



Research Report

Economic benefits of greenspace



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Economic benefits of greenspace

A critical assessment of evidence
of net economic benefits

Vadim Saraev

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Summary

This study provides a critical review of evidence of the net economic benefits, both direct and indirect, of initiatives to create or improve greenspace.

Specific objectives were to:

- Cover a spectrum of market and non-market values.
- Assess existing evidence against emerging government guidelines on value transfer, including whether they are sufficiently robust to be applicable to the benefit estimates of greening initiatives elsewhere.
- Identify gaps in evidence and consider the need for further research to address these.
- Recommend appropriate indicators to incorporate in emerging monitoring and evaluation frameworks to facilitate future assessments of the net economic benefit of greening initiatives.

Economic growth and investment

The review found little strong evidence of impacts of greenspace, although some (case-study-specific) evidence exists that investments in greenspace have a positive impact on constituent components such as job creation, new business start-ups and private investment. These impacts could consequently increase local gross value added (GVA). However, issues of the additionality and the net benefits of such investments have seldom been investigated in the depth required under current best practice guidance. Currently, only the Mersey Forest study was found to be sufficiently robust, although not without criticism. It estimated that every £1 invested in the Merseyside Objective One programme will generate over the lifetime of the investment (50 years) £2.30 in increased GVA (tourism, forestry and improvements in health).

Land and property values, aesthetics

A large body of evidence exists that supports a view that investment in improving greenspace has a positive effect. In particular, improving the aesthetic quality of place (visual amenity) increases land and property prices. This is not in itself unambiguously a benefit (as it may disadvantage prospective buyers). Nonetheless, property price increases may benefit local economies in indirect ways. They can encourage further property development in an area and increase local council tax receipts as a result. The estimated impacts are necessarily case and location specific and have a wide range of values. Having a well-managed greenspace nearby was found to result in average property premiums of 2.6% to 11.3%. In terms of a marginal change an extra percentage point increase in greenspace land-use share in the Census ward increases property prices by around 1%.

Regional and local economic regeneration

The typical level of investment in greenspace projects per full-time equivalent (FTE) job created or safeguarded was reviewed. Public expenditures per FTE job created were found to have a median value of about £46 000. The median value of public expenditure costs per FTE created or safeguarded was about £20 000. The range of values for the ratio of private to public investments was found to vary from 2 to 10, with a median value of about 4.2. That is, the median project levered in £4.20 in private sector investment for every pound of public investment.

Tourism

Visitor surveys and visitor number statistics remain major tools for assessments. However, only two studies considered the sensitivity of impact estimates to the availability of substitutes and issues of displacement and leakage, which should be the focus of any future primary research. Results are very location specific and cannot be easily generalised.

Health and well-being

Little robust evidence of net economic values of greenspace interventions for health and well-being was found. Moreover, there is no conclusive evidence on the strength of the relationship between the amount of greenspace in the living environment and the level of physical activity, and the causal link between the two. Nevertheless, a number of studies inferred some monetary estimates of health benefits by considering hypothetical scenarios of increased exercise and calculating potential National Health Service (NHS) cost savings.

A study for the UK National Ecosystem Assessment used new geo-located survey data (with 1851 respondents) to estimate the physical and mental health effects associated with UK greenspace. Linking changes in health utility score due to changes in environment to quality adjusted life years. The following monetary estimates (per person per annum) were obtained:

- Physical exercise (+3 hours of vigorous activity per week): £12–£39.
- Having a view of greenspace from your house (versus no view): £135–£452.
- Local broadleaved/mixed woodland land cover (+1% within 1 km of the home): £8–£27.

Water management

While the potential of greenspace and woodland in particular to reduce stormwater run-off and reduce flood risk by slowing water flows is often acknowledged, economic estimates are scarce and tentative. The only study, at Pickering, that provides economic estimates of the benefits of woodlands for flood management and erosion reduction reports a present value for these over 100 years of about £180 000 for 85 ha of woodland created.

Products from the land

Benefits associated with products from the land due to investments in greenspace are generally estimated on the basis of net increases in FTEs or GVA. Currently, only a single study of the Mersey Forest reports an estimate of the associated net impact of greenspace improvements. This found £164 000 of net benefit per annum, assuming £46 000 of GVA per FTE and four FTE jobs supported by 1000 ha of woodland.

Biodiversity

Only one study reported net additional biodiversity benefits. Two primary studies estimating willingness to pay (WTP) for the biodiversity benefits of greenspace (woodlands and SSSIs in particular) were also identified. A separate study used legacies to environmental charities as a proxy for the non-use value of biodiversity. Estimated legacy-based non-use values were around: £219 per hectare for National Trust countryside, £190 per hectare for the UK's Royal Society for the Protection of Birds (RSPB) reserves and £53 per hectare for National Trust for Scotland's Scottish countryside for 2008/09. Studying biodiversity benefits of other types of greenspace would help address an existing research gap.

Climate change adaptation and mitigation

The review showed a clear benefit of greenspace projects involving tree planting for carbon sequestration and potential for trees to reduce energy use during wintertime. However, the evidence is based on only three studies, of which two estimated the net monetary benefit due to carbon sequestration. Given that carbon sequestration benefits of woodlands are relatively well researched, focusing future research on other issues such as the role of trees in regulating temperature through shading and evapotranspiration during extreme weather episodes and energy saving in residential housing due to tree shelterbelts would help address this research gap.

Other evidence gaps

The review found no robust evidence of net economic values in such areas as 'labour market employment and productivity' and 'recreation and leisure' (as opposed to tourism) themes. As 'quality of place' is a compound concept with no established definition, there has been little economic research addressing it directly to date.

Introduction

Greenspace is the natural environmental components (green and blue spaces) that lie within and between a region's cities, towns and villages. Green infrastructure and green networks are two widely used terms to refer to greenspace and often focus upon connectivity. The former is mostly used in England and Wales while the latter is mostly used in Scotland. 'Environmental infrastructure' is another term often used by the UK Environment Agency to describe a network of essential environmental services, such as clean water provision, waste disposal, drainage and sewage services, and protection from flooding, without which our neighbourhoods would be uninhabitable. The review focused primarily, but not exclusively, on values quantified in monetary terms (recognising that some values – such as mental health benefits – may be difficult to quantify or place a monetary value on).

The research aims were to assess estimates of net economic benefits of initiatives to create or improve greenspace. The net economic benefit is comprised of both direct and indirect benefits of greenspace. Indirect effects can include not only multiplier effects (indirect and induced ones corresponding to Type I and Type II multipliers) but also impacts of a 'feel-good' factor or conducive environment for business. However, the latter ('feel-good' factor or conducive environment) are not covered here due to a lack of empirical results in the literature.

Placing accurate economic values on green infrastructure or its greenspace components is far from easy, but is becoming more important to support the case for sustained investment. Although the vast majority of the evidence points to green infrastructure benefiting many vital aspects of social and environmental sustainability, the challenge is to make decision-makers and others aware of the evidence, including the economic value of such 'indirect' benefits, and to help the Government to meet policy objectives in the best possible way. In most cases there is little doubt that returns on green infrastructure investment are high, but without adequate demonstration it is often difficult for a convincing case for investments to be made by comparison with other initiatives where direct cost-benefit valuation is simpler.

The important role of green infrastructure in delivering sustainable economic development and creating attractive and strong communities is acknowledged in many government documents. For example, issues of regeneration, development of brownfield land and

improvements to the local environment are addressed in a number of white papers, action plans and reports (HM Government, 2000; Department for Communities and Local Government, 2000; ODPM, 2003; Urban Green Spaces Taskforce, 2006). They also feature in the UK (covering England and all non-devolved issues), Northern Irish, Scottish and Welsh sustainable development strategies (Scottish Executive, 2005; HM Government, 2005; OFMDFM, 2010; Welsh Assembly Government, 2009).

Comparing the net economic benefit of greenspace interventions with that associated with other types of intervention may be important to secure value for money across different areas of public spending. However, as no studies comparing greenspace investments with other types of interventions were identified, none are included in this review.

The review focuses on the economic benefits of green infrastructure quantified in monetary terms while recognising that some values may be difficult to quantify or place a monetary value on. While the latter can also be important in assessing welfare impacts, they are not the focus of the current review.

Although the review adopts categories drawn from the greenspace literature, they appear to fit well with emerging ecosystem services frameworks and approaches. For example, drawing upon the Millennium Ecosystem Assessment framework (MEA, www.millenniumassessment.org), four major categories of ecosystem services adopted for the UK National Ecosystem Assessment (NEA, <http://uknea.unep-wcmc.org>) are:

1. Provisioning services: products obtained from ecosystems.
2. Regulating services: benefits obtained from the regulation of ecosystem processes.
3. Supporting services: ecosystem services necessary for the production of all other ecosystem services.
4. Cultural services: non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, or aesthetic experience.

Practical guidance on how policy changes affect ecosystem services and human welfare is provided, for example, by the impact pathway approach (Defra, 2007, p. 22). This considers the links between ecosystems, the provision of ecosystem services and how these contribute to human

welfare. In a simplified version a policy change impacts on an ecosystem leading to changes in ecosystem services (benefits to society) which in turn affect human welfare. These benefits can then be translated into economic values using various economic valuation techniques.

The review of the literature indicated the following categories covering the whole spectrum of potential economic benefits of greenspace projects (AMION, 2008; ECOTEC, 2008; NENW, 2008):

- Economic growth and investment
- Land and property values, aesthetics
- Labour market employment and productivity
- Tourism
- Recreation and leisure
- Health and well-being
- Quality of place
- Water management
- Products from the land
- Biodiversity
- Climate change adaptation and mitigation

It can be seen that most of these categories fit within one of the four main ecosystem services groupings. For example, 'products from the land' belongs to Provisioning services; 'climate change adaptation and mitigation', 'water management' and 'health and well-being' belong to Regulating services; 'products from the land' and 'biodiversity' belong to Supporting services; and 'labour market employment and productivity', 'tourism', 'recreation and leisure' and 'quality of place' belong to Cultural services.

The two remaining categories 'economic growth and investment' and 'land and property values' are more difficult to fit with MEA or NEA frameworks, although both can be affected by each of the above categories of ecosystem services. For example, increases in labour productivity included among 'health and well-being' benefits arising from regulating ecosystem services, will tend to be a driver of economic growth. Similarly, capital productivity (another driver of economic growth) may be affected by, for example, 'water management', 'climate regulation' and 'biodiversity'. Furthermore, 'land and property prices' have been used as a proxy for ecosystem services in some cases, as they can be considered to partly reflect benefits such as 'quality of place', 'recreation and leisure' and 'biodiversity'.

The high degree of interconnectedness and the partly overlapping nature of the 11 benefit categories serve to highlight potential risks of double counting in estimating the benefits of greenspace projects. Approaches to

avoiding these problems are considered further in the Methodology section.

In addition to covering more general literature, the review focuses upon case studies where economic valuation has taken place in order to demonstrate the net economic benefit of initiatives to create or improve green infrastructure.

The review does not focus on any particular country but draws on a wide pool of research publications in English considered relevant to the whole of the UK. It aims to be of interest both to other researchers and to government policy advisors.

Methodology

The review focused on the most recent evidence (published since 2000).

A literature review was conducted using two major online databases used for academic research: ISI (Information Sciences Institute) Web of Knowledge and Google Scholar. The following search string was used: 'green (investment* OR infrastructure OR space)'. For the latest five years and refined by General Categories= (Social Sciences) AND Languages= (English) it yielded 358 hits from the Web of Knowledge database (all records were viewed). *Ad hoc* searches using Google, and Forest Research and Forestry Commission colleagues helped uncover some useful additional references. Drawing upon any relevant previous reviews and material suggested by Forestry Commission Scotland (FCS) stakeholders and partner organisations published and unpublished literature providing evidence of the net economic benefits of greening initiatives were gathered.

The robustness of the existing evidence was assessed using expert judgement and critical analysis. Factors such as use of sound statistical techniques, an appropriate sample size, goodness of fit, statistical significance of findings, baseline and additionality methodologies applied, suitability for value transfer and comparability with findings of similar studies were considered. Statistical and econometric estimates were considered robust if robust statistical techniques were used (e.g. where there is a strong suspicion of heteroskedasticity of errors, i.e. random variables have different variances) and various scenarios or sensitivities were assessed (Eftec, 2010, Annex 3).

Economic valuation (welfare) and economic impact studies were distinguished. The latter investigates the effect of changes in demand, including government expenditure, on indicators such as value added and employment. It is concerned with net impacts and utilises concepts of additionality, deadweight, and leakage, displacement, substitution and multiplier effects (see below and Glossary). The former quantifies the benefits enjoyed by people as a result of the consumption of goods and services (including environmental services which are not traded in markets) and is based on welfare or well-being concepts, where policy aims to maximise the welfare of society (SEERAD, 2007).

A major conceptual difference between economic welfare/ economic value studies and economic impact ones is the treatment of employment. It is treated as a benefit in the

latter and as a cost in the former. When measuring welfare, labour appears as a cost because wages are a payment for the use of the labour resource (SEERAD, 2007). Conversely, in an economic impact assessment any employment is treated as a benefit even if it occurs in a loss-making activity that is actually having a negative economic effect on the aggregate value of output. Economic impact studies are not designed to determine whether or not any of the uses of the resources are economically efficient and welfare enhancing. They only compare differences in impact between using resources in different ways. Therefore, cost-benefit analysis (CBA) is a better tool for resource allocation decisions, while economic impact studies can be of most use for informing policy decisions when they compare the impacts from spending similar amounts of money in different ways (SEERAD, 2007).

The net economic benefit of creating or improving greenspace is defined as the net effect of the intervention. Widely accepted indicators of net economic benefit, especially in economic impact studies, include jobs, income and gross value added (GVA). For current purposes, economic benefit is broadly defined to include both economic values (e.g. climate change mitigation) and economic impacts (e.g. employment generation). One can find similarly broad definitions adopted in the literature, with overarching indicators encompassing both benefits and impacts adopted in some cases. For example, 'Total Monetised Benefit' (Regeneris, 2009, p. 33) aggregates three types of benefits: (i) GVA (e.g. expenditures by tourists); (ii) values for non-traded goods based upon willingness to pay (e.g. for biodiversity, landscape and visual amenity, and recreation); and (iii) other types of non-market valuation studies as well as social cost-saving estimates (e.g. for carbon sequestration, pollution absorption). The 'Total Monetised Benefit' is used as a device to yield a single numerical estimate of all benefits, as it is not possible to estimate net impacts (e.g. GVA) for non-market goods, nor values from impacts (e.g. increases in GVA). Closely related to the concept of 'additionality', net economic benefit is measured as the difference between the position if the intervention is implemented, and the reference case (also known as the counterfactual or 'base case') position expected to occur in the absence of the initiative. The evaluation process takes account of deadweight, and leakage, displacement, substitution and multiplier effects. Methods used to establish these effects and the baseline reference case were assessed drawing upon Scottish Enterprise guidance (Scottish Enterprise, 2008) and the

Department for Business, Innovation and Skills research (BIS, 2009). Definitions and different elements encompassed by these concepts are presented in the Glossary.

Double counting issues need to be considered in estimating net economic benefits. Double counting may occur when benefits from greenspace intersect and are not completely independent. This can be the case for at least two sets of benefits (Regeneris, 2009, p. 29):

1. Land and property prices are not independent of quality of place, recreation and leisure and biodiversity, with land and property prices incorporating these other effects, rather than being a separate economic benefit of greenspace.
2. Health and well-being and labour productivity benefits may overlap too, as increases in labour productivity can arise from increased health and well-being.

Avoiding double counting may require focusing exclusively on aspects not covered by other estimates. This approach is adopted in the Mersey Forest study (Regeneris, 2009, p. 33), for example.

Where existing evidence is judged sufficiently robust, its potential applicability to other areas using benefit transfer was assessed drawing upon emerging UK Government guidance (Eftec, 2010). When assessing the quality of evidence this recommended considering the following questions (Eftec, 2010, pp. 48, 79):

- Are the data collection procedures sound?
- For survey-based economic valuation methods is the sample representative?
- Does the study follow the best practice?
- Are the results consistent with the expectations based on the economic theory?
- Was GIS analysis used for spatially distributed goods?

According to the guidance (Eftec, 2010, Annex 2), information on the following factors should also be collected:

- Availability of substitutes? Generally the more substitutes there are the less the marginal value for a change is likely to be.
- Size of the good (e.g. greenspace) and the scale (direction and size) of change.
- Price of the good: in the case of non-market goods the associated willingness to pay (WTP) or willingness to accept (WTA).
- What controls were used for socio-economic factors (age, gender, income levels, employment, education,

number of children) that may affect the outcomes, and how should these be accounted for in using benefit transfer if feasible?

- Is the evidence applicable to urban, peri-urban or rural settings?

The extent to which spatial factors (e.g. distance decay) were taken into account in any aggregation, and whether sensitivity and/or scenario analysis was performed was noted. For example, sensitivity and scenario analysis was performed in Regeneris (2009), while Dunse, White and Dehring (2007) accounted for distance effects.

Use of statistical techniques such as meta regression analysis was considered initially as a method to investigate the variation in the effect of characteristics across studies (e.g. the effect of location characteristics across studies) and in determining a study's applicability in utilising a benefit transfer approach. It was not implemented due to lack of comparable studies.

The approach taken in the review is one of expanding geographic coverage. For each type of benefit the review focused in the first instance on evidence identified in UK studies. Where none have been undertaken or evidence is not sufficiently robust, studies in other European countries are reviewed. If no European studies are identified or evidence is not sufficiently robust, North American studies are reviewed. The primary focus is on greening initiatives where trees, woodlands or forests are a principal component.

Results

Subsections below contain reviews of relevant literature on net economic benefit of initiatives to create or improve greenspace.

Economic growth and investment

Investments in greenspace are thought to improve a region's image, helping to attract and retain high value industries, new business start-ups, entrepreneurs and workers. This in turn increases the scope for leveraging in private sector investment, reducing unemployment and increasing GVA (NENW, 2008, p. 8).

Although leveraging in private sector investments is beneficial to a local economy it must be acknowledged that (except for some foreign direct investments) this money is likely to have been displaced from elsewhere and therefore be of no net benefit to the UK economy (Slee, 2006, p. 546). In some cases, however, it may be beneficial in reducing regional disparities.

In total nine case studies (Table 1) were identified as being potentially relevant to the review of the benefits of green infrastructure on economic growth and investment. These were presented in six studies (EKOS, 1997; CESR, 2004; Land Use Consultants, 2006; CLES, 2007; CSI, 2008; Regeneris, 2009).

Table 1 Economic growth and investment.

Project	Estimated benefits	Reference	Value or impact study	Additionality issues
Riverside Park Industrial Estate in Middlesbrough. Investment in the green infrastructure of the park, over 1800 new trees planted.	Created a setting for stimulating business growth and investment, attracted new, high profile, occupants and saw occupancy grow from 40 to 78%, and levered over £1 million of private investment. 28 new businesses started up. Over 60 new full-time equivalent (FTE) jobs created.	CLES (2007)	Impact	Only basic comparisons to regional/national trends
Winsford Industrial Estate in Cheshire. Environmental and landscape improvements including new plantings.	88 new FTE jobs created. 13% increase in the number of employees in Winsford Wharton between 2003 and 2005 (compared to 2.9% for England as a whole). Private matched funding of over £290 000 was levered in. Number of businesses increased from 104 to 160 all paying business rates to the local authority.	CLES (2007)	Impact	Only basic comparisons to regional/national trends
Portland Basin Green Business Park, Tameside, Greater Manchester. Landscaping improvements.	Just under £425 000 of public sector funding levered in over £1.8 million of funding from the private sector. 13 new FTE jobs were created and a further 314 jobs safeguarded. As a result of the programme the number of businesses located in the park increased from 120 to 140.	CLES (2007)	Impact	Not considered
The National Forest. Creation of the forest – which spreads over 200 square miles (500 km ²) of the Midlands and includes a population of around 200 000. Between 1991 and 2006 over 7 million trees were planted and 5785 ha of woodland created.	Number of local jobs increased (1991–2001) by 4.1%. Jobs created, safeguarded (1995–2001): 213 FTE. By 2001 directly related regeneration programmes resulted in funding of £32.5 million for the area, which attracted leverage of £96 million and created over 500 jobs.	CESR (2004), NFC (2007)	Impact	Only basic comparisons to regional/national trends
Manvers Regeneration scheme by Rotherham Metropolitan Borough Council in South Yorkshire.	Over 20 years. Private sector investment in the scheme to date has been estimated at over £350 million, and about 9000 jobs have been created.	CSI (2008)	Impact	Not considered

Table 1 (Continued).

Project	Estimated benefits	Reference	Value or impact study	Additionality issues
Langthwaite Grange, Wakefield, West Yorkshire. Landscape quality and security improvements at a 57 ha industrial estate. Started 2005.	16 new businesses moving in, bringing over £12 million investment and creating 200 new jobs.	CSI (2008)	Impact	Not considered
The Mersey Forest, Merseyside (new tree planting, land reclamation, bringing woodland into management, creating access to greenspace and recreational facilities, managing and improving habitats, engaging local communities and business support activity for forestry businesses).	Direct increases in economic output in Merseyside: £2.8 million gross GVA from tourism spend, from forestry, and from improvements in health or £436 000 net additional impacts. The forest itself covers 465 square miles (1200 km ²).	Regeneris (2009)	Both	Well considered
Kennet and Avon Canal restoration. Restored historic waterway enhances landscape. The long-term restoration effort has involved £38.9 million since 1997, including a Heritage Lottery Fund donation of £25 million.	Direct and indirect employment created by the project totalled 150–210 FTE jobs between 1997 and 2002. The total number of jobs created and safeguarded by the project is estimated at 1198–1353 FTEs.	Land Use Consultants (2006, p. 9)	No details provided	No details provided
Improvements to the local footpath network in Dunkeld and Birnam (Perth and Kinross, Scotland): establishment cost (£70 000) and annual maintenance cost (£3000). A number of similar path projects are mentioned in CJC (2005b, p. 27) but with few details and all predate the 'last ten years' time frame focused on in this review.	Generated between £1.37 million and £3.69 million of income a year to the local economy, directly supporting between 8 and 15 FTE jobs.	EKOS (1997)	Impact	No details provided

The benefit of improvements in the local environment on local and regional economy is the main research topic in three case studies: Riverside Park Industrial Estate in Middlesbrough, Winsford Industrial Estate in Cheshire and Portland Basin Green Business Park in Tameside, Greater Manchester (CLES, 2007). None of the three projects deal exclusively with the improvement of greenspace, however. Other than landscape improvements (mainly planting and clean ups), measures included improving signage, lightning and access, roads and transportation, introduction of energy saving and waste recycling policies, security improvements (CCTV and fencing) and buildings renovations. Inclusion of these significant components of a project made it impossible (given available data) to quantify precisely the benefits that can be attributed to greenspace improvements alone. All of the projects resulted in new jobs created, new businesses started, private investment levered in, occupancy rates increased and less crime. While these could be expected to have increased local GVA, the extent to which this occurred is not reported.

Turning to additionality issues one can see that the study (CLES, 2007) used only a very crude measure of the net additional benefit, applying a basic comparison to regional

and/or national trends to infer and form judgement on additionality of interventions. The basic comparison to regional and/or national trends was performed in relation to employment, earnings and property prices and is not detailed or disaggregated by appropriate sectors or categories. For example, although local employment changes by industry sector were available for Winsford Industrial Estate, Cheshire, only aggregate values are compared (CLES, 2007, pp. 36–7). Sometimes total spend on the project is not presented, for example for Winsford Industrial Estate (CLES, 2007). This basic additionality treatment was performed only for employment for two case studies: Riverside Park Industrial Estate in Middlesbrough and Winsford Industrial Estate in Cheshire. It yielded over 16% and 13% of net (above local trends) growth in employment correspondingly in Riverside Park and Winsford. In our opinion, the issues of additionality are not investigated in accordance with best practice guidelines (Scottish Enterprise, 2008), because issues of leakage, displacement (e.g. how much of the higher occupancy rate can be due to displacement of businesses from immediate neighbouring areas), substitution and multiplier effects are not discussed or investigated. Values reported in the study are not suitable for use in a value transfer approach because

valuation itself is not up to best practice guidelines (Eftec, 2010, Annex 2). In particular, not all the necessary data were collected, and the impact assessment was not undertaken in accordance with best practice guidelines (see above).

Similar problems arise in quantifying the social and economic impact of the National Forest (CESR, 2004). Again only a basic comparison to regional and/or national trends was performed to infer and form a judgement on the additionality of interventions. The study reported growing employment rates and growing numbers of businesses, with number of businesses registered per 10 000 population above regional and national averages, overall levels of benefit dependence below regional averages, but average earnings still below regional averages. However, due to the length of the project sometimes comparison is infeasible because of data definition changes, for example age group definitions changed from Census 1991 to Census 2001 (CESR, 2004, p. 21). Some headline indicators (e.g. average property price and households without access to a car) only present a snapshot of development and not changes with respect to a baseline. Some data are not robust due to small sample sizes (CESR, 2004, p. 12). Spatial distribution was a key challenge in the collation of the data given that the National Forest boundaries generally do not coincide with ward boundaries that the majority of datasets are based upon (CESR, 2004, p. 14). Given the above data problems, impact estimates reported in the study are not suitable for use in a value transfer approach.

For two other case studies presented (CSI, 2008, pp. 20, 23), Manvers Regeneration scheme in South Yorkshire and Langthwaite Grange in Wakefield, West Yorkshire, only actual information on projects were reported without any attempt at comparison or estimating net additional benefits. The same comment applies to the Kennet and Avon Canal restoration (Land Use Consultants, 2006).

Finally, the Mersey Forest study (Regeneris, 2009) is the only one to take care of additionality and related issues (double counting, displacement and multiplier effects, sensitivity analysis) following best practice guidelines (Defra, 2007; BIS, 2009; Eftec, 2010). The issue of double counting is addressed by avoiding overlap among benefits (Regeneris, 2009, p. 29). However, the long-term discounting approach in calculating net present value (NPV) of benefits does not follow the Treasury Green Book advice (HM Treasury, 2003, pp. 98–9). In particular, benefits have been discounted at 3.5% per annum (the standard government social discount rate) for 50 years but were assumed to increase in real terms by 2%, in line with the UK trend growth in real income (Regeneris, 2009, Appendix B). By contrast, when discounting over a longer

time horizon the Treasury Green Book recommends using a 3% discount rate after the first 30 years, while a 2% annual real growth rate is already included in the initial 3.5% per annum standard government social discount rate. The study estimates that every £1 invested in the Merseyside Objective One programme will generate £2.30 in increased GVA over the lifetime of the investment. However, choice of a 50-year time horizon for appraisal of this project seems arbitrary (an approach not supported by the Treasury Green Book). The £2.30 increase in GVA estimated (Regeneris, 2009, pp. 3, 5), is composed of GVA from tourism expenditure, from forestry (i.e. direct jobs related to products from the land), and from improvements in health (cost savings to the NHS and increased economic output due to a reduction in ill health, absence from work and the incidence of premature death – for details see the Health and well-being section). Annual benefits in each case were estimated at the point where the trees have matured (Regeneris, 2009, pp. 29–30). This assumption may lead to an overestimation for some benefits. For example, the forestry GVA estimate is based upon an average for all types of woodland and so might be expected to overestimate the GVA associated with immature stands at the start of the Mersey Forest tree planting project. Similarly, tourism expenditure associated with visits to recently planted forests might be expected to be significantly lower than the average for country parks. The study applied GIS analysis to the benefits with spatial characteristics (Regeneris, 2009, pp. 30–1) including tourism. However, it is important to say that the study is not primary research but bases its estimates on those available in the existing literature (Regeneris, 2009, p. 8).

The following knowledge gaps are identified. More primary studies of interventions and investments to improve greenspace following additionality and impact assessment guidance (Scottish Enterprise, 2008; BIS, 2009) are needed to build up a database with intervention outcomes of reasonable quality that can be used later for a value transfer approach.

Summarising one could assert that there is little direct, strong and reliable evidence of impacts of greenspace on economic growth and investments. However, there is evidence (case study specific) that investments in greenspace have a positive impact on such constituent components of economic growth and investments as job creation, new business start up, and amount of private investments levered in. This should consequently increase local GVA. There are though a lot of issues regarding the estimates of additionality and magnitude of net benefit of such investments. Currently, only the Mersey Forest study (Regeneris, 2009) is reasonably robust and informative enough to make the findings on the value of annual benefits

acceptable for use in a value transfer approach, but bearing in mind the caveats discussed above.

Land and property values, aesthetics

Developing and improving greenspace in key locations within urban and semi-urban areas is argued to have significant benefits which are reflected in increasing property and land values. Investment in greenspace can lead to a rise in demand for homes and higher returns for the property sector. Greener areas have a better image and attract more visitors, bringing with them retail and leisure spending and providing job and rental opportunities. This in turn increases land and property values (NENW, 2008, p. 9).

Higher house prices used in hedonic studies (see Glossary for more explanations) can reveal people's preferences for greenspace. When greenspace is developed or improved near some location existing local homeowners may benefit from property price increases. However, a property price increase is not in itself unambiguously a benefit, especially as it may disadvantage prospective buyers. Nonetheless, property price increases may benefit local economies in indirect ways, such as by encouraging further property development in an area and increasing local council tax receipts as a result.

In total eleven studies (Table 2) were identified as relevant to the 'land and property values, aesthetics' topic (Garrod, 2002; GLA Economics, 2003; CABE, 2004, 2005; Forestry Commission, 2005; GEN Consulting, 2006; Dunse, White and Dehring, 2007; Mourato *et al.*, 2010; Prastholm *et al.*, 2002; Regeneris, 2009; Tyrväinen and Miettinen 2000;).

It is important to note that it is argued (Regeneris, 2009, p. 29) that land and property prices are not independent of quality of place (including visual amenity), recreation and leisure and biodiversity benefits, with land and property prices incorporating these other effects, rather than being a separate economic benefit of greenspace. This is why we also consider here improvements in aesthetic quality (focusing on visual amenity of greenspace for this review) and its valuation and effect on land and property prices. Visual amenity of greenspace can enhance the views from people's homes and/or on journeys to and from work thereby contributing to a higher quality of life (Regeneris, 2009, p. 18).

A primary study (Garrod, 2002) of public preferences for visual amenity with respect to woodland views forms a basis for another valuation (Regeneris, 2009). It uses stated preference approach with a GB-wide survey and choice experiment technique to estimate the value of woodland views from properties and on journeys in terms of individuals' WTP. It is the most recent primary study of that kind available in UK. The study follows

Table 2 Land and property values, aesthetics.

Project	Estimated benefits	Reference	Value or impact study	Additionality issues
The Mersey Forest	Net additional monetised benefit due to landscape improvements (visual amenity), views from home: £412 000 per annum and while travelling: £527 000 annum.	Regeneris (2009, pp. 36-7)	Both	Well considered in general, also uses WTP here
Development of Bold Colliery Community Woodland in St Helens, Merseyside.	Enhanced property values in the surrounding area by about £15 million and helped realise a further £75 million of new development.	Forestry Commission (2005)	Impact	Only basic comparisons to regional/national trends
Glasgow Green (the city's oldest park) Renewal project: £15.5 million investment of public funds (1999-2006).	Stimulated the development of new residential properties (net impact 500-750 new residential properties), enhanced average house prices and the total value of property transactions (net £3-4.5 million), a 47% increase in council tax yield (additional £0.8-2 million). The value of the land increased from a nominal £100 000 per hectare to £300 000.	GEN Consulting (2006)	Impact	Adequate
Ten case studies in CABE (2005) into the impact of park improvements on house prices, though often not clear how much was invested and what is the return.	A study found that, following improvements, houses near parks were, on average, 8% more expensive than comparable houses further away.	CABE (2004, 2005)	Value	Not applicable (use hedonic pricing method, see Glossary for explanation)

Table 2 (Continued).

Project	Estimated benefits	Reference	Value or impact study	Additionality issues
Comparison of 'greenness' across the City of London's 760 wards	Hedonic pricing approach showed that higher property values (in terms of the average house price) exist in areas with a higher percentage of open space: a 1% increase in greenspace (in London) was linked to 0.3 to 0.5% increase in house prices.	GLA Economics (2003)	Value	Not applicable (use hedonic pricing method, see Glossary for explanation)
Value of greenspace in Aberdeen	Hedonic pricing estimations yielded average premium values for property located near particular type of green space of: 10.1% for city parks, 9.0% for local parks and 2.6% for amenity greenspace.	Dunse, White and Dehring (2007)	Value	Not applicable (use hedonic pricing method, see Glossary for explanation)
Survey (GB-wide) to estimate the value of woodland views from properties and on journeys using stated preference approach	Respondents' estimated WTP: a woodland view for houses on the urban fringe is £269 per annum per household (2002 prices), and a view of woodland while travelling is £227 per annum per household (2002 prices).	Garrod (2002)	Value	Not applicable (use WTP, see Glossary for explanation)
Afforestation projects near provincial towns in Denmark	Hedonic pricing estimations yielded average premium values for property near forest of £24 500 (in 2009 prices)	Prastholm <i>et al.</i> (2002)	Both	Considered by using local house price deflator (use hedonic pricing method, see Glossary for explanation)
Analysis of amenity value provided by environmental goods across England, Wales and Scotland.	Large-scale study with a sample of around 1 million housing transactions (with location information) in the UK, between 1996 and 2008.	Mourato <i>et al.</i> (2010)	Value	Not applicable (use hedonic pricing method, see Glossary for explanation)

best practices but displays some shortcomings. First, the sample sizes are quite small for a GB-wide study: 211 and 205 completed questionnaires respectively for woodland views from homes and on journeys (Garrod, 2002, p. 9). Second, socio-economic characteristics were not utilised in WTP estimations (Garrod, 2002, p. 13). As a result robust WTP estimates were obtained only for some forest type/landscape configurations, that is only for urban fringe broadleaves, omitting coniferous woodlands and landscapes other than peri-urban ones (Garrod, 2002, p. 20). Finally, the typical distance between the viewer and the woodland in the images used in the study is not reported. Looking at one of the images used, the distance may be about 300 metres. This puts another limitation on use of the estimated WTP as the way in which the values decay with distance was not explored. Nevertheless, the robust WTP estimates for peri-urban broadleaves within approximately 300 metres of a viewer can be used in other studies. Naturally the above shortcomings of the primary

study apply to secondary studies (e.g. Regeneris, 2009) making use of the estimated WTP.

Expert judgement was used to evaluate the impact of community forest development on property prices near Bold Colliery Community Woodland in St Helens, Merseyside (Forestry Commission, 2005). Five beacon locations were used as benchmarks against which property price changes were judged. A beacon location in this report is a road identified as being typical of that particular locality, and thus containing properties that are typical in age, size, type and degree of modernisation and repair to the locality. It was established that once the general property price rises had been stripped out as well as any other differing factors the enhancement value of the housing stock is in the region of £15 million for the existing housing stock and as a result of the scheme new development to the value of £75 million has been realised. No additionality issues were explicitly assessed.

The Glasgow Green Renewal project study (GEN Consulting, 2006) is an impact study of public investments in greenspace. It addresses issues of additionality and net impact (GEN Consulting, 2006, p. 20), baseline scenario (p. 27) and displacement (p. 21). However, the collection of comparable data is not always possible and for some important indicators (change in number of businesses and employees) only 2004 and not 2006 data were available (GEN Consulting, 2006, pp. 23–4) leading to comparisons over different time periods for changes in the area and Glasgow as a whole. Also in discussing business development no numbers are given on the sample size of interviews with businesses (GEN Consulting, 2006, p. 25), and sometimes anecdotal evidence is used (p. 27). Despite investments in this once run-down area, house prices in Glasgow increased faster than at the Green. (Between 1998 and 2005 house prices in Glasgow increased by 111%, compared to 50% for the same period in and around the Green.) Nevertheless, in our opinion the estimates obtained by the study with respect to property market (increases in council tax generated and house prices and additional residential property transactions) and business developments (increases in the total value of rateable properties and number of businesses and total employment) can be used in a value transfer approach. The applicability of value transfer for a new study should be determined with the help of best practice guidance (Eftec, 2010).

A further three studies applied a hedonic pricing approach (see Glossary for more explanations) to estimate the benefits of urban greenspace as reflected in property prices. All of the papers followed best practices and their findings are judged as being sufficiently robust (Eftec, 2010, Annex 3) and can be used in a value transfer approach.

A London study (GLA Economics, 2003) applied a hedonic pricing approach to value 'greenness' across the City of London's 760 wards. Open space is modelled as the percentage of green areas (in km²) in each ward. The identifiable greenspaces are the Green Belt, Metropolitan Open Land, Sites of Metropolitan Importance, Sites of Borough Importance and Sites of Local Importance. Greenspace such as urban parks, private gardens and common greenspace around flats are excluded from this study, except in the Green Belt, because of data limitations (GLA Economics, 2003, p. 3). Socio-economic variables taken into account include housing density, deprivation, education, crime (domestic burglaries), travel and health accessibility, and environmental situation with respect to nitrogen dioxide (NO₂) concentration. Estimations showed that higher property values (in terms of the average house price) exist in areas with a higher percentage open space

holding all other factors constant, with a 1% increase in the amount of greenspace in a ward associated with a 0.3 to 0.5% increase in the average house price in that ward.

The findings of the above study were refined in an update (GLA Economics, 2010) that used better greenspace data and a wider range of built environment and locational factors analysed at a finer spatial scale. The importance of greenspace for house price formation is confirmed but with a lower estimated magnitude. Each hectare of greenspace within 1 km of housing increases house prices by 0.08%. Moreover, a regional or metropolitan park within 600 m increases total house value between 1.9 and 2.9%.

Another study presented a series of eight (two more cases out of the total ten investigate green spaces within a solely commercial property environment and are not reported here) case studies focused on parks of high environmental quality throughout the UK using a hedonic pricing method to estimate the benefits of urban greenspace (CABE, 2005). Property evaluation involved comparisons between the residential properties immediately overlooking the park and residential properties in a wider area around the park, including those bordering on the park, a street/block or two away from the park and several blocks away from the park. The results showed an increase in the property price linked to properties overlooking or being close to a high quality park with a wide range of benefit values. For properties 'on' the park the average premium was 11.3% (standard error 2.97) and for properties within close proximity the average premium was 7.3% (standard error 3.86). These are based on the author's calculation from the study data. An earlier study (CABE, 2004) reported that in the Netherlands a view of a park was shown to raise house prices by 8%, and having a park nearby by 6%.

A study of the value of greenspace in the city of Aberdeen, Scotland, applied hedonic pricing methods (Dunse, White and Dehring, 2007). The greenspace represented city parks (large parks), local parks and amenity greenspace. Data for 53 674 observed sales was obtained for 1984–2002 property transactions. Each property had associated geo-codes which allowed for precise GIS location and analysis with respect to greenspace features. The estimations yielded a positive and significant link between the additional percentage increase in net price and a reduction in distance towards the park for all property and park types but with significant variations across types. The location on the park edge was either insignificant or significantly negative for detached and other houses, which may have been due to the potential negative externalities that can be attributed to parks, such as issues of security and perceptions of danger or anti-social behaviour. For flats the park edge location was significant and positive probably

because the positive externality of a view and accessibility is valued higher than any negative effects. Combining the effects of location on the park edge and distance to the park the overall premium for a property located next to a park relative to a similar property 450 metres away is positive across all house types. Calculated average premium values were 10.1% for city parks, 9.0% for local parks and 2.6% for amenity greenspace.

The latest large-scale hedonic prices study (Mourato *et al.*, 2010) of the amenity value provided by various environmental resources was carried out for the UK National Ecosystem Assessment (NEA) (UK National Ecosystem Assessment, 2011, Ch. 22). The study used a sample of around 1 million housing transactions (with information on location at full postcode level, from the Nationwide building society) across England, Wales and Scotland, between 1996 and 2008. A rich set of internal and local characteristics of the houses was used. With regards to local environmental characteristics, the study (Mourato *et al.*, 2010) used nine broad habitat categories and six land-use share variables. The habitat variables are defined as the proportional share (0 to 1) of land cover of a particular habitat within the 1 km square in which a house is located. They are: (1) marine and coastal margins; (2) freshwater, wetlands and flood plains; (3) mountains, moors and heathland; (4) semi-natural grasslands; (5) enclosed farmland; (6) coniferous woodland; (7) broadleaved/mixed woodland; (8) urban; and (9) inland bare ground. Land use share (0 to 1), in the Census ward in which a house is located, of the following land types was used: (1) domestic gardens; (2) green space; (3) water; (4) domestic buildings; (5) non-domestic buildings; and (6) 'other'. Local labour market variables, accessibility and other controls were utilised as well.

Among many results the 'All England' model estimated that a 1 percentage point increase in greenspace land use share increases property prices by around 1%, which translates into a capitalised monetary value of around £2000. Also for the 'All England' model there is a strong and large positive effect from a percentage point increase in share of land cover in broadleaved woodland habitat (0.19% or £377) and a weaker but still sizeable relationship with coniferous woodland habitat (0.12% or £227). When Wales and Scotland are included these effects are stronger and even larger (0.25% or around £340 for broadleaves, and 0.15% or about £204 for conifers), although the model's explanatory power is slightly lower as data limitations preclude inclusion of some explanatory variables. Estimated monetary values are lower with inclusion of Wales and Scotland because the mean house price falls from £194 040 (England only) to £135 750 (all GB). The study also showed that increasing

distance to natural amenities is unambiguously associated with a fall in house prices (Mourato *et al.*, 2010, p. 22). For example, in England a 1 km increase in distance leads to a 0.70% fall in house price (equivalent to £1347) for National Trust land and a 0.24% fall (£461) for National Parks (Mourato *et al.*, 2010, p. 29).

A Finnish study (Tyrväinen and Miettinen, 2000) based on data from the sales of 590 terraced houses in the district of Salo, in Finland, over three years in the mid 1980s, found that having a view of the forest had a positive and significant effect on house prices. Taking account of multicollinearity and spatial autocorrelations, the estimations imply that a 1 km increase in the distance to the nearest forested area leads to an average 5.9% decrease in the market price of the dwelling. Dwellings with a view onto forests were on average 4.9% more expensive than dwellings with otherwise similar characteristics. Estimating a model where the distance to a forested park was classified using dummy variables showed that only distances up to 600 metres had a significant positive effect on the price of dwellings.

Research from Denmark (Prastholm *et al.*, 2002) on impacts of afforestation projects near municipal towns on property values, and people's preferences towards nature, green areas and forests, concluded that for 17% of respondents the proximity to nature, including forests, was the most important reason for choice of their current home. Using a hedonic pricing method the study estimated that the premium for property after afforestation project completion was almost €32 000 (equivalent to £24 500 at 2009 prices). The study also found that house prices decreased by 0.04% when the distance to a forest increased by 1%.

The major knowledge gap in this area is a lack of primary stated preference studies on WTP for greenspace improvements following best practice guidelines (Eftic, 2010) that can be used subsequently within a value transfer approach. The only GB-wide WTP study (Garrod, 2002) may serve as a basis for planning larger and/or more local studies. Hedonic studies only value aesthetics in as much as these are reflected in revealed market prices and will not account for non-use values (see Glossary for definitions), while WTP studies can yield total values and, in the case of aesthetics, the non-use value component may be significant.

Summarising, we see that a large body of evidence exists to support the view that investment in improving greenspace, and as a consequence aesthetic quality of place (visual amenity), positively affects land and property prices. The

estimated effects are necessarily case and location specific and have a wide range. Having a well-managed greenspace nearby results in average property premiums from 2.6 to 11.3%. In terms of a marginal change a 1% increase in the amount of greenspace in the vicinity is associated with about a 1% increase in the average house price (Mourato *et al.*, 2010, Table 3, p. 16). In addition, increasing the value of the housing stocks may increase council tax receipts in the locality (GEN Consulting, 2006, p. 14).

Regional and local economic regeneration

Regional and local economic regeneration is an important government activity. Economic regeneration means

increasing employment, encouraging business growth and investment, and tackling economic disadvantage (Audit Commission, 2005, p. 2). The comprehensive set of economic regeneration performance indicators was developed in consultation with local authorities and various central government departments involved in regeneration and performance management (Audit Commission, 2005, pp. 13–19). The indicators have been grouped into eight themes covering the main areas of interest in local economic development activity. A shorter version of them (focusing on economic aspects) is presented in Table 3.

The list of indicators in Table 3 suggests that regional and local economic regeneration is not an entirely separate greenspace benefit, but a compound one. In particular, it

Table 3 Economic regeneration performance indicators.

Theme	Performance indicator
Employment	The percentage of people of working age in employment
	Proportion of the working age population who are claiming Job Seekers Allowance (JSA)
	The percentage of local jobs in each sector
	Annual change in number of local jobs
Earnings and skills	Median annual earnings for all in full-time employment
	Percentages of population of working age qualified to various NVQ levels
Economic vitality	Gross value added (GVA) and its growth per head of local population
	The number of VAT registrations in the area per 10 000 economically active population
	Median property price
	Median earnings of full-time employees
	(i) Previously developed land that is unused or may be available for redevelopment and (ii) derelict land as a percentage of the local authority land area
Demography and deprivation	Percentage of people living in the local authority area categorised by gender, age bands and ethnicity
	Population density
	Children under 16 living in low-income households
	The percentage of the population of working age who are claiming key benefits
Town centres and tourism	Visits (measured by pedestrian footfall) to the town centre – (survey)
	Prime retail rent per square metre
	Day visitors per annum and their average spend
	(i) Bed nights per annum and (ii) room occupancy
Workforce development and employability	The percentage of employees and self-employed that have received job-related training in the last 13 weeks
Investment	Total number of (i) new investments and ‘inward investment’ enquiries and (ii) re-investments made in the area
	Jobs created and/or safeguarded (and cost per job) to which the authority’s promotional and support activity has made a significant contribution
	Brownfield land reclaimed as a percentage of all land made available for industrial, commercial and leisure purposes

Table 3 (Continued).

Theme	Performance indicator
Business and social enterprise support	Number of new business start-ups supported in the local area per 1000 VAT-registered businesses. Their survival rate (i.e. after two years)
	Number of persons employed by businesses occupying managed workspace provided by (or funded by) the local authority
	Number of business enquiries for advice and information received in the financial year per 10000 economically active population
	Jobs created in the last financial year by social enterprises that have received substantive support from the local authority

depends upon such benefits of greenspace as economic growth and investment, quality of place (including visual amenity), recreation and leisure, and tourism.

Investment in green infrastructure (creation, improvement and development of greenspace and landscaping) is thought to encourage and attract high value industry, entrepreneurs and skilled workers to a locality and region through the maintenance and creation of high quality, landscape sensitive, environmentally friendly living and working environments adding GVA to local economies (ECOTEC, 2008, p. 23). Similarly, investments to improve the aesthetic quality of place (including visual amenity) can be reflected in land and property prices. Therefore, the various indicators measuring the impacts of greenspace on regional and local economic regeneration include changes in employment (jobs created), new business start-ups, GVA, and land and property prices.

In total 13 studies (some with several case studies) were identified as relevant to the 'regional and local economic regeneration' topic (EKOS, 1997; Garrod, 2002; GLA Economics, 2003; CABE, 2004, 2005; CESR, 2004; Forestry Commission, 2005; GEN Consulting, 2006; Land Use Consultants, 2006; CLES, 2007; Dunse, White and Dehring, 2007; CSI, 2008; Regeneris, 2009) and are presented in Table 4.

Since individual studies have already been reviewed in earlier sections, we focus on summarising greenspace projects' outcomes across different regeneration themes (Table 3).

On Employment (including earnings and skills) five studies reported the creation of new jobs after the intervention. However, lack of information on project expenditure breakdowns and complex interactions among various project activities preclude direct comparisons. This calls for better monitoring. (See detailed suggestions the section on Economic indicators for monitoring and evaluation of greenspace interventions). Only the Glasgow Green

Renewal project (GEN Consulting, 2006, p. 17) reported a detailed breakdown of new jobs by demographic and social characteristics. There is also evidence that greenspace projects can be associated with a reduction in the number of Job Seekers Allowance (JSA) and incapacity and sickness related benefits claimants (CLES, 2007, pp. 27–8), and raises the skills level (CLES, 2007, p. 44).

Table 5 summarises the cost of different projects per FTE job created or safeguarded based upon the information given in the reviewed publications. Only rough estimates are possible given that the information drawn from these publications may be incomplete. We distinguish public and total (i.e. including private sector) investments required per FTE created, or created or safeguarded. The diversity of the projects is reflected in the range of public expenditure costs from £6000 to £3.9 million per FTE job created with a median value of about £46000. The value of £3.9 million per FTE job created probably overestimates the cost due to exclusion of the additional 165–245 construction job years created (GEN Consulting, 2006, p. 20). Assuming 50 job years as equivalent to one FTE, for example, would imply three to five further FTEs created and, roughly halves the estimate. The median value of public expenditure costs per FTE created or safeguarded is about £20000. This is in line, for example, with the estimates for the Regional Selective Assistance (RSA) Scheme for Scotland for 2000–2004, which range between £13273 and £34419 on the actual amount of assistance paid. The RSA was a prominent feature of regional policy in Great Britain for more than 30 years from 1972 to 2004.)

Various changes in demographic and deprivation indicators in the project area are reported in some studies (CESR, 2004; CLES, 2007) but without before and after comparisons. Difficulties include a mismatch between geographic boundaries of a project and local reporting area and definition changes over the lifetime of a project. Some studies report significant crime reduction in the project locality (CLES, 2007, p. 35; CSI, 2008, p. 23).

Table 4 Regional and local economic regeneration.

Project (and reference)	Estimated benefits		
	Employment (full-time equivalent, FTE)	Economic, business, investment	Other
Riverside Park Industrial Estate in Middlesbrough. Investment in the green infrastructure with over 1800 new trees planted. (CLES, 2007).	Over 60 new FTE jobs created. From 2003 to 2006 over the course of the improvements works numbers of Jobcentre Plus claimants decreased from 140 to 125; the number of incapacity and sickness related benefits claimants fell from 340 to 280.	Created a setting for stimulating business growth and investment, attracted new, high profile, occupants and saw occupancy grow from 40 to 78%, and levered over £1 million of private investment. 28 new businesses started up.	
Winsford Industrial Estate in Cheshire. Environmental and landscape improvements including new plantings. (CLES, 2007).	88 new FTE jobs created. 13% increase in the number of employees in Winsford Wharton between 2003 and 2005 (compared to 2.9% for England as a whole).	Private matched funding of over £290000 was levered in. Number of businesses increased from 104 to 160, all paying business rates to the local authority.	Significant crime reduction (vandalism rate halved)
Portland Basin Green Business Park, Tameside, Greater Manchester. Landscaping improvements. (CLES, 2007).	13 permanent jobs were created and a further 314 jobs safeguarded. Programme facilitated the gaining of 87 formal qualifications and the undertaking of 598 training weeks.	Just under £425000 of public sector funding levered in over £1.8 million of funding from the private sector. As a result of the programme the number of businesses located in the park increased from 120 to 140.	
The National Forest creation. (CESR, 2004).	Number of local jobs increased (1991–2001) by 4.1%. Jobs created or safeguarded (1995–2001): 213 FTE. Earnings growth at 5.6% has not kept pace with the regional averages of 11–12% over the period (1999–2002). Female earnings growth was around 2% slower, while male growth was some 7% slower.	By 2001 directly related regeneration programmes resulted in funding of £32.5 million for the area which attracted leverage of £96 million and created over 500 jobs (CESR, 2004, p. 43).	
Manvers Regeneration scheme by Rotherham Metropolitan Borough Council in South Yorkshire. (CSI, 2008).	About 9000 jobs have been created over 20 years.	Private sector investment in the scheme to date has been estimated at over £350 million over 20 years.	
Langthwaite Grange, Wakefield, West Yorkshire. Landscape quality and security improvements at a 57-hectare industrial estate. Started 2005. (CSI, 2008).	Created 200 new jobs	16 new businesses moving in, bringing over £12 million investment.	Crime has fallen by 70% in 12 months
Development of Bold Colliery Community Woodland. (Forestry Commission, 2005).		Enhanced property values in the surrounding area by about £15 million and helped realise a further £75 million of new development.	
Glasgow Green (the city's oldest park) Renewal project: £15.5 million investment of public funds (1999–2006). (GEN Consulting, 2006).	4 FTE, 165–245 construction job years associated with residential property development, including: 10 jobs for women; 5 for people under the age of 25; 41 jobs for people from Social Inclusion Partnership (SIP) areas.	Stimulated the development of new residential properties (net 500–750 new residential properties), enhanced average house prices and the total value of property transactions (net £3–4.5 million), a 47% increase in council tax yield (additional £0.8–2 million). The value of the land increased from a nominal £100000 per hectare to £300000.	Net visitor spend to the Green from 1998 to 2006 was between £14.9 and £22.4 million
Ten case studies into the effect of park improvements on house prices, though often not clear how much was invested and what is the return. (CABE, 2004, 2005).		A study found that, following improvements, houses near parks were, on average, 8% more expensive than comparable houses further away.	

Table 4 (Continued).

Project (and reference)	Estimated benefits		
	Employment (full-time equivalent, FTE)	Economic, business, investment	Other
Comparison of 'greenness' across the City of London's 760 wards. (GLA Economics, 2003).		Hedonic pricing approach showed that higher property values (in terms of the average house price) exist in areas with a higher percentage open space: a 1% increase in greenspace (in London) was linked to 0.3 to 0.5% increase in house prices.	
Value of greenspace in Aberdeen (Dunse, White and Dehring, 2007).		Hedonic pricing estimations yielded average premium values for property located near particular type of greenspace of: 10.1% for city parks, 9.0% for local parks and 2.6% for amenity greenspace.	
Survey (GB-wide) to estimate the value of woodland views from properties and on journeys using stated preference approach. (Garrod, 2002).			Respondents' estimated WTP: a woodland view for houses on the urban fringe is £269 per annum per household (2002 prices), and a view of woodland while travelling is £227 per annum per household (2002 prices).
The Mersey Forest, Merseyside (new tree planting, land reclamation, bringing woodland into management, creating access to greenspace and recreational facilities, managing and improving habitats, engaging local communities and business support activity for forestry businesses). (Regeneris, 2009).		Direct increases in economic output in Merseyside: £2.8 million gross GVA from tourism spend, from direct jobs (Products from the land), and from improvements in health or £436 000 net additional benefits.	Net additional monetised benefit due to landscape improvements (visual amenity), views from home: £412 000 per annum and while travelling: £527 000 per annum (Regeneris, 2009, pp. 36-7).
Kennet and Avon Canal restoration. Restored historic waterway enhances landscape. The long-term restoration effort has involved £38.9 million since 1997, including a Heritage Lottery Fund donation of £25 million (Land Use Consultants, 2006, p. 9).		Direct and indirect employment created by the project totalled 150-210 FTE jobs between 1997 and 2002. The total number of jobs created and safeguarded by the project is estimated at 1198-1353 FTEs.	Visitor numbers increased by 15% between 1995 and 2001. The net economic impact of the programme was estimated at £82 million to 2003. This included £29 million of direct expenditure on restoration and an additional £53 million of further investment in tourism, leisure and commercial development.
Improvements to the local footpath network in Dunkeld and Birnam: establishment cost (£70 000) and annual maintenance cost (£3000) (EKOS, 1997).	Generated between £1.37 million and £3.69 million of income a year to the local economy, directly supporting between 8 and 15 FTE jobs.		Helped reduce the seasonality of tourism employment; contingent evaluation techniques assigned a value of £170 000-£242 000 to the network across the population as a whole (visitors and residents).

On economic vitality, investment and business and social enterprise support, there is evidence of increases in business occupancy rates, business start-ups, property prices, and private sector investments levered in (see Table 4 for details). However, due to large differences between projects and level of reporting, comparisons are difficult. This is not unexpected since recommendations on economic regeneration performance indicators were published only in 2005 (Audit Commission, 2005). Nevertheless, we present a summary table of private sector investments levered in (Table 6). It shows the range of values for the ratio of private to public investments from 2 to 10 with a median value of about 4.2 (i.e. projects levered in

£4.20 of private sector investments for every pound of public investments). Although there were no precise data reported on the amount of private sector investments levered in for the Glasgow Green Renewal project, Glasgow City Council apparently levered in an amount of external funding twice the original public investment (GEN Consulting, 2006, p. 5).

Another UK study (Whitehead, Simmonds and Preston, 2006) found that investments in urban quality improvements led to office rents increasing by 15–35% with a mean rise of 24%. Retail rents were found to rise by 10–30%, with a mean of 22%. However, the study focused mainly on impacts of

Table 5 Cost of FTE creation.

Project	Portland Basin Green Business Park, Tameside	Riverside Park Industrial Estate in Middlesbrough ¹		The National Forest ²	Langthwaite Grange, Wakefield, West Yorkshire	Glasgow Green Renewal ³	Kennet and Avon Canal restoration ⁴	Improvements to the local footpath network in Dunkeld and Birnam ⁵
Source	CLES (2007, pp. 43–4)	CLES (2007, p. 28)		CESR (2004, pp. 49–50)	CSI (2008, p. 23)	GEN Consulting (2006, pp. 5, 17)	Land Use Consultants (2006, p. 9)	EKOS (1997)
Public investments (£000s)	424	500	3575	21 000	1200	15 494	38 900	125
Total investments (£000s)	1820	1000	15 000	21 000	13 200	15 494	38 900	125
FTE jobs created ⁶	13	60	60	181	200	4	180	12
FTE jobs safeguarded	314	No data	No data	32	No data	No data	1096	No data
Public expenditure per FTE created (£000s)	33	8	60	116	6	3873	N/A	10
Total investment per FTE created (£000s)	140	17	250	116	66	3873	N/A	10
Public expenditure per FTE created or safeguarded (£000s)	1	8	60	99	6	3873	30	10
Total investment per FTE created or safeguarded (£000s)	6	17	250	99	66	3873	30	10

1 The first column only includes business grants. The second column includes all public and private investments, including the *Evening Gazette* move to the Industrial Park which brought a further £14 million of investment to the area (CLES, 2007, p. 27). An additional 4605 jobs in a wider Middlehaven area were created (CLES, 2007, p. 49).

2 No data reported on private sector investments. The latest data on the National Forest includes the following information (NFC, 2007, p. 24): Between 1995 and 2006 around £115 million was invested in Forest-related projects and regeneration programmes in the area. NFC invested £24 million through the National Forest Tender Scheme, land acquisition and project grants. Partner organisations invested a further £36.5 million in Forest-related projects, including the £18.6 million Conkers Discovery Centre. The area also secured £54.4 million for coalfield, urban and rural regeneration programmes delivering wide-ranging community benefits.

3 No data reported on private sector investments.

4 No separate data are provided for jobs created and safeguarded for Kennet and Avon Canal. Jobs created are given as a range 150–210 of which we used a midpoint estimate of 180. Also jobs created and safeguarded are given as a range 1198–1353 of which we used a midpoint estimate of 1276. For presentation in the table we assume that number of safeguarded jobs is 1096 = 1276 – 180.

5 Jobs created are given as a range 8–15 of which we used a midpoint estimate of 12. Costs are establishment cost (£70 000) and annual maintenance cost (£3000). Conversion of the latter to present values depends upon the time horizon and discount rate assumed. For illustrative purposes, the annual maintenance cost was converted to present value of £55 000 assuming 30 years and 3.5% rate per annum.

6 In the case of the Glasgow Green Renewal project, an additional 165–245 construction job years were created (GEN Consulting, 2006, p. 20).

pedestrianisation, rather than investments in greenspace. Given problems reported with isolating confounding factors and possible displacement of shopping activities from other locations (Whitehead, Simmonds and Preston, 2006, pp. 4, 10), the magnitude of net economic impact is unclear and the use of a lower estimate for the range of uplift in rents of 10% is suggested.

An example of regional green infrastructure investment is the installation of a buffer zone of 330 metres on one bank of the upper Bristol Avon catchment, North Wiltshire (Everard and Jevons, 2010). The buffer zone work was completed in August 2008 at a capital cost of £4700. Habitat regeneration was fast and an important 'nursery area' of semi-static shallow water with cover was created for juvenile fish. Fishery benefits alone (the project was initially driven by angling interests) yielded an annual benefit of £828, comprising 9.6% of the estimated gross annual ecosystem service benefits of the scheme, and a lifetime benefit of £13 989, which alone represents a benefit-to-cost ratio of 3:1 relative to the investment in fencing. When wider benefits are considered (provisioning of 'fresh water', 'climate and erosion regulations', 'recreation and tourism', volunteering and 'provision of habitat') gross lifetime benefits (compounded over 25 years with a discount rate of 3.5%) from the buffer zoning project on the upper Bristol Avon rise to £144 860, representing a benefit-to-cost ratio of 31:1, which is considered exceptional value for money for such a small initial investment. However, the net benefit of this intervention is difficult to assess because the baseline (business as usual) scenario for the same time horizon of 25 years was not specified, and as ongoing maintenance costs are also not estimated.

Finally, an Environment Agency study (Everard, 2009) presents a retrospective valuation of benefits from ecosystem services for two case studies of regional green infrastructure investments. A catchment-scale study focused on the River Tamar on the Devon/Cornwall border, and a site-specific study was undertaken for the Alkborough Flats managed realignment scheme on the Humber Estuary. The Tamar

project yielded a benefit-to-cost ratio of over 100:1, while the Alkborough Flats project yielded a benefit-to-cost ratio of 3.22:1. As above, the gross lifetime benefits compounded over 25 years with a discount rate of 3.5% were estimated. Both studies suffer from the lack of a well-defined baseline scenario which precludes net valuation of the interventions.

Since this section is based on results from other sections (Economic growth and investment, Land and property values, aesthetics, and Tourism) the corresponding knowledge gaps identified and conclusions apply.

Labour market employment and productivity

More and better quality greenspace is considered to provide opportunities to develop a more productive workforce for employers through improved health, reducing stress, sickness and absenteeism. It helps to attract and retain motivated people (NENW, 2008, p. 9). Examples often cited in the literature (AMION, 2008; ECOTEC, 2008) in support of the link between labour productivity and greenspace (AMION, 2008, p. 20) include:

- 'survey work demonstrates that more than 60% of staff indicated that their surroundings and external views had the greatest effect on how they felt at work;
- anecdotal evidence suggests that the working environment has a positive effect on motivation and productivity;
- greenspaces are a key factor in recruiting and retaining highly skilled staff, with environment identified as a high priority when making locational decisions;
- university staff rated their situational design (external views and surroundings) as the most important feature in retaining them at their work place.'

Two effects are potentially at work here. First, health benefits of greenspace may increase labour productivity.

Table 6 Private investments levered in.

Project	Source	Public (£000s)	Private (£000s)	Leverage ratio (private/public)
Portland Basin Green Business Park, Tameside	CLES (2007, p. 44)	424	1820	4.3
Riverside Park Industrial Estate in Middlesbrough ¹	CLES (2007, pp. 25-7)	500	1000	2.0
Langthwaite Grange, Wakefield, West Yorkshire	CSI (2008, p. 23)	1200	12 000	10.0

¹ This is based on the business grant scheme data. If other data on investments are included (e.g. the *Evening Gazette* move to the park) the leverage ratio in this case changes to 4.2.

Second, quality greenspace can help attract and retain a motivated and skilled labour force. The second effect overlaps with the 'economic growth and investment' theme reviewed above and hence will not be considered here in detail. We could not uncover research that produced evidence of the mix changing towards a more skilled labour force due to greenspace interventions. Nor did we find any direct evidence measuring or estimating increases in labour productivity due to greenspace interventions. The evidence of health benefits of greenspace is reviewed in the appropriate section. Other studies reached similar conclusions on the lack of direct evidence of link between labour productivity and greenspace (Cousins and Land Use Consultants, 2009, p. 8; Regeneris, 2009, pp. 27–8).

The major knowledge gap in this area is a lack of primary studies that provide evidence of an increase in labour productivity and/or of the job mix changing towards a more skilled labour force due to greenspace investments.

In short, at present it has not been conclusively demonstrated that greenspace investments increase labour market productivity.

Tourism

Greenspace improvements can play a large role in generating new tourism opportunities. Creation of new greenspace such as community forests and greening city centres, can potentially attract new visitors and support urban retail and tourism sectors (ECOTEC, 2008, p. 26).

Tourist visits are generally less regular, longer and involve more travel than recreational visits. The England Leisure Visits Survey defines a tourist visit as one with a minimum of 3 hours and not taken regularly.

Tourism benefits are market-based and can be expressed in terms of GVA and jobs (FTEs). Expenditures by tourists visiting the site on, for example, transport, retail goods, food and drink, generates economic impact both directly and through indirect (supply chain) and induced (employees' incomes spent on goods and services) effects in the local economy. However, not every study distinguishes tourist and recreational/leisure visits, with often just an increase in visitor numbers reported.

In total five studies (Table 7) were identified as relevant to the 'tourism' topic (EKOS, 1997; GFA Race and GHK, 2004; Land Use Consultants, 2006; GEN Consulting, 2006; Regeneris, 2009).

Comprehensive visitor surveys (regular or before and after intervention) seem to be the best tool to obtain strong and reliable evidence of net impacts of investments in greenspace on tourism. Additionality of tourism and recreation benefits is very sensitive to availability of substitutes and issues of displacement and leakage. For example, on a net additional basis tourism impacts were only about 10% of the gross value in the case of the Mersey Forest (Regeneris, 2009, pp. 22, 30, 37).

Updated figures for the creation of the National Forest (NFC, 2009) show that tourism directly supported 4422 jobs in 2008. Annual visitor spending grew to £287 million in 2008. This includes expenditure (excluding VAT) on accommodation (£17.24 million), food and drink (£49.29 million), recreation (£19.66 million), shopping (£70.04 million), transport (£26.88 million) and indirect expenditure (£71.97 million). Of the total, 75% was accounted for by expenditure by day visitors. Out of 7.97 million visitors in 2008 93% (7.42 million) were day visitors and 7% (0.55 million) were visitors staying overnight.

The major knowledge gap in this area is a lack of primary studies on the availability of substitutes and issues of displacement and leakage that can significantly affect estimates of the additionality of tourism impacts.

In short, there are several studies of tourism impacts due to greenspace investments. Their major research tool is comparing data from comprehensive visitor surveys (regular, or before and after interventions). However, some studies fail to report baseline information, which makes estimating net additional impacts of a project impossible with any precision.

Recreation and leisure

Green infrastructure facilitates the provision of leisure and recreational opportunities (e.g. walking, viewing wildlife, cycling). It creates opportunities for community ownership, involvement and management of greenspace assets (ECOTEC, 2008, p. 27). Most visits to greenspace are free of charge. Nevertheless people value greenspace in terms of actual or planned use and stated and revealed preferences techniques can be applied to estimate the monetary value of visits to visitors.

In Table 8 we report some valuations of recreation and leisure activities with willingness to pay (WTP) estimates. Research for the Forestry Commission (Christie *et al.*, 2006) looked at seven forests located throughout Great Britain: Glentress, Dyfnant, Cwm Carn, Thetford, New Forest,

Table 7 Benefits of greenspace: tourism.

Project	Estimated benefits	Reference	Value or impact study	Additionality issues
The Mersey Forest	Direct increases in economic output in Merseyside from tourism spend: £2.8 million gross GVA, £252 000 net GVA per annum. The England Leisure Visits Survey in 2005 indicates that the average spend per tourist visit to the woods/forests was £31 in 2009/10 prices. It was assumed that the benefit was calculated at the point where the trees have matured and that this may lead to an overestimation.	Regeneris (2009, pp. 36–7) Regeneris (2009, p. 22)	Both	Well considered in general, also uses WTP here
Glasgow Green (the city's oldest park) Renewal project: £15.5 million investment of public funds (1999–2006).	Net visitor spend to the Green from 1998 to 2006 was between £14.9 and £22.4 million.	GEN Consulting (2006, p. 34)	Impact	Adequate
The National Forest creation	Since 1995 an additional 330 000 visitors have entered the area spending £128 million annually and creating over 500 new jobs.	GFA Race and GHK (2004, p. 37)	Impact	No details provided
Kennet and Avon Canal restoration. Restored historic waterway enhances landscape. The long-term restoration effort has involved £38.9 million since 1997, including a Heritage Lottery Fund donation of £25 million.	Visitor numbers increased by 15% between 1995 and 2001. The net economic impact of the programme was estimated at £82 million to 2003. This included £29 million of direct expenditure on restoration and an additional £53 million of further investment in tourism, leisure and commercial development.	Land Use Consultants (2006, p. 9)	No details provided	No details provided
Improvements to the local footpath network in Dunkeld and Birnam: establishment cost (£70 000) and annual maintenance cost (£3 000).	Helped reduce the seasonality of tourism employment; contingent evaluation techniques assigned a value of £170 000–£242 000 to the network across the population as a whole (visitors and residents).	EKOS (1997)	Impact	No details provided

Rothiemurchus and Whinlatter. The sites were chosen to cover a comprehensive range of forest recreation activities. In particular, four forest-based recreation activities were investigated: cycling, horse-riding, nature-watching and general forest visitor (walkers: short family/leisure walk, was the largest group). A total of 1568 interviews between May and September 2005 were undertaken. Three different economic valuation methodologies were used: travel cost model, contingent behaviour analysis and choice experiments. In terms of consumers' surplus values per trip range from £7.90 (about £9 in 2010 prices) for nature-watchers to approximately £14.00 (about £16 to £17 in 2010 prices) for cyclists, horse-riders, walkers and general visitors (Christie *et al.*, 2006, pp. 35, 50). It should be noticed that these are woodlands with specific facilities and that site selection was influenced by the recommendations made by forest managers. Additionally, only 15% of visits were day trips of less than 3 hours, the rest were longer trips and holidays away from home, putting the majority of respondents in a 'tourism' category

rather than 'recreation and leisure'. This also explains partly why people were prepared to pay more than average WTP from other studies.

A study from Finland (Tyrväinen, 2001) in two different urban environments (Joensuu and Salo) revealed that more than two-thirds of the respondents were willing to pay for the use of recreation areas. A good location (proximity to users) and active management (well-maintained and developed trails, lighting) raised the average WTP. In the case of monthly fees WTP ranged from 31 to 76 Finnish markka (FIM) per person per month (in 1995 prices, equivalent to £6–£16 in 2009). Moreover, approximately half of the respondents were willing to pay for preventing construction in urban forests. Estimated WTP ranged from 74 to 206 FIM per year per household for three years in Salo or Joensuu (equivalent to £15–£42 in 2009). The results revealed that the monetary value of amenity benefits in recreation areas is significantly higher (at least seven times higher) than the present maintenance costs.

Table 8 Valuations of recreation and leisure activities.

Project	WTP (£)	Sources
Average for walkers on the National Ridgeway Trail, per visit based on an average visit lasting 6 hours and visiting the trail six times a year.	1.85	Bennett, Tranter and Blaney (2003)
Nature-watchers visiting forests, per visit.	7.90	Christie <i>et al.</i> (2006)
Per recreational visit to a woodland, range depending on the distance travelled, from less than 10 miles (16 km) to over 150 miles (240 km), with average value of £1.66 for a day visit.	0.90–2.40	Scarpa (2003)
Recreation in urban forests (Finland), per person per month (converted to £ in 2009 prices).	6–16	Tyrväinen (2001)

Focusing on additionality issues is important in estimating the net benefits of recreation because these can be much smaller than the gross values. For example, for the Mersey Forest the annual benefit from recreation is estimated at around £405 000 on a net additional basis, which is only about 27% of the gross value estimated (Regeneris, 2009, pp. 22, 30, 37). This is due to the availability of alternatives.

No direct evidence was identified in the literature of the benefit of investment in greenspace on recreation and leisure. Moreover, a study from Norwich found no evidence of clear relationships between recreational activity and access to greenspace for 4950 middle-aged (40–70 years) respondents (Hillsdon *et al.*, 2006). Therefore, the strength of the link between recreation and availability of accessible greenspace is not entirely clear.

The major knowledge gap in this area is that not every publication reported ‘recreation and leisure’ as a separate category of greenspace benefit distinct from tourism. One reason may be that distinguishing a tourist visit from a recreational visit requires adoption of a necessarily somewhat arbitrary distinction.

In short, the same conclusion as for the tourism section applies, with detailed visitor surveys being the main tool for assessing the net impacts of investments in greenspace on recreation and leisure.

Health and well-being

Greenspace can improve air quality (due to pollution absorption by trees), help reduce stress levels with a positive

effect on mental health, and provide opportunities for informal and formal physical activity with a positive effect on physical health (UK National Ecosystem Assessment, 2011, Ch. 22). The economic benefit of increased activity can include (Regeneris, 2009, p. 23):

- cost savings to the National Health Service (NHS);
- increased economic output due to a reduction in ill health and absence from work;
- increased economic output due to a reduction in the incidence of premature death.

In total five studies (Table 9) were identified as relevant to the ‘health and well-being’ topic (Bird, 2004; Regeneris, 2009; Tiwary *et al.*, 2009; GENECON, 2010b; Mourato *et al.*, 2010).

Additionality issues are important in estimating health and well-being benefits, including how much additional physical activity is generated by new or improved greenspace sites (Regeneris, 2009, p. 37). For example, net additional benefits from exercise (£33 000) were only about 27% of the total gross value (£122 000) of health and well-being benefits estimated in the case of the Mersey Forest.

The UK study (Mourato *et al.*, 2010) adopted a similar theoretical framework to an earlier report (CJC, 2005a) on the economic benefits, in terms of physical and mental health, of changes in the provision of accessible greenspace. It identified three key stages in the valuation of the health benefits of ‘created exercise’ (i.e. exercise which would not have occurred otherwise) due to additional greenspace provision: (1) measuring the physical and mental health impact of exercise; (2) valuing the health benefits of exercise; and (3) estimating the probability of additional exercise with changes in greenspace. Adopting the same approach, the study by Mourato *et al.* (2010, pp. 58–66) considers a scenario whereby changes in greenspace management lead to an additional reduction of 1 percentage point in the numbers of sedentary people in the UK. Sedentary people are defined (CJC, 2005a) as those taking less than one 30-minute period of moderate activity per week. (It is estimated that roughly 23% of men and 26% of women were sedentary in 2001.) Health benefits of reductions in mortality and morbidity for three physical conditions (coronary heart disease – CHD, colo-rectal cancer and stroke) and reductions in morbidity for mental health (stress, anxiety and depression) are estimated using WTP methods. The total benefit is estimated at almost £2 billion, but falls to just over £750 million when people over 75 years are excluded.

Table 9 Health and well-being.

Project	Estimated benefits	Reference	Value or impact study	Additionality issues
The Mersey Forest	Net additional monetised benefit: £149000 per annum due to more exercise and lower air pollution.	Regeneris (2009, pp. 36-7)	Both	Well considered
Greenspace establishment across a 10 x 10 km area of East London	Two deaths and two hospital admissions would be averted per year	Tiwary <i>et al.</i> (2009)	Impact	Not applicable (simulation study)
Scenario whereby changes in greenspace management lead to an additional reduction of 1 percentage point in the numbers of sedentary people in the UK	Total health benefit is estimated at almost £2 billion, but falls to just over £750 million when people over 75 years are excluded.	Mourato <i>et al.</i> (2010)	Impact	Not applicable (scenario study)
Doubling the number of trees in the West Midlands (currently 8.1 million trees)	Could reduce deaths due to particulates in the air by up to 140 people per year	GENECON (2010b, p. 30)	Impact	No data
Park in Portsmouth	Estimates suggest potential savings of £4.4 million each year, including £910000 to the NHS.	Bird (2004, Appendix 1)	Value	No data
Footpath in Norwich	A 3 km footpath on the edge of Norwich could potentially save the economy £1 million, including £210000 to the NHS.	Bird (2004, Appendix 1)	Value	No data

No conclusive evidence on the strength of the relationship between the amount of greenspace in the living environment and the level of physical activity and the causal link between the two were found (Mourato *et al.*, 2010, p. 66). Nevertheless, the study used newly commissioned geo-located survey data (with 1851 respondents) to estimate the physical and mental health effects associated with UK greenspace. Results showed that physical exercise has a positive relationship with all health measures used in the study. In relation to the environmental variables, views of grassland from the respondent's home are significantly, substantially and positively linked with their emotional well-being and health-related utility. Also in terms of land cover larger areas of freshwater, farmland and non-coniferous woodland within 1 km of the home are all significantly positively associated with health utility scores (Mourato *et al.*, 2010, p. 74). Linking changes in health utility score due to changes in the environment to quality adjusted life years (QALYs), the following tentative monetary estimates (per person per annum) were obtained (Mourato *et al.*, 2010, p. 78, Table 18) based upon one QALY being valued at £6414-£21 519 in 2009 (Mason, Jones-Lee and Donaldson, 2009):

- Physical exercise (+3 hours of vigorous activity per week): £12-£39.
- Having any view of greenspace from your house (versus no view): £135-£452.
- Local broadleaved/mixed woodland land cover (+1% within 1 km of the home): £8-£27.

The London study (Tiwary *et al.*, 2009) focuses on the role of vegetation in mitigating the effects of particulate (PM10) pollution. Predicting (using model simulations) the PM10 concentrations both before and after greenspace establishment, using a 10 x 10 km area of East London Green Grid (based upon a scenario of 75% grassland, 20% sycamore maple and 5% Douglas fir) as a case study, the paper estimates that two deaths and two hospital admissions would be averted per year.

A rough estimate of the potential value that greenspace and footpaths provide (Bird, 2004, Appendix 1) is obtained given the cost of physical inactivity, calculated by the Cabinet Office Strategy Unit, as £8.2 billion per year for the UK as a whole. The analysis estimates the proportion of physical activity that greenspace (a public park and a circular walk) can contribute to the total amount of physical activity undertaken.

Drawing on a number of sources the benefit of taking up moderate physical exercise by increased cycling was valued (GENECON, 2010a, p. 37) at about £180 (in 2007 prices) per extra cyclist for the England and Wales population aged 15-64. Health benefits were measured in terms of reductions in all-cause mortality, utilising the Department of Transport's statistical value of a life.

However, it is important to emphasise that the argument about the link between health and greenspace is not entirely

settled. For example, no relationship was found between the amount of greenspace in the environment and whether or not people met the Dutch public health recommendations for physical activity in a recent large study in the Netherlands (Maas *et al.*, 2008).

A positive effect of greenspace on psychological well-being, including stress reduction and mental health improvements, is reported in a number of studies (Grahn and Stigsdotter, 2003; Fuller *et al.*, 2007; Nielsen and Hansen, 2007). Two studies from Sweden and Denmark (Grahn and Stigsdotter, 2003; Nielsen and Hansen, 2007) and a study from Bristol (Coombes, Jones and Hillsdon, 2010) also emphasise the fact that distance to greenspace and accessibility are important factors for the amount used. However, none of the studies reviewed has valued the effect of greenspace on mental health. Importantly studies (Fuller *et al.*, 2007; Caula, Hvenegaard and Marty, 2009) show that people prefer greenspace that is more natural and with a high level of biodiversity.

Finally, a UK study (Mitchell and Popham, 2008) investigated the social gradient of health inequalities. The study found that health inequalities related to income deprivation in all-cause mortality and mortality from circulatory diseases were lower in populations living in the greenest areas, supporting the hypothesis that access to greenspace reduced the gradient of health inequalities.

In summary, very few studies currently exist that have moved from establishing the link between greenspace and health and well-being to estimating measurable health outcomes such as avoided excess morbidity and mortality, increases in QALYs, avoided hospital admissions and/or treatments associated with implementing greenspace projects. Only once such data are available will economists be able to calculate the economic benefits of improved health due to greenspace interventions (e.g. drawing upon existing approaches to valuing reduced morbidity and mortality).

Quality of place

Green infrastructure can offer an improved living environment, including opportunities for recreation and visual amenity, and also potentially for empowerment through community action. Investments in greenspace can improve quality of life for local residents, increase community participation in ownership and management leading to higher community cohesion and lower crime, and thereby make a locality more attractive for business and skilled workers (ECOTEC, 2008, pp. 18–19).

It is argued (Regeneris, 2009, p. 18) that the 'quality of place' benefit is not independent of economic growth and investment, land and property prices (including visual amenity benefit), recreation and leisure and biodiversity benefits. Instead 'quality of place' incorporates these other effects, rather than being a separate economic benefit of greenspace.

Quality of place benefits arising from visual amenity were considered previously in the Land and property values, aesthetics section. Some quality of place benefits were also noted under the Regional and local economic regeneration section (e.g. crime reduction).

No references have been identified with explicit link between investments in greenspace and other economic benefit estimates relevant to 'quality of place' benefits. However, the following more general and indirect effects are often quoted (AMION, 2008, pp. 23–4; ECOTEC, 2008, p. A12; Cousins and Land Use Consultants, 2009, p. 9):

- A public satisfaction survey of Britain's parks and green spaces found that 97% of people believe that parks and greenspace create nicer places to live (GreenSpace, 2007).
- The findings from 'Public Attitudes to Architecture and the Built Environment' (CABE, 2002):
 - greenspace contributes to increased social interaction, greater social inclusion and community development;
 - 85% of people consider that the quality of public space and the built environment has a direct impact on their lives and on the way they feel;
 - there are relationships between access to greenspace and educational performance/childhood development;
 - improved greenspace helps improve community safety and reduce crime. More recent studies (CLES, 2007; CSI, 2008) also reported significant reduction in crime level of one kind or another (e.g. vandalism).
- A correlation exists between urban areas with a low number of green spaces and higher levels of deprivation (GLA Economics, 2003).
- Green Cities attract highly educated and skilled workers (Kahn, 2006).
- A belt of trees can reduce noise levels by as much as 6–8 decibels for every 30 metres width of woodland (Leonard and Parr, 1970).

Summarising 'quality of place' is a compound concept with no established definition and with little economic research addressing it directly. At present the majority of studies concentrate on the links between greenspace improvements and benefits that contribute to 'quality of place'. Although 'quality of place' can be useful in social and political

discourse it is generally considered a secondary entity for the purpose of economic analysis.

Water management

Investment in green infrastructure can result in an increase in urban greenspace, with canopy cover and 'soft surfacing' contributing to Sustainable Urban Drainage Systems (SUDS), acting to reduce and control run-off, improve absorption rates and provide storage capacity. It can result in less frequent and less dramatic flood events for urban areas, thereby reducing costs to business and residents. (ECOTEC, 2008, p. 17)

Few references have been identified with an explicit link between investments in greenspace and economic impacts relevant to water management benefits, except for a simulation study (Gill *et al.*, 2007) and an ex-ante evaluation (Nisbet *et al.*, 2011) of some practical measures for flood risk reduction at Pickering in North Yorkshire. This is the case for the UK and Europe. There is a lot more research on the role of trees in water management in the USA. However, the US results are not easily transferable because hydrological studies are very site specific, including particulars of local catchments and surface water sewer systems.

A simulation study for Manchester (Gill *et al.*, 2007) estimated that:

- increasing green cover by 10% in urban residential areas reduces run-off from these areas from a 28 mm precipitation event – expected in the 2080s High Emissions Scenario – by 4.9%;
- increasing tree cover by 10% reduces the run-off by 5.7%.

Up to date data on tree evaporation, woodland cover and water supply are presented in the (Read *et al.*, 2009, Ch. 10), but there are no economic estimates.

A pilot project (Nisbet *et al.*, 2011) based at Pickering in North Yorkshire explored how changes in land use and land management can help to reduce flood risk. The measures considered include building 150 large woody debris dams, the creation of floodplain woodland (30 ha), riparian woodland (50 ha) and other farm woodland (5 ha). Indicative estimates of the value of ecosystem services these woodlands provide were calculated. In particular, the project (Nisbet *et al.*, 2011, Appendix 12.5) utilised the following values (central estimates at 2011 prices):

- Provision of habitat (encompassing water quality improvement, biodiversity, aesthetic amenity and non-

consumptive recreation): for the riparian woodland £282 per hectare per year; for the floodplain woodland £1396 per hectare per year; for the farm woodlands £169 per hectare per year.

- Flood regulation (riparian woodland): £6000 per year.
- Erosion regulation (riparian woodland): £221 per year.

Habitat and erosion benefits are assumed to have zero value at the year of planting and to increase linearly until the above values are reached once the trees are a certain age: 20 years for habitat values and 12 years for erosion regulation. The flood risk reduction benefits are assumed to increase linearly from 70% of the maximum in year zero to the full benefit in year 3.

Finally, the present values of ecosystem services over a 100-year period were estimated (Nisbet *et al.*, 2011, p. 21, Table 22) (£ at 2011 prices):

- Provision of habitat: £2 773 000.
- Flood regulation (riparian woodland): £175 000.
- Erosion regulation (riparian woodland): £5000.

The major knowledge gap in this area is lack of primary studies that link physical findings on tree evaporation, woodland cover and water management to economic estimates. However, one useful building block for such studies could be the level of discount provided by water companies to properties that avoid discharging surface water into the combined sewer network. For example, for domestic properties in northwest England, the discount is £35.33 per annum; 'for commercial properties the discount varies with 'chargeable area' (area of the premises, discounting and permeable areas) in bands: for example, for a site 0.15–0.3 ha, the discount is £918 per annum, while for a site 2.5–5.0 ha it would be £15 313 per annum' (GENECON, 2010a, p. 27).

Finally, we report some water values from a large study of the UK ecosystem services (UK National Ecosystem Assessment, 2011, Ch. 22). Based on a Scottish Government assessment the marginal value for treated water ranges from £0.50 to £1.20 per m³. For raw water, the marginal value for irrigation water ranges between £0.23 and £1.38 per m³ for Scotland with higher values in eastern England.

The data above may be combined with information that the average suburban greenspace (turf grass) lot in the USA, which is about 930 m², can absorb nearly 23 m³ of rainwater without noticeable run-off (Heinze, 2011, pp. 7–9). Also empirical studies of green roof stormwater retention performance have found that green roofs can retain

anywhere from 40 to 80% of annual precipitation (CNT and American Rivers, 2010, p. 17).

In short, no direct (ex-post) economic evidence or estimates of woodland or other greenspace project benefits with respect to water management were found in the literature reviewed.

Products from the land

Greenspace, such as farmland and managed woodland and moorland is often in productive use (ECOTEC, 2008, p. 30). Here we consider mainly forestry products. Other products from the land may also be important but have not featured in the literature reviewed. Investments in greenspace can increase the amount of productive land and/or productivity, and this may increase FTE jobs and GVA in the locality. For example, jobs may be created in forest planting, harvesting, restocking, haulage and wood processing, with net impacts on GVA generated in the local economy. The only study identified to have estimated such impacts is Regeneris (2009) (see Table 10).

The Mersey Forest study (Regeneris, 2009, p. 28) relied on the Annual Business Inquiry 2006 data on GVA and employment in the forestry sector (using SIC 02: Forestry, logging and related service activities). Using these data, two assumptions were made: £46 000 of GVA per FTE and 1000 hectares of woodland supporting four FTE jobs. It was assumed that the benefit was calculated at the point where the trees have matured, this may lead to an overestimation.

Recent survey results put the number of people employed in the 'greenspace sector' (including public parks departments, nature reserves, botanical/zoological gardens, landscape services and architectural services) at about 122 000 in England (CABE, 2010a, Table 2, p. 8). However, no estimate of GVA per employee is reported.

Summarising, one sees that currently the major approach to valuing the 'products from the land' greenspace benefit is based on estimating a net increase in FTE (GVA) due to investments directed to enlargement and/or improvements of greenspace.

The review identified only a single study (Regeneris, 2009) that reported a net impact of greenspace improvements in terms of a 'products from the land' benefit.

Biodiversity

Investments in greenspace are thought to improve and protect habitats, thereby encouraging and maintaining biodiversity.

Biodiversity is a non-market benefit and mainly a non-use value. It comes from the value to individuals of knowing that the resource exists (existence value), or is available for others to use now (altruistic value) or in the future (bequest value). Therefore, the way to value biodiversity benefits is to use stated preferences techniques to elicit individuals' willingness to pay (WTP). The only study identified to have estimated such impacts is Regeneris (2009) (see Table 11).

The estimates of biodiversity benefit in the Mersey Forest study (Regeneris, 2009, p. 25) rely directly on a range of biodiversity marginal benefit estimates derived by Hanley *et al.* (2002), and depend on forest type:

- £0.35 per household per year for enhanced biodiversity in each 12 000 ha of commercial woodland.
- £0.84 per household per year for a 12 000 ha increase in lowland new broadleaved native forest.
- £1.13 per household per year for a 12 000 ha increase in ancient semi-natural woodland.

A study valuing England's ecosystem services (O'Gorman and Bann, 2008, p. 102) cited research (CJC, 2004, p. 21) that estimated the value of preserving or creating Sites of Special Scientific Interest (SSSIs) ranging from £0.41 to £1.14 per household per annum for individual SSSIs in 2004.

Although not perfect, an alternative measure of the non-use value of biodiversity can be provided by the study of actual payments for non-use-related wildlife conservation through legacies (UK National Ecosystem Assessment, 2011, Ch. 22). A recent study (Mourato *et*

Table 10 Products from the land.

Project	Estimated benefits	Reference	Value or impact study	Additionality issues
The Mersey Forest	Net additional monetised benefit: £164 000 per annum based on direct and indirect economic activities of the forestry sector.	Regeneris (2009, p. 36)	Impact	Well considered in general

Table 11 Biodiversity

Project	Estimated benefits	Reference	Value or impact study	Additionality issues
The Mersey Forest	Net additional monetised benefit: £38 000 per annum based on direct and indirect economic activities of the forestry sector.	Regeneris (2009, p. 36)	Impact	Well considered in general

al., 2010) examined the value of legacies to the largest environmental charities in the UK: the National Trust, the Royal Society for the Protection of Birds (RSPB) and the National Trust for Scotland. It estimated a legacy-based non-use value of around £219 per hectare of National Trust countryside, £190 per hectare of RSPB reserve and £53 per hectare of National Trust for Scotland's Scottish countryside for 2008/09, respectively. It is assumed that donors intended their legacy income to be spent on National Trust countryside, RSPB reserves or National Trust for Scotland countryside, although the preferences of donors about the actual allocation of their legacies are unknown.

Summarising, the review found only two primary studies valuing WTP for biodiversity benefits of greenspace, in particular woodlands and SSSIs. There is a need to widen the scope of such studies to include other types of greenspace. Two major problems hinder valuation of biodiversity benefits of greenspace. First, the biodiversity concept is very complex and this affects stated preferences study results as participants may not completely understand what they are valuing. Second, there is an aggregation problem because a significant part of biodiversity benefit is non-use value. For example, the biodiversity benefit of some particular greenspace site in England may be valued by people in the locality of the site, by people in the whole of England, and often by people of Scotland and Wales, and sometimes by all of the European community (i.e. it is not clear-cut at which level aggregation should stop).

Climate change adaptation and mitigation

Trees absorb carbon and provide natural air-conditioning for urban areas, reducing the need for heating and cooling. Several kinds of climate change mitigation and adaptation benefits may arise by increasing greenspace. Firstly, there is carbon sequestration in trees, other vegetative matter and soils. Second, there are energy saving costs due to lower heating and cooling

requirements associated with the benefits of shade which, in turn, may lower energy usage and reduce carbon emissions thereby adding an extra benefit (Regeneris, 2009, p. 17). Use of products from the land (e.g. timber) may also lead to carbon substitution benefits (e.g. use of timber instead of concrete and steel in construction, or use of woodfuel instead of fossil fuels (Table 12)).

The Mersey Forest study (Regeneris, 2009, pp. 15, 17) uses the estimate of an average of 3 tC (tonnes of carbon) per hectare per year over a full rotation from planting to harvesting (Broadmeadow and Matthews, 2003, p. 4). This estimate, however, is an upper limit on carbon sequestration that is only applicable to the top yield class. Therefore its use for the whole of the Mersey Forest leads to an overestimation. (Using half the top estimate, i.e. 1.5 tC per ha, would seem to be more appropriate.) The use of an average over a rotation biases discounted estimates for carbon sequestration upwards as the first years are characterised by emissions from planting and establishment and relatively low annual increment. The 3 tC per ha per year is about 11 tCO₂ per ha per year (using a conversion factor of 44/12 = 3.67). The study (Regeneris, 2009, p. 15) used the Stern Review (Stern, 2006) and calculated marginal social cost of carbon at £25 per tCO₂e (2007 prices). The cost increases by 2% in real terms per annum, to reflect rising damage costs from higher greenhouse gas concentrations. This yields £27.23 in 2009/10 prices using GDP deflator. This is lower than values recommended in more recent DECC guidance on valuing carbon for non-traded sectors (i.e. those emissions not covered by the EU Emission Trading System) (DECC, 2010). Therefore, this is a conservative estimate. Pricing carbon is a relatively new research area and values placed on carbon removal can vary widely between those prevailing in carbon markets and those reflecting the true social value of a carbon reduction. For example, prices in the EU's Emissions Trading Scheme (ETS) were around €14 per tCO₂.

A comprehensive study (Read et al, 2009) provides recent estimates of carbon sequestration in UK forests. Average annual removal of CO₂ from the atmosphere by closed-canopy Sitka spruce in northern Britain, yield class (YC)

Table 12 Climate change adaptation and mitigation.

Project	Estimated benefits	Reference	Value or impact study	Additionality issues
The Mersey Forest	Net additional monetised benefit: £16 000 per annum due to carbon sequestration in trees.	Regeneris (2009, p. 36)	Value	Well considered in general
Woodland planting at Pickering in North Yorkshire to reduce flood risk	The present value of climate regulation benefit (through carbon sequestration) over 100 years of planting 85 ha of woodland is £2.8 million	Nisbet <i>et al.</i> (2011)	Value	Well considered in general
Scotland, Edinburgh	Optimum placement of shelterbelt trees can reduce energy consumption (heating costs) in offices in Scotland by up to 18%	Liu and Harris (2008)	Impact	Cost of shelterbelt creation is not considered
Various sources	Building energy savings in the order of 3 to 9% from sheltering trees	Rawlings <i>et al.</i> (1999, p. 17)	N/A	This guidance note refers to a variety of sources used to compile the 'rules of thumb'. No detailed information is provided

14–16, is currently about 24 tCO₂ per ha between years 17 and 40. Taking into account initial losses from 'soil' respiration stimulated by site preparation, a conservative average annual figure over a typical 40-year rotation is about 14 tCO₂ per ha (Read *et al.*, 2009, pp. 21, 33). Carbon sequestration data for broadleaved woodland are less reliable. However, for example, an oak forest in the south of England achieves 62% of the above Sitka spruce rates of removals of CO₂ from the atmosphere (Read *et al.*, 2009, p. 31). While considering the cost-effectiveness of forestry the opportunity costs of alternative land use should be taken into account. Crucially, the figures above are only applicable to afforestation projects which do not involve clearfelling and restocking. When the management regime includes clearfelling and restocking the carbon sequestration figures are lower. For the above example of Sitka spruce with clearfelling and restocking every 40 years the amount of carbon sequestered in forest varies from 3.9 tCO₂ per ha per year (with standard 5-yearly thinnings, YC14) to 6.4 (with no thinnings, YC16). The time horizon for all these estimates is 200 years. Some other species can achieve much higher sequestration rates: for example for Douglas fir it is over 12 tCO₂ per ha per year (no thinnings, YC24). A range of estimates for carbon sequestration by woodland is provided in 'Carbon Lookup Tables' for the Woodland Carbon Code (www.forestry.gov.uk/carboncode), which account for carbon sequestration up to the long-run average (i.e. taking account of re-release on harvesting).

A pilot project (Nisbet *et al.*, 2011) based at Pickering in North Yorkshire explored how changes in land use and land

management can help to reduce flood risk, including creation of floodplain woodland (30 ha), riparian woodland (50 ha) and other farm woodland (5 ha). Annual carbon sequestration estimates covering standing biomass, soils and woody debris and accounting for carbon emissions from associated forestry operations were used from Forest Research's C-SORT model. Account was made for non-permanence risks (e.g. associated with windthrow and fires) by applying a buffer of 20% (central estimate) to reduce the carbon estimates. This is broadly in line with the 15–30% buffer currently recommended by the Woodland Carbon Code. The mean over the 100-year period is around 530 tCO₂ per year (central estimate). This is equivalent to an average annual carbon sequestration rate of about 6.3 tCO₂ per ha per year. The present value of climate regulation benefit over 100 years is £2.8 million (Nisbet *et al.*, 2011, p. 21, Table 22). Note that forestry costs, which are not attributable to a single ecosystem service, were reported separately.

An interesting study (Liu and Harris, 2008) shows the potential for energy saving through trees sheltering buildings from wind. The research showed that if optimally placed with respect to the prevailing winds and possible solar gains into the sheltered building during wintertime, that shelterbelt trees (a single row of trees with shrubs planted at the base is suggested) can reduce energy consumption (heating costs) in offices in Scotland by up to 18% (Liu and Harris, 2008, p. 119). This result was based upon modelling a typical two-storey, middle-sized open-plan office building. There is no economic cost-benefit analysis in the study.

Focusing on cooling through evapotranspiration, modelling studies in Greater Manchester, UK, showed differences in temperature of around 10°C between built environments (e.g. town centres) and greenspace areas (Gill *et al.*, 2007). Although no economic analysis is presented in the study it shows the potential benefits that greenspace may provide during heat wave episodes that are predicted to increase in frequency with climate change due to global warming. The excess mortality due to heat waves can be quite large. For example, over 2000 excess deaths are estimated for England and Wales for the heat wave in 2003 (Johnson *et al.*, 2005).

Summarising, the review showed that there is a clear benefit of tree planting for carbon sequestration and a lot of potential for trees to reduce energy use during wintertime. Also there is a potential for greenspace to alleviate the impact of extreme weather events such as summer heat waves though no firm economic evidence is currently available.

Economic indicators for monitoring and evaluation of greenspace interventions

A core set of economic indicators to enable monitoring and evaluation of net economic effect of greenspace interventions is proposed below. Drawing upon Scottish Enterprise guidance (Scottish Enterprise, 2008), additionality of benefits of new or improved greenspace can be measured as the difference between the position if the intervention is implemented and the reference case (also known as the counterfactual or 'base case') position expected to occur in the absence of the initiative. The evaluation process must account for deadweight, and leakage, displacement, substitution and multiplier effects.

A recent English study (CABE, 2010b) presents a large number of indicators for various features of greenspace: quantity, quality, use by people, proximity, management and value to local people.

Comprehensive lists of tests are presented in recent studies (AMION, 2008; ECOTEC, 2008) based on the northwest of England experience and summarised in the review on green networks (Cousins and Land Use Consultants, 2009). Other studies (Audit Commission, 2005; Land Use Consultants, 2010) also present assessment criteria of economic development. Table 13 chooses selectively from the above studies focusing on indicators that can help to assess the net economic benefit of greenspace interventions.

In terms of economic importance the following five key indicators are suggested: GVA, FTE, median annual earnings, the number of new business start-ups per 1000 VAT-registered businesses and median property prices.

It is impossible to foresee the needs of every specific project that can be undertaken in relation to greenspace. Although the indicators suggested in Table 13 appear fairly comprehensive, for fine tuning and choosing the most appropriate indicators for specific cases, consulting the references mentioned above in addition to the five key indicators is recommended. There are 31 indicator rows in Table 13. However, some rows can be associated with multiple indicators (e.g. the FTE and cost per job rows may be associated with three different indicators: FTEs created, FTEs safeguarded and combined FTEs created or safeguarded). Choice of mean or median statistics is also up to the researcher.

To estimate additional (net) economic benefits of greenspace interventions a number of steps are required for a project (Scottish Enterprise, 2008; BIS, 2009). First, at the start of a project (case with intervention) a snapshot of the current state needs to be recorded. At the end of the project another snapshot needs to be made. Intermediary snapshots can be made and when benefits take time to be realised (sometimes a number of years) some follow-up snapshots are required. Next local trends over the intervention period need to be estimated to create a baseline case scenario (reference case without intervention) of business as usual (BAU) development. Depending on data availability and the scale of the project this BAU estimate may range from metropolitan area to county level, region or country.

Then, the gross direct effects (i.e. the difference between the assessment point and the start point of a project) can be estimated for the project and BAU case. Gross direct effects for the reference case are termed the 'deadweight' (for details see the Glossary). The difference between the gross direct effects for the project and BAU case yields a basic measure of the additionality or net benefit of a project. However, many projects can be affected by significant issues of leakage, displacement, substitution and multiplier effects (see Glossary for definitions). These have to be taken into account both for a project and BAU case to reveal the true additional benefits of a project.

Table 13 Core economic indicators.

Indicator	Description
Economics	
GVA	Gross value added per head of local population
GVA growth	GVA growth per head of local population
Employment	
	Full-time equivalent jobs in a project area (created and/or safeguarded)
	The percentage of people of working age in employment
	Proportion of the working age population who are claiming Job Seekers Allowance (JSA)
	The percentage of local jobs in each sector
	Annual change in number of local jobs
Earnings and skills	
	Median annual earnings for all in full-time employment
	Percentages of population of working age qualified to various NVQ levels
	The percentage of population of working age in job-related training
Business and investments	
	The number of VAT registrations in the area per 10 000 economically active population
	The number of new business start-ups per 1000 VAT-registered businesses
	Volume of inward investments, private sector investments levered in
	Cost per job created and/or safeguarded
Property market	
	Mean and/or median property prices
	Number of properties
	Property distribution by tax bands
	Volume (number) of transactions
	Value of transactions
	Generated council tax
Demographics	
	Population
	Population density
	Children living in low-income households
	Adults living in low-income households
	The percentage of population of working age who are claiming key benefits
Retail and tourism	
	Visits (measured by pedestrian footfall) to the town centre - (survey)
	Prime retail rent per square metre
	Day visitors per annum
	Day visitors average spend
	Bed nights per annum
	Room occupancy

Future research

This section focuses on potential future economic research that is both feasible and would help address some of the knowledge gaps identified on the net benefit assessment of greenspace interventions.

Future research could progress in the following fashion and would be facilitated by interdisciplinary co-operation. First, in areas where research on economic benefits of greenspace is in its infancy and no reliable prior knowledge exists economists should do primary empirical studies to quantify net economic outcomes focusing upon the types of indicator suggested in the previous section. Second, based upon this data economists could compare the economic benefits of improved greenspace in different settings. Finally, economists could apply cost-benefit analysis or maximisation algorithms to various greenspace creation and management options to analyse which are the most cost-effective.

Focus areas for primary research include: (i) 'labour market employment and productivity', especially such issues as greenspace effects on attracting skilled labour force and its retention and productivity; (ii) 'recreation and leisure', especially if there is a need to separate it from tourism; (iii) 'health and well-being' (which although very complex, would require moving beyond simple association or correlation to undertake longitudinal studies to establish causal links and the temporal distribution of effects); (iv) 'water management' (currently only at the stage of preliminary physical measurements); (v) 'biodiversity' (an area that currently suffers from dearth of comprehensive studies with often one or two studies focusing on a single type of greenspace – mostly woodlands); and finally, (vi) 'economic growth and investment' (an area that suffers from lack of research on inward investment flows). It is also notable that there are currently relatively few studies on values of projects associated with other types of greenspace apart from woodlands.

Hedonic price methods represent a particularly fruitful avenue of research of greenspace impacts on land and property values. They are attractive because they use actual market data to reveal individuals' preferences for particular greenspaces. Although confined to estimating use values, they provide an attractive alternative to demanding, complex and resource-intensive stated preferences methods, provided that the requisite geo-coded property transaction data are available. Their fruitfulness is clearly demonstrated by the number of published studies (some

reviewed above) showing the positive effect of greenspace on property values. Given continuing improvements in GIS software and data availability, the following opportunities to further our understanding of greenspace effects on land and property prices are worth considering:

- Extending the geographic coverage of studies. For example, for Scotland only a study for Aberdeen is available. Also, although Scotland is a part of the UK-wide study (Mourato *et al.*, 2010), there are no separate results for Scotland. Future research might perhaps focus on Edinburgh and/or Glasgow.
- Focusing exclusively on land prices (if data exist on sales of land for development).
- Studies of urban fringe greenspace and woodlands rather than urban inner areas and parklands.
- Deepening research to investigate further how various factors associated with greenspace such as distance, visibility, accessibility, greenspace type (e.g. park, golf course, woodland) and the size of greenspace affects different property types (terraced housing, flats, semi-detached and detached houses with or without gardens).
- Applying controls for local demographics, such as population density, unemployment, crime and income levels, could also be used to elicit the value of greenspace effects that otherwise can be obscured by the above factors.

Finally, while many studies focus on the total value of greenspace benefits there are few studies yielding estimates of marginal values (i.e. the extra cost (benefit) of providing one more or less unit of a particular greenspace (Angus *et al.*, 2006, p. 6)). This information is of particular relevance to policy makers because in theory the optimum allocation of greenspace is achieved where:

- marginal benefit of an extra unit of greenspace is equal to a marginal cost;
- marginal benefit of an extra unit of greenspace is equal across all types of greenspace, otherwise reallocation would increase total benefit.

The review identified no studies that compare greenspace investments with other types of interventions. This kind of research could be a fruitful area for future investigation.

Conclusions and recommendations

The review showed that there is a growing body of research generally, but not unanimously, confirming many benefits of greenspace. However, economic estimates of these benefits are sparse at present.

The review showed that for 'economic growth and investment' there is little direct, strong and reliable evidence of benefits of greenspace on economic growth and investments. However, there is (case-study-specific) evidence that public investments in greenspace have a positive impact on such constituent components of economic growth and investment as job creation, new business start-ups, and private investment levered in. This should consequently increase local gross value added (GVA). However, many issues remain regarding estimating additionality and the magnitude of the net benefit of such investments. Currently, only the Mersey Forest study (Regeneris, 2009) is sufficiently robust and informative to make the findings on the estimate of annual benefits acceptable for use in a value transfer approach. The study estimated that every £1 invested in the Merseyside Objective One programme will generate over the lifetime of the investment (50 years) £2.30 in increased GVA, composed of GVA from tourism spend, from forestry (i.e. direct jobs related to products from the land), and from improvements in health. However, various caveats were also noted about this estimate, including that benefits are derived based on mature forests or averages for all woodlands, rather than taking into account lower benefits expected as woodland matures.

In terms of knowledge gaps it was noted that more primary studies of interventions and investments to improve greenspace following additionality and impact assessment guidance (Scottish Enterprise, 2008; BIS, 2009) are needed. These could help build up a database with intervention outcomes of reasonable quality that can be used later for value transfer approach.

For 'land and property values, aesthetics' a large body of evidence exists that support the view that investment in improving greenspace and the aesthetic quality of place (visual amenity) positively affects land and property prices. The estimated impacts are necessarily case and location specific and have a wide range. Having a well-managed greenspace nearby results in average property premiums from 2.6 to 11.3%. In terms of a marginal change an extra percentage point increase in greenspace land use share increases property prices by around 1% (Mourato *et al.*, 2010).

The major knowledge gap in this area is a lack of primary stated preference studies on WTP for greenspace improvements following best practice guidelines (Eftec, 2010) that can be used subsequently within a value transfer approach. The only GB-wide WTP study (Garrod, 2002) may serve as a basis for planning larger and/or more local studies. Hedonic studies only value aesthetics in as much as they are reflected in revealed market prices and will not account for non-use value, while WTP study can yield the total value and in the case of aesthetics the non-use value component may be significant.

The 'regional and local economic regeneration' theme yielded rough estimates of the typical amount of investment required per FTE created or safeguarded associated with reviewed greenspace projects. Public expenditures per FTE job created had a median value of about £46 000, while the median value of public expenditure costs per FTE created or safeguarded is about £20 000. The range of values for the ratio of private to public investments was found to vary from 2 to 10 with a median value of about 4.2 (i.e. for every pound of public investments projects levered in £4.20 of private sector investments).

There are a number of studies of 'tourism' benefit of greenspace. Visitor surveys and visitor number statistics remain major tools for assessments. However, only two studies considered the sensitivity of impact estimates to the availability of substitutes and issues of displacement and leakage. Even for these two studies (GEN Consulting, 2006; Regeneris, 2009) the assessment of additionality is based solely on reasonable assumptions and not on primary empirical research (Regeneris, 2009, p. 35). The records of accessible greenspace available for recreation and its uses prior to interventions are important for calculating net additional impacts. There is a need for primary empirical research on the effect of substitutes on visitor numbers in terms of displacement and leakage.

A number of studies are reported under the 'health and well-being' theme. However, only two of them (Regeneris, 2009; Mourato *et al.*, 2010) provide net economic values of greenspace interventions for health and well-being. Importantly, there is no conclusive evidence on the strength of the relationship between the amount of greenspace in the living environment and the level of physical activity and the causal link between the two at present. This constitutes the major research gap.

At present only a small number of papers move a step forward from asserting and/or researching the link between greenspace and the economic benefits and their estimation. Gaps are especially apparent in 'labour market employment and productivity', 'recreation and leisure' (as opposed to tourism) and 'water management' themes. Also 'quality of place' is a compound concept with no established definition and with little economic research addressing it directly. At present the majority of studies concentrate on the links between greenspace improvements and benefits that contribute to 'quality of place'. Although 'quality of place' can be useful in social and political discourse it is currently seen to be a secondary, derived entity for the purpose of economic analysis. However, in future research it could possibly be conceptualised as an emergent property that cannot simply be measured as the sum of constituent parts. Any quantitative assessment of 'quality of place' may require development of new methodology on data collection and estimation.

The 'products from the land' greenspace benefit is based on estimating a net increase in FTE (GVA) due to investments directed to enlargement and/or improvements of greenspace. Currently, only a single study on the Mersey Forest creation (Regeneris, 2009) reports a net impact estimate of greenspace improvements. This may be related to the fact that for smaller projects where landscape improvement is only one component of a complex mixture it is difficult to elicit the number of FTEs exclusively related to greenspace given inadequate data collection. The major recommendation here is for a comprehensive evaluation of the relevant area statistics before and after an intervention using indicators suggested in the Economic indicators for monitoring and evaluation of greenspace interventions section.

For 'biodiversity' benefits, only one study (Regeneris, 2009) reported net additional benefits, and currently only two primary studies valuing WTP for biodiversity benefits of greenspace, in particular woodlands and SSSIs, exist. A study focusing on flood management (Nisbet *et al.*, 2011) considers benefits of habitat creation while planting riparian woodland. However, the biodiversity benefit is mixed with a number of other benefits of habitat creation in this study. An interesting approach to estimate non-use values of biodiversity is presented in a study (Mourato *et al.*, 2010) of legacies given to environmental charities. However, this valuation can only serve as a partial proxy for biodiversity non-use value (UK National Ecosystem Assessment, 2011, Ch. 22).

Major knowledge gaps remain in our understanding of biodiversity value, in particular the basic knowledge of threshold effects and 'safe' stock sizes (UK National Ecosystem Assessment, 2011, Ch. 22). The recommendation is to widen the scope of stated preference studies to include many more types of greenspace.

Finally, for 'climate change adaptation and mitigation' benefits of greenspace the review showed that there is a clear benefit of tree planting for carbon sequestration and a lot of potential for trees to reduce energy use during wintertime. However, this is based on only three studies (Liu and Harris, 2008; Regeneris, 2009; Nisbet *et al.*, 2011), of which two (Regeneris, 2009; Nisbet *et al.*, 2011) estimated the net monetary benefit due to carbon sequestration. Generally, carbon sequestration benefits of woodlands are relatively well researched. Therefore, the recommendation is to focus future research on such issues as the role of trees in regulating temperature through shading and evapotranspiration during extreme weather episodes such as heat waves, and to extend research on energy saving in buildings due to trees wind sheltering to cover not only office buildings but residential housing as well.

Future primary studies should follow best practice guidelines (Defra, 2007; Scottish Enterprise, 2008; BIS, 2009; Eftec, 2010) recommended for ecosystem valuation and impact assessment and for making their findings suitable for value transfer application. When a project involves complex landscape and built environment intervention the greenspace component should be reported separately whenever possible.

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Glossary

In economic valuation (welfare) studies economic value is often measured by the willingness to pay (WTP) for environmental goods or willingness to accept (WTA): total economic value (TEV) is the sum of the WTP of all individuals whose well-being is affected by changes in the quantity (or quality) of an environmental good arising from a particular policy or project. These TEVs are used in cost-benefit analysis (CBA) to compare the potential welfare improvement associated with an investment in different types of greenspace changes in different areas.

Use value is associated with current or future uses of a good or service. One can distinguish direct use values that may be 'consumptive' (e.g. timber) or 'non-consumptive' (e.g. recreational activities), indirect use values that include key ecosystem services (e.g. climate regulation, flood protection), and option values that are associated with retaining the option to use a resource in the future.

Non-use value is derived from the knowledge that environmental resources continue to exist (existence value), or are available for others to use now (altruistic value) or in the future (bequest value).

Note that two basic variants of **value transfer** exist: unit value transfer and value function transfer, with some variations within these. The approaches are distinguished by their degree of complexity, data requirements and the perceived reliability of the results:

- Unit value transfer can be either an unadjusted unit value transfer from single or multiple studies, or an adjusted unit value transfer, where value is adjusted to account for the differences between the study and policy goods with respect to factors that may influence economic value. The most common adjustment factor is income.
- The value function transfer provides more control, allowing a set of factors found to explain variation in economic values for the study good (e.g. WTP, socio-economic characteristics of the affected population, characteristics of the good, the change in its provision and the availability of substitutes) to be controlled for (EFTEC, 2010, p. 51).

Net economic value (of creating or improving greenspace) is the net effect of the intervention. It is closely linked to the

concept of additionality and takes account of deadweight, and leakage, displacement, substitution and multiplier effects.

Total net additional local impact (or benefit) of an intervention = Total net local effects (case with intervention) – Total net local effects (reference case without intervention)

where

Total net local effects = Net local effects + Multiplier effects.
Net local direct effects = Gross local direct effects – Displacement and substitution.
Gross local direct effects = Gross direct effects – Leakage.
Gross direct effects = the difference between the assessment point (often at the end of a project) and the start point of a project, also called deadweight for the reference case.

Additionality may be related to scale (e.g. a greater quantity of business turnover or jobs may be delivered in an area), timing (e.g. an activity may happen earlier than would otherwise have been the case) and quality. Scale additionality is the most significant type when it comes to assessing overall economic impact in terms of gross value added (GVA) (Scottish Enterprise, 2008, p. 3). The time period over which additionality is calculated should be long enough to capture all the important costs and benefits of the intervention.

Deadweight is defined as benefits that would have occurred without the intervention. It is the quantification of outputs, outcomes and impact under the reference case. It is based on assumptions on economic, social and environmental trends or events that are likely over the intervention period (Scottish Enterprise, 2008, pp. 6–7).

Displacement is defined as the proportion of project benefits accounted for by reduced benefits elsewhere in the target area. It happens when, due to the intervention, the project takes market share or labour, land or capital from other existing businesses within the geographical area thereby reducing existing local activities. Closely related is the effect of substitution that arises where a business substitutes one activity for a similar one (such as recruiting a jobless person while another employee loses a job) to take advantage of public funds within the project.

Leakage is defined as the proportion of benefits that go to those outside the intervention's target area or group. That is benefits occur not where intended.

Multiplier effects are wider economic impacts (on jobs, expenditure or income) associated with additional local income, local supplier purchases or longer term effects. Two types of multiplier can be identified (Scottish Enterprise, 2008, p. 12):

- a supply linkage multiplier (sometimes referred to as an indirect multiplier or Type I multiplier) due to purchases made as a result of the intervention and further purchases associated with linked firms along the supply chain;
- an income multiplier (also referred to as a consumption or induced multiplier or Type II multiplier) associated with local expenditure as a result of those who derive incomes from the direct and supply linkage impacts of the intervention.

Methods to value non-market goods associated with visual amenity and greenspace fall into two categories: revealed preference methods and stated preference methods. In the first category are travel costs and hedonic models that measure only use values, with the value of open space being deduced from the estimated relationship between the value of a property and measures of proximity to open space and other property and neighbourhood characteristics. As they are based upon analysis of actual market data, revealed preference methods are often preferred by economists. In the second category are contingent valuation (CV) and choice experiment (CE) methods that use surveys and direct work with people to elicit their preferences with respect to open space. In principle the latter have the advantage that they can be used to estimate the total value (i.e. both use and non-use values).

In **hedonic price models (HPM)** the value of the view is separated from the total value of the landscape by the use of control variables to account for other landscape characteristics (e.g. woodland's size, shape and species composition), property features and the individual's socio-economic background. In the stated preference approach this separation is achieved by questionnaire design including necessary background and context information.

The majority of studies find a positive impact of nearby greenspace. In the case of the hedonic approach it is reflected in the higher house prices, while in the case of the stated preference approach it is reflected in a positive willingness to pay (WTP).

Hedonic studies usually evaluate open space close to home primarily related to scenic views and other characteristics, while stated preference studies can capture broader, more

general perceived benefits from open land preservation, including non-use values not measured in hedonic studies. Stated preference studies can also reveal the particular attributes of open space valued by respondents. Hedonic studies only measure the value of marginal changes in the open space amenity, while the stated preference studies tend to estimate the value of large changes in the amount or provision of the amenity.

In case studies, where small changes and use value linked to property market and recreation are investigated, the hedonic pricing method is most appropriate (conditional on data availability). A good example is valuation of amenity woodland views as seen from property and small changes of woodland cover in the cities and near-urban fringes. However, for large-scale changes and/or where non-use or total value is sought the stated preferences methods are most appropriate.

There is no clear link between valuation studies which use revealed preference and stated preference methods and additionality issues of impact assessment studies. First, while impact assessment studies use at least two snapshots of the development, before and after an intervention, revealed and stated preference models usually are cross-sectional studies with a single snapshot. Second, unlike impact assessment studies, revealed and stated preference models are concerned with individuals' preferences rather than resource allocations. That is the finding that some individuals are prepared to pay more for living nearer greenspace has no relation to additionality issues (including deadweight, leakage, displacement, substitution and multiplier effects).

A substantial body of literature, including government policies, acknowledges the important role of greenspace in sustainable development and the creation of attractive and economically vibrant communities. Greenspace refers to the natural environmental components (green and blue spaces) that lie within and between a region's cities, towns and villages. This Research Report provides a critical review focusing on the most recent evidence (years 2000-2011), of the net economic benefits, both direct and indirect, of initiatives to create or improve greenspace. Despite some conflicting evidence, the Report shows that there is a growing body of research that confirms the benefits. For example, a large-scale study undertaken for the UK National Ecosystem Assessment showed that a percentage point increase in greenspace land use share in a Census ward increases property prices by around 1%. Both expansions of broadleaved woodland and of coniferous woodland were found to have positive effects, with the impact of the former greater than the latter. The Report also highlights gaps in research providing robust estimates of net economic benefits.



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