below shows the Project Data Entry sheet featured at the beginning of the Calculator. Fields highlighted in yellow are for data entry.

	Current	Proposed		
Project area	0	0	*ha*	*Linked to tool 1.4*
Total area of greenspace	0	0	*ha*	*Linked to tools 1.4, 2.1, 4.7 and 10.1*
New green space created	n.a.	0	*ha*	*Linked to tools 2.1, 4.7, 5.1*
Area of greenspace enhanced	n.a.	0	*ha*	*Linked to tool 5.1*
	Current	**Proposed**		
Trees/tree cover	0	0	*number/ha*	*Linked to tools 1.7 and 3.4*
Additional tree cover	n.a.	0	*number/ha*	*Linked to tool 1.5 and 1.7*
Green roofs? Total area?	0	0	*sq.m*	*Linked to tool 1.5*
Current land use				*Context only*
Project context eg inner city, urban or rural area (or a mix of all)?				*Context only*
Land ownership?				*Context only*
What is the level of deprivation in the area? Refer to IMD data				*Context. Can contribute to business case.*
Is there currently a lack of green space in the area? Refer to local open space audit results and associated open space standards. Refer to national benchmarks such as ANGsT standards. How will this project help?				*Context. Can contribute to business case.*
Does the site have heritage value? What features are being enhanced/protected/ promoted through the project?				*Context. Can contribute to business case.*
	Current	**Proposed**		
Cycle routes	0	0	*km*	*Linked to tool 4.2b*
Current cycle routes upgraded	n.a.	0	*km*	*Linked to tool 4.2b*
Footpaths	0	0	*km*	*Linked to tool 4.2a*
Footpaths upgraded	n.a.	0	*km*	*Linked to tool 4.2a*
Is the land publicly accessible?				*Context only*
Is the site currently well connected or remote?				*Context only*
Will the project improve green travel options?				*Context. Can contribute to business case.*
Assessment of transport impact conducted?				*Context. Can contribute to business case.*
Links to existing networks				*Context. Can contribute to business case.*

	<300m	<1200m	<450m		
Number of households within 300m, 1200m and 450m	0	0	0		*Linked to tool 4.2a, 4.2b, 5.1 and 10.1*
Number of businesses within 300m and 1200m	0	0			*Context. Can contribute to business case.*
Number of residents within 300m and 1200m	0	0			*Links to tool 4.2a, 4.2b and 3.3*
Other beneficiaries ?					*Context only*
	Current	**Proposed**			
Number of community groups involved	0	0			*Context. Can contribute to business case.*
Total number of users per year	0	0			*Context. Can contribute to business case.*
Of which number of local visitors (recreation)	0	0			*Linked to tool 9.1*
Of which number of tourist visitors (tourism)	0	0			*Linked to tool 8.1*
Number of people involved in physical activity	0	0			*Context. Can contribute to business case.*
Estimate of working population	0	0			*Linked to Benefit 7.4*
Is the site liable to flooding? What is the level of flood risk?					*Context only*
	Current	**Proposed**			
Number of residential properties at flood risk	0	0			*Context. Can contribute to business case*
Number of commercial, business, industrial premises at flood risk	0	0			*Context. Can contribute to business case.*
Amount of SUDS storage	0	0		*m3*	*Context. Can contribute to business case.*
Length of watercourse	0	n.a.		*km*	*Context only*
Length of watercourse improved/restored	n.a.	0		*km*	*Context. Can contribute to business case.*
Existing ecological quality?					*Context only*
	Current	**Proposed**			
Area designated for nature and wildlife conservation (local designation)	0	0		*Ha*	*Linked to Tool 10.1*
Area designated for nature and wildlife conservation (national designation)	0	0		*Ha*	*Linked to Tool 10.1*
Area of woodland w/biodiversity value not captured above (ie: not protected through local or national designation)	0	0		*Ha*	*Linked to Tool 10.1*
Area of wetland w/biodiversity value not captured above (ie: not protected through local or national designation)	0	0		*Ha*	*Linked to Tool 10.1*

	Current	Proposed		
Number of construction jobs created as a result of scheme delivery	n.a.	0		*Context. Can contribute to business case.*
Number of jobs created/safeguarded for management/maintenance of site	n.a.	0		*Linked to tool 11.2*
Number of new businesses established	n.a.	0		*Context. Can contribute to business case.*
Average residential property price in the area	£0	n.a.	£	*Linked to 5.1*

Appendix 3: Tool index

Benefit groups	Functions	Tools	Tool Outputs				Recommended timeframe for value assessment
			Monetary	Quantitative	Qualitative		
1. CLIMATE CHANGE ADAPTATION & MITIGATION	Shelter from wind	1.1 Reduced building energy consumption for heating	□	□	■	*Monetisation and quantification functional for residential properties only*	10 years
		1.2 Avoided carbon emissions from building energy saving for heating	□	□	■	*Monetisation and quantification functional for residential properties only*	10 years
		1.3 Avoided damage from wind and storms	X	X	■	*Monetisation and quantification require further research*	t.b.d.
	Reduction of urban heat island effect	1.4 Reduction of peak summer surface temperatures	X	■	■	*Monetisation requires further reserch*	t.b.d.
	Cooling through shading and evapo- transpiration	1.5 Reduced energy consumtion for cooling	■	■	■		10 years
		1.6 Avoided carbon emissions from building energy saving for cooling	□	□	■	*Monetisation and quantification functional for green roofs only*	10 years
	Carbon storage and sequestration	1.7 Carbon stored and sequestered in woodland and forests	□	□	■	*Monetisation and quantification functional for broadleaf woodland only*	50 years, benefit accrual period 20-25 years with new tree planting
		1.8 Carbon stored and sequestered in non-woodland based landscapes	X	X	■	*Monetisation and quantification require further research*	t.b.d.
2. WATER MANAGEMENT & FLOOD ALLEVIATION	Interception, storage and inflitration of rainwater	2.1 Energy and carbon emissions savings from reduced stormwater volume entering combined sewers	■	■	■		30 years
		2.2 Reduced wastewater treatment costs for domestic and commercial water customers	■	■	■		30 years
		2.3 Avoided costs of traditional water drainage infrastructure	X	X	■	*Monetisation and quatification requires access to average contruction costs data*	30 years
3. PLACE & COMMUNITiES	Catalyst for community cohesion and pride	3.1 Willingness to pay for a view of urban green space	X	X	■	*Monetisation and quantification requires further research*	10 years
		3.2 Increase in volunteering	X	□	■	*Monetisation requires bespoke appraisal. Quantification requires access to good project data.*	5 years
4. HEALTH & WELLBEING	Provision of attractive opportunities for exercise	4.1 Health costs savings from increase in physical activity	X	X	■	*Monetisation and quantification require further research*	10 years, benefit accrual period first 5 years
		4.2 Reduced mortality from increased walking and cycling	■	■	■		10 years, benefit accrual period first 5 years
	Stress and mental illness alleviation	4.3 Health cost savings from mental health disorders	X	X	■	*Monetisation and quantification require further research*	t.b.d.
	Healing time reduction	4.4 Health cost savings from reduced in-patient stays	X	X	■	*Monetisation and quantification require further research*	10 years
	Air pollution removal	4.5 Reduced mortality from respiratory illnesses	X	X	■	*Monetisation and quantification require further research*	25 - 50 years, benefit accrual period 20-25 years with new tree planting
		4.6 Avoided costs for air pollution control measures	■	■	■		25 - 50 years, benefit accrual period 20-25 years with new tree planting

Benefit groups	Functions	Tools	Tool Outputs				Recommended timeframe for value assessment
			Monetary	Quantitative	Qualitative		
5. LAND AND PROPERTY VALUES	Setting for higer value residential and commercial properties	5.1 Residential land and property values uplift	■	■	■		n.a.
		5.2 Commercial land and property values uplift	X	□	■	*Monetisation requires further research. Quantification requires access to good project data.*	t.b.d.
6. INVESTMENT	Setting for inward investment	6.1 Private sector investment levered	X	X	■	*Monetisation and quantification require further research*	10 years
		6.2 Employment creation	X	X	■	*Monetisation and quantification require further research*	10 years
		6.3 Image enhancement	X	X	■	*Monetisation and quantification require further research*	10 years
7. LABOUR PRODUCTIVITY	Reduction of absenteism from work	7.1 Savings from reduced employee turnover	X	X	■	*Monetisation and quantification require further research*	10 years, benefit accrual period first 5 years
	Labor productivityimprovement	7.2 Increase in labour productivity	X	X	■	*Monetisation and quantification require further research*	10 years
	Attraction and retaintion of high quality staff	7.3 Savings from reduced absenteism from work	□	□	■	*Monetisation and quantification based on proportion of workforce cycling or walking to work*	5 years
8. TOURISM	Tourism attraction	8.1 Tourism expenditure	■	■	■		10 years
		8.2 Employment supported by tourism	□	□	■	*Monetisation and quantification require good project data.*	10 years
9. RECREATION & LEISURE	Provision of recreation opportunities	9.1 Recreational use by the local population	■	■	■		10 years
10. BIODIVERSITY	Provision, protection and enhancement of natural habitats	10.1 Willingness to pay for protection or enhancement of biodiversity	■	■	■		10 years
11. LAND MANAGEMENT	Production of food, timber and industrial crops	11.1 Market value of products	X	X	■	*Monetisation and quantification require bespoke appraisal*	10 years
	Land management	11.2 Employment suported by land management	■	■	■		8 years

Benefit groups to be considered for future work:
12. MOBILITY & CONNECTIVITY
13. EDUCATION

For further information visit www.bit.ly/givaluationtoolkit