Cyfoeth Naturiol Cymru
Natural Resources Wales

The State of Natural Resources Report (SoNaRR): Assessment of the Sustainable Management of Natural Resources.
Technical Report.
Chapter 5. Well-being in Wales.

Natural Resources Wales

Final Report

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About Natural Resources Wales

We look after Wales' environment so that it can look after nature, people and the economy.

Our air, land, water, wildlife, plants and soil – our natural resources - provide us with our basic needs, including food, energy, health and enjoyment.

When cared for in the right way, they can help us to reduce flooding, improve air quality and provide materials for construction. They also provide a home for some rare and beautiful wildlife and iconic landscapes we can enjoy and which boost the economy.

But they are coming under increasing pressure – from climate change, from a growing population and the need for energy production. We aim to find better solutions to these challenges and create a more successful, healthy and resilient Wales.

Evidence at Natural Resources Wales

Natural Resources Wales is an evidence based organisation. We seek to ensure that our strategy, decisions, operations and advice to Welsh Government and others are underpinned by sound and quality-assured evidence. We recognise that it is critically important to have a good understanding of our changing environment.

We will realise this vision by:

- Maintaining and developing the technical specialist skills of our staff;
- Securing our data and information;
- Having a well resourced proactive programme of evidence work;
- Continuing to review and add to our evidence to ensure it is fit for the challenges facing us; and
- Communicating our evidence in an open and transparent way.

The State of Natural Resources Report (SoNaRR) Report Contents

This document is one of eight chapters of the State of Natural Resources Report.

Chapter 1	Introduction to the State of Natural Resources Report (SoNaRR): An assessment of sustainable management of natural resources
Chapter 2	Understanding drivers of change in natural resource use
Chapter 3	Summary of extent, condition and trends of natural resources and ecosystems in Wales
Chapter 4	Resilient Ecosystems
Chapter 5	Well-being in Wales
Chapter 6	Identifying Unsustainable Management
Chapter 7	Towards sustainable management of natural resources
Chapter 8	Assessment of the sustainable management of natural resources
Annex	Technical Annex for Chapter 3
Annex	Technical Annex for Chapter 7 (Part 1)
Annex	Technical Annex for Chapter 7 (Part 2)
Annex	Method for assigning confidence to evidence presented
Annex	Record of confidence assessments
Annex	Acronyms and Glossary of terms

All of the SoNaRR documents can be downloaded from the NRW website: www.naturalresources.wales/sonarr.

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5. Ecosystem Benefits to Well-being

Introduction

Ecosystems provide a wide range of services, which in turn create benefits that link natural resources with people's well-being. These 'ecosystem services' are often the result of human management of natural resources and can be grouped under four headings:

- **Supporting system and services:** necessary for the production of all other ecosystem services, such as soil formation, nutrients cycling and primary production
- **Provisioning services:** such as crops, fish, timber and genetic material
- **Regulating services:** such as water purification, biological control mechanisms, carbon sequestration, pollination of commercially valuable crops
- **Cultural services:** providing a source of aesthetic, spiritual, religious, recreational or scientific enrichment

The aim of this chapter is to provide an assessment of the ecosystem services and benefits that contribute to well-being in Wales by considering existing evidence against the seven national Well-being Goals[1]. Where there are apparent links to well-being that are difficult to measure or quantify, we have included them but highlight that there are gaps in our knowledge.

At the end of the chapter, we set out how we will draw on the assessment of well-being and resilience to inform our **initial** assessment of the risks to well-being[2]. Over time we will refine the assessment with the Welsh Government, stakeholders, the academic community and the wider public so that it can contribute to decision-making across both public and private sectors.

5.1. Well-being in Wales

The Well-being of Future Generations (Wales) Act 2015 sets out seven well-being goals (Figure 5.1) which describe "the kind of Wales we want to see"[3]. Together they provide a shared vision for the public bodies listed in the Act to work towards. The Act makes it clear that the listed public bodies must work to achieve all of the goals as an integrated set, not just a selected one or two in isolation.

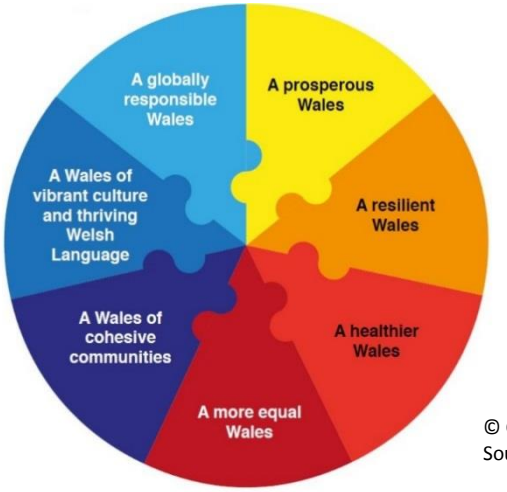

Figure 5.1 The Well-being Goals[3].

In this report we are explicit about how natural resources and ecosystems contribute to *all* of the goals and we emphasise not only the interaction *between* goals but also the scope of different elements *within* each goal.

For each goal we describe how natural resources and ecosystems contribute benefits to well-being. Starting with the "Resilient Wales" goal, we outline the many ways that ecosystems contribute to and **underpin** economic, social and ecological resilience. Ecosystem services support **all** aspects of the well-being goals and are not limited to the resilient Wales goal.

For the remaining six goals, rather than repeat the description of contributions made by each ecosystem, we focus on the key contributions made by natural resources and ecosystems together using Welsh evidence wherever possible. How broad habitats contribute to well-being will vary depending on their location, condition and extent, and how they are valued by society – we are keen to develop this understanding through the Area Statement process.

It is important to stress that this is not a systematic review of all available evidence but an assessment intended to inform policy development; it builds very much on previous reports[4] such as the UK National Ecosystem Assessment[5]. To help to inform the development of the national natural resources policy, we have highlighted some of the most notable and relevant relationships to well-being.

As well as looking at benefits, the assessment considers where natural resources can help to manage or mitigate some of the *negative* impacts on well-being associated with environmental threats, such as climate change, air pollution, and flooding.

5.2. How ecosystems contribute benefits for Well-being

The Resilient Wales Goal

A nation which maintains and enhances a biodiverse natural environment with healthy functioning ecosystems that support social, economic and ecological resilience and the capacity to adapt to change (for example climate change)[3].

A detailed analysis of ecological resilience is provided in Chapter 4. This is based on the key attributes of ecosystem resilience and makes an assessment of diversity, extent, condition and connectivity. This section concentrates more on the ways that natural resources and ecosystems support the functioning of social and economic systems, particularly the capacity to adapt to climate change.

Mountains, moorlands and heaths
Although they are sparsely populated, upland habitats contribute to the functioning of social and economic systems in many ways. As well as playing an important role in the water cycle, they help provide a wide range of functions and regulating services; these include water purification, carbon storage and carbon sequestration. Upland habitats also have the potential to store water to help reduce flooding downstream and to maintain river base flows during periods of drought[6]. From the cultural perspective, they inspire people (such as the poet R.S. Thomas) and contribute greatly to Wales' distinctive landscapes and national identity. Although mountains, moorlands and heaths are characterised by their species-poor habitats, they are known for charismatic species, such as black grouse. People are more likely to identify mountains and moors as the places they would like to visit more often for recreation[7].

Semi-natural grasslands
Semi-natural grasslands are mostly still within farming systems, but are distinguished from the improved grasslands of enclosed farmland by their history (lack of recent cultivation, re-sowing or heavy fertilisation) and lower-intensity management. They provide climate regulation through sequestration and storage of carbon and other greenhouse gases. They help the purification of pollutants and storage of water. Grasslands can closely interact with wetland systems; in particular, water meadows which were traditionally managed so that they stored seasonal floodwaters.

Enclosed Farmland
Enclosed farmland is largely managed to produce food. It also supports functioning of social and economic systems in a number of ways, being a focal point for relationships within and between rural communities. The positive management of enclosed farmland is important to help safeguard against soil loss, to reduce impacts on water quality from pollution and siltation and to address localised flooding. Enclosed farmland is a distinctive landscape in which plants, animals and other organisms live and through which they travel. How we use farmland can also have a significant bearing on global resource use in terms of the import and export of foods, the use and alteration of energy and water, and emissions of greenhouse gases (see the globally responsible Wales section).

Woodlands
Woodlands contribute to the functioning of social and economic systems and well-being in many ways. They help to regulate climate stress at a local level, provide carbon sequestration, contribute to flood and low river flow risk management, safeguard soils, improve air quality, reduce noise pollution and regulate pests and

diseases. They play a major role in pollination, soil formation, nutrient cycling, water cycling and oxygen production, all of which are crucial in supporting our health and well-being. The effectiveness of these supporting and regulating services is dependent on the nature, extent, condition and resilience of woodland ecosystems, as explained in Chapters 3 and 4.

Although the evidence is incomplete, it is accepted that one of the most important regulating services that woodlands provide is their capacity to sequester carbon. Predicated changes in climatic conditions have wide-ranging implications for woodlands in Wales in terms of how they are managed, the suitability and distribution of different tree species and the benefits derived from them, and also in relation to Wales' carbon footprint and the role woodlands play in climate change mitigation and adaptation. The ability of woodlands to adapt to climate change is a function of their ecological resilience (see Chapter 4) and will have significant repercussions for the social and economic well-being of Wales.

Urban Environments

Towns and cities are part of ecosystems too. They are characterised by their history, structure and function (including both natural and built components) and by the cycling and conversion of energy and materials within them. They have their own spatial organisation and distinctive patterns of change which influence species' behaviour patterns, population dynamics and the formation of communities[8]. Eighty percent of Wales' population lives in towns and cities and the number of city dwellers is likely to increase significantly over the next 20 years, with Cardiff, Wrexham and Swansea likely to be particularly affected[9].

Natural resources within urban areas, particularly green infrastructure - parks, amenity trees and community woodlands, rivers and ponds - can support communities (our social systems), providing opportunities for interaction and engagement. This helps to build social cohesion along with improved mental well-being and increased physical activity, both of which are of particular benefit in more deprived areas where social cohesion is often at a lower level (this is explored in greater detail in section 5.7). Local parks are the most commonly visited places for informal recreation and therefore recognised as important sources of cultural services[7].

Green infrastructure is critical in helping to adapt to and mitigate the impacts of climate change and air pollution. For example, it can provide opportunities for air and water purification, carbon sequestration, noise alleviation and surface water regulation. All of these benefits, which contribute to the functioning of social and economic systems, are considered further below (and in Chapter 3 and the Technical Annex for Chapter 7).

Freshwater

Rivers, streams, lakes and wetlands are fundamentally important for our survival. They provide drinking water and contribute to our enjoyment of life through the opportunities they provide for leisure and the appreciation of water in the landscape, and are important for the sustenance of other ecosystems.

In particular, freshwater systems help to control runoff from the land to rivers, floodplain inundation, groundwater recharge, and water quality[10]. These processes are vital for the regulation and supply of water, nutrients, energy flows, solutes, sediments and migratory organisms to ecosystems. Freshwater systems remove and dilute pollutants, store waters to help maintain flows and capture carbon. They are therefore critically important in supporting the functioning of social and economic systems and our ability to adapt to climate change.

Coastal Margins

Coastal margin habitats form a transition zone between sea and land and make an important contribution to social and economic systems by reducing coastal erosion and flooding, providing natural sea defences and dissipating wave energy[11]. These are particularly important regulating services. The CCRA17 Evidence Report[12] has identified risks to infrastructure services from coastal flooding and erosion; and to business from the loss of coastal locations and infrastructure. It has also identified risks to the viability of coastal communities from sea level rise. The enhancement of natural coastal margin systems may provide the additional protection required to combat the impacts of climate change while preserving the essential character of settlements. Coastal margins also play an important role in ameliorating air and water pollution and in climate regulation through carbon sequestration. In terms of supporting services, coastal margins deliver primary production benefits and nutrient and water cycling. Coastal communities and food producing industries benefit from the provision of seafood and fish as well as speciality foods, such as saltmarsh lamb, from coastal margins habitats. Such habitats are also an integral element of coastal landscapes and seascapes in Wales which attract a significant number of tourists and provide recreation activities, including walking, boating and beach activities. They are the setting for many protected sites because of their importance for birds (seabirds, wildfowl and waders).

Marine

Marine ecosystems are crucially important for supporting a resilient Wales. As well as playing an important role in primary production, and nutrient and water cycling, marine ecosystems help to regulate water and air quality by trapping, assimilating and degrading pollutants[13]. They provide seafood (fish and shellfish) and support associated coastal communities and food processing industries.

Marine organisms and processes also play a significant role in global climate regulation through the regulation and storage of carbon. However, little is known about how human activity affects this service. We do know is that the accumulation of carbon dioxide and other emissions in the ocean has led to acidification. This may lead to ecosystem damage and functional changes causing possible impacts on shellfish yields and fish productivity, changes in wildlife resources and a decrease in the ability of marine organisms to provide climate regulation.

In terms of cultural services, marine habitats and species make a significant contribution to tourism and recreation, including wildlife watching (e.g. birds and cetaceans), sea angling and adventure sports. Marine ecosystems, and the seascapes in which they sit, also contribute to cultural heritage and identity and provide inspiration for art and design.

The Welsh Government Marine Evidence Report (WMER)[14] provides an overview of the status, use and potential future of our marine natural resources in Wales. Prepared in support of the development of the Wales Marine Plan, it includes a breadth of evidence on how the marine environment supports our well-being – much of which we have not been able to include within the body of this report, but which has contributed to the assessment of risks to well-being in Chapter 6.

Further evidence on marine ecosystem services can also be found in Natural England Commissioned Report NECR088[15].

Other natural resources

Soil, water, air, minerals, timber, non-renewable resources and waste.
These raw materials are clearly essential for the production of material goods, the supply of construction and building materials, for manufacturing and processing industries and for the production of fuel and energy. They are fundamental to our basic needs, and we draw on natural resources both from within and beyond Wales to meet these needs.

We have chosen to look at the use and management of raw materials separately rather than try to assess their contribution to well-being. In particular, we have chosen to focus on where their management or use create potential issues for the resilience of ecosystems or the benefits they provide. This is set out in Chapter 6.

Animals, plants and other organisms (Biodiversity)
As well as considering the broad habitats, it is important to consider the contribution biodiversity makes to the functioning of social and economic systems.

Animals, plants and other organisms play a wide range of functional roles in ecosystems and therefore in the processes that underpin ecosystem services. The extent, condition and trends of our animals, plants and other organisms have been considered in Chapter 3 of the report (in particular section 3.1) alongside Chapter 4. However, we still lack quantitative data that would allow us to link current biodiversity status and trend data with the delivery of ecosystem services[16].

Protecting biodiversity can help us to adapt to climate change[17]. Healthy ecosystems will be more resilient to climate change and so more able to maintain the supply of ecosystem services on which our well-being depends. Some reports on climate change suggest that nature-based solutions should be an integral part of the overall adaptation and mitigation effort.

Biodiversity is also a cultural service. People's appreciation of and connections with nature are fundamental to their health and well-being[18] and to educational attainment. Some recent studies report that human beings have an innate and very strong link with the natural world but suggest that these connections are being lost, with negative implications for well-being[19, 20, 21, 22]. This is considered further under the well-being goals below.

Pollination is a fundamentally important ecosystem service. The value of pollination as a contribution to UK agriculture and horticulture is £690m[23]. The value of honey produced in Wales is also considerable with a wholesale value in excess of £2 million in 2011[24]. If we were to lose this valuable service, the cost of replacing it with hand pollination has been estimated at £1.9 billion per year in the UK[25]. There are likely to be significant consequences for society from the loss of pollination services because they underpin the functioning of many other ecosystems.

The Prosperous Wales Goal

> *An innovative, productive and low carbon society which recognises the limits of the global environment and therefore uses resources efficiently and proportionately (including acting on climate change); and which develops a skilled and well-educated population in an economy which generates wealth and provides employment opportunities, allowing people to take advantage of the wealth generated through securing decent work*[3]***.***

Wales' natural resources make a substantial contribution to a 'Prosperous Wales'. They provide employment and a focus for skills development and education. All products and consumables derive from natural resources – although not always sourced in Wales. (The "globally responsible Wales" section discusses our resource use and this is developed further in Chapter 6.)

Direct benefits to well-being are provided through current economic activity and employment, which is supported by the extent and condition of our natural resources and the ways in which ecosystem services contribute to well-being. In addition, the prospect of future development of a low carbon economy offers a significant opportunity for sustainable growth based on the sustainable management of natural resources.

Provisioning services

Food and **Fibre** production (agriculture and timber) and **Fisheries** are significant industries in Wales, particularly in rural areas, giving rise to numerous SMEs.

The Gross Value Added (GVA) for Welsh agriculture as a whole is £385 million[26]. This underpins the £6.1 billion annual turnover and £1.55 billion GVA attributed to the on-farm production and food manufacturing sector[27].

The volume of milk production increased by over 20% between 2004/05 and 2014/15[28,29].

The number of egg producing holdings has expanded in recent years with the free-range market accounting for some 89% of the production base[30]. Poultry units affect local concentrations of airborne ammonia, with potentially adverse impacts on sensitive habitats and plant species[31].

The number of free-range egg laying poultry flocks in Wales has risen in recent years in response to increasing demand. Expansion is concentrated in the Welsh Borders

where densities can exceed 15,000 birds per km^2 [28]. The storage and subsequent spreading of manure can also impact on water quality.

The forestry sector in Wales in 2015 had an annual GVA of £499.3 million. The GVA of the forestry sector has risen in the last few years and is now higher than it was in 2005. It should be noted that no estimate has been made of the GVA of woodland-based recreation businesses. In 2013, it was estimated that the forestry sector in Wales employed between 8,500 and 11,300 people.
Welsh freshwater and marine fisheries also make a significant contribution to the economy. Total landings by UK vessels into Wales were estimated at £2.8 million of fish and £12.0 million shellfish (mainly scallops, whelks and crabs/lobsters) in 2014[14].

Renewable energy sources, such as wind, hydro, solar power and biomass have contributed to growth in the energy sector in the last 10 years and offer significant potential for further growth:

> *1,200km coastline offers an opportunity to capture tidal and wave energy resources. Wind resource both offshore and onshore offers opportunity, with one estimate, indicating that 2,000 MW of onshore wind capacity could be developed by 2025, supporting 2,000 jobs over the life time of the projects and adding £2 billion to the Welsh economy [32]*

In common with any other form of development, the inappropriate siting of renewable energy schemes can have an adverse effect on environmental interests. The strategic policy and planning framework in Wales provides an opportunity for Natural Resources Wales, Local Planning Authorities and developers to work together to identify opportunities for the deployment of renewable energy schemes in the most appropriate locations.

The Anafon project in Abergwyngregyn, North Wales, is an example of a social enterprise producing hydro-power. The project is expected to generate approximately 957 MWh, enough to supply about 230 households and to offset more than 19,000 tonnes of CO_2 emissions over the first 40 years of its life. The project intends to reinvest income to support energy efficiency, infrastructure and social initiatives in Abergwyngregyn and the wider local community[33].

The Low Carbon Economy is outperforming the economy as a whole[34]. Between 2010 and 2013, Gross Value Added (GVA) for the sector grew at a compound annual rate (CAGR) of 8.7%. Over the same period the whole economy grew by 3.4% a year; based on ONS data for GVA (basic prices)[35].

Table 5.1 shows that the seven sub-sectors with above average growth (together growing by 20.3% a year in terms of GVA between 2010 and 2013) accounted for 15% of employment within the sector in Wales versus 19.5% across the whole UK.

Table 5.1 Low carbon energy sector economy: Gross Value Added (GVA) figures, sales and employment[34].

Low carbon energy sub-sector	GVA 2010-2013 CAGR	Sales 2010-2013 CAGR	Employment		Share of Sector Employment	
	UK	UK	Wales	UK	Wales	UK
Alternative fuels	+24.4%	+21.9%	600	19,800	3.5%	4.3%
Offshore wind	+16.9%	+2.5%	400	13,700	2.3%	3.0%
Marine	+13.3%	+5.5%	100	3,100	0.6%	0.7%
Onshore Wind	+11.5%	+5.3%	600	19,000	3.5%	4.1%
Geothermal	+11.0%	+12.0%	100	3,500	0.6%	0.8%
Energy controls & control systems	+10.6%	+5.1%	400	12,800	2.3%	2.8%
Low emission Vehicles	+8.7%	+5.3%	400	18,100	2.3%	3.9%
Total for the 7 sub-sectors with above average growth	**+20.3%**	**+12.8%**	**2,600**	**90,000**	**15.0%**	**19.5%**
Total for the sector	**+8.7%**	**+7.0%**	**17,300**	**460,600**	**100.0%**	**100.0%**

2014 saw a much greater increase in activity. Energy generation growth increased by 1055% between 2013 and 2014 (increase of 230,000 MWh from 2012 to 2013, increase of 2.4 million MWh from 2013 to 2014)[36]. The Gwynt y Mor windfarm, off the coast of Rhyl, accounts for about half of that.

Water supply

The value of water currently licensed for abstraction in Wales is £5.6 billion[37]. We have to consider demand for water abstracted in Wales and from further afield to evaluate the amount of water used to produce the food and goods we consume. An estimated 3,400 litres of water per person per day is used to produce the food and goods our society uses. Only 38% of this water comes from rivers, lakes and groundwater reserves in the UK[37]. The UK is the sixth largest net importer of water in the world[38].

Population forecasts for Wales mean that household demand for water could increase by 3%, an additional 12 million litres per day by 2025[a] [39][40].

Regulating services

[a] Population in 2016 = 3,110,815 and projected to increase to 3,196,380 (2.7%) based on 144 l/h/d = increase of 12,321,360 litres per day by 2025

Water and hazard regulation
Natural resources help provide resilience to natural disasters, such as flooding, coastal flooding, heatwaves and geological processes (including landslides). Flooding of major road and rail links and the loss of electrical cables and gas pipes in 2015 shows how floods can impact significantly on infrastructure provision, causing disruption to communities and additional costs for utility companies.

Work has been done to identify the effectiveness of man-made flood defence schemes. The 2014 report to Welsh Ministers on Flood and Coastal Risk Management in Wales reported that, "*costs … were avoided as a result of the investment made in flood defences and other risk management measures. An analysis of the winter 2013/14 floods alone showed that less than 1% of properties at risk actually flooded and indicated that the financial damages therefore avoided came close to £3 billion and allowed the local economies to recover more quickly*" [41].

The contribution that natural resources make to hazard regulation is further considered under "an Equal Wales".

Cultural Services

'Green space' is short-hand both for vegetated land, such as parks, community gardens, trees, woodlands and hedges, informal spaces, allotments and food growing sites, and for areas of water, such as rivers, canals, lakes and ponds. The definition also includes the sea shore, maintained for the recreation and enjoyment of communities in our villages, towns and cities. 'Green infrastructure' describes the network created by all these spaces.

In urban areas, there is evidence that well-managed green infrastructure can increase economic growth at local and national level, attracting inward investment and increased visitor spend. The UK NEA estimated that amenity value of green-space alone could range from losses of £1.9 billion p.a. to gains of up to £2.3 billion per year to the UK's economy, depending on policy scenarios[42].

As well as amenity value, green infrastructure provides important regulatory services, such as pollution filtration, flood risk reduction and the mitigation of temperature extremes. There is evidence to suggest that green infrastructure can prevent costs occurring from natural hazards and is often a more cost-effective way to meet environmental challenges.[43] One example is Dŵr Cymru Welsh Water's Rainscape initiative at Llanelli. It is anticipated that it will remove approximately 4,365 megalitres of water a year from the sewer network[44] reducing the costs of water treatment and pollution from overflowing storm drains.

Environmental settings and their cultural benefits
Environmental settings have a significant influence on tourism which supports inward investment, provides employment, and offers opportunities to develop new skills. The inter-relationship between natural resources and recreation and tourism is reflected in the economic benefits that are derived from our National Parks and wider landscapes, the provision of diverse recreation opportunities, and national assets such as the Wales Coast Path:

- The value of wildlife and outdoor activity tourism to Wales is estimated to be in the region of £6.2 billion[45] with an estimated 206,000 jobs across Wales.

- 3.594 million visitor trips were attributed to coastal tourism in 2013[14] with the most popular draws being landscape, countryside and the beach[46]. This brought £602 million to the economy with growth predicted at 10%[14].

- The three Welsh National Parks attract 12 million visitors per year with spending of £1 billion on goods and services[47].

- The Wales Coast Path attracted an estimated 2.82 million visitors between September 2012 and September 2013, resulting in an estimated contribution of £32 million to the Welsh economy[48].

These assets often rely on the quality of the natural resources and ecosystems, such as the quality of bathing waters. All Welsh designated bathing waters met the stringent standards of the revised Bathing Water Directive in 2015[49], providing a very important resource for coastal communities, visitors and the Welsh economy.

A study commissioned by WWF Cymru in 2012, 'Valuing Wales' seas and coasts' stated that the coastal and marine environment contributed £6.8 billion to the economy of Wales, supporting more than 92,000 jobs[50].

Recreational fishing (trout, sea trout, salmon) on our rivers also contributes significantly to the Welsh economy. In 2001 the value of fishing /and inland fisheries was estimated at £147 million in total. More recent studies estimated gross expenditure in Wales by anglers at £74 million, supporting almost 1,500 Welsh jobs and £32 million of household income[51].

In addition to direct economic benefits, there are indirect economic benefits (cost savings) from the contribution these assets make to people's health and well-being. These indirect benefits are more difficult to attribute and quantify. Health benefits will be considered in the "Healthier Wales" section below.

The Healthier Wales Goal

> *A society in which people's physical and mental well-being is maximised and in which choices and behaviours that benefit future health are understood* [3]*.*

Natural resources make a significant contribution to the physical health and mental well-being of people in Wales, both through health improvement and health protection. All ecosystems support some aspect of health, indicating both the breadth and impact of the benefits. However, because 80% of Wales' population lives in towns and cities, the concentration of benefits per head of population and opportunity to optimise those benefits is greatest in urban areas.

Regulating services

Regulation of air, water and soil quality

Ecosystems can help purify air, water and soil. Of particular relevance to health in Wales is air quality, which has a direct impact on people's life expectancy. In the UK, two air pollutants (particulate matter and nitrogen dioxide) contribute to the early deaths of between 40,000 and 50,000 people annually[52]. Furthermore, the costs of poor air quality in terms of health impacts add up to £20 billion a year[52]. A report by Public Health England estimates that the proportion of deaths in Wales due to long term exposure to man-made particulate air pollution (PM2.5) is 4.3%[53]. Poor air quality has not only a direct impact on health but can also discourage people from venturing outdoors, which in turn contributes to more sedentary lifestyles[54].

Health effects do not relate solely to the direct impacts of air pollution. Actions such as promoting the use of non-motorised means of transport as a means of reducing local emissions of pollutants can help people to become more active, improving their health and fitness. In turn, this may also help individuals to become more resilient to the direct ill-effects of air pollution[55].

Similarly, measures to mitigate climate change have health knock-on benefits. For example, measures to reduce greenhouse gas emissions from transport can deliver improvements in air quality[56].

Natural resources and ecosystems can play a role in reducing the impacts of poor air quality. The role of trees in contributing to cleaner and healthier air is highlighted in a study by Lancaster University[57]. This benefit can be maximised by carefully designed tree planting along transport corridors. The Lancaster study also highlights which species are best suited to particulate removal; identifying ash, alder, maple, pine and birch.

The Tawe catchment, Wrexham and Bridgend i-Tree Eco studies have measured the contribution their urban trees make to capturing particulate pollution. Every year across these towns, 257 tonnes of pollutants are removed by trees, of which 30.5 tonnes is PM_{10} and 20.5 tonnes is $PM_{2.5}$. The United Kingdom Social Damage Cost (UKSDC) valuation of removing 30.5 tonnes of PM_{10}, using the higher 'transport urban medium' approach, is £1.9 million per year[58].

Hazard Regulation

Flooding can cause death, illness, injury and stress with impacts possibly greater for more socially vulnerable communities[59].

Providing advance flood warnings and activating flood defence mechanisms not only help to prevent loss of life but also allow people to take action to protect themselves and their property. This can help to reduce the impact of other adverse health effects, such as anxiety about flooding, injury or exposure to contaminants.

Some flood defences not only protect lives and properties but make a significant contribution to the improvement of health and well-being; for example, by providing urban green space and recreational facilities (e.g. cycle paths/walkways). Creating or restoring habitats to manage flood risk can provide health benefits by increasing opportunities for recreation and leisure and improving access to the natural environment.

Adapting to climate change

The CCRA17 Evidence Report[60] has identified a series of climate-related risks which together have implications for human health. In each case the urgency assessment ascribed by the CCRA 17 Report is indicated in parentheses, as follows:

- Risks to health and wellbeing from high temperatures (research priority)
- Potential benefits to health and wellbeing from reduced cold (more action needed)
- Risks to health from changes in air quality, notably in relation to ground level ozone and aeroallergens such as pollen (research priority)
- Risks to health from vector-borne pathogens, such as the transmission of Lyme disease by ticks (research priority)
- Risk of food borne disease cases and outbreaks, notably salmonellosis (no further action required currently)
- Risks to health from poor water quality in relation to both drinking water supplies and sea water (sustain current action)
- Risk of household water supply interruptions (sustain current action)

These risks arise within the natural and built environments, but the distinction between these two spheres is frequently blurred. The way that we manage the environment, and make use of the ecosystem services that it provides, should recognise these risks and seek to minimise them.

Cultural Services

It is widely recognised that many of the key health issues faced by Wales (like other countries) are associated with lifestyle choices and are in many ways considered to be 'preventable'[61,62]. These include many of the chronic conditions caused by insufficient physical activity, such as cardiovascular disease, Type 2 diabetes, chronic kidney disease, some cancers, osteoporosis, and arthritis. Increasing physical activity to the level recommended by the Chief Medical Officer and the World Health Organisation is one of the key priorities in Wales, and outdoor recreation makes a significant contribution to achieving this target. Twenty-eight percent of all Welsh adults meet the recommended level of physical activity by participating in outdoor recreational activities[7].

A growing body of evidence demonstrates a positive link between spending time in a natural environment and mental health. Impacts appear to differ according to socio-economic status, age and gender, but where natural environments are used as settings for mental health promotion or therapy, the outcomes, albeit weak, tend to be positive and cost effective[22]. The CCRA17 Evidence Report[60] has identified opportunities from warmer temperatures for increased outdoor activities. The enhancement of urban green space should allow these opportunities to be realised.

Mental health benefits are derived from both outdoor *activity* and *proximity* to natural environments. For example, just being in the outdoors can help people deal better with anger, fatigue, sadness and stress. A recent study found that children with ADHD showed an improvement in behaviour in woodlands compared to urban environments.

Studies have also shown that there are significant positive links between mental well-being and increased green-space in urban areas[19].

Actions to address other environmental issues, such as the management of flood risk, have also been found to have a positive effect on mental health and well-being. Reviews of Flood Awareness Wales found that involvement in community flood planning and increasing preparedness demonstrated tangible benefits to the mental health and well-being of individuals, including a reduction in Post Traumatic Stress Disorder and the depression that people sometimes experience after being flooded.

Community grown food
A literature review by Sustain (the alliance for better food and farming) suggests a number of ways that growing food can contribute to health and well-being[63]. In recent years, there has been a reported rise in demand for allotments, which can also provide a range of other ecosystem services[64].

Tranquillity is an element of many natural environments. The conditions which give rise to it can include: not just an absence of noise but the presence of positive noise such as birdsong; the visual quality of the landscape and a sense of personal security[54]. Quality of life may be enhanced when people have quiet and inspiring places where they can interact more closely with living nature.

Unnatural noise levels interfere with tranquility so it is perhaps not surprising that after air quality, noise is estimated to be a leading cause of the environmental burden of disease in the European Region. Noise exposure can impact on mental well-being and may increase blood pressure and heart rate during sleep[54].

Air pollution and noise are often emitted from the same sources (notably road traffic), and locations of poor air quality often coincide or overlap with locations subject to high noise levels. Benefits can be gained by implementing solutions that address both issues[55].

Preferences for the types of green-spaces (including rivers, lakes and sea) that people use for healthy recreation and what they enjoy doing there are becoming better understood. Although we can map accessible green-space and the routes that connect them, there is no fail-safe way of determining which areas of Wales provide the most opportunities for health and recreation. Given the spectrum of interests and uses, there is clearly a role both for urban green spaces where the majority of people live and for more remote visitor facilities if we want to promote better opportunities for health.

The Equal Wales Goal

> *A society that enables people to fulfil their potential no matter what their background or circumstances (including their socio economic background and circumstances)* [3].

To ensure that all people in Wales are able to reach their full potential, they need to have equality of opportunity. This means addressing not only social and economic inequality but also environmental inequality. Environmental inequalities may be defined as the unequal impact of environmental influences on health and well-being

or the unequal access to ecosystem services. These environmental influences include early-years education or care settings, housing, public spaces, environmental planning, travel and transport, access to nature and environmental problems, such as poor air quality or climate change causing increased energy costs.[65]

Regulating services

In terms of inequality the impact of exposure to hazards associated with climate change, such as flood risk and heat, are compounded by environmental, social and economic factors[66]. These aspects of vulnerability are unequal in their extent and distribution and include:

- age: both the very young and elderly people
- health: people with existing poor health or specific conditions
- housing: both types of housing and tenancy status
- lack of greenspace
- low income and associated deprivation
- lack of social capital: access to services (including environmental education) and social mobility

Exposure to a hazard such as increased flood risk, combined with social vulnerability (of individuals and communities) leads to what has been termed 'climate disadvantage'. ClimateJust have noted that:

> *How exposure and vulnerability coincide determines the extent of climate disadvantage in an area and where the impacts may be most severe. To effectively tackle climate disadvantage, consideration needs to be given to measures to reduce social vulnerability as well as reducing exposure of the population.*[67]

This applies to risks from overheating in urban areas as much as to flooding. Buildings, roads and other artificial surfaces absorb heat more than vegetation and water, leading to urban areas becoming hotter than their rural surroundings and creating an Urban Heat Island effect. During heatwaves, night time temperatures in towns and cities remain high due to this effect, making it hard for people to recover from heat-stress suffered during the day. This can increase the number of deaths in vulnerable groups such as the sick and elderly.

The intensity of urban heat islands can be reduced by increasing the extent of water and vegetation in urban areas and by restructuring urban areas to give a more even distribution of green infrastructure. A study in Manchester estimated that a 10% increase in vegetated surfaces, particularly with urban trees which promote cooling, could ensure that the city suffered no more deadly 'hot nights' under the worst-case climate change scenario for 2080 than it currently suffers[68]

The 'physical environment' also makes up one of the eight domains of the Welsh Index of Multiple Deprivation (WIMD). However, the relationship between overall total 'deprivation' and 'physical environment' deprivation is complex and not necessarily equivalent. For example, areas with a similar ranking of overall deprivation might have very different levels of environmental deprivation, as illustrated in Table 5.2.

Table 5.2 Areas of similar overall deprivation with different environmental deprivation, by rank, 2014[69].

Lower Super Output Area (LSOA)	WIMD Overall Rank	Physical Environment Rank
Monkton, Pembrokeshire	80	1,727
Cwmbach 2, Rhondda Cynon Taf	81	162
Llanrumney 6, Cardiff	84	321

Ranked out of 1,909 LSOAs. The ranks are from 1 (most deprived) to 1,909 (least deprived)

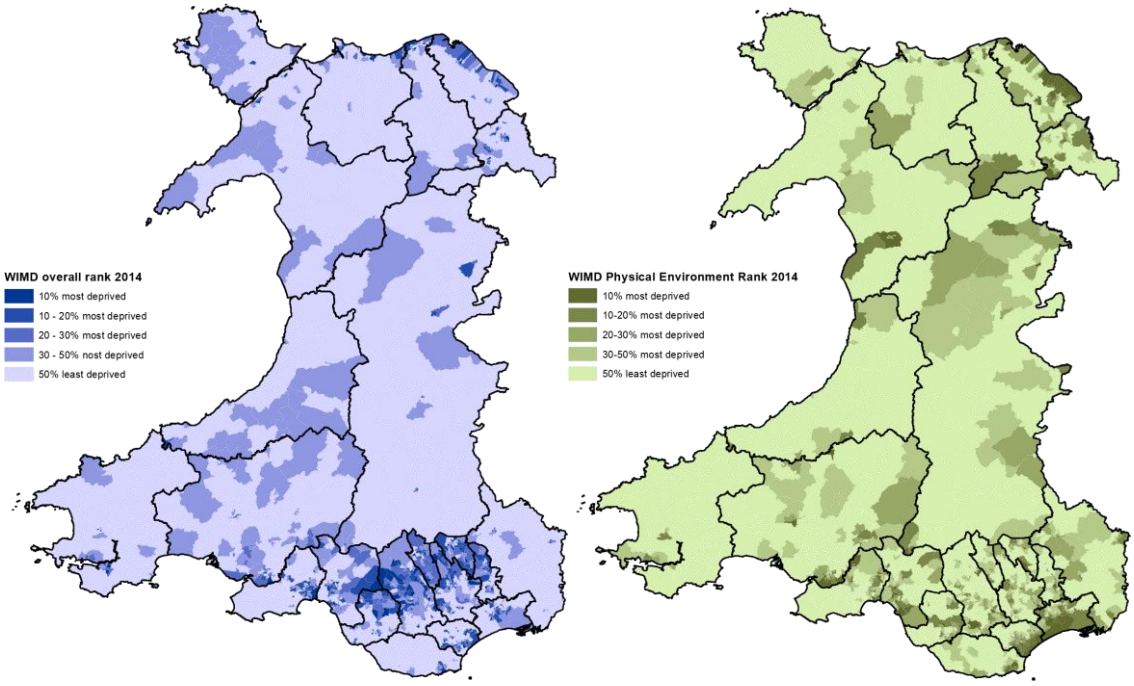

Figure 5.2 Wales Index of Multiple Deprivation Overall and Physical Environment rank[69].

The Physical Environment Domain comprises 3 sub-domains: proximity to waste and industrial sites, flood risk and air quality. The key results of the 2014 WIMD show that:

- There were concentrated areas of physical environment deprivation in cities and industrial areas in South Wales, whilst the most prominent pockets of physical environment deprivation in North Wales were in Dolgellau (primarily due to high flood risk values) and Deeside (due to a combination of factors which varied at the LSOA level).
- Flintshire had the highest proportion of LSOAs *in the most deprived 10%* in Wales for the physical environment domain (34.8%). In contrast, Anglesey, Conwy, Ceredigion, Merthyr Tydfil and Monmouthshire had no LSOAs in the most deprived 10%.
- The most deprived physical domain LSOA was Queensferry in Flintshire.

Other inequalities exist, although more information is needed. For example, tree cover in deprived areas tends to be lower and relatively less 'rich' in terms of amenity trees. In Rhyl (where a number of small areas fall within the most deprived 10 percent

of areas in Wales), all wards except one have less than 10% canopy cover, and the most deprived Rhyl West ward has only 2% cover. Across Wales as a whole, 63% of least deprived wards have cover greater than 15%, whereas only 23% of more deprived wards have greater cover than 15%[70].

Cultural Services

Access to ecosystems providing cultural services are also unequally distributed in Wales. For example, proximity to green-space varies between areas, whilst participation in outdoor recreation has been found to have significant differences relating to social and economic factors. In particular, elderly and disabled people were much less likely to take part in outdoor recreation (and therefore gain the associated health benefits), along with people who lived in Community First Areas. People from black and minority ethnic (BAME) backgrounds, young people, people who live in inner cities, women, older people and people on low incomes all make limited use of the countryside and green outdoor spaces.[71]

Using woodlands as an example, recent survey data[7] revealed that woodlands were the second most favoured outdoor destinations overall, after local parks. When woodland visits were compared to all visits to the outdoors, there were some statistically significant differences:

- woodland visits were more likely to be taken by those aged 16-24 (57%), those living in North Wales (56%), dog owners (56%), those who were employed (56%), men (56%)
- going to woodlands was more likely to interest those with children in the household and to those in the bottom 10% of most deprived areas. 64% of adults in 2015 said that they had easy access to woodland without a car, and this figure has stayed roughly stable over the last 10 years[72]
- The percentage of people with access to a 20 ha+ woodland within 4km has risen steadily between 2004 and 2012

Access to the environment to support children's learning and play has been shown to improve their cognitive development. Experiences gained through childhood can continue into later life; a child's attitude towards exercise lays the foundation for their habits as an adult[73]. The Public Opinion of Forestry Survey (2015)[74] revealed a sizeable increase in the percentage of households involved in woodland education in 2015, increasing by 9 percentage points from 2013.

The Cohesive Communities Goal

Attractive, viable, safe and well-connected communities[3].

There are many links to explore between any ecosystem type and the contribution it can make to attractive, safe, viable and well-connected communities. Communities and 'places' are shaped by the connections between natural resources and people.

Cultural services

One key aspect that is positively associated with communities is the provision of attractive and well-managed local green-space which provides a welcoming safe space for residents and visitors. The Green Flag Award sets a national standard for

high quality local green spaces. In 2015-16, 69 Local Authority-managed and 41 community-managed public green spaces in 19 local authority areas obtained Green Flag Awards in Wales[75] (Figure 5.3). Green Flag parks are distributed across Wales, but with particular concentrations in both the south and north-east.

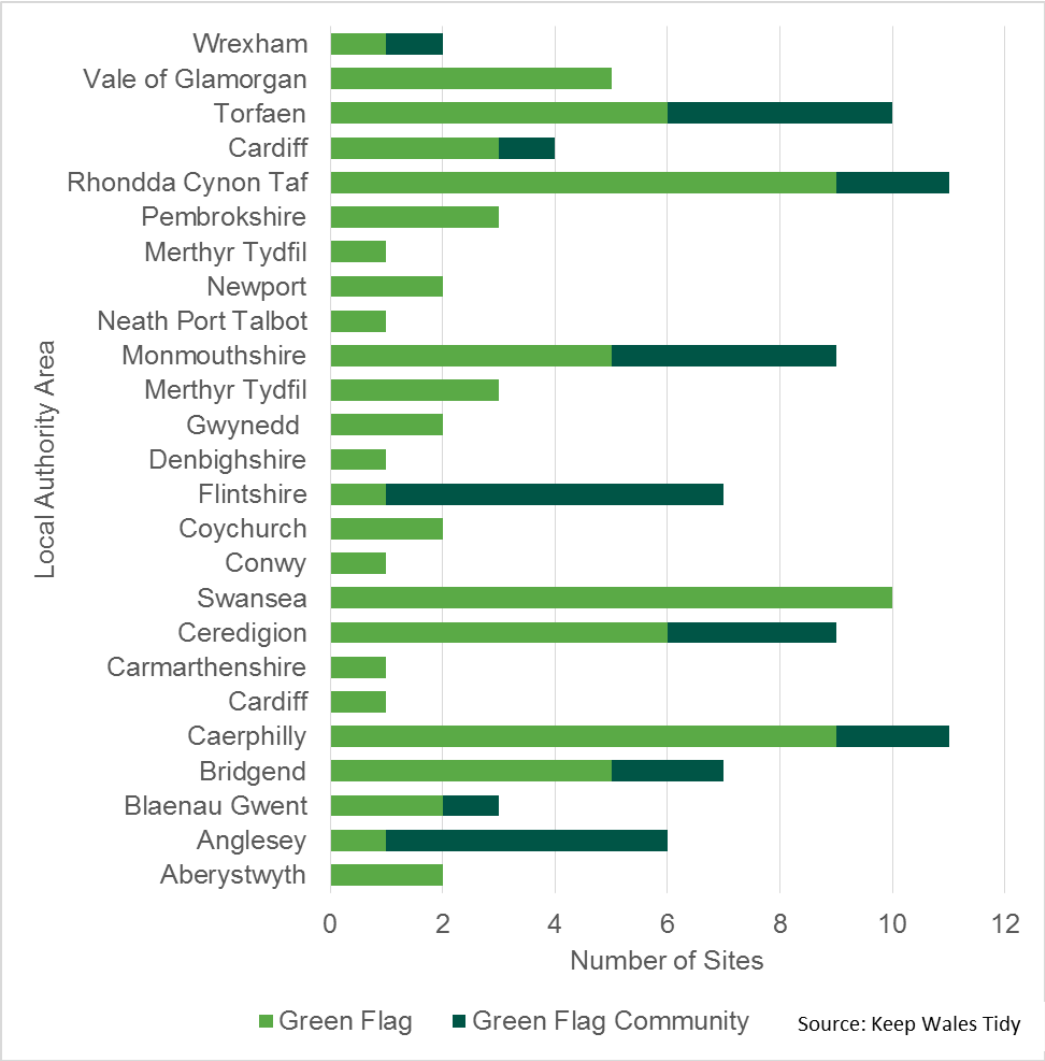

Figure 5.3 Green Flag Sites by Local Authority Area 2015/16[75]

Similarly, the Blue Flag, Green Coast and Seaside awards set the standard for beaches based on: water quality, environmental management, education, and facilities. 44 beaches in Wales were awarded the Blue Flag in 2016[76] (Figure 5.4).

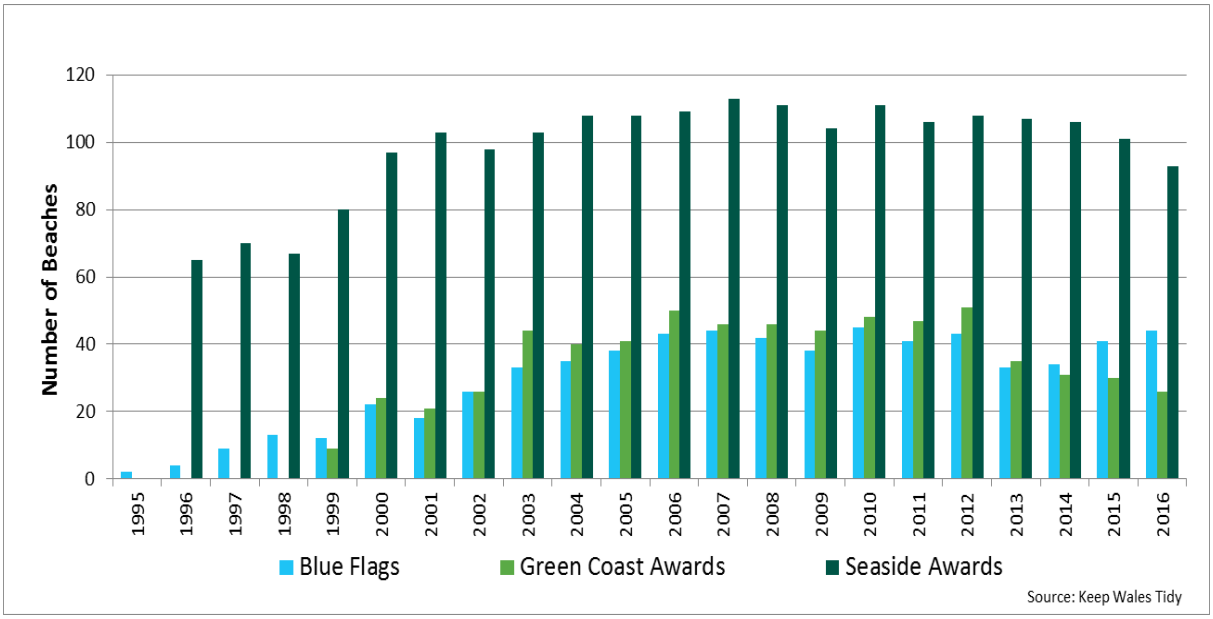

Figure 5.4 Welsh Beach Awards 1995 to 2016[75]

Initiatives aimed at involving communities in the management of their local parks and woodlands have also been shown to increase social capital, improve community cohesion and reduce antisocial behaviour. For example, the Cydcoed initiative in Wales, which ran between 2000-2008, was aimed at increasing community involvement in local woodlands in areas of either poor access or high deprivation. The evaluation of this project found that there had been an increase in social contact, trust, and active engagement, along with a reduction in antisocial behaviour[77].

Communities are also enhanced by the provision of good quality walking and cycling routes, many of which are also 'green corridors' which serve to facilitate the movement of species. The National Cycle Network in Wales provides 1,200 miles of cycle paths, passing within a mile of over 60% of the population. It supported 29 million walking and cycling trips in 2011[78].

Natural resource management can be a means to build social resilience and can help communities to mitigate and adapt to hazards. This has been the focus of recent flood awareness initiatives led by NRW which aimed to build the resilience of communities and individuals through the development of Flood Plans and the active involvement of local volunteers. Recent work by the Joseph Rowntree Foundation *et al* [79, 80] has focused on the inter-relationship between exposure to climate hazards such as flood risk and social vulnerability, mapping what has been referred to as 'climate disadvantage'[81]. Increasing well-being will require a response that tackles this complex balance of building social resilience and mitigating environmental risk.

In relation to woodlands, recent survey data illustrates that they can both positively and negatively impact on community well-being. In 2015, 94% of respondents to the Public Opinion of Forestry Survey[74] identified at least one benefit of woodlands to local communities, while 38% identified at least one disadvantage. The positive

benefits chosen by most people were: they provide ‘places for wildlife to live’, ‘places for recreation’ and ‘they improve the landscape.’ The most common disadvantage chosen was that woodland provided a ‘place for criminal activity’ to occur. In relation to community engagement, the same survey revealed:

- an increase in the percentage of adults involved in volunteering in woodlands, increasing 2 percentage points between 2013 and 2015
- a large increase in the area of land leased or owned by community groups between 2008 and 2010

Finally, a sense of pride in community and place is often associated with groups of people with common interests and employment – particularly those who have cultural associations with the land.

The Vibrant Culture and Welsh Language Goal

> *A society that promotes and protects culture, heritage and the Welsh language, and which encourages people to participate in the arts, sports and recreation*[3]*.*

Landscapes, culture and heritage are intrinsically linked, especially in Wales. The interaction between people and place is highlighted by the European Landscape Convention, which defines landscape as

> ‘*an area as perceived by people, whose character is the result of the action and interaction of natural and/or human factors’*.

It is worth noting that over 25% of Wales is nationally valued for its scenic quality and character, including 3 National Parks and 5 AONBs, with iconic landscapes providing a clear sense of place and cultural identity. Landscapes have played a significant role in the development of distinct cultural practices, such as local building materials and traditions, along with locally specific art and literature.

Cultural Services

Natural resources provide extensive opportunities in Wales for participation in arts, sports and recreation by both local residents and visitors. The Welsh Outdoor Recreation Survey (WORS)[7] found that the vast majority of people in Wales visit the outdoors, with over 80% of adults taking part in informal outdoor recreation at least once every four weeks. People take part in a wide range of activities, ranging from active pursuits, such as hill walking, mountain biking, and kayaking, to more leisurely activities, such as wildlife watching and picnics. Many of these activities are dependent on a high quality natural environment, with people visiting a diversity of places, from local parks to woodlands, mountains and the sea.

The quality, accessibility, and diversity of natural landscapes are also significant factors that encourage and support tourist visits to Wales. The top reason for coming to Wales, given by both UK and overseas visitors, is to enjoy the scenery, landscape and countryside.

There is also a deep sense of local identity, culture and connectivity that is created through the relationship between people and places, as exemplified in the Welsh phrase ‘milltir sgwâr’ and the word ‘bro’, meaning ‘our patch’ or local community area respectively. This concept matches the definition of landscape in the European Landscape Convention, as ‘an area as perceived by people’. People relate to landscapes as places to live, work and enjoy, as contributors to our sense of belonging, identity, well-being and quality of life, and for delivering multiple benefits.

Public perception studies have shown that many cultural services and benefits can be derived from a variety of different landscape types such as moorland or enclosed farmland, each contributing aesthetic appeal and a sense of place and history; in addition to the habitats they contain. The overall cultural benefit derived from such landscape diversity can be greater than the sum of individual cultural benefits from individual ecosystems.

There is also a strong correlation between landscapes and the Welsh language, as demonstrated in a wide range of ‘place-specific’ Welsh words.

The Globally Responsible Goal

> *A nation which, when doing anything to improve the economic, social, environmental and cultural well-being of Wales, takes account of whether doing such a thing may make a positive contribution to global well-being and the capacity to adapt to change (for example climate change)* [3]*.*

Accounting for the global impact of Wales is closely associated with our use of natural resources. It includes the impact both of what we emit and what we consume from other countries. This has been measured as the ‘Ecological and Carbon Footprint of Wales’ (2015)[82] by the Stockholm Environment Institute and GHD. Highlights from this report found that:

- Wales’ ecological footprint is estimated at 10.05 million global hectares (gha), which is approximately 5 times the size of Wales, the equivalent of 3.28 global hectares per capita (gha/c)
- Wales’ carbon footprint is estimated at 34 Mt CO2e, or 11t CO2e per capita

The report states that:

> *“At the current level of consumption, a number of key natural resources are being depleted faster than they can be replenished, and the planet’s capacity to absorb our wastes is exceeded. In other words it is not sustainable in the long term, because we are exceeding the world’s biocapacity. That is to say, in order to sustain our current consumption in the long term we would require more than one planet Earth to provide the resources and absorb the wastes*.”

Wales is similar to other developed countries in this regard, although our ecological foot print is marginally lower than the UK average[82]. However, these estimates show that if everyone in the world consumed the same as the average Welsh citizen, just over 2.5 planets would be required to sustain us.

Ecosystems help to mitigate the impact of our carbon footprint by keeping carbon stored in soils and biomass.

Greenhouse Gases
The Environment (Wales) Act 2016[83] commits Wales to reducing its greenhouse gas emissions by 80% by 2050. The latest greenhouse gas inventory for Wales[84] showed that energy supply constituted 42% of total 2013 greenhouse gas emissions. The main sources of emissions were power stations (76%) and oil refineries (16%).

Biodiversity
There are a number of international commitments on biodiversity which contribute to "a globally responsible Wales". The UK is a signatory to the Convention on Biological Diversity including the Aichi Biodiversity Targets as well as other international obligations such as the regulation of wildlife trade (CITES), the Ramsar Convention on wetlands of international importance, the protection of species and habitats of European importance (Bern Convention), the protection of migratory species (Bonn Convention), the protection of sites of international cultural or natural significance (World Heritage Convention), and the OSPAR Convention for the marine environment (to prevent and eliminate pollution, to assess the quality of the marine environment, and to protect and conserve ecosystems and biological diversity in the north-east Atlantic region).

Food Production and Security
Wales and the UK operate within global food production markets. For those animals and crops that are suitable for production here, Wales has options on a scale between being totally self-sufficient, buying on the open market or somewhere in between. The CCRA17 Evidence Report[60] identifies three risks in this area: risks from weather-related shocks to international food production and trade; imported food safety risks; and risks and opportunities from long-term, climate-related changes in global food production. It recommends that any consideration of how to use the Welsh environment for supplying food should consider these three risks, and the potential impacts on people here and elsewhere.

5.3. Well-being and resilience

Having considered how natural resources can contribute to well-being, we can begin to consider the links between the state of natural resources, and their ability to deliver benefits. Chapter 7 draws evidence from across the report to assess the potential risks to well-being, given:

- extent, condition and trends of natural resources and ecosystems set out in Chapter 3
- initial assessment of the resilience of ecosystems in Chapter 4
- benefits they provide set out in Chapter 5

This analysis begins to identify where well-being may be at risk, or where natural resources are perhaps not currently being utilised to optimise their potential for well-being and other benefits. This is presented as a summary of the key considerations in the form of a natural resources and well-being "risk register". The approach draws on

the methodology developed by Mace *et al*[2], and is supported by a technical appendix which sets out the underpinning evidence that informs our conclusions.

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