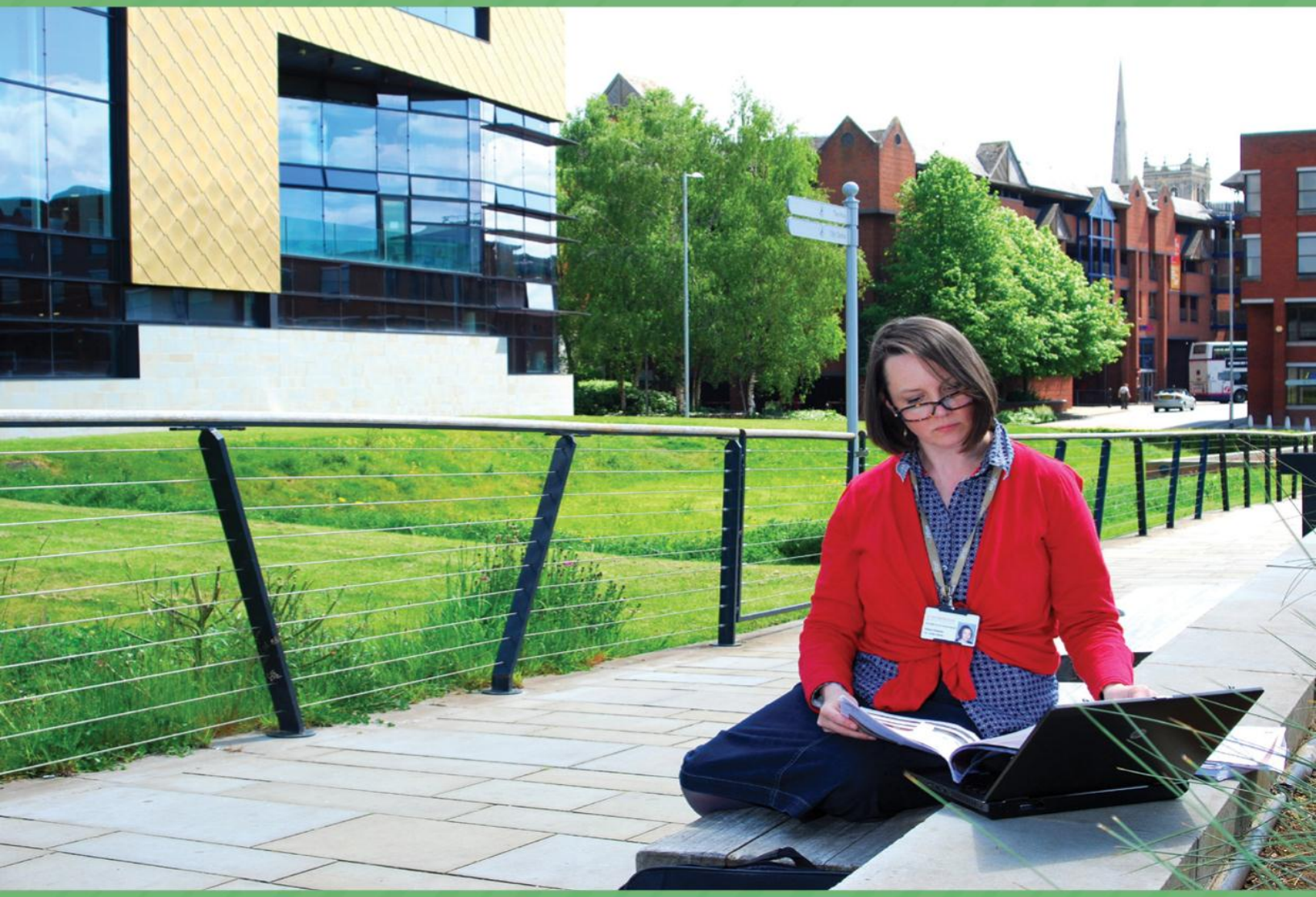

Green Infrastructure Framework 4:
Socio-economic Benefits of Green Infrastructure

September 2014

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worcestershire county council

Contents

CHAPTER 1: INTRODUCTION

Preparation of this evidence paper on the socio-economic benefits of Green Infrastructure (GI) has been led by Worcestershire County Council's Strategic Planning and Environmental Policy Team. The paper, known as 'Framework Document 4', has been endorsed by the Worcestershire Green Infrastructure Partnership.

Partnership members include the Worcestershire Wildlife Trust, Natural England, Environment Agency, Forestry Commission, English Heritage, the County and District Councils and the Voluntary Sector.

Background to the study

The Worcestershire Green Infrastructure Partnership is producing a series of "framework documents" which provide the evidence base for the development of the GI Strategy.

- **GI Framework Document 1** provided an introduction to the concept of GI and also identified the need for the strategic planning of GI and the policy drivers that support the planning of GI at differing spatial scales.
- **GI Framework Document 2** provided an introduction to the natural environment data sets of landscape, biodiversity and historic environment and developed the concept of GI Environmental Character Areas based on the quality and quantity of these natural environment assets.
- **GI Framework Document 3** identified the functionality, and supply of strategic recreational assets in Worcestershire. It also explores the potential need for new recreational assets and identified areas of search and potential funding mechanism for new facilities.
- **GI Framework Document 4** (this document) explores the relationship between health, climate change, economy and green infrastructure.

The 4 framework documents will form the detailed evidence base for the Worcestershire Green Infrastructure Strategy, which sets out the vision and opportunities for multi-functional green infrastructure in the county.

Note:
Green Infrastructure framework documents have benefited from scrutiny and input from stakeholders. The framework documents and the Strategy are non-statutory and hold the status of guidance to provide a framework for the planning of a comprehensive multifunctional green infrastructure throughout Worcestershire.

Purpose of the study

GI presents a co-ordinated interdisciplinary approach to environmental planning that is proactive, multi-scale and multi-functional. GI can deliver benefits to the environment and can contribute to the development of better places in which to live, work and invest.

This paper is the fourth in a series of papers towards the development of a Worcestershire GI Strategy that will enable the strategic planning, co-ordination, delivery and management of existing and future green spaces. It aims to explore how multifunctional green infrastructure solutions can provide economic and health benefits as well as contribute to climate change mitigation and adaptation.

The Audience

This paper provides the evidence required to support Local Planning Authorities (LPA) and other organisations involved in the development of GI strategies and as such the primary audience are the county and district LPAs within Worcestershire. This paper will also be of interest to the development industry, utility companies, Local Strategic Partnership members and anybody with an interest in how to plan for GI in Worcestershire.

The paper intends to be a useful tool to policy makers but does not diminish the need for the reader to be alert to both existing and emerging evidence and policy on planning for GI.

Scope and Structure of the study

This GI Framework 4 consists of three sections:

- Economic benefits of green infrastructure
- Health & wellbeing benefits of green infrastructure
- Climate change benefits of green infrastructure

It focuses on the socio-economic context of GI and investigates synergies between green infrastructure and socio-economic issues facing Worcestershire. It explores how multifunctional green infrastructure solutions can provide economic, health and climate change benefits.

The chapters portray the current Worcestershire status in relation to each of the socio-economic themes with the use of statistical information, maps and local studies. This includes findings of the mapping and data analysis which was undertaken to inform the setting of the strategic priorities identified in the Worcestershire Green Infrastructure Strategy 2013-2018.

Additionally, the chapters provide a narrative and examples of various ways in which GI contributes to a well-functioning economy, prosperous and healthy communities and climate change mitigation and adaptation. They identify how the appropriate application of GI solutions can maximise benefits and minimise risks to Worcestershire's economy, natural environment and residents.

Information Sources

This Framework Document 4 uses local/county level information wherever possible. Where local level information was not available the relevant national or regional data and research was used to supplement the local evidence base.

This document has been inspired by and benefits from two pieces of work in particular. The basis for the socio-economic context came from the groundbreaking Natural Economy Northwest programme which was produced by the Northwest Regional Development Agency and Natural England in 2009. Furthermore, Natural England's Microeconomic Evidence for the Benefits of Investment in the Environment Review (2012) proved to be an invaluable source of evidence on the economic benefits of GI. The full list of sources can be found in Appendix B.

Mapping methodology

Chapters 2 and 3 assess and provide a spatial illustration of various datasets to portray the current socio-economic status of Worcestershire. This paper is concerned with areas performing particularly well in terms of the economy, to highlight green infrastructure's contribution to the wealth of local communities in the county. Following this approach, the health performance maps draw attention to the areas with the lowest prevalence of ill-health in Worcestershire.

The methodology for the maps illustrating health indicators (such as obesity) and economic indicators (such as unemployment levels) uses the top-performing 25% of areas in the county as a threshold to identify the best areas relative to the county as a whole. This threshold has been chosen to enable broad patterns and locations of 'best' areas to be identified, but must necessarily be treated with caution; it does not imply that the remaining 75% of the county's areas perform poorly, and many areas within the 75% could actually perform relatively well. Detailed information on datasets used and analysis of the maps can be found in the relevant chapters.

The individual thematic maps have been combined to identify the overall county performance for both economy and health. It has been achieved by overlaying all of the thematic maps, dividing the county into three groups and categorising each LSOA within Worcestershire as "excellent", "good" and "less good" performing areas.

Context

GI is often described as 'multifunctional', providing a range of environmental, social and economic services or "ecosystem services". GI influences almost all aspects of our lives, through directly benefiting the economy or through improving quality of life. More information on the context for the multifunctionality of green infrastructure can be found in Appendix A.

CHAPTER 2: ECONOMIC BENEFITS OF GREEN INFRASTRUCTURE

INTRODUCTION

The economic benefits of GI are widely recognised by policy makers at different levels. Sustainability West Midlands recognises that well-connected, accessible green infrastructure can greatly improve 'quality of place' through improving appearance and providing a range of other benefits. These can substantially boost inward investment, attract companies and in turn employees, customers and services[1].

This chapter focuses on the benefits that green infrastructure can bring to the local economy. It explains how a quality natural environment can contribute to increased property and rental values, attract more inward investment and visitors to the area or be a cost saving solution to flood risk mitigation or health improvement.

This chapter quantifies the financial costs and savings where possible; however where there was a lack of relevant information, the paper recognised the potential contribution from green infrastructure in qualitative terms, such as customer satisfaction.

This chapter explores links between GI and the following areas:

- Property prices and quality of place
- Economic growth and investment
- Tourism
- Agriculture and Land Management

There are also significant economic benefits that green infrastructure provides to the health & wellbeing sector which are described in Chapter 3 of this paper. Chapter 4 explores how green infrastructure can be a financially viable solution to climate change adaptation and mitigation.

[1] West Midlands Regional Observatory (nd) West Midlands: Fit For The Future?

ECONOMIC BENEFITS

Property and quality of life

A property located within 450 metres of a park can be up to 19% higher in value than houses not in such proximity

Economic Growth and Inward Investment

Increased investment in green infrastructure, such as in the Riverside Park Industrial Estate in Middlesbrough (which included planting of over 1800 new trees) created a setting for stimulated business growth. As a result, it attracted new high profile occupants and saw occupancy grow by 38%. It leveraged over £1m of private investment, 28 new businesses started up and 60 new jobs were created.

Tourism

In 2008, visitors to the English countryside spent £11.5 billion and generated 340,000 jobs.

Agriculture & Land Management

The Sustainable Catchment Management Programme (SCaMP) in the Peak District provided £2.7 million of grants towards the cost to farmers for works such as moorland restoration, woodlands, farm infrastructure or protecting watercourses and allowed them to access additional agri-environment income for ten years. Reduction in chemical inputs to drinking water as a result of the programme provided financial savings to United Utilities.

Climate Change

The wider risks and costs of climate change to the national economy are estimated to be equivalent to losing up to 20% of GDP. Green infrastructure can reduce these costs through contributing to climate change mitigation and adaptation.

Flood Risk

The Association of British Insurers predicts that a $2^{o}C$ temperature rise will increase annual insured losses in Great Britain from inland flooding by 8% or by £47 million to £600 million. Well executed green infrastructure can reduce flood risk costs through both flood alleviation solutions and mitigation of climate change contributors, such as the CO_2 emissions that are partially responsible for the extreme weather events.

Health & Wellbeing

Increased physical activity through access to high quality green spaces has the potential to save the NHS £2.1 billion a year.

ECONOMIC CONTEXT

There is a link between a place's overall prosperity and the quality of the surrounding natural environment. This chapter aims to identify this prosperity in Worcestershire by investigating unemployment, household income and employment deprivation patterns.

Employment deprivation patterns in this paper are portrayed using the Indices of Multiple Deprivation (IMD), which cover a range of socio-economic measures[2]. Access to quality green infrastructure will primarily contribute to addressing health, but will also indirectly link to economic and some social factors within the indices (such as crime). Recent evidence proves that GI can help to create more attractive and healthier places for people to live which may attract more affluent residents into these areas. Accessible and quality green spaces also encourage physical activity and facilitate social interaction which can help in building self-esteem and contributing to the social mobility of disadvantaged people.

This information has been spatially represented on context maps (Figures 2, 3 and 4) and amalgamated together on the combined economic map (Figure 1). The following datasets have been used to map green infrastructure related economic patterns in Worcestershire:

Economic indicator	Datasets	Map
Unemployment	This indicator represents the claimant count and claimant count rate for Jobseekers Allowance (JSA) as of August 2012	Figure 2
Household income	The household income indicator uses 'Paycheck', which accounts for income from employment (earnings) as well as that from other sources, for example investments and savings *(CACI Ltd, 2012)*	Figure 3
Employment Deprivation	This indicator uses the Employment domain of the English Indices of Deprivation 2010 at Lower Level Super Output Area (LSOA) level.	Figure 4

Note: In this mapping exercise, the top 25% of areas in Worcestershire have been selected in each case; however it cannot be stated that areas outside of this threshold are necessarily "bad" as in many cases these areas are still much better than the Worcestershire average, and are also better than the national average. Therefore this information should be used with caution and further analysis undertaken if using these maps for purposes other than those for which they are intended.

[2] Socio-economic measures of IMD include:
1. Economic factors including household income, employment rates
2. Health factors including life expectancy, disability and morbidity, mental health issues and risk of premature death
3. Education, skills and training including attainment at levels 2, 3 and 4 and higher education
4. Housing including homelessness and overcrowding
5. Crime including violent crime, burglary, theft and criminal damage
6. Housing environment including poor quality housing, air quality, and road traffic accidents.

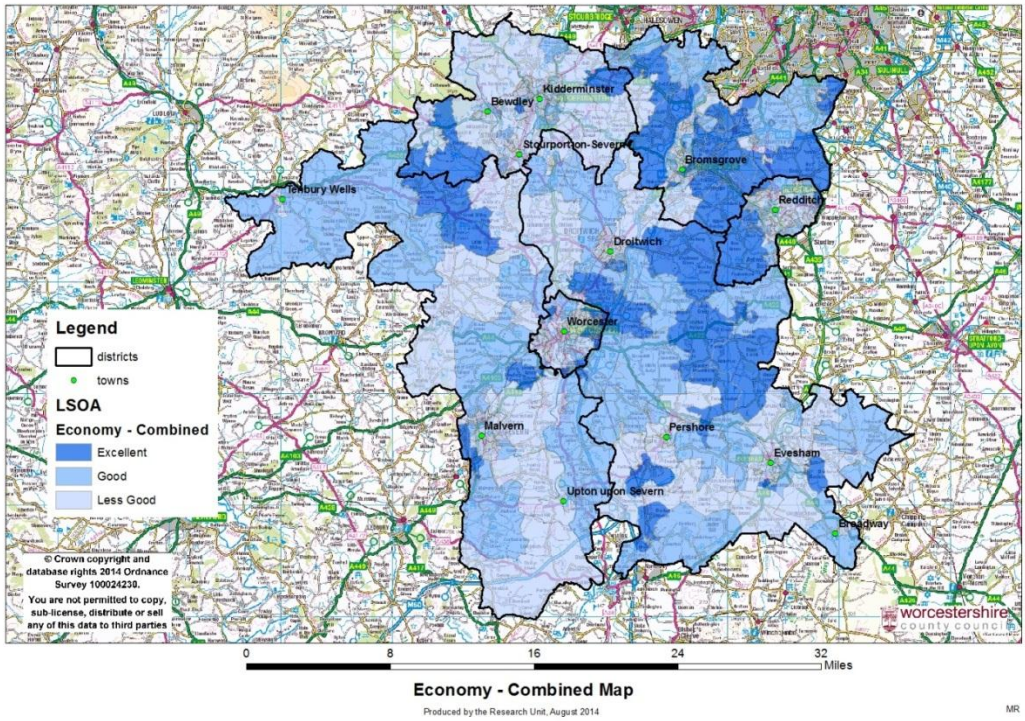
Overall economic performance

The economic performance of Worcestershire is generally good. High performing areas are scattered to the north-east of Worcestershire, continuing past Droitwich and to the east along the A44. The Birmingham and Black County conurbation, with good transport links encouraging commuting, is likely to be a factor here, influencing the higher employment levels and younger age profile of the area.

Similarly, the same positive socio-economic pattern of the south east corner of the county is likely to be influenced by the proximity to Stratford-upon-Avon and good transport links. More prosperous areas are also to be found around Malvern and Abberley Hills. The rural and picturesque character of these parts of Worcestershire could be considered as one of the factors attracting high-income earners and wealthy retirees to settle.

There may, however, be some issues of hidden rural deprivation in Worcestershire, which is generally hard to measure due to being more dispersed than in urban areas.

Figure 1: GI related economic indicators: Combined map[3]



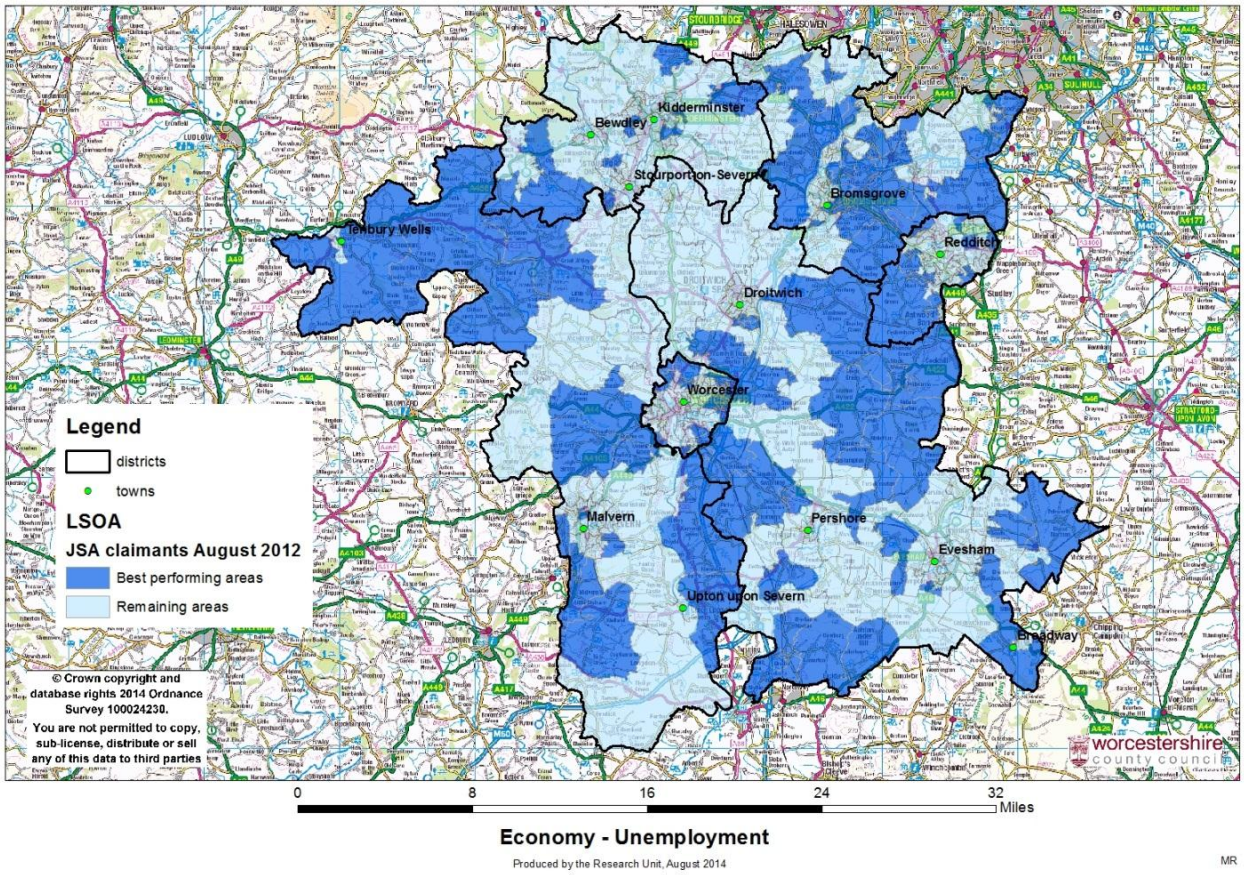
[3] The overal Economy map overlays the three aspects of the economy considered in more detail in the following pages (unemployment, household income and IMD economy) and combines them into an overall map of the economy in the county. Those areas rated as the best performing areas (and in the top 25% of all areas in the county) in all three of the above economic aspects have therefore been ranked as "excellent" in economic terms. The map show 55 LSOAs that meet these criteria. Areas that were outside the top 25% in one or two of the economic aspects considered were ranked as "good", consisting of 85 LSOAs, with those areas in the best 25% for none of the economic aspects (numbering 224 LSOAs) ranked as "less good".

Unemployment numbers

In Worcestershire, in September 2012 there were around 10,500 people claiming Jobseekers Allowance (JSA), representing 3.0% of the population aged 16-64; this is a lower percentage than for the West Midlands and England. Across Worcestershire, Redditch, Worcester and Wyre Forest have the highest claimant count rate at 3.7%, higher than the England average, and Malvern Hills has the lowest at 2.2%.

Generally, concentrations of unemployment are found in the more built up areas of the county, in particular Kidderminster, Redditch and Worcester. The lowest job seeker allowance counts can be found in rural areas of the county (with the exception of the Vale of Evesham along the A46, and the southern and northern Teme Valleys). This general pattern could be explained by higher population densities and deprivation levels in the urban areas, whilst wealthy professionals and retirees tend to settle in the greener, more visually attractive rural areas.

Figure 2: GI related economic indicators: Unemployment[4]



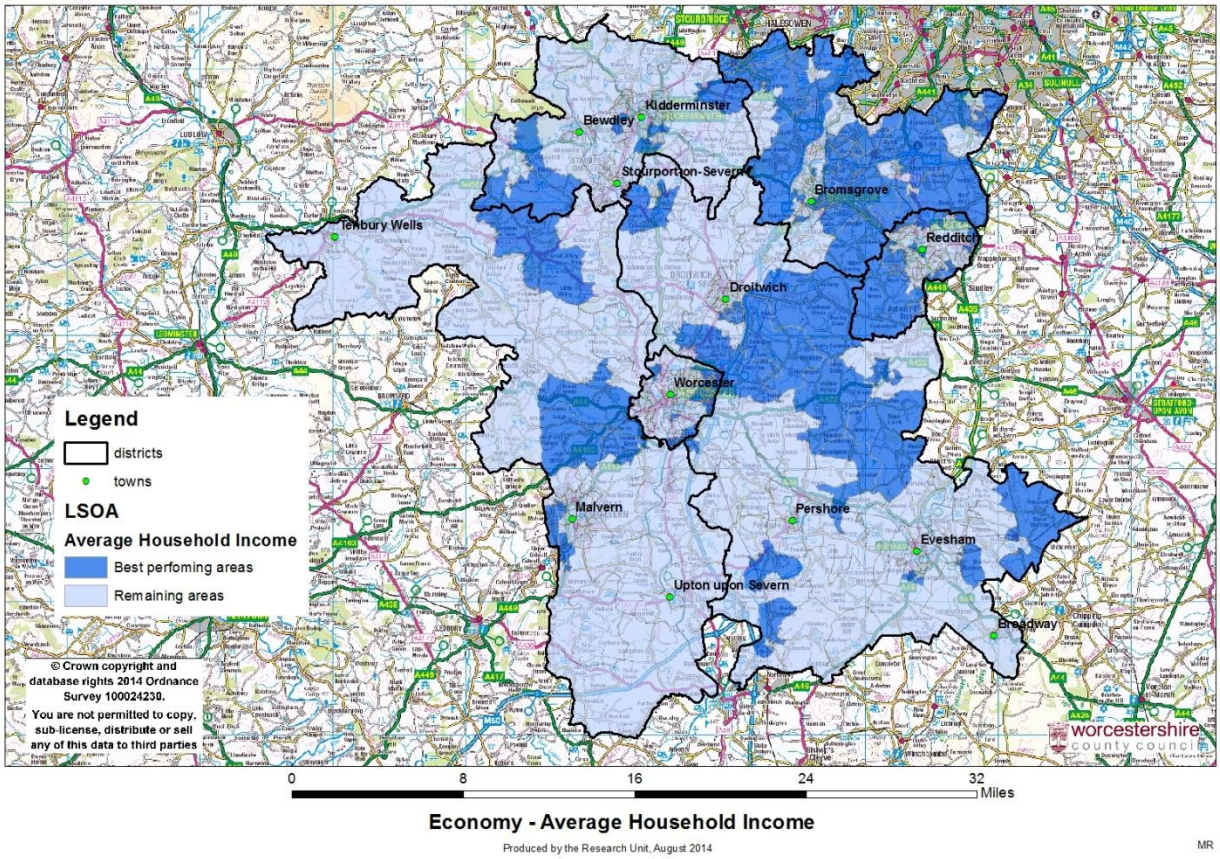
Note: This map was created by considering unemployment rates at LSOA level across the county as at August 2012.

[4] The map identifies those areas with a very low level of unemployment, with only those areas with a Job-Seekers Allowance rate of 1.5% or less being considered as "good". This is equivalent to the 25% best LSOAs in the County.

Household Income

The median household income in Worcestershire is just under £37,000. This is higher than the median for the West Midlands and England. Household incomes are highest in the north east of the county, particularly in Bromsgrove district. This could be influenced by links with the Birmingham and Black Country conurbations. The high income areas stretch further down to cover the eastern villages of the county. There are also smaller but still significant pockets of wealth at the edge of the Cotswolds, to the west of Worcester, and in the Wyre Forest – Abberley Hills area. The high numbers of wealthy residents in these areas could be due to the areas' attractive landscape and historic environment settings, and their proximity to prominent green assets such as the Cotswolds AONB.

Figure 3 - GI related economic indicators: Household income[5]



Notes: This map considers average annual household income at LSOA level taken from CACI data from 2012.

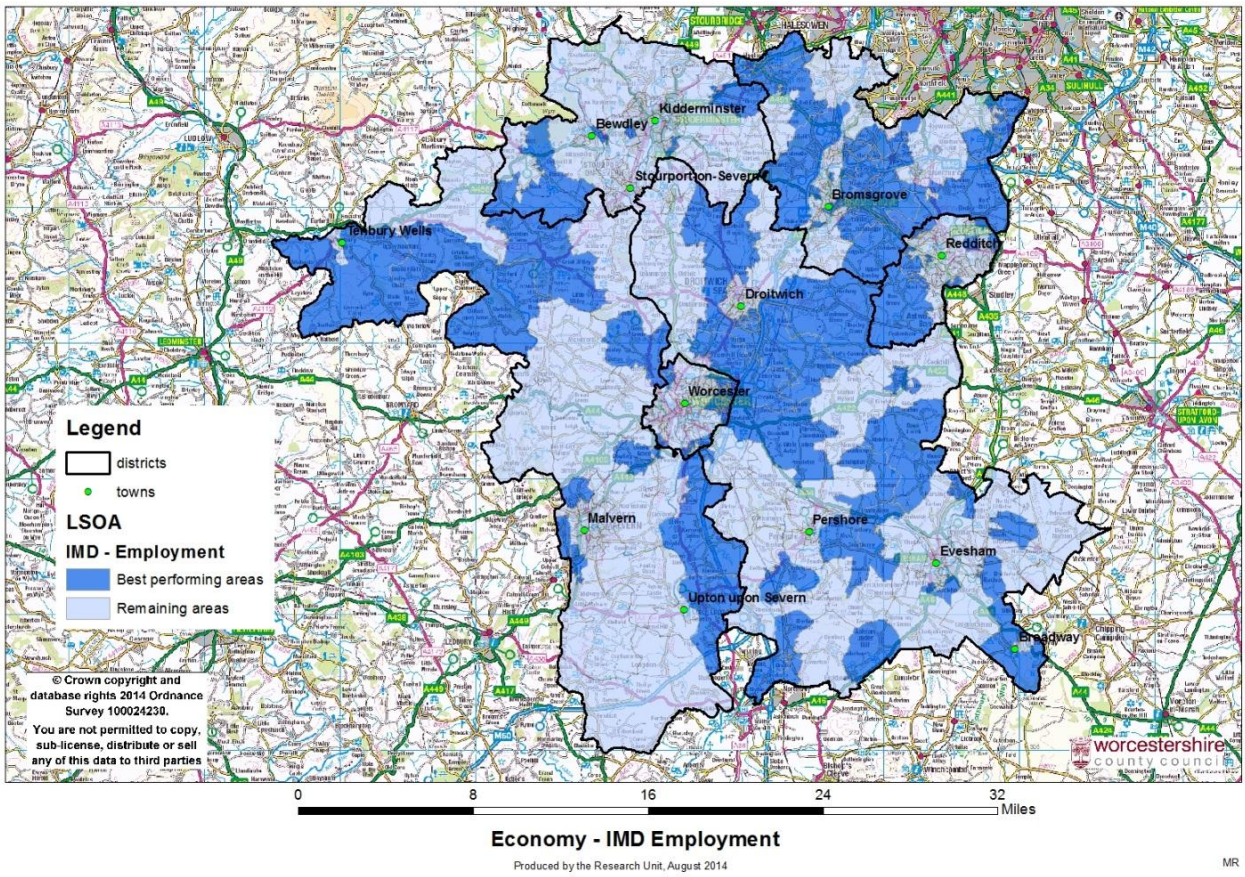
[5] The map identifies only those areas that have the highest average household annual income, with £42,000 being chosen as the threshold. This threshold again picks out the best 25% of areas in the county, with those 75% of areas with a household income lower than £42,000 p.a. making up the remaining areas.

Employment Deprivation

Twelve Lower Super Output Areas (LSOAs) in Worcestershire are in the top 10% of employment-deprived areas in England. This represents 3.3% of the LSOAs in the county, with 64 LSOAs (17.7%) in the top 30% of employment-deprived areas[6].

Rural fringes of the main urban settlements are generally performing well in terms of economic deprivation. The least deprived areas are those within picturesque countryside such as around the Abberley Hills, Bredon Hill, the edge of the Cotswolds and villages in the east and very western edge of the county. A combination of factors could be responsible for this pattern, including the proximity of settlements to transport routes linking people with jobs in the major conurbations (Birmingham & the Black Country, Oxford and Cheltenham); the high-quality natural and historic environment attracting wealthy professionals; and elevated house prices providing a barrier to the unemployed or those on low incomes.

Figure 4: GI related economic indicators: Employment Deprivation[7]



Note: This map was created by looking at the IMD 2010 deprivation level of LSOAs specifically in the Economy domain.

[6] Department for Communities and Local Government (March 2011) English Indices of Deprivation 2010 at Lower layer Super Output Area (LSOA) level

[7] The map selects those areas in the least deprived 25% areas of the county.

PROPERTY PRICES AND QUALITY OF PLACE

There is widespread literature which has established a link between environmental improvements in the form of green infrastructure investments and an increase in housing and land values. Proximity to high quality and accessible greenspace can directly impact upon house prices and greener places can increase visitors and improve rental values.

GI can boost Property Prices through:

- Provision of high quality green spaces in proximity to properties
- Creation of leisure walks and attractions
- Flood risk prevention
- Provision of gardens, orchards and allotments
- Contribution to the visual attractiveness of place
- Providing for community wellbeing

Current Situation

Quality of place

Worcestershire is considered a good place to live by its residents based on the quality of natural environment[8]. More specifically, in a recent poll Worcester was voted one of the happiest places to live in the UK and the happiest place to live in the West Midlands, with the quality of parks, the outdoor environment and local character being key factors[9].

House Prices

House prices in Worcestershire gradually increased during the late 1990s and early 2000s following the national trend, resulting in the median house price in 2007 (£179,000) being nearly three times the 1996 figure (£60,000). The credit crunch and collapse of the housing market saw prices drop in 2007, partially recovering in 2011 to the £172,000 level (just 1% under 2007 prices). The highest median property prices can be found in the rural areas of Malvern Hills and Wychavon districts, as well as in Bromsgrove, which is a popular location for people working in the Black County and Birmingham conurbation[10].

Opportunities

There is a link between environmental improvements and the regeneration of deprived areas. Investment in landscaping, parks, trees and allotments can change negative perceptions of neighbourhoods and consequently reduce housing abandonment rates and increase property prices in the area.

9 out of 10 adults in in the UK identify parks, playgrounds and green spaces as important in making their neighbourhood a good place to live or work[11]. Microeconomic Evidence for the Benefits of Investment in the Environment Review (MEBIE) suggests that proximity to and views of greenspace can increase house prices. The study claims that a view of forest and

[8] Worcestershire County Council (2012) Worcestershire Viewpoint Survey November 2011
[9] Rightmove.co.uk survey reported in The Guardian March 2013.
[10] Department for Communities and Local Government (2013) Live tables on housing market and house prices: Table 586: Median house prices based on Land Registry data, by district, from 1996
[11] Ipsos Mori survey http://www.groundwork.org.uk/news--events/news/2012/90-of-adults-say-green-spaces.aspx

water can increase of the value of a house by 7% and 5% respectively. Properties located within 450 metres of a park can be worth up to 19% more than houses not in such a location[12]. It needs to be noted that the layout, siting and standard of maintenance of the park will influence security and perceptions of danger or anti-social behaviour in parks and the prices of surrounding properties. Furthermore, larger parks were identified as having more positive impact on value uplift than smaller parks[13].

Note:

This information needs to be looked at as anecdotal. There are numerous contextual factors such as the social make-up of an area, the size and quality of the green space, etc. which can also impact on property prices.

Case Study: South Worcester Concept Statement – The Environmental Dimension Partnership (EDP) Perspective

Since early 2010, the environmental consultancy EDP has undertaken a wide range of baseline environmental studies to inform potential development options for an urban extension to the south of Worcester, including ecology, landscape, public open space, rights of way and archaeological/heritage studies. As a multidisciplinary environmental consultancy, the EDP team has naturally progressed project assessment and design under the ethos of Green Infrastructure (GI).

Following completion of initial baseline studies at South Worcester, EDP engaged representatives from the local authorities, national agencies and community groups under the umbrella of a 'GI Group'. This group included representatives from the Forestry Commission, Natural England, Environment Agency, Worcestershire County Council and the Wildlife Trust. The group (as a whole or in sub-groups to focus on specific aspects) has met a total of nine times over a 12 month period.

Reflecting on the value of joint working one year on, EDP Partner (and landscape architect) Ben Rosedale observed: "*From the outset, the GI Group provided a very effective forum for discussions between the developer's consultant team and the key consultees. In contrast to the normal development of site options, having the right people in the same room at the same time enabled very rapid resolution of site specific issues. We were also able to jointly produce a GI Concept Plan containing agreed objectives for the delivery and monitoring of GI on site. By agreeing the priorities at an early stage, the developer team have been able to progress landscape design options and consideration of viability issues with increased confidence – which we believe will deliver time, risk and cost efficiencies in the development of mitigation strategies."* EDP developed a GI Strategy for South Worcester which was submitted alongside a site-wide planning application in 2013.

Source: Ben Rosedale, EDP, private communication

[12] Natural England (2012) Microeconomic Evidence for the Benefits of Investment in the Environment - review

[13] CabeSpace (2005) Does money grow on trees?

ECONOMIC GROWTH AND INVESTMENT

Green Infrastructure can boost economic growth and job creation. The natural environment provides a range of products and services which contribute to the expansion of various economic sectors that are particularly prevalent in the predominantly rural area of Worcestershire.

It can attract inward investment and support job creation in the area. Various factors such as visual attractiveness and quality of place can play an important part in companies' decisions about siting their premises. There is also an awareness of the promotional effect that businesses incorporating environmentally friendly solutions can have on companies' customers, partners and employees.

GI contributes to Economic Growth and Inward Investment through:

- Natural heritage and attractive landscapes
- Creating green and visually attractive business premises
- Providing a healthy environment
- Increasing labour productivity
- Supporting health of employees and reducing their sickness levels
- Cost reductions through providing natural solutions to flooding

Current situation

Economic performance

Total GVA in Worcestershire in 2011 was £9,159 million, which equates to 9.6% of the West Midlands total. Although GVA in the county has increased steadily since the late 1990s there was a notable fall in output in 2009 during the recession; it has since begun to increase again[14].

There is a positive trend in terms of the number of new businesses established in the county. There were 2,325 new businesses established in Worcestershire in 2011, a 6.9% increase compared with 2010. The West Midlands and England both saw rises over the same period (9.8% and 12.0% respectively)[15].

Economic priorities for Worcestershire

The Worcestershire Local Enterprise Partnership[16] aims to attract significant private sector investment into the county through implementing its Growth Plan. The LEP recognises that local landscapes, cultural heritage and quality natural environment make Worcestershire a "*magnificent business location*"[17].

[14] Worcestershire County Council (2013) Local Economic Assessment
[15] Ibid
[16] Local Enterprise Partnership - partnerships between local authorities and businesses setting the economic priorities for the area
[17] Worcestershire Local Enterprise Partnership (2012) Business Plan

Opportunities:

Natural environment products and services

The natural environment provides an enormous range of products (such as water or soils), services (such as production of food worth £15 billion to the national economy)[18] and support to a wide range of economic sectors (including agriculture and horticulture). Protecting natural areas can deliver economic returns that are 100 times greater than the cost of their protection and maintenance[19]. In 2009 approximately 122,000 people in the UK were employed in the green space sector, including parks management, forestry and landscape services[20].

The forestry and primary timber processing sector on its own contributes £1.7 billion in gross value added to the UK economy and supports 43,000 jobs[21]. It is estimated that targeted intervention by government in forestry could create up to a further 7,000 direct jobs, many of them in our most deprived rural areas. This new interventions would accrue numerous benefits such as carbon reductions and strengthen domestic wood manufacturing[22].

Attracting new business and local business growth

The interdependent nature of sectors in the rural economy and the interdependencies between rural and urban areas is well documented in Worcestershire. The quality of the natural environment forms a key part of the Worcestershire 'offer' for businesses seeking to locate in the county, with many indigenous business citing quality of life as a key factor in their choice of business location. Business leaders in Worcestershire see the environment as one of a series of factors taken into consideration alongside other more business-focused issues as part of any options appraisal for locating a business[23].

There are some outstanding examples which support the theory of green infrastructure providing widespread benefits to businesses. For example, a study of commercial space in London shows that companies are prepared to pay a premium to be close to high quality open space[24].

[18] Research Councils UK (nd) Adding Value: How the Research Councils benefit the economy
[19] Economics of Ecosystems and Biodiversity study quoted in Natural Environment White Paper (p10)
[20] CABE, Green space skills 2009: National employer survey findings
[21] Defra (2013) Government Forestry Policy Statement
[22] Confor (2012) Forestry: 7,000 Green Jobs and Low-carbon Growth
[23] Internal discussions with the Economic Development team at Worcestershire County Council
[24] Gensler & Urban Land Institute (2011) Open Space: an asset without a champion?

Case Study: Natural Benefits for Business project in Cumbria

The Natural Benefits for Business project in Cumbria indicated that actions taken by local companies to protect and enhance biodiversity provided economic gains, including:

- greater customer satisfaction and increased return on sales;
- boosted staff morale, leading to better staff retention;
- reduced management costs resulting from "light touch" grounds maintenance
- reduced security costs resulting from vandals and thieves being deterred by traditional hedgerows.

***Source**: Natural England (nd) Natural Benefits for Business*

Labour productivity

Access to greenspace can increase labour productivity and reduce costs caused by sickness absence. MEBIE report suggests that there is a connection between an attractive green environment and increased health of employees as this encourages exercise[25]. Physically active workforces are at a lower risk of certain health issues (such as obesity, heart or respiratory diseases) if there is access to greenspace, which could reduce employee sickness costs incurred by businesses. The provision of quality green spaces in business areas can encourage moderate exercise activities and can contribute to better employee health. This could potentially contribute towards the national minimum recommendation of 30 minutes of physical activity five times a week for each adult.

The most popular forms of physical activity for most people are those that can be incorporated into everyday life, such as walking to work. Green infrastructure can encourage physical activity through creating attractive and safe open public spaces and travel routes such as cycle paths.

Stress is considered the biggest single source of employee sickness absence. Recent research has found that access to green spaces can provide a sense of rest and enable workers to be more productive[26]. Looking at nature through a window can lead to reduced stress and improved work performance in the office[27].

[25] Natural England (2012) Microeconomic Evidence for the Benefits of Investment in the Environment - review
[26] Virginia Cooperative Extension: Nutrient Management cited in Project EverGreen http://projectevergreen.org/resources/economic-benefits-of-green-spaces/
[27] World Health Organisation Commission for Social Determinants (2009) The Marmot Review. Strategic Review of Health Inequalities in England post-2010 Task Group 4: The Built Environment and Health Inequalities Final Report

Case Study: Europe's largest green roof at Kanes Foods

Kanes Foods, a leading UK supplier of fresh chilled vegetables based in the Vale of Evesham, constructed a new sustainable salad factory covered with the UK's largest wildflower green roof. The curved roof is covered in grass which incorporates a range of indigenous wild flowers. The roof maximises the thermal efficiency of the building whilst providing a new wildlife habitat which blends into the contours of the surrounding Cotswold Hills.

The roof provides multifunctional benefits to the company, employees, natural environment and local economy. The Kanes green roof:

- Improves the health and wellbeing of the company's employees through access to the surrounding nature and improved air quality.
- Contributes to the company's productivity and profits by reducing the number of employees taking sickness absence.
- Protects Worcestershire's landscapes, which are valued by locals and visitors, from detrimental visual impact.
- Supports the local economy by creating a landmark feature, which is unique for this type of industry. This attracts attention and potentially inward investment from outside the county.
- Reduces energy costs to the company through better thermal insulation of the building.
- Significantly reduces surface water runoff volumes and rates of rainfall leaving roofs.
- Enhances biodiversity through the wildflower meadow attracting butterflies and birds. It is also anticipated that the roof will host skylark nestings.

***Source**: Kanes Foods website*

TOURISM & THE VISITOR ECONOMY

Accessible and high quality green spaces are a major part of Worcestershire's tourist offer. They support the needs of local residents and can also be a potential attractor for visitors contributing to the tourism sector.

GI contributes to tourism through:

- Natural heritage and attractive landscapes
- Healthy environment
- Encouraging healthy behaviour of local residents and visitors
- Boost of the visitor's spend
- Specialist tourism such as food and drink festivals

Current situation

Sector performance

Tourism is one of the largest industries in Worcestershire, worth approximately £539million in 2008[28]. It is estimated that in 2010 it employed over 11,000 people. This sector attracts 10 million visitors to Worcestershire each year.

Tourism offer

Many of Worcestershire's high quality green spaces attract visitors from within and outside the county. Green infrastructure assets such as the Lickey and Clent Hills are predominantly attracting *"day visitors"* travelling from Worcestershire or surrounding areas including the Birmingham and Black Country conurbation.

Some of Worcestershire's assets such as the Malvern Hills, Cotswolds and Wyre Forest are nationally recognised. The Guardian recently identified The British Camp in the Malvern Hills as one of the best views in England[29]. These assets attract day visitors and so called *"staying visitors"* who usually come from further afield and tend to prefer longer visits.

Visitor preferences

Tourists visit Worcestershire for many purposes including enjoyment of the county's countryside, scenery and wildlife, visiting attractions & events, using waterways, exploring the local heritage as well as taking part in various activities. In 2005, at least 12% of all visitors to Worcestershire came for walking and hiking[30].

Opportunities:

Visitor economy

Traditionally, business and tourism have been treated as separate economic sectors. In Worcestershire there is an interest from business sector in providing a more integrated approach which builds on the natural environment offer to create a coordinated business

[28] The Sub-Regional Value of Tourism in the UK in 2008 published by Tourism Intelligence within the Office of National Statistics
[29] Guardian (2010) Britain's best views: The British Camp, Malvern Hills http://www.guardian.co.uk/travel/2010/may/06/britains-best-views-worcester-malvern
[30] The Worcestershire Visitor Survey 2005

tourism package for the county. This initiative seeks to encourage increased longer term visits by people whose primary purpose in visiting Worcestershire is business related[31].

Visitors have a direct impact on the local economy through spending money on accommodation, food & drink or fees for cultural and outdoor activities. There are no local estimations on how much people have spent by visiting GI related attractions but national estimations suggest there is a clear link between green infrastructure and tourism. In 2008, visitors to the English countryside spent £11.5 billion and generated 340,000 jobs. Forest related tourism expenditure on day visits to forests exceeds £2 billion per year. Similarly, the attractive landscapes of the South West of England have been estimated to have attracted sufficient visitors to support over 70,000 jobs in that region [32].

The many natural products grown in Worcestershire generate financial benefits for the retail sector but also contribute to other sectors such as distribution and tourism. Worcestershire's local produce is celebrated in many events and festivals such as Apple Fest in Tenbury Wells, Pershore Plum Festival or the Vale of Evesham British Asparagus Festival. These events attract many visitors and generate significant returns on investment. For example, it is estimated that the Pershore Plum festival attracted 17,000 visitors (2007 figures)[33].

Health links

Attractive and accessible GI assets contribute to the health and wellbeing of both local residents and tourists from outside the county through supporting healthy lifestyles, promoting physical activity and providing a healthy environment. This can provide long term savings to local and national healthcare budgets. The economic benefits of the health/GI interrelation are explored in more detail in Chapter 3: Health Benefits of Green Infrastructure.

[31] Internal discussions with the Economic Development team at Worcestershire County Council
[32] Natural England (2012) Microeconomic Evidence for the Benefits of Investment in the Environment - review
[33] Wychavon District Council (2011) Shaping the future together, August 2011

Case Study: Droitwich Canals

The Droitwich Canals were reopened in 2011, more than 70 years after being officially abandoned. The £12.7m restoration project was undertaken by a wide range of public, private and voluntary sector partners, and created the 'Mid-Worcestershire ring', the only short break cruising ring in England.

The ring allows boats, cyclists and walkers to make a 21-mile circular journey through some of the Britain's most beautiful and historic countryside. As part of the canal restoration project, a linear park has been created providing picnic sites, fishing pegs, and new stop off points for boaters, walkers and cyclists. The area is also rich in wildlife so everyone can enjoy the sights and sounds of nature up close, such as at Coney Meadow Reedbed, a 5.5 hectare wildlife habitat near Salwarpe.

It has been estimated that the network extension to Droitwich Canal will generate a significant economic gain for the area, including:

- £2.75m additional visitor spend
- 196 FTE jobs
- £3,088,800 uplift values for adjacent houses
- 322,000 additional visitor days
- 10 to 15 new businesses established
- 3,300 boat movements on the Droitwich Canals
- 12,000 annual cycling visits
- 2,000 annual canoe visits
- 3,500 annual angling visits
- £144,000 annual health benefits

Source: Economic Development Team, WCC and British Waterways Droitwich Barge Canal.

AGRICULTURE AND LAND MANAGEMENT

A major continuing challenge is to increase food production while improving environmental outcomes. This challenge is particularly relevant to Worcestershire where economic success is largely reliant on agricultural land uses and food production. Green infrastructure can be a multifunctional solution which addresses these issues.

GI supports Agriculture & Land Management through:

- Clean water and soils
- Water supply
- Flood risk prevention
- Protecting important species such as bumblebees
- Provision of gardens, orchards and allotments
- Agricultural diversification
- RDPE funding

Current situation

Worcestershire's farmed area in 2010 was 117,165 ha, which is approximately 67% of the county's total land. Worcestershire's financial output from horticulture accounts for 20% (£70 million) of the overall output in the West Midlands[34]. The Vale of Evesham plays an important role in horticulture, hosting a large number of businesses specialising in that sector.

It is estimated that in 2012, 55% of Worcestershire residents grew fruit and/or vegetables for their own consumption, mainly in their garden or in tubs. There are differences across the county in the level of such activity, with residents in Malvern Hills district being most likely to grow their own food.[35]

Opportunities

Multifunctional benefits

Green infrastructure can provide benefits to agriculture, horticulture and wider food production sectors whilst protecting and enhancing the natural environment. In the wider sense, GI supports well-functioning ecosystem services (the benefits that a healthy environment provides for people) which are essential to growing food and breeding healthy animals (such as clean water and soils)[36]. For example, planting trees on the edge of a field can reduce pollutant run-off to watercourses and ensure long-term clean water provision. GI solutions are multifunctional, therefore the same trees could be a natural flood management structure to slow water flow from the land. This in itself will provide savings to the farming sector through reducing the need for water purification and reducing the risk of crops being affected by flooding.

Opportunities for these sectors are connected to new and innovative ways of farming such as water storage facilities. Agricultural and horticultural businesses could face damaging water shortages in the coming decades as a result of predicted increased summer droughts. In many parts of Worcestershire, water resources are under severe pressure. The majority of catchments in which horticultural production is concentrated have been defined

[34] European Food and Farming Partnership (2011) Getting to the heart of horticulture
[35] Worcestershire County Council (2012) Worcestershire Viewpoint Survey May 2012
[36] More detail about ecosystem services can be found in Appendix A of this document

by the Environment Agency as being either over-licensed and/or over-abstracted. Well executed water storage facilities such as ponds can not only provide water supply for businesses in dry periods, but can also provide a wide range of green infrastructure benefits, such as biodiversity or landscape.

The key to successful application of GI solutions is a cross-boundary and cross-organisational approach to management and creative incentives for land users to manage their land for nature's benefit. This is particularly important in relation to natural resources such as water where upstream land uses and water management impacts downstream habitats and users of water.

Direct financial opportunities

Multifunctional GI can offer direct financial opportunities to farmers and land owners. European initiatives managed by the Rural Development Programme for England (RDPE) have a £3.9 billion budget, of which £3.3billion is allocated to agri-environment and other land management between 2007-2013. A further £600million has been allocated to make English agriculture and forestry more competitive and sustainable[37].

The aim of this funding is to provide financial support to farmers and land managers for initiatives that protect, preserve and improve the quality of water, air and soil, the abundance of bio-diversity, and in the enrichment of landscapes.

There are two relevant schemes:

- Agri-Environment schemes to provide rewards to farmers for environmentally-sensitive land management
- The England Woodland Grant Scheme to provide funding for the planting and management of woodlands

Furthermore, there may be potential for the Payment for Ecosystem Services (PES), an initiative supported by the Natural Environment White Paper which states that land managers should be "*getting returns from a range of ecosystem services in addition to those they get from food production"*[38]. PES could be put in place to support farmers and land managers through changes to traditional activities and land management practices to enhance the level of ecosystem services, e.g. flooding of wetland or improved water quality[39].

Agricultural diversification

Green Infrastructure can provide new opportunities for agricultural diversification for food and non-food crops. GI can support rural areas and the agricultural industry undergoing

[37] RDPE Network & National Care Farming Initiative Joint Project (2010) Support for Care Farming Through the Rural Development Programme for England. A review and look forward
[38] HM Government (2011) Natural Environment White Paper, p.24
[39] DEFRA (2010) Payment for Ecosystem Services

structural change through diversification opportunities to supply local markets for biofuels and biomass[40].

Research suggests[41] that there is sufficient resource in Worcestershire to support development of biomass energy production for heat and/or power. Farmers in Worcestershire are already growing energy crops including *miscanthus* (most popular), oil seed rape and willow coppice.

Woodland

Finally, green infrastructure can deliver economic benefits through the creation and maintenance of existing woodland. New and existing woodland can support the local economy through supplying woodfuel and biofuels. For example, the woodchip boiler installed in Worcestershire County Council's County Hall produces around 1 million kWh of renewable heat every year. This uses around 600 tonnes of woodfuel annually, sourced from local forestry operations.

Use of timber from existing woodland can play an important role in sustaining rural communities, and providing employment opportunities in timber harvesting, transport, and supply chains. Government estimates that a medium scale 20MW wood-fired power plant (supplying energy for around 20,000 homes) would provide full-time employment for 48 permanent staff and significant short-term employment opportunities[42].

[40] Natural England (2012) Microeconomic Evidence for the Benefits of Investment in the Environment - review

[41] IT Power (2008)Renewable Energy in Worcestershire

[42] Centre for Economics and Business Research report for the Forestry Commission (2010) The economic value of the woodfuel industry to the UK economy by 2020, (June 2010) http://www.biomassenergycentre.org.uk/pls/portal/docs/pAge/BeC_teCHNICAL/reseArCH%20AND%20stUDIes/eCoNoMIC%20stUDIes/2010-06-30%20eCoNoMIC%20VALUe%20oF%20WooDFUeL_reVIseD%20report.pDF

Case Study: Overbury Farms – Sustainable Food Production

Overbury Farms, on the slopes of Bredon Hill in Worcestershire, covers over 1,500ha of land and is a mixed farming business combining arable and vegetable crops, together with a sheep enterprise of 1,100 ewes. A proportion of the company's produce is sold direct through the internet to the public but the majority goes to large retailers including lamb to Sainsbury's and barley sold to Carling.

Since 2003 Overbury has achieved LEAF (Linking Environment and Farming) accreditation. LEAF is a charity which promotes integrated farm management, combining traditional methods and modern technology to produce nutritious food through sustainable practices. Overbury is one of only 1,700 farms in the UK to hold this accreditation, which is renewed annually.

Overbury Farms secured accreditation through solutions such as integrating sheep into arable rotations, rainwater harvesting from lambing shed roofs and use of solar panels to reduce energy costs. The farm is also a pioneer for so called "precision farming" which uses modern technology such as GPS to apply fertiliser depending on precise soil fertility. This uses resources more efficiently and can vary the seed rate across the field. Other benefits include establishing crops faster, cheaper and more efficient soil management and minimising release of nitrogen to the environment.

Jake Freestone, the farm's manager, said that *"using variable rate fertiliser applications on one field alone have saved 4.8 tonnes of fertilizer and a reduction in cost of over £1,400, in 6 years".* He recognised that being environmentally friendly and more efficient "*appeals to his customers, helps build trust and strategic business alliances. For example, being LEAF-Marqued has secured a premium for oilseed rape for the next 5 years.*

In October 2012, Overbury Farm became a LEAF demonstration farm showcasing best sustainable practices to visiting community groups, conservation organisations, local schools and other farmers.

Source: Overbury Farms website http://www.overburyfarms.co.uk/
The Newspaper of the Cotswolds AONB, Issue 28, Spring/Summer 2013, A New LEAF

CHAPTER 3: HEALTH & WELLBEING BENEFITS OF GREEN INFRASTRUCTURE

INTRODUCTION

There is a strong link between the provision of accessible and good quality green spaces and improved health of residents. GI offers opportunities for increased physical activity, exposure to nature, and climate change resilience and mitigation, which could help to reduce levels of ill-health and increase the wellbeing of local residents.

The major challenge lies in the deeper understanding of these links and opportunities and coordination of the strategies produced by various stakeholders. Linking work undertaken by the health and wellbeing sector with the partners responsible for the provision of green spaces in our towns and cities can ensure the supply of multifunctional infrastructure which caters well for the health and wellbeing of residents.

This chapter identifies these links and explores the opportunities that GI can offer towards maintaining and improving health and wellbeing in Worcestershire. It introduces five indicators which measure the level of health issues which could be positively influenced by GI, including obesity, heart and respiratory diseases, mental health and health related deprivation. It then describes how GI can contribute towards reducing occurrences of ill-health and how it can support greater community cohesion.

This chapter focuses information under three themes, which cover:

- Financial benefits
- Health and wellbeing levels
- Social inclusion and community cohesion

GI BENEFITS TO HEALTH & WELLBEING

Physical Activity

Increasing physical activity through access to high quality green space has the potential to save the NHS £2.1 billion a year.

Physical Health: Obesity

Forest Research (2010) proves that under 25's are more likely to be obese if they do not have access to green space.

Physical Health: Heart Diseases

Proximity to greenspace is generally associated with increased levels of physical activity. Regular physical activity can reduce coronary heart disease by 10%.

Mental Health

The University of Essex proved that mental health can benefit from engagement in physical activities and direct exposure to nature. 89% of the participants in their study felt that exercising in the natural environment was the most influential factor in improving their frame of mind.

Climate Change Related Conditions

Informed selection and strategic placement of trees and GI can reduce the 'urban heat island' effect and cool the air, reducing health-related premature human death during high-temperature events, which account for 1,100 deaths per year.

Community Cohesion & Wellbeing

A study undertaken by Sullivan et al. (2004) found that the number of people engaged in social activity was 83% higher in areas surrounded by green spaces than in areas of concrete and sparse vegetation

HEALTH CONTEXT

Access to quality green infrastructure will primarily contribute to addressing health and wellbeing issues within the indices (including social factors such as crime). Recent evidence proves that accessible and quality green spaces encourage physical activity, improve social interaction, help build self-esteem, and contribute to the social mobility of disadvantaged people. Health deprivation patterns are represented in this paper by the Indices of Multiple Deprivation (IMD), which cover a range of socio-economic measures[43].

This information has been spatially represented on context maps, and has been amalgamated on a combined health map. The maps and accompanying narrative are presented under subheadings below.

The following datasets have been used to map health patterns in Worcestershire:

Health indicator	Datasets	Map
Obesity	CACI and Kantar Health ACORN data	Figure 6
Heart Disease	CACI and Kantar Health ACORN data	Figure 7
Respiratory Conditions	CACI and Kantar Health ACORN data	Figure 8
Mental Health	CACI and Kantar Health ACORN data	Figure 9
Health Deprivation	This indicator uses the Health domain of the English Indices of Deprivation 2010 at Lower Layer Super Output Area (LSOA) level.	Figure 10

Note: In this mapping exercise, the top 25% of areas in Worcestershire have been selected in each case; however it cannot be stated that areas outside of this threshold are necessarily "bad" as in many cases these areas are still much better than the Worcestershire average, and also are better than the national average. Therefore this information should be used with caution and further analysis undertaken if using these maps for purposes other than those for which they are intended.

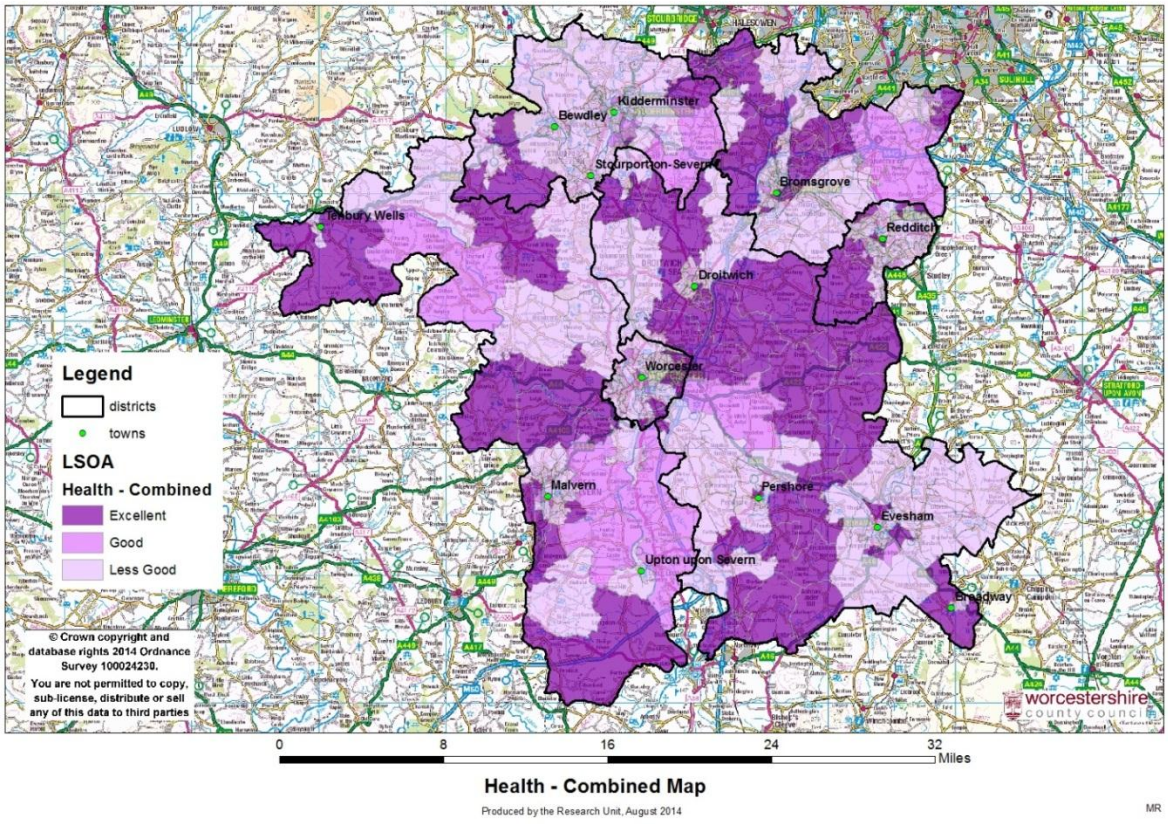
[43] See Chapter 2: Economic Benefits of Green Infrastructure for more detail on IMD.

Health Combined

Worcestershire presents a varied picture in terms of ill health. However, it performs relatively well when compared to national figures. The county has a higher average obesity rate (25%) than the national average (24%). Heart disease is an issue for most areas in Worcestershire, despite the numbers improving and remaining lower than the UK average. There are also pockets of health related deprivation, mental health and respiratory diseases across the county.

Health problems are a predominantly urban issue in Worcestershire; however there are also some pockets of poorer health in the more rural parts of the county. The lowest counts of ill-health can be found around Tenbury Wells, Wyre Forest/Abberley Hills area, the eastern villages towards Bredon Hill and Bredon settlement, the edge of the Cotswolds and Malvern Hills, the south-western edge of the county, the A44 - A4103 corridor stretching to the west from Worcester City, and major parts of Bromsgrove District along major transport routes towards Birmingham and the Black Country conurbation. It can be seen that healthier areas broadly match the wealthier parts of the county.

Figure 5: GI related health indicators – combined map[44]



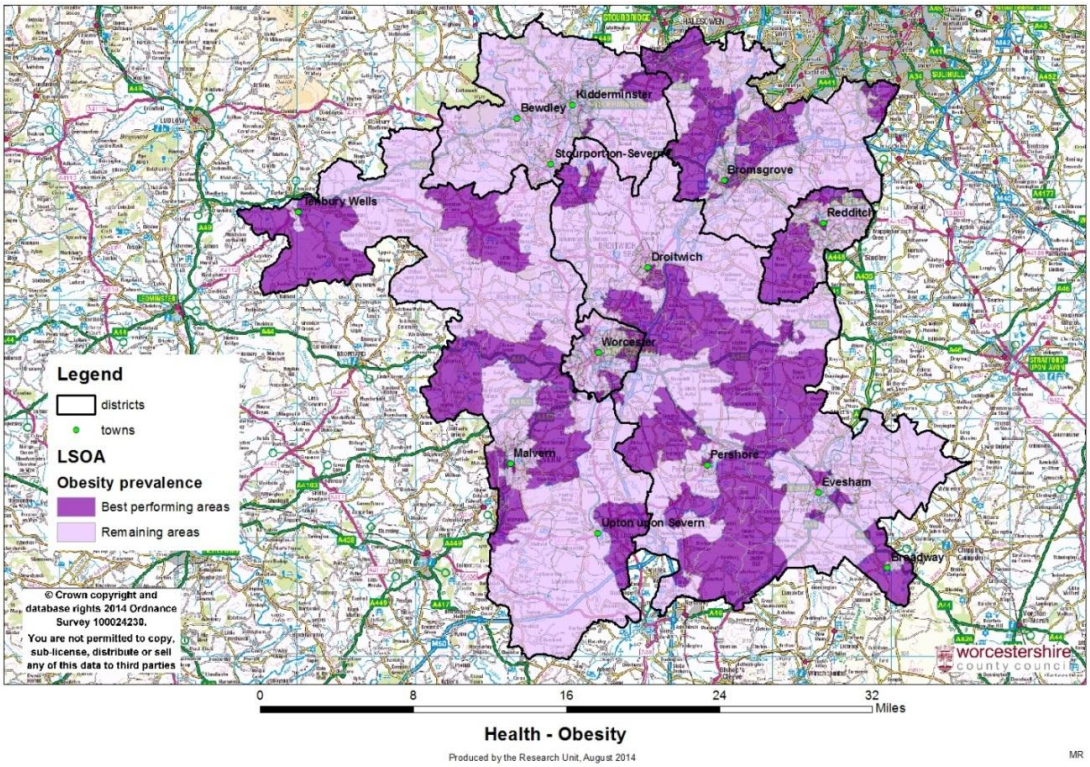
[44] Areas that were rated as "best performing" (and in the top 25% of all areas in the county) in three or more of the five considered health aspects are ranked as "excellent" in terms of health (labelled in dark purple) which accounted for 86 of the 364 LSOAs in the county. Those areas that were outside the top 25% in all five of the health aspects considered were ranked as "less good" and accounted for 160 LSOAs in the county, with the remaining 118 LSOAs labelled as "good".

Obesity

It is estimated that in 2012 23% of all adults in Worcestershire were obese[45] which is 1% above the national average[46]. Childhood obesity is also a major problem in the county where 17.5% of Year 6 children are recognised as obese. Furthermore, each year, Worcestershire experiences approximately 400 deaths due to obesity related ill-health such as diabetes, high blood pressure, heart attack, stroke and cancers[47].

Geographically, obesity is predominantly an urban issue, however varying levels of this problem can be noticed throughout the county. The least obese areas are scattered across the county. They include: the corridor to the west of Worcester; the Malvern Hills; Abberley Hills; Redditch rural fringe; the Worcester-Droitwich corridor; eastern villages; the edge of the Cotswold villages; areas in proximity to Bredon Hill; the A44 - A4103 corridor stretching to the west from Worcester City; and major parts of Bromsgrove District along major transport routes towards Birmingham and the Black Country conurbation. There could be a number of factors responsible for higher levels of obesity in more urban areas, such as higher deprivation and lower income levels, increased numbers of hot food takeaways and a lower quantity and quality of green spaces for physical activity.

Figure 6: GI related health indicators: Obesity[48]



Note: The map considering obesity uses Health Acorn data to estimate prevalence of obesity at postcode level. These obesity levels are then apportioned up to LSOA level to obtain an estimate of obesity levels for each LSOA in the county.

[45] Obesity - determined by using weight and height of a person to calculate a number called the "body mass index" (BMI). An adult who has a BMI of 30 or higher is considered obese.

[46] Public Health Observatory profiles, http://www.apho.org.uk/resource/view.aspx?RID=142075

[47] Worcestershire Health and Well-being Board (2012) Joint Strategic Needs Assessment.

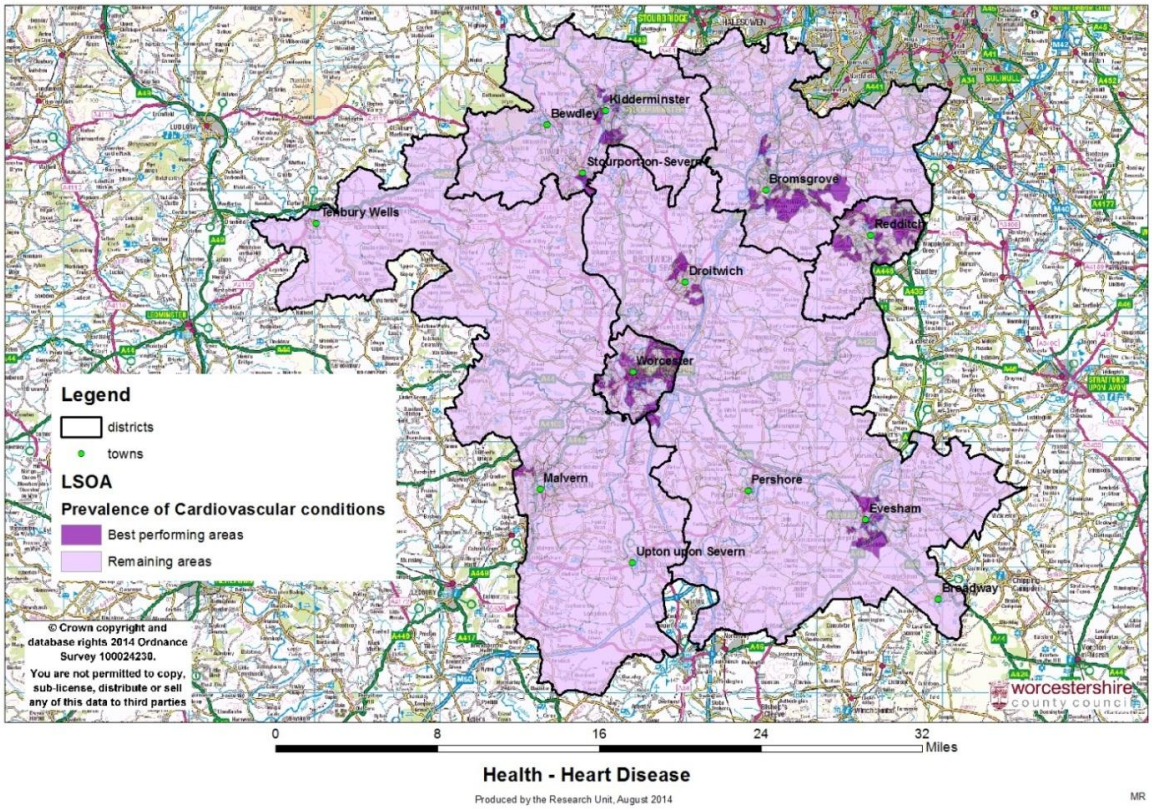
[48] Areas with a prevalence of obesity of 86.4% or lower of the national average have been identified, which signifies the "best 25%" areas within Worcestershire.

Heart Diseases

Mortality rates from cardiovascular diseases have shown a huge reduction since 1996, slightly more marked in men than women[49]. The rate in Worcestershire is significantly lower than the national rate. In 2011/12 the emergency admission rate for coronary heart disease, all persons, in Worcestershire was 196.0 per 100,000 (1,644 admissions). This is lower than England (198.3 per 100,000) and similar to the West Midlands (195.9 per 100,000)[50].

Patterns of heart disease are more dispersed than the other health indicators assessed, with only a few areas reaching our threshold for the best performing areas. Contrary to other health indicators, heart diseases are less prevalent in the urban settlements and urban fringes of Worcester City, Redditch, Bromsgrove, Kidderminster and Evesham. There are many factors which could have influenced these patterns in Worcestershire, including age, deprivation-related high cholesterol, obesity, physical inactivity, diabetes, unhealthy diets and harmful use of alcohol.

Figure 7: GI related health indicators: Heart Diseases[51]



Note: This was created using Health Acorn to estimate prevalence rates at postcode level, then aggregating up to LSOA level to obtain prevalence levels.

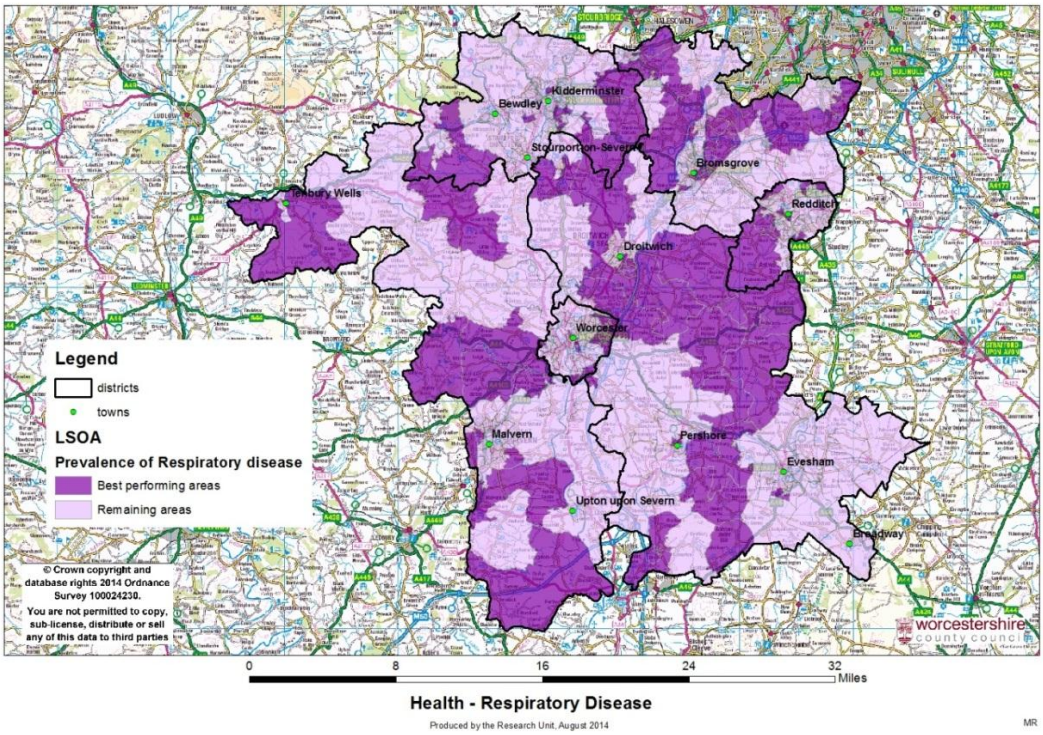
[49] Worcestershire County Council (nd) Public Health Annual Report 2007-08
[50] South East Public Health Observatory (SEPHO) http://www.sepho.org.uk/default.aspx
[51] Areas with a cardiovascular disease prevalence of less than 95% of the national average have been identified, which signifies the "best 25%" areas within Worcestershire for prevalence of cardio-vascular and heart diseases. In contrast with most other diseases discussed, the lowest prevalence of heart disease occurs largely in urban areas in the county.

Respiratory diseases

Prevalence of Chronic obstructive pulmonary disease (COPD), a collection of lung diseases including chronic bronchitis, emphysema and chronic obstructive airways disease, is increasing in Worcestershire[52]. Between 2008 and 2010, there was an annual average of 743 deaths with respiratory disease as the underlying cause. This represents 13.6% of deaths across the county, slightly lower than the England average of 13.8%. Across the same time period in Worcestershire, there was an average of 1,800 deaths per year where respiratory disease was listed as either the underlying cause of death or as a contributory cause of death, a total of 32.8% of all deaths compared to 34.2% in England[53].

Respiratory related conditions are generally a problem for residents across the county. The exceptions to this are: a corridor to the west of Worcester; an area to the south of Malvern Hills; an area north from Bewdley and Kidderminster; the Worcester-Droitwich corridor; eastern villages; and areas in proximity to Bredon Hill. Redditch has the highest prevalence of COPD and Malvern Hills the lowest. The difference between the two is as much as 25%[54]. It is difficult to draw conclusions on the reasons for these patterns. They could be connected to air quality and access to the natural environment, alongside other factors such as economic deprivation or the age profile of the population.

Figure 8: GI related health indicators: Respiratory Diseases[55]



Note: The map considering respiratory disease was created in a similar way to the obesity map, using Health Acorn to estimate prevalence rates at postcode level, then aggregating up to LSOA level to obtain prevalence levels.

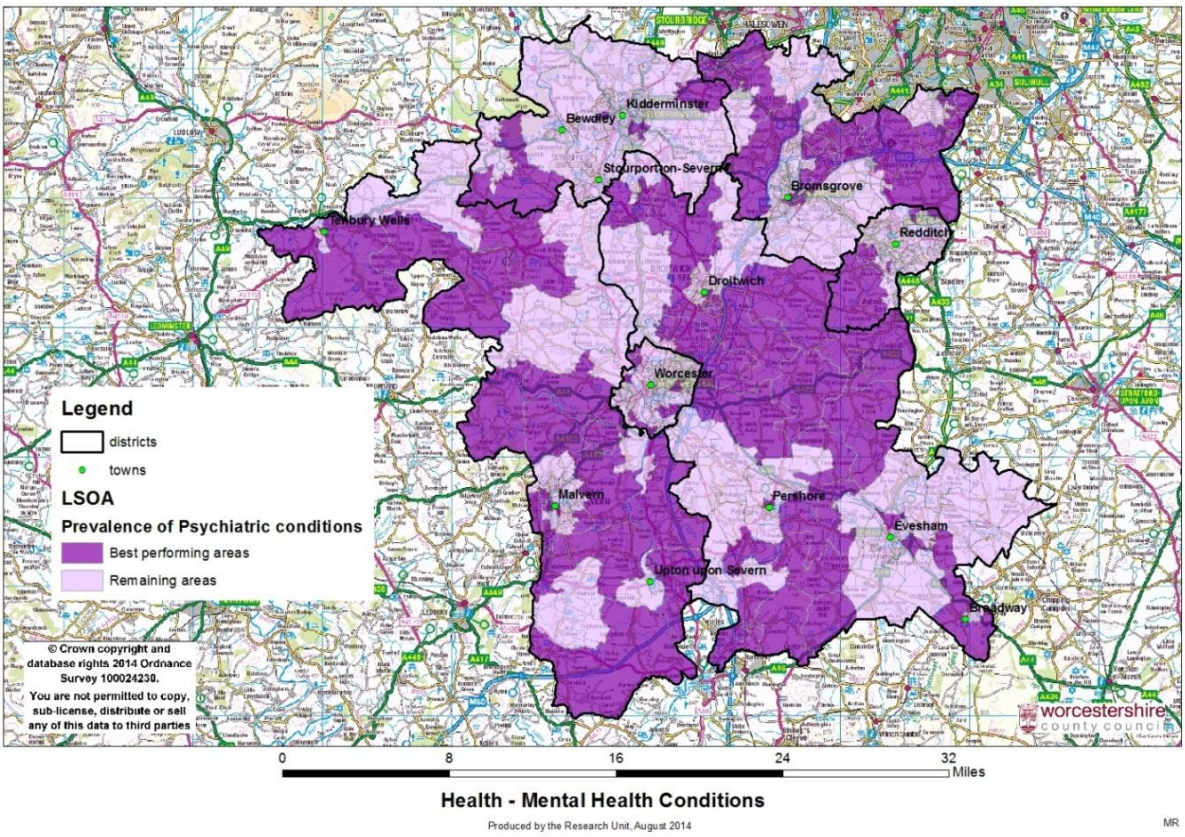
[52] Worcestershire Health and Well-being Board (2013) Joint Strategic Needs Assessment
[53] CACI and Kantar Health, Health ACORN data
[54] Worcestershire Health and Well-being Board (2013) Joint Strategic Needs Assessment
[55] Areas with a prevalence of respiratory diseases of less than 94% of the national average have been identified, which signifies the "best 25%" areas within Worcestershire. In general the "best" areas with the lowest prevalence of mental health problems in the county tend to be in the more rural areas.

Mental Health Conditions

Nationally, at least one in six individuals suffers from a mental health related condition at any one time. More widely, it is predicted that depression may become the second most common reason for disability in developed countries[56]. The Joint Strategic Needs Assessment (2013) estimates that one adult in eight in Worcestershire has some form of mental health problem, with depression on the increase in Worcestershire and more prevalent than in either the West Midlands or England.[57].

In spatial terms, mental health problems are found in and around major settlements. There are also some pockets in the Vale of Evesham and in the eastern part of Bromsgrove District adjacent to Redditch and in the corridor stretching northwards from Worcester along the River Severn.

Figure 9: GI related health indicators: Mental health conditions[58]



Note: The map considering mental health conditions was created in a similar way to the obesity map, using Health Acorn to estimate prevalence rates at postcode level, then aggregating up to LSOA level to obtain prevalence levels.

[56] Mental Health Organisation, website http://www.mentalhealth.org.uk/help-information/mental-health-statistics/UK-worldwide/

[57] Worcestershire Health and Well-being Board (2013) Joint Strategic Needs Assessment

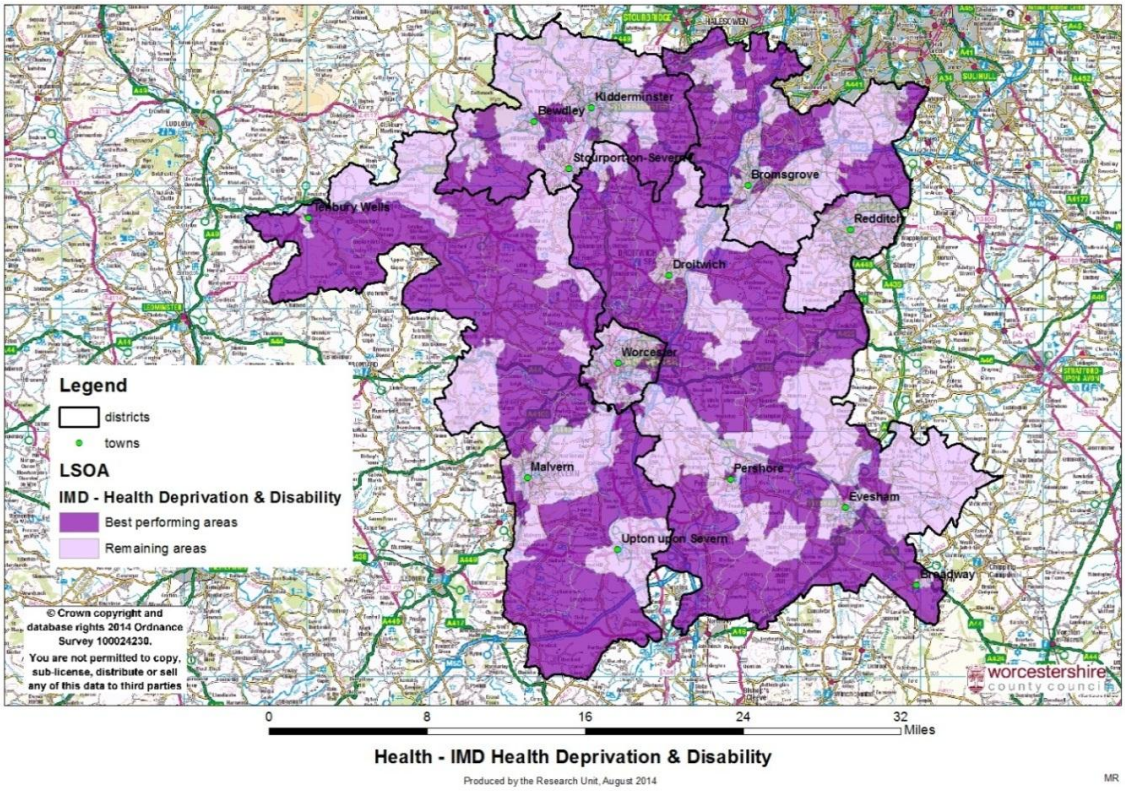
[58] Areas with a prevalence of psychiatric conditions of less than 82.5% of the national average have been identified, which signifies the "best 25%" areas within Worcestershire. In general the "best" areas with the lowest prevalence of mental health problems in the county are in the more rural areas.

Health Deprivation

Worcestershire has 13 Lower Layer Super Output Areas (LSOAs) in the top 10% of areas for health deprivation nationally, representing 3.6% of areas in the county. There are 65 LSOAs (18%) in the top 30% health deprived.

Redditch is the district which is the most health-deprived in the county. 7 LSOAs in Redditch (12.7%) are in the top 10% deprived, with 27 LSOAs, almost half of all areas in Redditch, in the top 30% for health deprivation. Worcester City and Wyre Forest are also relatively heath deprived in comparison with the rest of the county, with each having around 20% of their LSOAs in the top 30% for health and disability deprivation[59]. External factors such as increased economic deprivation, a lower quality of built and natural environment, and closely-related personal behaviour and lifestyle choices could all contribute to the distribution of ill-health in Worcestershire.

Figure 10: GI related health indicators: Health deprivation[60]



Note: This map is created by looking at the IMD 2010 deprivation level of LSOA's, specifically in the Health and Disability Domain

[59] Department for Communities and Local Government (March 2011) English Indices of Deprivation 2010 at Lower Super Output Area (LSOA) level. This domain measures premature death and the impairment of quality of life by poor health. It considers both physical and mental health. The domain measures morbidity, disability and premature mortality but not aspects of behaviour or environment that may be predictive of future health deprivation.

[60] The map highlights those areas that are within the least 25% deprived areas in the county, representing 90 LSOAs, so therefore only those areas that have a very low level of health deprivation are identified.

FINANCIAL BENEFITS

A healthy natural environment and access to natural green spaces can provide long term economic benefits and contribute to reductions in ill-health treatment costs.

GI provides health & wellbeing benefits through:

- Contributing to prevention of health problems
- Reducing money spent on treating illness

Current situation

Costs associated with physical inactivity.

The annual cost of physical inactivity in England is estimated at £8.2 billion[61]. Lack of physical activity can be partly responsible for higher obesity and other physical health risks. It can also negatively influence people's moods and motivation which can lead to reduced economic activity and increased depression and anxiety levels.

Costs associated with mental health

The total cost of mental illness in England is predicted to reach £77.4 billion with £754 million spent on drug prescriptions. This spend includes other factors such as losses in the economy due to people's inability to work (£23.1 billion) and spend on NHS hospital and community health services (£4.9 billion)[62].

£106 million was spent by the NHS on treatment of mental health problems in adults and children in Worcestershire in 2010/11. £9.4million was spent by Worcestershire County Council on social care for adults with mental health problems[63].

Costs associated with obesity

It is estimated that the NHS costs of managing conditions associated with obesity nationally could reach £10 billion per year by 2050, while the wider costs to society and business are expected to be even higher, at £49.9 billion per year[64]. Locally-based financial estimations indicate that the NHS spends over £80 million treating obesity related ill-health and another £60 million treating the consequences of excess weight[65].

Opportunities

The need for more preventive rather than reactive approaches to human health is increasingly being recognised amongst stakeholders at different tiers. At the national level, the Annual Report of the Chief Medical Officer recognised that *the benefits of regular physical activity to health, longevity, wellbeing and protection from serious illness have long*

[61] National Institute for Health and Clinical Excellence (2008) National costing report: Physical activity and the environment
[62] Peacock, J et al (2007) Got the Blues, then find some Greenspace. The mental Health Benefits of Green Exercise Activities and Green Care.
[63] Worcestershire Health and Well-being Board (2012) Joint Strategic Needs Assessment
[64] Foresight Report: Tackling obesity. Future choices (Government Office for Science) http://www.foresight.gov.uk/OurWork/ActiveProjects/Obesity/KeyInfo/Index.asp
[65] Worcestershire Health and Well-being Board (2012) Joint Strategic Needs Assessment

been established[66]. It reinforces the minimum recommendation of 30 minutes of physical activity five times a week for an adult. At the county level, Worcestershire Health and Wellbeing Board has recently published the Joint Health and Wellbeing Strategy 2013-2016 which encourages a greater emphasis on prevention, early intervention and early help as a means to achieve quality and value for money health results.

Green infrastructure supports this new preventative approach to health. Providing for outdoor physical activity, and providing a friendly environment for people and patients to relax and interact with natural green spaces can reduce occurrences of many physical and mental diseases, whilst saving large amounts of money otherwise spent on treatments.

Regular participation in physical activities has been shown to improve physical and mental health. Increasing physical activity through access to high quality greenspace has the potential to save the NHS £2.1 billion a year[67].

Case Study: The Walking For Health initiative

The Walking For Health initiative, which is funded by Macmillan and hosted by The Ramblers (previously managed by Natural England) aims to promote walking as a healthy exercise. The programme runs approximately 600 schemes to offer short, free, local health walks in communities across England.

Initial evaluation of the programme indicated that every £1 invested in the programme delivered £7 in benefits to the NHS, through an increase in both mental and physical health and well-being.

There are several established health walks groups across Worcestershire which can be found on the Walking For Health initiative website. Health Walks are supported by the Worcestershire Walking Network, a partnership funded by Worcestershire County Council Countryside Service and the Public Health Department, NHS Worcestershire.

Source: The Walking For Health website http://www.walkingforhealth.org.uk/about-us
Worcestershire County Council website
http://www.worcestershire.gov.uk/cms/countryside/explore-the-countryside/health-walks.aspx

[66] The Annual Report of the Chief Medical Officer 2009, p. 21
[67] Benefits of Green Infrastructure: Report by Forest Research (October 2010)

HEALTH AND WELLBEING

Green infrastructure can reduce numbers of physical and mental health sufferers through facilitating physical activity and providing visually attractive and calming landscapes.

It also creates an opportunity for interaction between various population groups, increases community cohesion and reduces levels of antisocial behaviour.

The successful delivery of these objectives is dependent on the levels of quality and accessibility of natural assets.

GI supports the health and wellbeing of Worcestershire's residents through:

- Provision of accessible and quality green spaces
- Supply of healthy, locally grown food
- Visually attractive and relaxing landscapes
- Provision of communal spaces for people to meet and undertake activities
- Ensuring a healthy environment, e.g. fresh air and cooling effect.

Current situation

Physical activity

In England, only 28% of adult women and 40% of adult men are meeting physical activity guidelines which recommend 150 minutes of moderate activity every week. Generally, participation in physical activity declines significantly for older population groups. The level of participation also varies between geographical areas and socio-economic position[68].

A 2011 public survey estimated that the majority of Worcestershire residents (87%) felt that physical activity is important to them. 72% of residents spend at least 30 minutes on moderate physical activity at least three days each week and 18% of residents every day of the week[69].

Worcestershire's natural assets

Worcestershire is rich in green spaces, with 6 major watercourses and 7% of the total land cover being woodland. There are sub-regional assets such as the Malvern Hills and a number of smaller local green assets including country paths and formal parks. These assets deliver a wide range of recreational opportunities. There is also potential for their expansion. For example, the Lickey Hills and the Clent Hills provide valuable open space for recreation, access to nature and panoramic views over Birmingham and the surrounding countryside.

Accessibility to green space

There are over 11,750 ha of accessible natural green spaces[70] in Worcestershire which are available for use by the general public for free-to-access recreation during daylight

[68] Worcestershire County Council, Public Health webpages http://www.worcestershire.gov.uk/cms/public-health/staying-healthy-and-campaigns/physical-activity/benefits-of-exercise.aspx

[69] Worcestershire County Council (2012) Worcestershire Viewpoint Survey November 2011

[70] The Accessible Natural Greenspace Standard (ANGSt) model identifies the maximum distance that any resident should have to travel from their home to reach natural or semi-natural green space which is freely accessible. It is divided into four tiers:

- Sites and habitats over 500ha should be within 10km

hours. This includes strategic recreational provision and smaller natural green spaces at a neighbourhood or district scale and the public rights of way network. There are also natural green spaces available to be used for a charge.

Overall 55.2% of Worcestershire residents are within 5km of sites that are 100ha or larger (county-scale sites) and 31.8% are within 10km of sites that are 500ha or larger (sub-regional scale sites). This falls short of Natural England's Natural Green Space Target that all communities should be within 5/10km respectively of a 100/500ha site.

The proportion of households within 5km of county-scale sites is higher in the north of the county due to a cluster of assets including the Wyre Forest, Lickey and Clent Hills, and other facilities in neighbouring counties. Access to county-scale sites is also good in Malvern Hills district due to the proximity of the Malvern Hills.

The proportion of households with access to sub-regional provision is also high in the Malvern Hills and Wyre Forest districts. Many of the county-scale recreational assets in these areas are, however, near to or over capacity and face significant visitor pressure from within the sub-region[71].

Wychavon is a rural district, but access to recreational assets is low and the network of rights of way is less dense than in the rest of the county. Access to county-scale and sub-regional assets is also poor in Worcester city, although access to neighbourhood-scale assets is good.

The majority of existing facilities are currently experiencing high level of demand and are unlikely to be able to absorb an increase in visitor numbers without having a detrimental impact on habitats, visitor experience or the quality of the site. To overcome this, a new country park or similar facility will be required in the county, to accommodate the informal recreational needs arising from predicted population growth[72].

Research by the Woodland Trust shows that less than 15% of the population of England has access to local woodland within 500m of their home. In Worcestershire this figure is even lower at 11.5%[73].

Opportunities

Mental health and wellbeing

Contact with nature can have therapeutic effects on individuals and communities through providing relaxation and calming opportunities. An extensive range of literature and research suggests there is a strong correlation between the proximity and quantity of green spaces and issues such as the longevity and risk of mental illness, levels of stress, and the reduction in symptoms of Attention Deficit Disorder amongst children[74]. Green landscapes, walks, parks and landscaping features such as trees in the surrounding environment play a curative role. The provision of an adequate amount of

- Sites and habitats over 100ha should be within 5km
- Sites and habitats over 20ha should be within 2km
- Sites and habitats over 2ha should be within 300m

[71] Worcestershire County Council (2013) Worcestershire Green Infrastructure Framework Document 3
[72] Natural England: Accessible Natural Greenspace Standard.
[73] Woodland Trust - Woodland Access Standard (WASt)
[74] Deakin University Australia (2010) Beyond Blue to Green: The benefits of contact with nature for mental health and well-being

accessible green space when planning for new developments and retrofitting green infrastructure features into existing development contributes to the quality of place and mental wellbeing of residents.

Case Study: Therapeutic Farming at Top Barn

The Top Barn special needs training centre is located on a 300ha mixed farm five miles north of Worcester on the banks of the River Severn. The site has a history of extensive mineral working and has been restored to a mixture of farmland and recreational uses. The client list at Top Barn includes people with severe learning disabilities, physical disabilities and brain injuries, as well as mental health patients and disengaged young people. There is also a wide range of courses for the local community and anyone interested in rural skills and a sustainable lifestyle.

A staff member, Roger Bates, adds his own perspective. *"Coming to the farm provides people with an opportunity to achieve something. They can make a connection from making the seed beds, planting things and looking after them. They can see they are not isolated tasks."*

The main aim is to provide training, education and therapeutic opportunities with a rural theme. Activities include horticulture, farming, animal husbandry, woodland skills, alternative building and farmhouse style cookery using home-grown produce. Lessons take place both inside and outdoors.

Ian Iontton, visually impaired, visiting Top Barn for several months claims that *"Being with animals and out in the countryside is better than being in a classroom, all closed in. Here, I am thrown challenges that show me I can do things rather than getting stressed about things I can't."*

Source: Community Care, "The therapeutic value of care farms", 22nd March 2007 and Farmers Weekly "Care

Physical activity and access to green spaces

People with good access to green space are 24% more likely to be physically active[75] which is why green infrastructure provision can be crucial in addressing this issue. A report from the former Office of the Deputy Prime Minister (2002) suggests that increasing the standard of public spaces in order to create sustainable and more inclusive living could create an "unintended outcome" of increased physical activity[76].

The most popular forms of physical activity for most people are those that can be incorporated into everyday life, such as walking to work.[77] Green infrastructure can encourage physical activity through creating attractive and safe open public spaces and travel routes such as cycle paths. These measures, in combination with exercise, have beneficial effects on mental health. Moderate regular exercise can enhance mood, self-esteem and reduce stress – the elements that can increase risk of depression. The University of Essex proved that mental health can benefit from engagement in physical activities and direct exposure to nature. 89% of the participants in this study considered

[75] Natural England (2012) Microeconomic Evidence for the Benefits of Investment in the Environment
[76] Office for the Deputy Prime Minister (2002) Living spaces: cleaner, safer, greener
[77] National Institute for Health and Clinical Excellence (2008) National costing report: Physical activity and the environment

exercising in the natural environment to be the most influential factor in improving their frame of mind[78].

The Marmot Review commissioned by the Secretary of State for Health in 2010 reviewed the most effective evidence-based strategies for reducing health inequalities in England. The study highlighted the link between the physical environment and health and well-being of communities and saw active travel and improved access to open and green spaces as one of the priorities for action. According to the review, there should be a park or small play area within 4 minutes' walk from each household[79].

Case study: Diglis Bridge

In 2010, Sustrans in partnership with Worcestershire County Council and Worcester City Council completed the development of Diglis Bridge over the River Severn in Worcester. The project created a series of new and improved walking and cycling routes which lead to a new non-vehicular crossing over the River Severn which links into national cycle networks. This created a high quality traffic-free riverside loop and improved access to the riverside.

The riverside loop has transformed the way local residents incorporate exercise into their daily routine by running and walking for fitness, health reasons or the enjoyment of surrounding landscapes and wildlife.

Many walking and cycling groups have either set up or moved to take advantage of the new routes. There are now five regular walks run under the national Walking for Health initiative and Worcester is in the first year of a five year Heart City programme run by the British Heart Foundation. It is estimated that that there are approximately 1,000 cyclist and 4,000 pedestrian journeys using the bridge each month.

The improvement to Worcester waterfront also attracted new visitors, providing benefits to local businesses including at least a 20% increase in sales for Diglis House Hotel.

Source: Sustrans (nd) Health Benefits Getting people active in Worcester
Sustrans (nd) Case study: getting Worcester walking and cycling

Physical health

Delivering GI priorities such as active travel and improved access to open and green spaces will contribute to the physical health and mental wellbeing of local communities. Natural England's research indicates that people with good access to green space are 24% more likely to be physically active[80].

Physical activity is the key to prevention but can also be the treatment for some diseases and disorders. Worldwide calculations estimate that physical activity could prevent approximately 6% of coronary diseases, 7% of type two diabetes and 10% of breast and

[78] Peacock, J et all (2007) Got the Blues, then find some Greenspace. The mental Health Benefits of Green Exercise Activities and Green Care.
[79] The Marmot Review (2010) Fair Society, Healthy Lives
[80] Natural England (2008) Microeconomic Evidence for the Benefits of Investment in the Environment – review, http://publications.naturalengland.org.uk/publication/32031

colon cancers. The Lancet magazine claims that inactivity increases the risk of many adverse health conditions such as coronary disease and diabetes, and shortens life expectancy. It also decreases the world population's life expectancy by 0.68 years[81]. The national estimations are even higher estimating that regular physical activity could reduce coronary heart disease by 10%, risk of type two diabetes by 33-50% and hip fracture for elderly by 50% in British communities[82].

It is crucial that residential areas are supported with accessible and good quality green spaces. They can be utilised for walking, cycling and a variety of organised and non-organised sport activities. There are many good practice examples already in place in Worcestershire. For example: Worcester Cripplegate Park runs weekly outdoor military fitness classes, as does Worcester Woods Country Park. A variety of parks across Worcestershire are used by running and cycling clubs.

Case study: Green Gym programme
In 1998 the environmental charity Conservation Volunteers started the Green Gym programme, which aims to improve the natural environment while providing volunteers with ways of enhancing their fitness. The programme started as a single pilot project, grew to approximately 55 projects by 2006 and received financial support from central government. The Green Gym projects are run by experienced leaders which give the participants the opportunity to undertake conservation tasks. This improves their physical condition, gives an opportunity to learn new skills and builds confidence whilst the local green spaces receive appropriate care and maintenance. The local Green Gyms are often run by separate organisations under the licence of the Conservation Volunteers.

One successful example of this programme in the West Midlands is Telford Green Gym. It targets some of the most vulnerable and deprived groups in the area, in relation to social exclusion, low income and health inequalities. A survey undertaken amongst the participants indicated that, as a result of the Green Gym, most of them felt more positive and confident about the future, had made friends, and had reported improvements in their physical health including weight loss, eating more healthily and cutting down on alcohol and cigarettes.

Source: *The Conservation Volunteers website http://www.tcv.org.uk/greengym*
Telford and Wrekin Primary Care Trust (non-dated) Telford Green Gym leaflet

Social interaction and community cohesion

Local green spaces such as parks can facilitate increased social interaction, contributing towards community cohesion and development of an attachment with the locality.

Where residents perceive the quality of green space to be good they are generally more satisfied with their neighbourhood and more prone to interaction. A study undertaken by Sullivan et al. (2004) found that significantly more individuals engaged in social activity in green spaces as opposed to concreted ones[83].

[81] I-Min Lee et all (2012) Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy, The Lancet, vol 380, 21 July 2012, p.219-229.
[82] The Annual Report of the Chief Medical Officer 2009
[83] Forest Research (2010) Benefits of Green Infrastructure

Community gardening schemes including allotments or orchards are a great opportunity to establish and maintain contact with the community and with nature for a range of demographic groups. Involvement in development of community gardening spaces can enhance the physical health and emotional wellbeing of residents as well as motivate them for more community engagement[84].

Case Study: Worcester Parkrun
Worcester Parkrun, set up in 2004 by a group of volunteers, is a weekly 5km event for runners of all standards, which takes place every Saturday morning in Worcester Woods Country Park.

It offers an opportunity for all local community groups, young and old, at different ability levels, to come together on a regular basis to enjoy the park and get physically active for free. There can be as many as 350 runners of all abilities, many of whom follow a journey from being reasonably unfit to fitter and healthier in a short space of time.

After each of the events the participants are encouraged to join others at the Orchard Cafe at Worcester Woods to chat to other runners over a cup of tea or coffee and be a part of the running community.

Two of the participants who joined the Worcester Parkrun in the last three years said that the people involved are very helpful and that they had made a lot of new true friends through running there.

The Parkrun quickly improved their fitness levels, which led to them taking on other runs including 10km races, a half marathon, a duathlon and an ultra-race of 46.5 miles.

They praised this event with the following words:
"Parkrun has changed both our social lives and physical and mental wellbeing making us healthier and fitter. We have even set up a new running club in Pershore called Pershore Plum Plodders, which is growing weekly and has even encouraged first time runners to take up the sport too".

Source: Worcester Parkrun website: http://www.parkrun.org.uk/worcester/aboutus/
Worcestershire County Council internal communication.

Social Inclusion

Certain population groups are particularly prone to social exclusion. This includes people with disabilities, ethnic minorities, elder people, urban deprived populations and people in lower socio-economic groups. Community cohesion encouraged by access to green spaces can have a positive impact on creating social interaction between members of these groups.
Overall, more deprived communities tend to be in areas where there is less green infrastructure or where it is of poorer quality[85]. National research on patterns of use of

[84] Ely, Pitman (2012) Green Infrastructure, Life support for human habitats. The compelling evidence for incorporating nature into urban environments
[85] CABE Space (2010) Community green: using local spaces to tackle inequality and improve health

green space revealed that members of these disadvantaged groups were less likely to visit the natural environment, with key barriers for greater participation being a lack of time, issues of costs and transport. Despite these barriers, they were more likely to use close-to-home green spaces. This highlights the importance that the proximity and accessibility of green spaces have on increased social inclusion and the positive mental attitude of residents leading to increased social mobility[86].

The quantity as well as quality of green spaces have significant influence over their level of use. People are generally prepared to travel further to a higher-quality park. A study completed by CABE stated that only 1% of those living in social housing reported using their local green space due to concerns about safety, lack of access and poor quality environment[87].

Antisocial behaviour

There is evidence to suggest that domestic violence levels can be lower in greener areas, and crime levels significantly lower in residences near natural spaces. This may be caused by potentially stronger community ties that residents of deprived neighbourhoods can develop in greener surroundings[88].

Green infrastructure can facilitate working with excluded population groups including young people and offenders to help reduce antisocial behaviour. Generally, contact with nature can provide a sense of calmness and therefore reduce levels of anger and frustration which contribute to antisocial behaviour.

Various activities and the teaching of new skills concentrated around the natural environment, such as forest schools, have been seen as beneficial to disadvantaged and excluded societal groups.

[86] Natural England (2012) Monitor of Engagement with the Natural Environment: The national survey on people and the natural environment Annual Report from the 2012-13 survey
[87] CABE Space (2010) Community green: using local spaces to tackle inequality and improve health
[88] Forest Research (2010) Benefits of Green Infrastructure

Case Study: Sherwood Pines Forest Park

The Forestry Commission is running sessions in bushcraft and traditional woodland skills at Sherwood Pines Forest Park, Nottinghamshire. These activities benefited students from Oakdale Learning Centre which provides out of school support for young children who have struggled with mainstream schooling and had been excluded from their schools due to significant behavioural incidents.

The Forestry Commission together with Oakdale staff developed a learning programme to meet the students' needs for kinaesthetic learning in varied surroundings. The programme consisted of a number of afternoon activities including constructing fires, building shelters, felling small trees, carving green wood and undertaking an assault course.

As well as learning traditional woodland skills, the students also developed their team building and social skills which will help in reducing their antisocial behaviour and integration within the society and mainstream school system.

The project succeeded with students' good attendance and active participation in the activities throughout the autumn and winter seasons.

Source: *Laura Freer, "Working with excluded young people to help reduce antisocial behaviour", Countryside Recreation Network News, Volume 22, Autumn 2013,*

CHAPTER 4: CLIMATE CHANGE BENEFITS OF GREEN INFRASTRUCTURE

INTRODUCTION

Green Infrastructure offers us a solution to delivering sustainable development that meets the needs of the local economy, local people and the natural environment. Effective maintenance and management of our natural environment can offer services to support our efforts to tackle climate change; not only through supporting emissions reduction but also through lessening the impacts that severe weather and gradual changes to climate may have on the local area. Green infrastructure has a key role to play in tackling climate change. It provides a realistic alternative to traditional hard engineering or high energy solutions for dealing with issues such as flooding or hot weather. Across the county we have already seen examples of the application of green infrastructure principles resulting in multiple benefits.

GI CONTRIBUTION TO TACKLING CLIMATE CHANGE

Money Saving

The Association of British Insurers predicts that a 2^{o}C temperature rise will increase annual insured losses in Great Britain from inland flooding by 8% or by £47 million to £600 million.

Building Resilience

The development of Paradise Park in London did not require air conditioning due to the thermal mass of the green roof. This has led to a reduction in energy use of 3,800kW/hrs and a saving of 1.6 tonnes of CO_2.

Climate Change Mitigation

Green spaces can benefit carbon storage. Vegetation absorbs CO_2 from the atmosphere. The more vegetation there is, the more CO_2 will be taken up.

Improve Health & Strengthen Communities

Strategic placement of trees and other green spaces can reduce the urban heat island effect and cool the air by 2^{o}C to 8^{o}C[1] and reduce number of deaths caused by hot weather conditions.

CLIMATE CHANGE CONTEXT

Weather

The latest climate projections for the UK (UKCP09) indicate the following key headline messages:

- milder but wetter winters
- warmer but drier summers
- more frequent and intense extreme weather events.

The extent of the changes in climate will vary over time depending on the levels of both human and natural influences. When considering a project it is important to determine its expected life span and the potential impacts the climate may have over the whole life of the project. For example, a new building may have an expected life span of 60 years. The construction measures would become insufficient for the whole life of the building and potentially leave the site vulnerable when impacted by likely future climate conditions.

The changes in climate that are predicted nationally by the 2020s are:

- the temperature on the warmest day in summer could increase by as much as 5.5^{o}C[89]
- the temperature on the warmest night in summer could increase by as much as 3.6^{o}C[90]
- summer precipitation could decrease by as much as 25%[91]
- winter precipitation on the wettest day could increase by as much as 20%[92]
- The temperature on the coolest day in winter could increase by as much as 3.8^{o}C[93]

By the 2050s it is expected that the change in temperatures and extremes of rainfall will be greater:

- the temperature on the warmest day in summer could increase by as much as 8^{o}C[94]
- the temperature on the warmest night in summer could increase by as much as 6.5^{o}C[95]
- summer precipitation could decrease by as much as 36%[96]
- winter precipitation on the wettest day could increase by as much as 40%[97]
- the temperature on the coolest day in winter could increase by as much as 4.6^{o}C[98]

[89] Projection for medium emissions scenario for 2020s using 90% probability level
[90] ibid
[91] Projection for medium emissions scenario for 2020s using 10% probability level
[92] Projection for medium emissions scenario for 2020s using 90% probability level
[93] ibid
[94] Projection for medium emissions scenario for 2050s using 90% probability level
[95] ibid
[96] Projection for medium emissions scenario for 2050s using 10% probability level
[97] Projection for medium emissions scenario for 2050s using 90% probability level
[98] Projection for medium emissions scenario for 2050s using 90% probability level

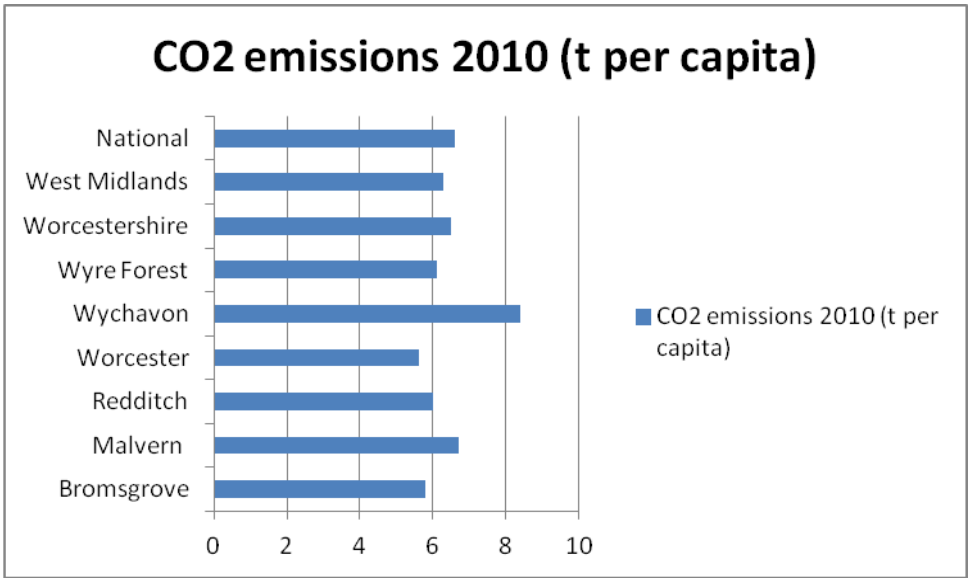
Worcestershire emissions

In Worcestershire, the latest data (2010) indicates that CO_2 emissions are 6.5t per capita, following a reduction of 11% since 2005. This is below the national average of 6.6 t per capita but greater than the West Midlands average of 6.3 t per capita. Emissions per capita vary between districts in Worcestershire. The districts with the lowest emissions for 2010 were Worcester (5.6t per capita), Redditch (6t per capita) and Bromsgrove (5.8t per capita). The district with the highest emissions per capita was Wychavon (8.4t per capita)[99]. This could be due to it being distinctly rural and the sparse nature of the settlement resulting in greater use of private cars for travel and (as much of the district is off the gas grid) the use of emissions-intensive forms of fuel such as oil to heat homes.

Notwithstanding the above, generally higher concentrations of total CO_2 emissions are found around urban centres and along major transport corridors and lower emissions usually come from the more rural areas of the county.

Figure 11 compares all district and county figures with the regional and national emissions figure for the same year to show the area with the highest emissions.

Figure 11: Latest (2010) CO_2 emissions figures for Worcestershire, Districts, West Midlands and National



Air Quality

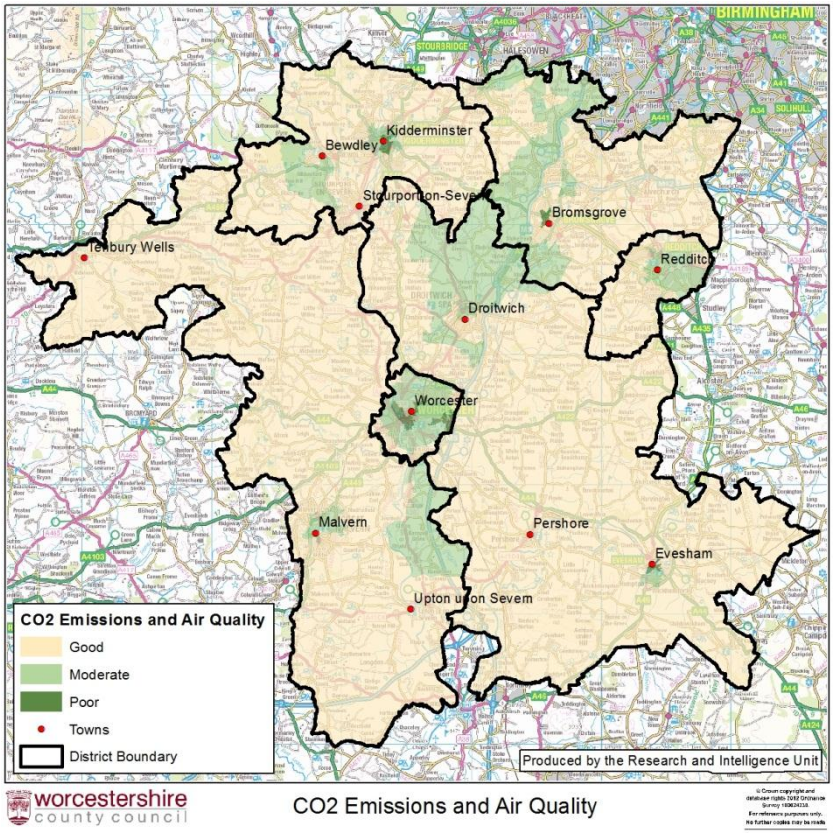
Air quality in Worcestershire is generally good. It is generally better in rural areas and worse around urban areas and major road infrastructure. National policy requires local authorities to declare Air Quality Management Areas (AQMAs) and to put action plans in place where concentrations of nitrogen dioxide exceed set limits. The AQMAs are hot-spots where there is traffic congestion, often in narrow streets that have buildings close to the kerbside forming 'canyons', or roads with high traffic flows. There are a total of 10 designated AQMAs located in four Worcestershire districts: Bromsgrove (4), Worcester (3), Wychavon (1) and Wyre Forest (2)[100].

[99] Department for Energy and Climate Change (2013) Local and Regional CO_2 Emissions Estimates for 2005-2010, produced by AEA

[100] Worcestershire Partnership (2013) State of the Environment Report: Air Quality

Figure 12 below illustrates the levels of CO_2 emissions and air quality in Worcestershire which are proxies for measuring the level of the county's contribution to global climate change.

Figure 12: CO^2 emissions and air quality in Worcestershire



Source: *Department for Energy and Climate Change (2013) Local and Regional CO_2 Emissions Estimates for 2005-2010, produced by AEA*

ECONOMIC BENEFITS

Green infrastructure can be a cost effective solution in mitigating and adapting to climate change. Tree planting and other green landscaping provide natural air conditioning and contribute towards greenhouse gas absorption. This can contribute to minimising future climate change related events such as floods and droughts.

GI is a cost-saving solution to climate change mitigation & adaptation and flood management through:

- Reducing cost of ill health associated with climate change
- Minimising costs resulting from flooding
- Reducing costs of droughts to the local economy
- Reducing energy costs

Current situation:

Climate change costs

Climate change is a serious global threat and failing to address it could lead to serious costs to the environment, people and economy. The Stern Review (2005) states that *"if we don't act, the overall costs and risks of climate change will be equivalent to losing at least 5% of global GDP each year, now and forever. If a wider range of risks and impacts is taken into account, the estimates of damage could rise to 20% of GDP or more"*[101].

Extreme weather impacts

Climate change may increase the costs of doing business. The Association of British Insurers, for example, predicts that a 2°C temperature rise will increase annual insured losses in Great Britain from inland flooding by 8% or by £47 million to £600 million. Indeed, as a result of flooding in June and July 2007, there were an estimated 185,000 insurance claims in the UK, of which 35,000 were commercial claims[102].

Across Worcestershire we have already felt the impacts of severe weather in previous years. The extensive flooding in 2007 had a significant impact on the economy of Worcestershire. The closure of the Severn Valley Railway not only meant loss of revenue for that business but all the other businesses (such as hotels and cafes) which rely on the tourism that the railway brings to the area. These flood events are thought to have cost Worcestershire £6.4 million per week. Furthermore, the collapse of a culvert under the road at Cropthorne on the B4084, due to supporting soil being washed away by floodwater, led to repairs costing nearly £1million, which took 6 months to complete[103].

Opportunities:

Severe weather events

Severe weather such as flooding has a negative impact on the county's roads, which disrupts commuters and delivery traffic. Some businesses have been directly impacted by severe weather events which can result in costly repairs and loss of business. It is important to limit disruption to the local economy by lessening the impact a single severe weather event might have. For example, opportunities for farmers to store water on their

[101] HM Treasury (2005) The Stern Review: The Economics of Climate Change. p. vi
[102] WCC (2011) Worcestershire County Economic Assessment 2010-2011
[103] Worcestershire County Council (nd) Worcestershire Local Climate Impacts Profile

land during wetter weather which can then be used to water crops during drier periods could alleviate issues faced by water abstraction restrictions.

Flooding

Green Infrastructure features such as buffering of watercourses provide a way of minimising fluvial flooding. Carefully planned landscaping incorporating flood defences can provide benefits to developers through a more efficient planning application process, cost reduction and increased property values. In 1999 Bryant Homes/Taylor Wimpey addressed the issue of flood risk at their Diglis Water development by designing a waterfront park which provided an attractive, multifunctional focal point along the edge of the River Severn. The waterfront park was designed to be flooded and to hold water when the river reaches its capacity. As a result, the marketability factor of Diglis Water was high and the site outperformed sales of other schemes in the Midlands during the recession of 2008-10.[104]

Sustainable drainage schemes (SuDS) provide a GI solution for managing both fluvial and pluvial flood risk. Related to these, green roofs are one of a number of opportunities for channelling surface water, providing biodiversity enhancements, and in some cases providing spaces for access and recreation.

Energy use

Businesses which are high emitters of CO_2 are also high energy users; this not only means high energy bills but potential reputational risk, as many companies increasingly seek to trade and interact with fellow businesses with similar green credentials. Finding more natural methods for reducing temperatures in urban spaces could reduce the demand for cooling for some businesses. Green infrastructure methods could include strategic planting of urban trees to provide shading for people and buildings. An appropriate application of green roofs can provide cooling and insulation for buildings. Plants on rooftops absorb heat, keeping buildings warmer during winter months and cooler during summer months. For example, the Paradise Park development in London has not installed air conditioning due to the thermal mass of the green roof. This has led to a reduction in energy use of 3,800kW/hrs and a saving of 1.6 tonnes of CO_2.[105]

Case Study: Red Hill School, Worcester

Red Hill School in Worcester opened in 2007. The school site had previously had problems with flooding. The development includes a swale system in one area of the grounds capable of storing excess water on the site. This not only alleviates flooding issues on site but holds water that would otherwise be flowing directly in to storm drains.

In 2010 Defra commissioned a study which compared the estimated costs of traditional drainage versus the SuDS solution for the school. It demonstrated the significantly reduced cost of implementing SuDS over traditional drainage at all rates examined. SuDS were considerably cheaper due to the storage being provided within landscape features, reducing the need for expensive traditional water storage.

Source: *Defra's Water Availability and Quality Evidence Programme (2012) Comparative Costings for Conventional Drainage and SuDS.*

[104] Landscape Institute (2011) Why Invest in Landscape?
[105] Environment Agency (website) http://www.greenroofstoday.co.uk/

SOCIAL BENEFITS

Another health benefit of green infrastructure stems from the improvement of the local environment, which can indirectly improve the health of communities. Increasing green cover can improve air quality and mitigate effects of climate change (such as extreme weather conditions) which can reduce air quality related mortality rates or heat-wave related health risks.

GI can mitigate the effects of climate change on local communities through:

- Improving air quality
- Reducing carbon emissions
- Providing urban cooling and shading
- Minimising negative heatwave-related health issues

Climate change is expected to have varied impacts on different members of society, from the impact of poor air quality on those with underlying respiratory illness, to creating opportunities to strengthen communities through shared interests such as gardening.

Current situation

Air quality related health issues

Increased CO_2 levels can lead to reduced air quality in the area which will generally increase the percentage of people suffering from respiratory diseases.

The assessment of health indicators (2008) identified that Worcestershire residents suffer from respiratory diseases (the cause of 13.6% of all deaths), but the number of deaths caused by these conditions is slightly lower than the England average (13.8% of all deaths). More detail on respiratory diseases can be found in the context section in Chapter 3.

Heatwave-related health issues

There are approximately 1,100 heatwave-related premature deaths per year in the UK, with these numbers increasing even higher during exceptionally hot years. Across the county we see a sharper increase in mortality when temperature rises to 26^{o}C or higher. "*An estimated 8-11 extra deaths nationally occur each day for each degree increase in air temperature during the summer heatwaves*"[106].

Opportunities

Carbon storage and garden spaces

Green infrastructure can create widespread opportunities for reducing emissions in the local area and additional benefits for residents. Green spaces can benefit carbon storage, as vegetation absorbs CO_2 from the atmosphere[107].

The benefits of green space for carbon storage cannot only be realised through afforestation practices, but also on a smaller scale through appropriate use of garden spaces. Gardens can provide spaces for growing local food and for recreation in a

[106] Doick, Hutchings (2013) Air temperature regulation by urban trees and green infrastructure, Forest Research, Research Note

[107] Imperial College London (2012) Plants may absorb more carbon dioxide than previously thought, Article by Simon Levey

predominantly urban area and can be beneficial to the mental wellbeing of residents.[108] It needs to be noted that private gardens therefore form integral components of a green infrastructure network, but their function as green spaces cannot be guaranteed due to a lack of control over the way they are managed.

Removal of air pollutants and health benefits

There has been increasing recognition of the importance of green space in the absorption of pollutants produced in the industrial sector and transport systems in urban environments[109]. It has been estimated that doubling the tree cover in the West Midlands alone would reduce mortality as a result of poor air quality from pollutants by 140 people per year[110].

The removal of air pollutants such as ozone, CO_2 and particulates can be favourable for the health of local people. Ground level concentrations of ozone are a particular problem during hotter weather due to the action of sunlight on the pollution. Ozone concentrations are likely to be higher on hot, sunny days. This means that with more frequent hotter days expected as the climate changes, the impact of ozone on respiratory illness will become more prevalent.

Effects of extreme weather on health of residents

Warmer summers are expected to impact health, both negatively and positively. Urban areas tend to be warmer than more rural locations due to the heat absorption during the day and the slow release of heat from hard structures during the night and the heat output from air conditioning units. By providing green space in urban areas, the natural environment can be used to provide cooling. Strategic placement of trees and other green spaces can reduce the urban heatwave effect and cool the air by 2^{o}C to 8^{o}C[111] and reduce the number of deaths caused by hot weather conditions.

Warmer weather also encourages the use of outdoor spaces. The opportunity to use green spaces for recreation is not only good for physical health and fitness but also improving the mood and mental wellbeing of local people. Appropriate natural shading offered by tree canopies can help reduce exposure to the sun and related health issues.

Provision of green space could help to cool urban areas overnight. During hotter weather, buildings have to cool overnight by emitting heat to the surrounding area. Night time temperatures have to drop below 15^{o}C to allow for sufficient cooling. For example, a study by the University of Manchester has shown that increasing tree cover in urban areas by 10% could decrease the expected maximum surface temperature in the 2080s by up to 4°C[112].

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[108] Guite et all (2006) The impact of the physical and urban environment on mental well-being, Journal of the Royal Institute of Public Health, Public Health 120, p. 1117-1126

[109] Forest Research (nd) Improving air quality, http://www.forestry.gov.uk/fr/URGC-7EDHQH

[110] Stewart, H., Owen S., Donovan R., MacKenzie R., and Hewitt N. (2002). Trees and Sustainable Urban Air Quality. Centre for Ecology and Hydrology, Lancaster University

[111] Doick, Hutchings (2013) Air temperature regulation by urban trees and green infrastructure, Forest Research, Research Note

[112] Handley, J and Carter, J (2006) Adaptation strategies for climate change in the urban environment, Draft final report to the National Steering Group, Centre for urban and regional ecology, University of Manchester www.sed.manchester.ac.uk/research/cure/downloads/asccue_final_report_national_steering_group.pdf

Case Study: Warndon Villages, Worcester - community led green spaces

Since summer 2011, Transition Worcester Orchard Workers have been working with Worcester City Council to revive an Orchard in the Warndon Villages areas of the city. Few local residents were aware of the Orchard after 20 years of neglect. A group of local residents, the City Council and Transition Worcester orchard workers all began work to make the orchard a usable space where there is easy access to the fruit.

In the first year, over 40 volunteers were involved in rejuvenating this green space into a useable community resource where residents can take pride in the fruits grown at the site and teach others how to make fruit juice.
This project shows the power of the community in supporting green space development and the value this has to local residents.

Source: *www.transitionworcester.org.uk*

ENVIRONMENTAL BENEFITS

Changes in the climate are expected to result in a range of impacts globally, nationally and across the county[113]. We are unable to stop weather events from happening but we can respond to them more effectively. How we respond to these impacts is crucial to future sustainability and an opportunity to build natural resilience to change through effective maintenance and management of the local environment.

GI can mitigate the effects of climate change on the natural environment through:

- Improving water quality and quantity
- Reducing flood risk
- Providing biodiversity enhancements
- Improving air quality
- Reducing carbon emissions
- Restoration practices on former minerals sites

Current situation

Habitats

Isolated habitats will find adapting to shifts in the climate more difficult as species movement becomes more difficult. Generally, species will move to the climate band most suitable for them. Isolated green spaces will limit this movement, making it more difficult for species to adapt to change.

Water quantity

Rainfall variations are already resulting in periods of water shortage and excess. At the start of 2012, following previously drier than normal winters, a drought was announced by the Environment Agency. Ground water levels had declined resulting in water abstraction licence restrictions across Worcestershire. Changing the way we think about water use, can limit disruption from water shortage or excess water.

Water quality

Alongside the issue of excess or shortage of water comes the quality of local water bodies. The majority of watercourses in Worcestershire are at a medium or high risk of not meeting the Water Framework Directive (WFD) objective. The WFD has set a target that all surface and ground waters should aim to reach 'good' status by 2015 and all water bodies must reach 'good' or 'high' status by 2027. Diffuse pollution from phosphates and nitrates is causing the most problems in Worcestershire's watercourses, with Worcestershire having the highest levels of these pollutants in the West Midlands. Issues of quality can be exacerbated by low water flows or by excess rainfall washing pollutants in to the water[114].

Flooding

The types of flooding that arise in Worcestershire include fluvial flooding (from water courses), rising groundwater and pluvial flooding (from surface water run-off). Pluvial flooding can occur anywhere in the county as it is the result of large amounts of rainfall being unable to drain away effectively.

Approximately 10% of the land area of Worcestershire is at risk of fluvial flooding (about 167km^2). There are over 9,000 properties at risk of fluvial flooding, approximately 4% of

[113] UK Climate Projections (UKCP09)
[114] Worcestershire County Council (2011) 'Planning for Water in Worcestershire' Technical Research Paper

the total number of properties in the county. 38% of these properties are at significant risk; 30% are at moderate risk; 32% are at low risk[115].

Opportunities

Sustainable Drainage

The use of SuDS can hold water for when there are drier periods. SuDS aim to return the drainage of an area to a more natural system state rather than rainwater running straight in to the nearest water course or storm drain. Allowing the natural filtration of water back in to the environment helps to alleviate impacts of flooding. Across Worcestershire we have already seen the widespread impacts of flooding from fluvial and surface water.

The use of SuDS could regulate water levels and help address water quality associated with flow. This method of water regulation will also support biodiversity as sustainable drainage systems can also contribute to biodiversity enhancements in both rural and urban environments.

Case study: The Hive, Worcester

The Hive, Worcester's joint public and university library and history centre opened its doors to the public in July 2012. The iconic building is built to mitigate against or to be resilient to future climate and incidents of severe weather, which are expected to increase. Two water meadows are situated along the western elevation of the building which can hold excess water following intense or prolonged periods of rainfall. These water storage basins have been planted with a range of native wildflower species, based on communities found locally in traditional lammas meadows. They are used as a recreational area during drier periods.

Trees

Trees can reduce the likelihood of surface water flooding in urban situations too, when rain water overwhelms the local drainage system, by regulating the rate at which rainfall reaches the ground and contributes to run off. Slowing the flow increases the possibility of infiltration and the ability of engineered drains to take away any excess water. This is particularly the case with large crowned trees[116].

Bioenergy can offer huge carbon savings, since the carbon emitted by burning biomass or biofuels is balanced overall by the carbon taken in by the crops as they grow. However, the carbon and environmental costs of growing, harvesting, transport and processing, need to be taken into account.

[115] Ibid
[116] Mr David Armson (2012) The Effect of Trees and Grass on the Thermal and Hydrological Performance of an Urban Area. Thesis submitted to the University of Manchester for the degree of Ph.D. in the Faculty of Life Sciences.

Evidence suggests that significant greenhouse gas savings can be achieved through burning of woodchip to generate heat, gasification of biomass to produce electricity and the use of biofuels produced from biomass[117].

Restoration of mineral sites

Mineral extraction offers an opportunity to shape the landscape as part of site restoration to aid habitat resilience, flood alleviation and water quality, and to provide other GI benefits such as access and recreation. Mineral sites in England have the potential to exceed nine UK BAP habitat expansion targets through their restoration[118] and the Mineral Products Association has produced a map of former quarries and other industrial locations returned to nature and with public access, which are now considered of special interest to nature conservationists and members of the public. The MPA has called this network of restored sites a 'National Nature Park'[119].

Case study: Tame Valley Wetlands Landscape Partnership and Middleton Hall Quarry

In 2012 the Tame Valley Wetlands Landscape Partnership in Staffordshire and Warwickshire received heritage lottery funding to restore the Tame Valley and the surrounding floodplain landscape, providing improved access to the many heritage sites and to the river, whilst providing training, volunteering opportunities, events and activities for local people. The underlying geology of the Tame Valley has shaped the development of the landscape, primarily through man's exploitation of the rich mineral resources available within the Tame Valley, including coal, clay, sand and gravel. Many of the sand and gravel extraction pits have filled with water and become nationally important wetland sites for birds and other wildlife. However, over time this has also led to fragmentation of the landscape.

In one of the steps towards improving the landscape, an innovative river improvement technique, known as river braiding, was carried out on lengths of the Tame at Hanson's Middleton Hall Quarry. This reprofiling created islands, riffles and shingle beds which improve water quality and increase numbers of fish and invertebrates, as well as improving the river's appearance and function in the flood plain. This in turn has numerous benefits for wildlife, including habitat creation for species such as otter, water vole and kingfisher, which contribute significantly towards the targets in Staffordshire's Biodiversity Action Plan.

Source: The Wildlife Trusts (July 2012) Tame Valley secures Heritage Lottery Fund support (http://www.wildlifetrusts.org/news/2012/07/26/tame-valley-secures-heritage-lottery-fund-support)

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[118] Nature After Minerals: how mineral site restoration can benefit people and wildlife. Davies, A. 2006. The RSPB, Sandy, UK.

[119] http://www.mineralproducts.org/nature_map.htm

APPENDIX A: SOCIO-ECONOMIC BENEFITS – SUMMARY TABLE

Economic Benefits	
Property prices	A property located within 450 metres of a park can be up to 19% higher in value than houses not in such proximity.[1]
	A view of forest and water can increase of the value of a house by 7% and 5% respectively.[2]
Quality of life	9 out of 10 adults in in the UK identify parks, playgrounds and green spaces as important in making their neighbourhood a good place to live or work.[3]
Natural environment products and services	Production of food worth £15 billion to the national economy.[4]
	Protecting natural areas can deliver economic returns that are 100 times greater than the cost of their protection and maintenance.[5]
Green jobs creation	In 2009 approximately 122,000 people in the UK were employed in the green space sector, including public parks departments, nature reserves and landscape services.[6]
GVA contribution	The forestry and primary timber processing sector on its own contributes £1.7 billion in gross value added to the UK economy.[7]
Attracting new businesses	Significant investment in the green infrastructure of the Riverside Park Industrial Estate in Middlesbrough, which included planting of over 1,800 new trees, created a setting for stimulating business growth. It leveraged over £1m of private investment, attracted new high-profile occupants, 28 new businesses started up and 60 new jobs were created.[8]
Reduced sickness levels	There is a connection between an attractive green spaces and increased health and wellbeing of employees. Green infrastructure encourages physic such as obesity, heart or respiratory diseases al activity and lowers the risk of certain health issues (such as obesity, heart or respiratory diseases).[9]
Labour productivity	Stress is considered the biggest single source of employee sickness absence. Recent research has found that access to green spaces can provide a sense of rest and allow workers to be more productive.[10]
Visitor economy	In 2008, visitors to the English countryside spent £11.5 billion and generated 340,000 jobs.[11]
	Forest related tourism expenditure on day visits to forests exceeds £2 billion per year.[12]
	Worcestershire's local produce is celebrated in many events and festivals. For example, it is estimated that the Pershore Plum festival attracted 17,000 visitors (2007 figures).[13]
Financial opportunities for farmers and land	Agri-Environment schemes to provide rewards to farmers for environmentally-sensitive land management.
	The England Woodland Grant Scheme to provide funding for the

managers	planting and management of woodlands.
	There may be potential for the Payment for Ecosystem Services (PES), an initiative to support farmers and land managers through changes to traditional activities and land management practices to enhance the level of ecosystem services, e.g. flooding of wetland or improved water quality.[14]

[1] Natural England (2012) Microeconomic Evidence for the Benefits of Investment in the Environment – review
[2] Ibid
[3] Ipsos Mori survey http://www.groundwork.org.uk/news--events/news/2012/90-of-adults-say-green-spaces.aspx
[4] Research Councils UK (nd) Adding Value: How the Research Councils benefit the economy
[5] Economics of Ecosystems and Biodiversity study quoted in Natural Environment White Paper (p10)
[6] CABE, Green space skills 2009: National employer survey findings
[7] Defra (2013) Government Forestry Policy Statement
[8] Gensler & Urban Land Institute (2011) Open Space: an asset without a champion?
[9] Natural England (2012) Microeconomic Evidence for the Benefits of Investment in the Environment – review
[10] Virginia Cooperative Extension: Nutrient Management cited in Project EverGreen http://projectevergreen.org/resources/economic-benefits-of-green-spaces/
[11] Natural England (2012) Microeconomic Evidence for the Benefits of Investment in the Environment – review
[12] Ibid
[13] Wychavon District Council (2011) Shaping the future together, August 2011
[14] DEFRA (2010) Payment for Ecosystem Services

Health & Wellbeing Benefits	
Increased physical activity	Lack of physical activity can be partly responsible for higher obesity and other physical health risks. It can also negatively influence people's moods and motivation which can lead to increased depression and anxiety levels.
	Increasing physical activity through access to high quality greenspace has the potential to save the NHS £2.1 billion a year.[1]
	The Chief Medical Officer recommends 30 minutes of physical activity five times a week for an adult to maintain healthy lifestyle.[2]
	Evaluation of the Walking For Health initiative indicated that every £1 invested in the programme delivered £7 in benefits to the NHS, through an increase in both mental and physical health and well-being.[3]
Reducing obesity levels	Financial estimations indicate that the NHS spends over £80 million treating obesity related ill-health and another £60 million treating the consequences of excess weight in Worcestershire.[4]
	It is estimated that 25% (120,000) of all adults in Worcestershire are obese which 1% above the national average is. Another 40% of adults are overweight.[5]
Improving mental health	One adult in eight in Worcestershire has some form of mental health problem with the most common being depression and anxiety.[6]
	£106 million was spent by the NHS on treatment of mental health problems in adults and children in Worcestershire in 2010/11. £9.4million was spent by Worcestershire County Council on social care for adults with mental health problems.[7]
Encouraging social interaction and inclusion	Where residents perceive the quality of green space to be good they are generally more satisfied with their neighbourhood and more prone to interaction. A study undertaken by Sullivan et al. (2004) found that significantly more individuals engaged in social activity in green spaces as opposed to concreted ones.[8]

[1] Benefits of Green Infrastructure: Report by Forest Research (October 2010)
[2] The Annual Report of the Chief Medical Officer 2009, p. 21
[3] http://www.walkingforhealth.org.uk/about-us
[4] Worcestershire Health and Well-being Board (2012) Joint Strategic Needs Assessment
[5] ibid
[6] ibid
[7] ibid
[8] Forest Research (2010) Benefits of Green Infrastructure

Climate Change Benefits	
Reducing costs of dealing with extreme weather events to businesses	The Association of British Insurers, for example, predicts that a 2^{o}C temperature rise will increase annual insured losses in Great Britain from inland flooding by 8% or by £47 million to £600 million.[1]
	As a result of flooding in June and July 2007, there were an estimated 185,000 insurance claims in the UK, of which 35,000 were commercial claims.[2]
	The Paradise Park development in London has not installed air conditioning due to the thermal mass of the green roof. This has led to a reduction in energy use of 3,800kW/hrs and a saving of 1.6 tonnes of CO^2.[3]
Reducing impact of extreme weather conditions on infrastructure	2007 floods in Worcestershire caused the collapse of a culvert under the road at Cropthorne on the B4084, due to supporting soil being washed away by floodwater. This led to repairs costing nearly £1million, which took 6 months to complete.[4]
Reducing costs of flood risk to new developments	In 1999 Bryant Homes/Taylor Wimpey addressed the issue of flood risk at their Diglis Water development by designing a waterfront park which provided an attractive, multifunctional focal point along the edge of the River Severn. As a result, the marketability factor of Diglis Water is extremely high with the site proving to be one of the most popular in the Midlands.[5]
Cost savings	A study commissioned by Defra proved that cost of implementing SuDS at the Red Hill School site in Worcester were considerable cheaper than traditional drainage system.[6]
Reducing impacts of the poor air quality on human health	It has been estimated that doubling the tree cover in the West Midlands alone would reduce mortality as a result of poor air quality from pollutants by 140 people per year.[7]
Reducing impacts of raising temperatures on human health	A study by the University of Manchester has shown that increasing tree cover in urban areas by 10% could decrease the expected maximum surface temperature in the 2080s by up to 4°C.[8]
Increasing community cohesion	An appropriate use of garden spaces are an important component in a green infrastructure network can provide spaces for growing local food and for recreation in a predominantly urban area and can be beneficial to the mental wellbeing of residents.[9]

[1] Association of British Insurers, 2009. Assessing the risks of climate change; financial implications: http://www.abi.org.uk/Media/Releases/2009/11/45222.pdf
[2] WCC (2011) Worcestershire County Economic Assessment 2010-2011
[3] Environment Agency (website) http://www.greenroofstoday.co.uk/
[4] Worcestershire County Council (nd) Worcestershire Local Climate Impacts Profile
[5] Landscape Institute (2011) Why Invest in Landscape?
[6] Defra's Water Availability and Quality Evidence Programme (2012) Comparative Costings for Conventional Drainage and SuDS

[8] Stewart, H., Owen S., Donovan R., MacKenzie R., and Hewitt N. (2002). Trees and Sustainable Urban Air Quality. Centre for Ecology and Hydrology, Lancaster University

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www.sed.manchester.ac.uk/research/cure/downloads/asccue_final_report_national_steering_group.pdf

APPENDIX B: MULTIFUNCTIONAL GI

What is GI?

Green infrastructure is the network of green spaces and natural elements that intersperse and connect our cities, towns and villages. Green infrastructure is contributed to by many different elements. These include biodiversity, the landscape, the historic environment, the water environment (also known as blue infrastructure), public access to green spaces and informal recreation sites.

Multifunctional GI

A coordinated approach to managing the GI components and assets can safeguard critical natural areas while providing climate change resilient infrastructure and supporting socio-economic wellbeing of residents. At the centre of this approach lays ***"multifunctionality"***, which in the GI context means the integration and interaction of different functions and activities in relation to the piece of land or wider area. For example, the urban GI created by green roofs reduces storm water runoff and water pollution while also decreasing the urban heat effect, improving building insulation and contributing to local biodiversity.

GI as opposed to "grey" infrastructure tends to be designed to perform more than one function. Figure 13 sets out the key priorities for each of the environmental aspects of green infrastructure.

Figure 13: Green Infrastructure Components

In combination these interventions can deliver multiple socio-economic and environmental benefits.

A single GI project can tackle or offer a partial solution to several problems and deliver multiple objectives. This makes GI a valuable, beneficial, cost-effective and practical tool in addressing various environmental and socio-economic demands and pressures. Figure 14 illustrates the multifunctional benefits that GI can provide.

Figure 14: Benefits of multifunctional green infrastructure

Over the past few years, there has been a broadening discussion of the value of the "natural environment" and natural systems that support people's existence. Living things including both fauna and flora are essential ingredients of a well-functioning ecosystem. For example, food production requires good quality natural resources such as soils and water and attractive landscapes can help in making the most of the human interaction with nature. Nature can provide wide-ranging societal and economic benefits, which are an effect of the processes often described as ***"ecosystem services"***. Multifunctional GI, by being at the core of ecosystem services, is seen as a value for money way of linking nature with the built environment.

Value of GI

The concept of multifunctionality in the GI context means that a single area of land can deliver multiple benefits by applying several or a single solution. Its contribution across several functions can be measured by placing a monetary value on the functions performed. For example, estimates can be made of the likely scale of savings that GI flood management solutions can provide to the local economy; these could arise through reducing the number of residential and business properties flooded, reducing the number of local residents requiring public health support with physical and mental health issues, or reducing the costs of post-flooding road maintenance. However, there are still several values upon which it is difficult to place a financial figure, particularly around the cultural and aesthetic benefits. These are largely expressed in qualitative terms, such as recreational opportunities gained, but in such cases some alternative valuation methods can be used; for example, the value of proximity to green spaces can be measured by a proxy indicator of people's willingness to buy a property in a particular area with such proximity, relative to their willingness to buy elsewhere.

The difficulty in putting a financial value on GI has recently been addressed by the economic valuation of ecosystem services. In principle, GI protects and supports functioning ecosystems, therefore understanding the values and tools used in identifying them could contribute to the evaluation of GI[120]. Currently, extensive work is being undertaken at the national level to identify tools for the financial evaluation of ecosystem services and GI. Until then, the monetary evaluation of GI solutions will remain a challenging task.

Ecosystem Services

The ecosystems approach is essentially about shifting the focus of policy-making and delivery away from looking at natural environment policies in separate 'silos' - e.g. air, water, soil, biodiversity - and towards a more holistic or integrated approach based on whole ecosystems[121].

Ecosystem services are the benefits that a healthy environment provides for people, either directly or indirectly, and four broad types of ecosystem service are usually recognised:

• **Provisioning services** - products obtained from ecosystems, including food, timber, woodfuel, fresh water, biodiversity, genetic resources, biochemicals, natural medicines and pharmaceuticals.

• **Regulating services** - benefits obtained from the regulation of natural processes, including: the regulation of air quality, climate, flooding and erosion; water purification; disease and pest control; pollination; and buffering pollution.

• **Cultural services** - the non-material benefits people obtain through spiritual enrichment, cognitive development, reflection, recreation and aesthetic enjoyment.

[120] European Commission (2012) The Multifunctionality of Green Infrastructure.
[121] Defra (2007) - Securing a healthy natural environment: An action plan for embedding an ecosystems approach.

• **Supporting services** - the services that are necessary for the production of all other ecosystem services, including soil formation, photosynthesis, primary production, nutrient cycling and water cycling.

The ecosystem approach means recognising that regardless of its current main use, any area of land has the potential to deliver a very wide range of services (such as flood management, biodiversity, or recreation) and it is important that the diversity of these services is recognised in policy and decision making. There may, however, be a limit to the extent to which multifunctionality can be pursued without impairing the delivery of one or more of the services involved. For example, there may be trade-offs to be made between archaeology and diversity of wildlife or flood management.

GI Policy Context

The multifunctional approach to GI is present in current national policy and has been increasingly and successfully integrated into local policies and actions with growing impetus. UK policy on GI is found in, among others, the following sources:

The Natural Environment White Paper (2011) recognises that nature, economic growth, prosperous communities and personal wellbeing are interconnected. It sees a wider value, in addition to the intrinsic one, to the natural environment which provides a range of benefits and services to different spheres of people's lives. The document suggests that inclusion of green infrastructure, supporting well-functioning ecosystems and coherent ecological networks could increase the value that the natural environment generates to the economy and health & wellbeing.
The document emphasises the multifunctional benefits of GI, which are to:

- support economic growth;
- improve public health, wellbeing and quality of life;
- drive biodiversity and the functioning of natural systems such as rivers and flood plains; and
- reduce the negative impacts of climate change.

The National Planning Policy Framework (2012) states that Local Plans should address climate change, biodiversity and landscape issues through "planning positively for the creation, protection, enhancement and management of networks of biodiversity and green infrastructure".

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