The Second State of Natural Resources Report (SoNaRR2020)

Assessment of the achievement of sustainable management of natural resources: Urban

Natural Resources Wales

Final Report

About Natural Resources Wales

Natural Resources Wales's purpose is to pursue sustainable management of natural resources. This means looking after air, land, water, wildlife, plants and soil to improve Wales's well-being, and provide a better future for everyone.

Evidence at Natural Resources Wales

Natural Resources Wales is an evidence-informed 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
- communicating our evidence in an open and transparent way

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Restrictions: None

The Second State of Natural Resources Report (SoNaRR2020) contents

This document is one of a group of products that make up the second State of Natural Resources Report (SoNaRR2020). The full suite of products are:

Executive Summary. Foreword, Introduction, Summary and Conclusions. Published as a series of webpages and a PDF document in December 2020

The Natural Resource Registers. Drivers, Pressures, Impacts and Opportunities for Action for eight Broad Ecosystems. Published as a series of PDF documents and as an interactive infographic in December 2020

Assessments against the four Aims of SMNR. Published as a series of PDF documents in December 2020:

SoNaRR2020 Aim 1. Stocks of Natural Resources are Safeguarded and Enhanced

SoNaRR2020 Aim 2. Ecosystems are Resilient to Expected and Unforeseen Change

SoNaRR2020 Aim 3. Wales has Healthy Places for People, Protected from Environmental Risks

SoNaRR2020 Aim 4. Contributing to a Regenerative Economy, Achieving Sustainable Levels of Production and Consumption

The SoNaRR2020 Assessment of Biodiversity. Published in March 2021

Assessments by Broad Ecosystem.. Published as a series of PDF documents in March 2021:

Assessment of the Achievement of SMNR: Coastal Margins

Assessment of the Achievement of SMNR: Enclosed Farmland

Assessment of the Achievement of SMNR: Freshwater

Assessment of the Achievement of SMNR: Marine

Assessment of the Achievement of SMNR: Mountains, Moorlands and Heaths

Assessment of the Achievement of SMNR: Woodlands

Assessment of the Achievement of SMNR: Urban

Assessment of the Achievement of SMNR: Semi-Natural Grassland

Assessments by Cross-cutting theme. Published as a series of PDF documents in March 2021:

Assessment of the Achievement of SMNR: Air Quality

Assessment of the Achievement of SMNR: Climate Change

Assessment of the Achievement of SMNR: Energy Efficiency

Assessment of the Achievement of SMNR: Invasive Non-native Species

Assessment of the Achievement of SMNR: Land use and Soils

Assessment of the Achievement of SMNR: Waste

Assessment of the Achievement of SMNR: Water Efficiency

Updated SoNaRR evidence needs. Published as a data table on web in March 2021

Acronyms and Glossary of terms. Published as a PDF in December 2020 and updated in 2021 as a data table on the web

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Tables and Figures

1. Headline Messages

By definition, urban areas are where most people live, so they are the source of most human created impacts on the other broad ecosystems. At the same time, this concentration of people presents opportunities for innovation that helps to reduce impacts on the wider environment (WWF, 2019; EU, 2018).

Through rethinking urban design, transport and planning, urban areas can be thought of as 'urban ecosystems' at the forefront of addressing the climate and nature emergencies. This would improve quality of life across the board by designing quiet, safe, clean and green urban space. It would also create new employment opportunities by enhancing the market for new technologies and green architecture.

Urban areas cannot solve their problems at the local level alone. Better policy integration and new governance, involving closer partnership and coordination at the local, regional and national levels, are required.

Urban ecosystems are where most people live and therefore:

- Are the source of most of humanity's demands on other ecosystems.
- Are where the impacts of environmental change on most people are felt.
- Offer great opportunities to create a healthy, productive, zero carbon society.
- Need an adequate supply of green infrastructure to secure liveable places for both people and nature.

2. Introduction

'Cities are ecosystems: they are open and dynamic systems which consume, transform and release materials and energy; they develop and adapt; they are shaped by humans and interact with other ecosystems.' EEA, 2010

The boundary of this urban system has expanded over time, from local to regional, then national to global. The issues for the management of natural resources have also changed and can be characterised as (Figure 1) (Ravetz, 2015):

- **'brown agenda'** – a focus on poverty, including human sanitation, water supply and air pollution.
- **'grey agenda'** – more focus on production, where environmental issues focus on industrial pollution and urban transport impacts.
- **'green agenda'** – more focus on consumption, including global climate emissions, consumer supply chains and corporate responsibility.

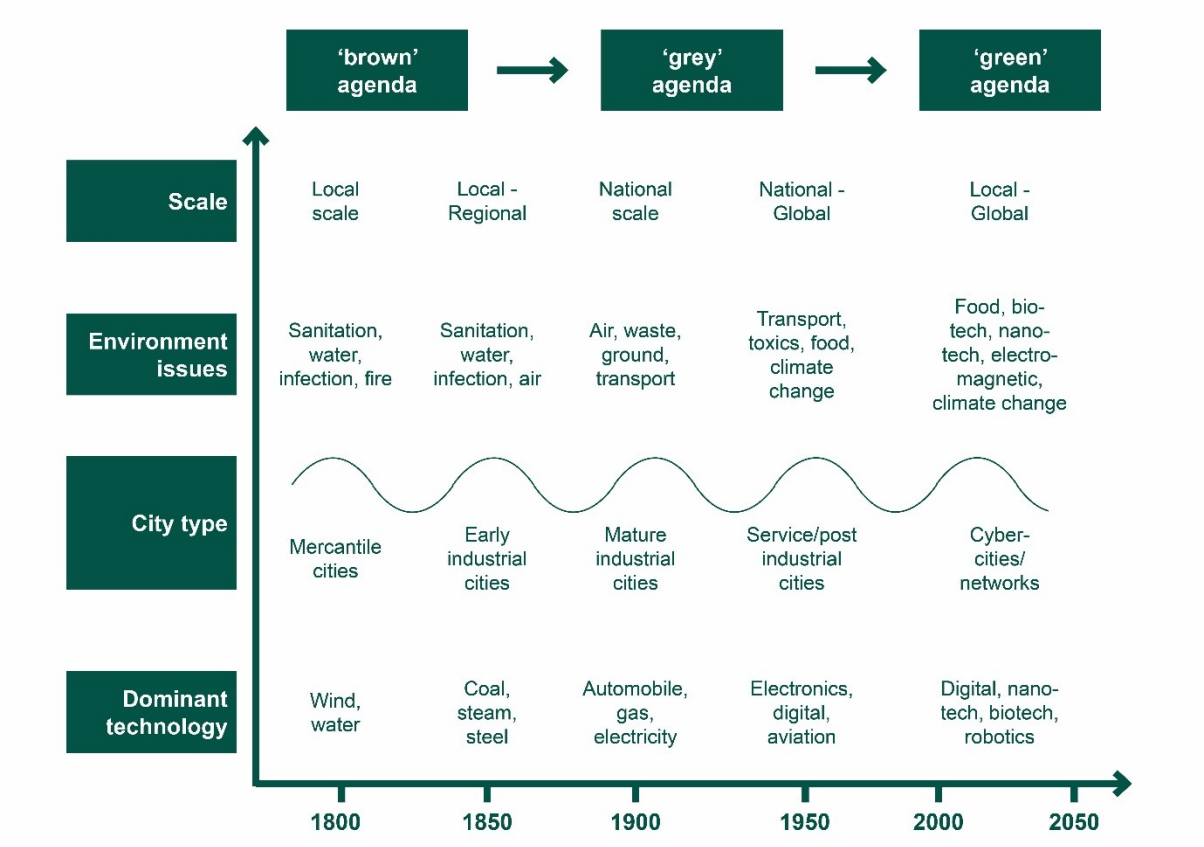

Figure 1 Urban Environmental Transitions
Source: Ravetz, 2020, based on Barnett, 1998; Macotullio and McGranhan, 2006; Ravetz, 2006

Natural resources provide ecosystem services which contribute to a good quality of life through clean air, low noise levels, clean water, a liveable climate and urban green spaces.

Some of the natural resources used in urban areas are bulk minerals, aggregates and construction materials sourced locally. Other natural resources, such as food, are sourced from across the world, through globalised chains of production and consumption - this creates a global impact, for example, from the energy and transport systems used.

In terms of the flow of energy and material resources through urban areas, improvements in the efficiency of buildings, transport and industry, have been outweighed by growing demand for energy, water, construction materials and the general flow of globalised consumer goods (Ravetz, 2015).

Improving the sustainability of urban areas requires a focus that is broader than simply looking at actual resources in a given area. Instead, a systems-based approach is needed. This needs to minimise the impact of urban areas on the wider environment and increasing the resilience of urban areas through properly planned and managed green infrastructure. A systems approach to these connections is shown in Figure 2.

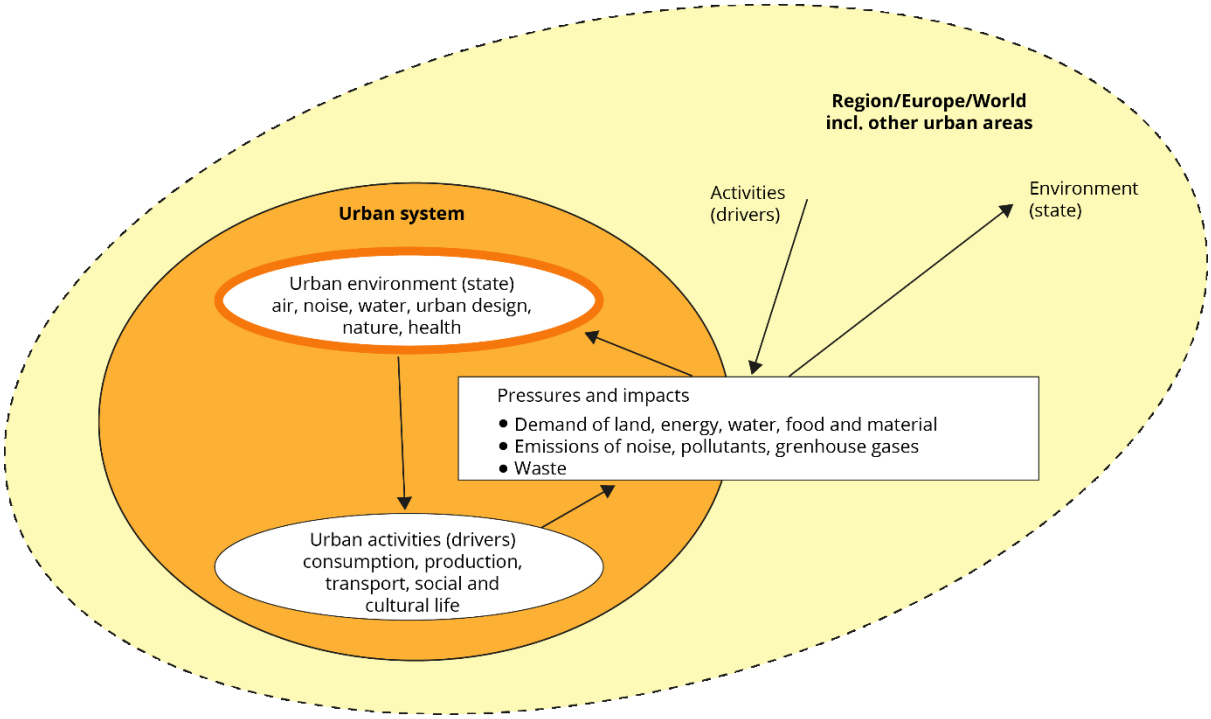

Figure 2 The Urban Environment in relation to areas and activities beyond cities and town
Source: EEA, 2010

Urban areas need to be analysed and managed like any other type of ecosystem. Given that the urban system is human made and functions to provide people with a habitat that meets their needs, it needs to be assessed from a specifically human perspective to delivering sustainability.

In 2015, the UN adopted the 17 Sustainable Development Goals. The 11th goal seeks to 'make cities inclusive, safe, resilient and sustainable'. In line with this goal, we have defined the sustainable management of natural resources relevant to urban areas as a sustainably managed urban environment which:

- Plays an active role in addressing the climate and nature emergencies by minimising its impact on other ecosystems, in Wales and beyond, for example in terms of waste, energy and transport.
- Is resilient to environmental changes, for example minimising the impacts of climate change on the built environment can fit under this, including green infrastructure solutions.
- Provides healthy places for both people and biodiversity, for example good air quality and adequate supply of greenspace.

3. State and Trends (Aim 1)

Here, we will look at the state and trends of the natural resources relevant to urban areas and the drivers of change affecting them. Viewed as ecosystems, urban areas are open, dynamic systems which consume, transform and release materials and energy. Urban areas develop, change and adapt in common with other ecosystems.

Summary Assessment of State and Trends and Future Prospects – Urban Ecosystem

The following tables give a brief description of the past trends and future prospects for the Urban Ecosystem. These are assessed to be:

- Improving trends or developments dominate shown in green
- Trends or developments show a mixed picture shown in amber
- Deteriorating trends or developments dominate shown in red

Further information is provided to put this in context.

Table 1 Key message – Past trends and future prospects of healthy places delivering ecosystem services

Time Period	Rating	Description
Past trends	Mixed picture	7,000 mature trees and their ecosystem services have been lost from urban areas between 2006 and 2013. The urban tree population is ageing and new trees are not being planted to replace those lost. Diversity of urban tree species is also low.
Future Prospects	Deteriorating	Removing trees is predicted to lead to an ongoing loss of ecosystem services due to their role in combatting the effects of climate change. The spread of tree diseases may also reduce ecosystem services even further.

Robustness: Data robustness if high. Evidence on tree loss and time to replace ecosystem services is good. Evidence on tree species and disease impact is good. Evidence on management resources for green space is good.

Table 2 Key message – Past trends and future prospects of Resilience to climate change: flooding

Time Period	Rating	Description
Past trends	Deteriorating	Six of the ten wettest years on record for the UK have occurred since 1998 (Met Office, 2020). Growing evidence of climate change and the increasing recurrence and severity of major flood events over recent decades shows that flood risk in Wales is increasing. Increased extremes in our climate are leading to the extreme flood events Wales experiencing on a more regular basis. (NRW, 2020a). There are currently 245,000 buildings at risk of flooding across Wales.
Future Prospects	Deteriorating	Under the UK Committee on Climate Change (UKCCC) climate change scenarios the risk of flooding is expected to increase significantly (ASC, 2016a). Flood Risk Assessment Wales (FRAW) data indicates that flood risk is expected to increase by approximately 20-30% in the next 100 years (M Pugh, 2021, personal communication, 9 February).

Robustness: Robustness is good. The FRAW data used to generate the numbers of properties at risk of flooding is industry-leading and uses innovative techniques in flood modelling. Having been completed in 2019, this is considered to be the best available data at this time.

Table 3 Key message – Future prospects of resilience to climate change: overheating

Time Period	Rating	Description
Future Prospects	Mixed picture	Under the UKCCC climate change scenarios the risk of overheating is likely to increase. 14% of the housing stock is expected to be either at risk, or at severe risk of overheating by 2050 (Green et al., 2019) but the exact scale of the impact is unknown.

Robustness: Data robustness is medium - based on climate change scenarios, there is a clear risk, but the exact scale of the impact is difficult to establish (Green et al., 2019)

Table 4 Key message – Past trends and future prospects of impact of energy efficiency of Welsh Housing Stock

Time Period	Rating	Description
Past trends	Mixed picture	Wales has some of the oldest and least thermally efficient housing stock in Europe (Green et al., 2018). The percentage of dwellings that were estimated to have an "adequate energy performance" has increased to to 47% in 2017-18, compared to 11% in 2008 (Welsh Government, 2019a). Where "adequate" is defined as an Energy efficiency, Standard Assessment Procedure (SAP), rating of 65 or above.
Future Prospects	Deteriorating	If Wales is to meet its climate targets, buildings will need to operate at close to zero emissions by 2050, which is a significantly higher standard than "adequate energy performance" (Green et al., 2018). Research by Cardiff University on behalf of Welsh Government concludes that "it is technically possible to reduce emissions by 80% from baseline levels through changes to the housing stock" (Green et al., 2018). However, such large scale change requires maximum uptake of technically viable action. These include actions that at present do not have financial return on investment. Cleaner energy supply is projected to be a key aspect of any potential road map.

Robustness: Data robustness is high. This is a well researched subject area with a number of reports available from different sources which all present a similar picture of the scale of the challenge. However, data covers all dwellings in Wales, not just those in urban areas.

Table 5 Key message – Past trends and future prospects of the impact of new development

Time Period	Rating	Description
Past trends	Mixed picture	The impact of new development on the natural environment is estimated to be significant as some towns were built on flood plains and in biodiverse riparian zones.
Future Prospects	Mixed picture	Currently, it is estimated that around 8,300 new houses are needed every year. There is potential for the impact of those developments to be reduced through policy interventions, some of which have already been initiated by Welsh Government.

Robustness: Data robustness is medium/low. The level of robustness of datasets is unknown and it is not possible to disaggregate the data to an acceptable level, such as data on construction in urban and rural areas. However, the overall picture that emerges of the scale of resource use, emissions and waste generated by the construction industry is consistent.

Table 6 Key message – Past trends and future prospects of the impact of transport on the urban environment

Time Period	Rating	Description
Past trends	Deteriorating	Wales has high rates of car use for commuting and has seen small reduction in carbon emissions from transport since 1990. Electrification of trains and road transport is beginning to reduce emissions, as are increases in active travel.
Future Prospects	Mixed picture	Reaching a 43% reduction in transport emissions by 2030 and 79% by 2050 requires an accelerated programme of transport decarbonisation. The ambition outlined in the Wales low carbon delivery plan (Welsh Government, 2019b) is positive, although current progress against the targets could mean that more needs to be done. Increasing uptake of Ultra Low Emissions Vehicles (ULEVs) should help achieve significant reductions in transport emissions in the next decade.

Robustness: Data robustness is high. This is a well researched subject area and there are a number of reports available from different sources which all present a similar picture of the scale of the challenge. However, data covers all transport in Wales, not just those in urban areas.

Air Quality

Urban air quality may have improved significantly since the 1990s. However, it still presents major management problems, especially in “hot-spots” such as Hafodyrynys Road in Caerphilly where oxides of nitrogen breached the hourly limits on NO_2 on more than the 18 permitted number of occasions in 2018 (Ricardo Energy and Environment, 2018).

Gaseous air pollutants produced by road traffic are likely to continue to decline as internal combustion engines are phased out and replaced by electric vehicles. This transition will take some time and air pollution from internal combustion engines will remain a threat to human health, as will emissions generated through the burning of fuels such as coal and wet wood. Air pollution is discussed in more detail in the Air Quality Chapter.

Noise

Transport sources cause a large number of people to be affected by noise. Noise modelling suggests that the homes of over 300,000 people may be exposed to sufficient transport noise to create problems from sleep disturbance (Welsh Government, 2018 and WHO, 2009)

Water – Quality and Quantity

The majority of the 24 Water Resource Zones in Wales are projected to remain in surplus until at least the 2080s, provided that both supply and demand are actively managed (ASC, 2016b). Climate change is expected to restrict the supply of water whilst population growth will add to demand. The challenge of ensuring an adequate water supply is covered in more detail in the Water Efficiency chapter.

The risk of flooding is significant in Wales, with 129,800 dwellings estimated to be at risk of pluvial flooding, 71,500 at risk of tidal flooding and 90,150 at risk of fluvial flooding (source: data extrapolated from the NRW Flood Risk Assessment Wales, 2019b, using undefended counts for the 1000 year flood). As well as damage to houses and businesses, flooding accounts for significant losses in infrastructure services. For example, 166 km of Wales’s strategic road network is estimated to have a 1 in 75, or 1.3%, chance of flooding in any given year (ASC, 2016b).

A combination of misconnections of dirty water, from sewage and washing, at workplaces, in particular industrial estates, homes, privately owned septic tanks and treatment plants together with rainwater collected from manmade surfaces, such as building roofs, roads and pavements, collectively contribute to a mixture of water pollution within towns and cities. This can include dust/grit, oils, detergents, metals, road salt, bacteria from animal faeces and other particulates which become collected through surface water drainage systems or directly into local streams and lake from localised drains.

This pollution can have an impact on rivers, lakes, groundwater, estuaries and coastal waters. In some instances, pollutants from historically contaminated land and atmospheric pollution contribute to the problem in surface waters and groundwater.

A recent consultation on significant water management issues highlighted that pollution from towns, cities and transport contributed to failures in 101 water bodies reported under the Water Framework Directive (WFD) (NRW, 2019a). Pollution from towns, cities and transport has been highlighted as one of the top five reasons why water bodies fail under the WFD (NRW, 2015). This highlights the need for water-sensitive urban planning.

Urban Green Space

Urban areas contain a substantial area made up of domestic gardens, parks, allotments, cemeteries, ponds, road verges and brownfield sites. Detailed analysis of four British urban centres, Bristol, Edinburgh, Reading and Leeds, show that over 60% of the total landcover is “green” – with residential gardens making up 24–36% of each city. Urban centres in Wales are expected to follow a similar pattern.

Managed as part of a green infrastructure (GI) network, green spaces can deliver many benefits in the same place at the same time. GI can: provide wildlife habitats, regulate temperature, absorb flood water, reduce public exposure to air pollution, promote mental health, encourage healthy exercise and attract people to use active travel routes instead of their cars. Section 6.2 of Planning Policy Wales defines green infrastructure (PPW, 2018).

The extent of accessible green spaces is highly variable. Most homes in Wales are within 10km of green spaces of 500ha but most urban areas in Wales do not have accessible green space within 300m of all homes (Stats Wales, 2012). Most local authority areas have one or more sites which have won a Green Flag or Green Flag Community Award owing to their good condition (Keep Wales Tidy, 2020). The number of such awards is growing annually, but the proportion of green spaces with such awards is very low and most authorities enter only their “flagship” parks and green spaces as these are likely to be the only spaces which meet the quality criteria.

The largest investigation into the UK’s public parks and green spaces concluded that long-term under-funding had led to the decline of UK parks with over 80% failing to reach a “good” standard (Urban Green Spaces Taskforce, 2002). The condition of major parks and green spaces has improved since the publication of this report as suggested by the number of Green Flag Award winners. Local governments manage the bulk of urban green spaces including parks and their budgets for this area of work have suffered disproportionate reductions (APSE, 2019; HLF, 2016).It may be inferred from this evidence that if the resources devoted to parks and green spaces decline to the historical extent described in the Urban Green Spaces Taskforce report, then their condition will also return to that described in the report.

Urban Trees

Trees in urban areas are spread across private gardens, parks and streets. A study for England shows that 66% of all urban trees are in gardens and grounds, while 20% are in public parks and 12% on streets (Britt and Johnston, 2008). 7,000 mature trees were lost from urban areas in Wales between 2006 and 2013. This represents a significant loss of the size of tree which delivers ecosystem services most cost-

effectively (NRW, 2016). In 2020, Wales had an ageing population of urban trees which is not being replenished (NRW, 2020b).

There is also a lack of diversity of urban tree species: Asian longhorn beetle potentially threatens 58% of the Cardiff's trees whose services are valued at £6.4 billion (Hand et al., 2018). 42% of Wrexham's trees feature only 3 species with only ten species forming 70% of the total population (Rumble et al., 2015). If observations seen in Cardiff and Wrexham are typical of the rest of Wales, then lack of tree diversity could lead to massive losses if disease affects the main urban tree species found in Welsh towns.

Biodiversity

Urban development can negatively affect biodiversity and ecosystem services through loss or damage to habitats. The growth of urban areas over the last century has required large scale development to meet the demands of the mobility, energy and food systems. Built development and the resulting sealing of soil results in permanent damage to soil functions and an increase in pollution from water run-off.See the Land Use and Soils chapter for more information.

The biodiversity of urban green space varies according to its management, surrounding land use and connection to neighbouring green space. The State of Nature report 2019 showed that urbanisation had a greater impact on species than any other habitat change. Depending on the habitat being built on and the type of development, urban areas can increase levels of biodiversity, at least for certain species. Urban areas have become significant refuges for species such as bees and other pollinators as the quality of the surrounding farmed countryside continues to decline (BTO, 2018). Urban areas have been shown to support a higher number of bee species than rural areas, with gardens and allotments being particular hotspots (Hayhow et al., 2019).

Hedgehogs are classed as being vulnerable to extinction on the Red List for mammals. However, their numbers are increasing in low density urban developments, seemingly helped by public efforts to improve garden habitats and connectivity. Species such as foxes and herring gulls have shifted to urban areas, with refuse providing a plentiful food source and conflict with humans ocurring (Hayhow et al., 2019).

Built Development

One of the main pressures affecting the urban ecosystem itself, is the need for new development. It is estimated that between 6,700 and 9,700 additional housing units will be required each year during the period of 2018-19 to 2022-23 (Welsh Government, 2019c).

New development provides opportunities to improve water and energy efficiency and to make buildings more resilient to climate change. However, construction consumes a significant amount of natural resources, contributes to greenhouse gas emissions and produces waste. The construction industry is the single largest consumer of natural resources in the UK. In 2012, it was estimated that 639,000 tonnes of waste

generated by the Construction and Demolition sector in Wales was landfilled (NRW, 2012). See the Waste chapter for more information.

Developing new housing also produces significant amounts of greenhouse gasses. The European Commission estimates that the whole life cycle of buildings, including extraction of building materials, manufacture, transport, construction and end of life disposal, is responsible for half of all energy use, 40% of all greenhouse gas emissions, half of all raw material extraction and a third of all water use (EU, 2019). See the Energy chapter for more information.

While it is difficult to get a complete picture of the environmental impact of the construction process, it is clear that if current building practices continue, meeting the demand for new housing in Wales will create a significant environmental impact.

Climate Change

Greenhouse gas emissions in Wales fell by more than a quarter between 1990 and 2018 (Figure 3). This is mainly due to more efficient energy generation, natural gas replacing coal, chemical industry decline, waste reduction and changes in manufacturing output. See the climate change chapter for more information.

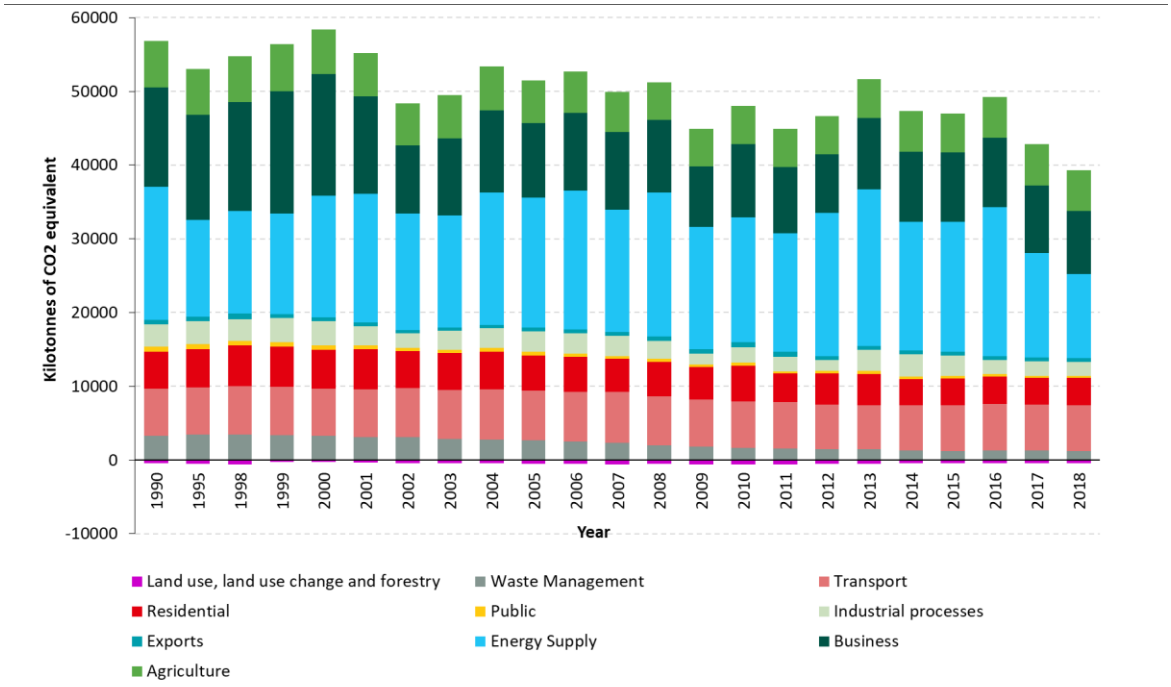

Figure 3 Wales's Greenhouse Gas Emissions by sector 1990 to 2018
Source: NAEI, 2020

Transport

Urban transport contributes to carbon emissions, air and water pollution, noise pollution, and the social and economic effects of congestion or lack of transport opportunities.

- As in most other parts of the UK, private road transport remains the dominant mode of travel - it accounts for the overwhelming majority of commuting journeys in Wales.
- In 2017, 81% of commuters in Wales used a car as their usual method of travel. This was a small decrease since a peak of 84% in 2013.
- The registration of ultra-low emissions vehicles is increasing but this is from a low base. As a proportion of all vehicles registered in Wales, it is the lowest of any UK country or region.
- The proportions of people walking or cycling to work, travelling by rail and using buses remained stable between 2002 and 2018 over the past 15 years (TSGB, 2020).

As most people in Wales live in urban areas, most transport emissions are related to urban areas.

Transport is the 3rd largest source of carbon emissions in Wales after energy supply and business (NAEI, 2020) (Figure 3). The 2020 emissions reduction target from transport from 1990 to 2020 is 14%, meaning that by 2018 the target was missed by 10.25%. See the climate change chapter for more detail.

In 2018,road transport made up 92% of Welsh transport emissions (NAEI, 2020) In 2006, cars accounted for 76% of all trips between 2 and 3 miles and 80% of trips longer than five miles. Above one mile, more than half of all trips were by car in 2006 (Lucas and Jones, 2009). However, passenger journeys on local buses in Wales have reduced by 23% between 2008-09 and 2017-18 (Welsh Government, 2019e). Rail passenger journeys in Wales increased by 29.9% between 2007-08 and 2017-18 (Stats Wales, 2020), but rail transport only made up 1.39% of Welsh transport emissions in 2018.

Energy

Between 2005 and 2019, total electricity demand has reduced by 18%. Around 22% of electricity generated in Wales in 2019 was from renewable sources. The amount of renewable electricity generated is the equivalent of 48% of electricity consumed in Wales, a 5% point increase compared to 2016. At the end of 2017, the installed capacity for renewable energy was 10% higher than the previous year and more than 3 times higher than in 2012 (Welsh Government, 2019d).

Heating and powering buildings make up 9% of Welsh Greenhouse Gas emissions. Urban buildings have a key role to play in decarbonising Wales and delivering healthy, desirable and sustainable places to live. Welsh Government has a target for 1 Gigawatt (GW) of locally owned renewable energy by 2030. By 2030, emissions from buildings have a target to be 40% lower than emissions in 1990. In 2016, emissions from buildings were 31% lower than 1990 (Welsh Government, 2019b).

The UK's legally-binding climate change targets will not be met without the near-complete elimination of greenhouse gas emissions from UK buildings (UKCCC, 2019). In the urban environment opportunities for emissions reductions from buildings are primarily energy efficiency, generation of low carbon electricity and moving to low carbon heating and cooling. See the Energy chapter for more information.

Wales has some of the oldest and least thermally efficient housing stock in Europe. Only 10% of Welsh housing stock was built between 1998 and 2016, after more stringent energy performance requirements were introduced. Because demolition rates are low, it is anticipated that 90% of the 2050 housing stock has already been built (Green et al., 2018).

The Welsh Government has implemented a number of initiatives to improve the efficiency of the Welsh housing stock. The percentage of dwellings with adequate energy performance increased from 11% to 47% between 2008 and 2018 (Welsh Government, 2019a), where "adequate" is defined as an energy efficiency (SAP) rating of 65 or above.This is a significant improvement, but it has been estimated that to achieve an 80% reduction in greenhouse gasses, the Welsh housing stock will need to be made even more efficient – including water efficiency measures – and operate at close to zero emissions (Welsh Government, 2019b), see the Water Efficiency Chapter.

Uptake of micro renewables is low with only 7% of Welsh households using one or more types of renewables such as solar panels, solar photovoltaics, wind turbines, biomass or heat pumps to generate energy (Welsh Government, 2019a).

The burning of emission generating solid fuels, such as coal and wet wood, is widespread in Wales. Across the UK, this practice is estimated to be the largest single contributing source of PM2.5 and has an impact on the air quality in both the immediate neighbourhood and wider afield (Welsh Government, 2020).

4. Assessment of Ecosystem Resilience (Aim 2)

Most people in Wales live in urban areas and most resources are therefore consumed in these areas. This leads to impacts on the wider environment, which can be split into impacts created through the use of these resources, such as air pollution and waste, and the direct impacts created in the ecosystems that provide these resources, such as water, food and aggregates.

It is not possible to undertake an assessment of the resilience of urban areas given their largely human-made nature, however resilience assessment for other ecosystems will pick up the impacts urban areas have on them. The most relevant focus on resilience in urban areas is the supply of ecosystem services to people, (assessed in Aims 3 and 4), such as in resilience of housing to flooding.

5. Healthy Places for People (Aim 3)

Urban areas would ideally provide people with good air quality, low noise levels, supplies of clean water, high quality green space and a stable local climate.

The Regulating and Cultural ecosystem services for well-being provided by urban ecosystems are outlined in Table 7 and Table 8 below. They are developed from the set of services and definitions of the UK NEA Conceptual Framework (Mace et al., 2011). The Wales assessment is our current interpretation based on expert opinion.

Table 7 Relative importance of regulating ecosystem services provided by Urban Ecosystems in Wales

Regulating services	**Level of Importance**
Climate	High
Hazard	Medium-High
Pollination	Medium-Low
Noise	High
Water quality	Medium-High
Soil quality	Medium-Low
Air quality	High

This table is adapted from that in UKNEA synthesis (UK National Ecosystem Assessment, 2011).

Table 8 Relative importance of cultural ecosystem services delivered by Urban ecosystems in Wales

Cultural services	**Level of Importance**
Environmental settings: local places	High
Environmental settings: landscapes/sea-scapes	Not provided

This table is adapted from that in UKNEA synthesis (UK National Ecosystem Assessment, 2011).

Flooding

Flooding is already a significant issue across Wales, with 245,000 buildings currently estimated to be at risk , extrapolated from Flood Risk Assessment Wales (NRW, 2019b). It is anticipated that this risk will increase due to climate change, which is expected to result in more intense and more frequent heavy rainfalls and sea level rise. Additionally, the likelihood of heat waves and the associated risk of overheating, is expected to increase.

In January 2019, it became mandatory for most new development in Wales to use Sustainable Drainage Systems (SuDS) (Welsh Government, 2019g). This means that new developments should incorporate design for surface water management, based on principles designed to work with nature. SuDS use a range of techniques to mimic natural drainage, attempting to keep rain where it falls through infiltration or storage. Systems frequently incorporate flow buffering and filters that remove sediments and provide natural treatment of pollutants. Legally, SuDS must be supported by a management plan and funding for its operational lifetime, and must be designed to deliver multiple benefits wherever possible. This provides opportunities to increase the extent of GI available to counteract the effects of climate change, as well as benefits for biodiversity, amenity and addressing water quality issues.

Water Pollution

Water pollution is variable across urban areas. Urban water courses are prone to pollution from sources including: combined sewer overflows during floods; contamination from faecal coliform bacteria from pets; foul-water drains mis-connected to storm water drains; and run-off from roads contaminated with petroleum products, dust and micro-plastics.See the Freshwater chapter for more information.

Heat Island Effect

The people most vulnerable to the urban heat island and flooding effects of climate change are in South Wales, especially urban centres, Cardiff, Swansea, Newport, Neath Port Talbot, and the Valleys, Blaenau Gwent, Rhondda Cynon Taf, Merthyr Tydfil (Kazmierczak et al., 2016). The benefits of Green Infrastructure (GI) to reduce this impact are extremely valuable; for example, the cooling benefit of Cardiff's GI is estimated at over £1.4m each year in cost savings from air conditioning and the avoidance of labour productivity loss (Kuyer et al., 2018a).

Should disease kill mature urban trees, it would take at least 60 years for their replacements to become large enough to deliver the lost ecosystem services. 60 years from now is likely to be when climate change begins to be felt more strongly and where missing ecosystem services (air cooling, shade, flood amelioration) will be in greatest demand, especially in areas of highest deprivation.

Street trees take 60 years to reach the "break-even point" where the value of their ecosystem services exceeds their planting and maintenance costs - after that, payback continues for over 100 years. However, costs are significant because large

trees need planting in large volumes of soil in underground structures which support the road and footway. This high investment cost has discouraged developers and local authorities from planting large street trees and has led to planting small, short-lived tree species which need replacing before they reach the break-even point (Green Blue Urban, 2018).

Noise Regulation

The annual monetary benefit of the health effects of noise regulation by urban trees in Wales is estimated at somewhere between £1m and £2.6m (Kuyer et al., 2018b). With average traffic noise of between 45 A-weighted decibels (dBA) and 80 dBA, it was found that smaller woodland areas, less that 3,000m^2, are associated with an average noise reduction of 1dBA. The noise reduction from larger woodland areas, greater than 3,000m^2, was associated with a reduction of 2dBA on average (Kuyer et al., 2018a).

Pollination

Pollinators continue to decline in the wider countryside but urban areas are important as sources of food and breeding sites (Baldock et al., 2015). The Action Plan for Pollinators in Wales (Welsh Government, 2013) promotes pollinator-friendly management of road verges and urban green spaces including close mown grass around public buildings.

Access to Green Spaces and Gardens

Most Welsh towns and cities do not have green space within walking distance of all households (Stats Wales, 2012). The quality of existing local green space cannot be verified as most local green spaces are not assessed against the Green Flag Award criteria (Keep Britain Tidy, 2016). Garden sizes in new developments are decreasing (Thompson and Head, undated). Many homes in densely populated areas in the larger towns and cities in Wales do not have access to an outdoor area, such as a garden, and people from Black and Minority Ethnic groups (BAME) are less likely to have access to a private garden than the majority population (ONS, 2020). BAME groups are therefore disproportionately reliant on public parks and gardens for their health and mental well-being benefits.

Urban tree canopy cover in many disadvantaged areas is less than the 20% suggested by the Welsh Government (Welsh Government, undated) and the Furture Generations Commissioner (FGC, 2020). The extent of urban tree canopy cover is very low in many coastal towns and the population of urban trees appears to be ageing with fewer new trees being added. The diversity of tree species is low, making them vulnerable to pests and diseases.(NRW, 2016; NRW, 2020b).

Climate Change and the Built Environment

The following risks from climate change are particularly relevant for the urban environment (ASC, 2016a):

- The risks presented to communities, infrastructure and people's health and well-being from flooding and sea-level rise.
- The risk to the public water supply from drought and low flows.
- Risks associated with an increase in extreme weather, including the risk of overheating.

Risks from flooding

We used the Flood Risk Assessment Wales dataset (NRW, 2019b) to estimate the number of properties at risk for the present day, 1 in 1,000 year 'undefended' scenario. Surface Water counts also include flooding from small watercourses which typically have a catchment area less than 3km^2. Table 9 shows that the number of properties most at risk are those in the most built-up local authorities. Mitigation for Fluvial and Tidal flooding are discussed in other chapters.

Table 9 Total Number of Properties at Risk in Local Authority Areas from Fluvial, Tidal and Surface Water sources (NRW, 2019b)

Local Authority Area	Fluvial	Tidal	Surface Water
Anglesey	230	503	2,114
Blaenau Gwent	1,578	0	5,469
Bridgend	3,661	704	6,647
Caerphilly	4,304	0	8,026
Cardiff	18,989	13,795	8,158
Carmarthenshire	5,580	2,657	6,961
Ceredigion	1,741	838	2,108
Conwy	5,443	9,835	4,391
Denbighshire	3,211	8,305	3,771
Flintshire	4,241	7,479	6,520
Gwynedd	3,060	3,195	6,131
Merthyr Tydfil	1,217	0	4,331
Monmouthshire	2,643	1,504	1,893

Local Authority Area	Fluvial	Tidal	Surface Water
Neath Port Talbot	9,794	3,770	7,681
Newport	5,010	16,708	6,294
Pembrokeshire	642	341	1,804
Powys	3,837	0	5,846
Rhondda Cynon Taff	7,289	0	20,555
Swansea	3,918	913	8,916
Torfaen	1,595	0	3,512
Vale of Glamorgan	749	494	4,733
Wrexham	1,437	1	3,997

Risk to water supply

More action is likely to be needed to achieve more ambitious, but technically feasible, levels of demand reduction for drinking water. Reducing water use in homes is considered to be one of the most important ways to enhance the resilience of water supplies across the UK (ASC, 2016a).

Risks caused by extreme weather events, incuding overheating

Overheating is expected to become a more significant issue in the future that will affect both people's health and the provision of services. However, the exact scale of the impact on well-being is currently unclear (ASC, 2016a). Most homes in Wales were built before Welsh Government guidance on building design to minimise the risk of overheating was introduced (Welsh Government, 2014).

The intensity of heat waves in Europe is projected to increase by between 1.4ºC and 7.5ºC for a rise in global mean temperature of 2ºC (ASC, 2016a). At the same time, the population aged over 75, who are expected to be particularly sensitive to high temperatures, is projected to increase from 9% in 2015 to 19% in 2085 (ASC, 2016a).

Risks from environmental noise

Urban areas concentrate people in a small area and while this provides opportunities for resource efficiency, it also creates impacts such as noise. Undesirable noise affects more people in urban areas and exposure to high noise levels increases the risk of ill health and a poor quality of life

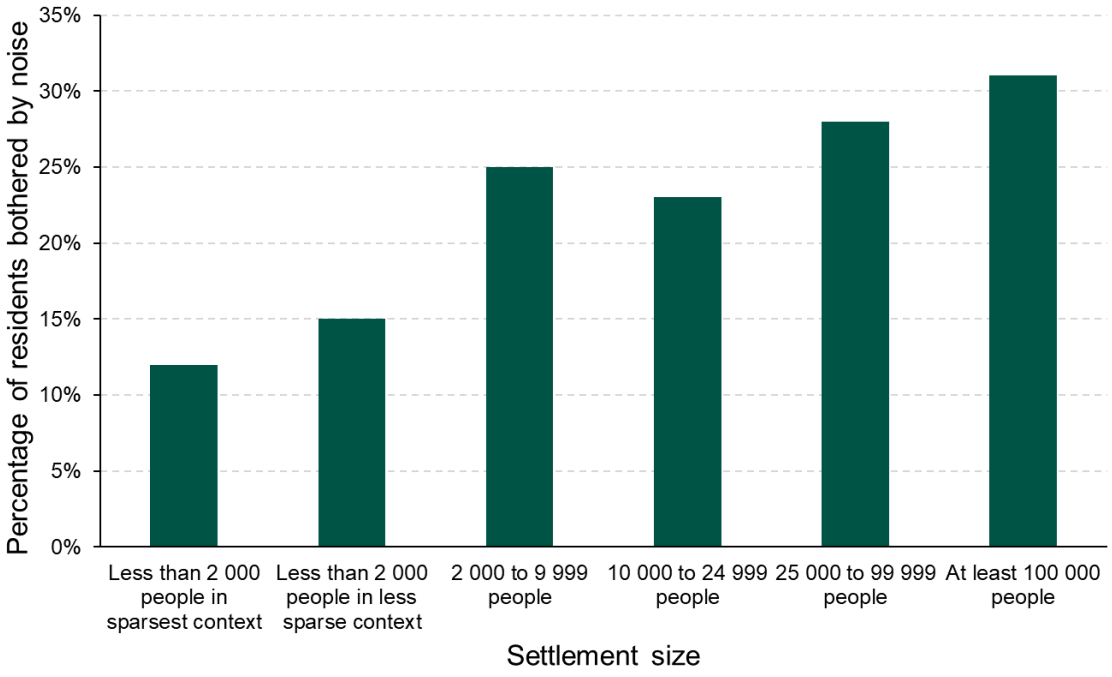

Figure 4 Percentage of residents in urban areas of Wales that are bothered by noise (Welsh Government, 2018)

Green infrastructure can both reduce the intensity of noise and its psychological impact. The HOSANNA project showed that vegetation could reduce noise intensity when added to noise abatement structures (Nilsson, 2013). The Welsh Government recommends the creation or protection and proper management of tranquil green spaces in the built environment to mitigate the impact of environmental noise (Welsh Government, 2018).

6. Regenerative Economy (Aim 4)

Urban areas require a significant amount of resources to continue to function. Only a small amount of the provisioning services that urban areas rely on, such as food and energy, are produced in the urban areas themselves. Urban areas therefore rely on other ecosystems across Wales and further afield for these services, which in turn has a significant impact on the wider environment. See Sections 0 and 4 for more detail.

Securing more sustainable levels of production and consumption will focus around the food, energy and mobility systems with an additional focus, in urban areas, on the construction industry.

The provisioning ecosystem services for well-being provided by ‘urban ecosystems’ are outlined in Table 10. They have been developed from the set of services and

definitions of the UK NEA Conceptual Framework (Mace et al., 2011). The Wales assessment is our current interpretation based on expert opinion.

Table 10 Relative importance of provisioning ecosystem services delivered by Urban ecosystems in Wales

Provisioning services	**Level of Importance**
Trees, standing vegetation, peat	High
Wild species diversity	Medium-High

This table is adapted from that in UKNEA synthesis (UK National Ecosystem Assessment, 2011).

Energy

The UK Committee on Climate Change (UKCCC) calculates that an increase of 134GW of renewable electricity is needed by 2035 to decarbonise the UK's electricity supply. Urban areas can play a significant role in reducing carbon emissions and other environmental impacts of energy generation through local generation, energy efficiency and demand management. Key opportunities for low carbon electricity in urban areas include solar photovoltaics (PV), energy storage, electrification of transport and electrification of heating.

Energy generation for space heating and hot water makes up a large proportion of Welsh building emissions and is the hardest to decarbonise. Reducing emissions from heating is primarily solved through heating efficiency (See the energy chapter). Moving to renewable sources of heat is also important.

Mobility

Transport is the third largest source of greenhouse gas emissions in Wales (NAEI, 2020). Road transport creates local particulate air pollution and oxides of nitrogen which present a major threat to human health in urban areas (Ricardo Energy and Environment, 2018). If the Welsh Government's Active Travel Plan succeeds in further reducing the demand for private transport in urban areas, it will help to reduce these two threats.

Careful integration of green infrastructure in active travel routes is essential to increase their safety and appeal. Public transport should displace private cars in urban areas if it can be made both more attractive and convenient. The use of Ultra Low Emissions Vehicles in urban areas could be encouraged by installing charging points in all new developments and retrofitting charging points in public car parks and on-street parking bays.

Construction of new developments

To improve the sustainability of new construction, action will be required at every stage of the development process; from ensuring the initial design minimises the use of energy and non-renewable resources, through to the re-use and recycling of materials at the end of the building's life.

Using more sustainable building materials is one way to reduce the impact of the built environment. For example, if wood is used instead of steel and cement, this will help to displace industrial carbon emissions, but also store carbon in buildings.

While using wood as a building material does not provide permanent sequestration of carbon, it does provide storage on timescales of decades to centuries. It has been estimated that over a 60 year period, a timber framed house could save around 7 tCO_2e (NHBC, 2011).

According to Welsh Government, demand for Welsh timber for construction had been constrained by over-specification in design requirements. Although this significant barrier has been lifted, better education and awareness programmes need to be developed and there is also potential for clearer regulation and standard setting (Welsh Government, 2019b). A range of cultural, skills and financial barriers in the construction sector also need to be overcome (UKCCC, 2019).

Around 80% of timber used in construction in the UK is imported, but Welsh Government consider it to be feasible to use domestic supply chains and reduce Wales's reliance on imported products (Welsh Government, 2019b). The timber supply chain, including processing facilities, are not yet in a position to support the widespread use of Welsh timber to reduce all reliance on imported products.

7. Synergies and Trade-offs

Trade-offs

While the increasing intensity of development within specific urban areas reduces impacts on the wider countryside, the biodiversity value of existing urban green space can be impacted. In seeking to situate new development in existing urban areas by in-filling on undeveloped land and brownfield sites, there is a trade-off between the loss of urban ecosystem services and the protection of those in rural areas where development would otherwise have happened.

Dense new urban development can include green infrastructure on roofs, walls and transport infrastructure. Green infrastructure in new urban areas will not have the same biodiversity value as any undeveloped area that they replace, but green infrastructure in new developments on degraded land can provide new opportunities for biodiversity (Snep et al., 2009). In some cases green infrastructure can directly replace "grey" infrastructure, for example, by replacing bitumen with grass reinforced with mesh. This will cost money but will be cost-effective as green infrastructure delivers many functions in the same place at the same time, such as air pollution reduction, noise control, storm-water drainage, air cooling, traffic calming and landscaping (Hansen and Pauleit, 2014; Jaluzot and Ferranti, 2019).

While hard to quantify, there has also been a trade-off between the quality of urban space in Wales and that elsewhere. While Welsh urban environments have seen a substantial rise in their cleanliness, major environmental impacts are now displaced to other nations, with pollution and expropriation of resources on a global scale (McGranahan, 2006; Ravetz, 2006; UNEP, 2013).

Synergies

Green Infrastructure is a proven tool for maintaining and improving the resilience of urban ecosystems which can:

- maintain and enhance biodiversity
- reduce and mitigate climate change impacts
- reduce surface water run-off
- improve the liveability of the urban environment for people and wildlife (WWF, 2019)

Increasing energy efficiency of housing stock can reduce fuel poverty and reduce greenhouse gas emissions

The total greenhouse gas emissions from the buildings sector, which covers the emissions generated by heating buildings make up around 10% of the total Welsh carbon budget. In 2018, 12% of all households in Wales were in fuel poverty, with 2% in severe fuel poverty (Welsh Government, 2019h). See the Energy chapter.

Energy use and associated emissions can be reduced by retrofitting energy saving technologies, but this comes at a significant cost. Case studes indicate that achieving an 80% reduction in carbon emissions from an average house, generally requires an investment of more than £800/m^2 (Green et al., 2018). Costs may reduce as technologies become more established but reducing emissions from the buildings sector to close to zero will require significant investment.

Using timber as building material can help reduce emissions and support the timber industry

There is potential to reduce the impact of the built environment by using more sustainable, renewable building materials. Timber frame construction could reduce emissions by up to around 3 metric tonnes of Carbon Dioxide Equivalent (tCO_2e) per home through the displacement of high-carbon materials such as cement and steel and by storing carbon in the building. (UKCCC, 2019) If carbon generated through refurbishment and disposal is considered as part of the model, carbon savings could be as high as 7 tCO_2e over a 60 year period (NHBC, 2011).

Sustainable Drainage Systems can reduce flood and pollution risk while delivering biodiversity benefits

The cost of flooding is known to be significant. The average financial residential insurance claim for the 2015/16 winter floods in the UK was approximately £50,000. For businesses, the average was £134,696 per claim (Environment Agency, 2018). The likelihood of surface water flooding in urban areas can be reduced by "retro-fitting" SuDS such as those implemented in Welsh Water Rainscape projects in Llanelli.

There is potential to reduce the risk of localised flooding through the use of SuDS. Green Infrastructure like SuDS can also significantly improve biodiversity over conventional infrastructure equivalents and in some cases, has comparable measures of biodiversity to natural counterparts (Filazzola et al., 2019). While neither green infrastructure nor engineering solutions will ever totally eliminate flood risk, a mix of approaches are available to manage the risk.

SuDS are now mandatory for most new development in Wales. Existing developments will make up 90% of the housing stock in 2050. Because of the considerable costs associated with flooding (Environment Agency, 2018), retrofitting SuDS in the right places is likely to be cost effective. For example, the Greener Grangetown scheme retrofitted SuDS to 13 streets for the cost of insurance claims on 50 houses for a single flood.

In order to tackle diffuse water pollution from existing areas, retrofitting of SuDS is required. This involves implementing SuDS solutions where improvements to local drainage are proposed and usually, in conjunction with other projects such as town centre refurbishments, improvements to green space, or road improvements.

Beyond the urban boundary itself, the same benefits SuDS can provide for flood management will come from natural flood management, for example woodland management in the tops of catchments.

Green Infrastructure to reduce overheating and deliver biodiversity benefits

Overheating particularly affects urban areas, as heat absorbed by man-made surfaces is released into the atmosphere at night.

This risk of overheating is expected to increase as a result of climate change (ASC, 2016a). After energy efficiency measures are introduced, mid terraced dwellings constructed between 1965 and 1990 are estimated to be at an elevated risk of overheating in 2050, while flats built after 1965 are expected to be at a severe risk thoughout peak summer months (Green et al., 2018). These two types of housing make up 14% of the Welsh housing stock.

Green Infrastructure (GI) can help to reduce the heat island effect, while also providing additional benefits such as biodiversity, recreation and flood regulation. It has been estimated that increasing the current area of GI in Greater Manchester by 10%, in areas with little or no green cover, would result in a cooling by up to 2.5°C

and could keep the current number of dangerously hot nights in 2080 at the 1990 level even under a high emissions scenario (Gill et al., 2007).

Local Climate

Green Infrastructure can play a part in regulating the micro-climate by providing shade, thermal insulation, moisture and wind protection. It can also lower the heat-island effect, which is projected to become even more important with increasing temperatures as a result of climate change.

Green space, including SuDS, plays a role in maintaining or increasing the rainfall infiltration potential of an area. By slowing the rate of rainwater run-off during storms, it can broaden and flatten the “flood peak” and help relieve conventional drainage systems.

Vegetation can hep to improve air quality and noise conditions. Dense shrub and tree plantings can help to absorb dust and pollutants while also acting, to a certain extent, as a filter for noise (Fang and Ling, 2003; Abhijith et al., 2017).

Properly managed urban GI delivers multiple benefits in the same place at the same time (Raymond et al., 2017); using GI to achieve one goal such as in reducing overheating, will normally deliver other beneficial outcomes including flood management, air pollution reduction, biodiversity enhancement and increased human well-being. For example, large species of trees deliver ecosystem services far better and for longer than smaller species (Green Blue Urban, 2018), therefore meeting the requirements of the Future Generations Act to think long term and to integrate across functional boundaries.

Managing road verges for biodiversity can save money and deliver other benefits.

Urban road verges can host significant biodiversity, connect urban greenspaces, manage storm water and trap pollution. Cutting verges less often could enhance biodiversity, aesthetics and pollination services, while saving money. Retaining mature trees and planting additional trees of the right kind in the right places would enhance biodiversity, reduce pollution, regulate temperature, store carbon and manage stormwater (O'Sullivan et al., 2017).

Converting lawns to flowering meadows saves money, benefits pollinators and can reduce anti-social behaviour.

Lawns can be managed in similar ways to road verges to create flowering meadows which are attractive to pollinators and people (Welsh Government, 2013; NRW, undated). This saves money on mowing and there is also significant evidence that increased amounts of well-managed green space can reduce aggressive behavior in urban-dwelling adolescents (Younan et al., 2016). Public buildings like offices, schools and hospitals and social housing occupy a significant proportion of urban areas, therefore the conversion of the close-mown grass which often surrounds them to biodiverse meadows offers a way to save money while tackling the biodiversity emergency.

8. Opportunities for action to achieve the sustainable management of natural resources

‘Cities are ecosystems: they are open and dynamic systems which consume, transform and release materials and energy; they develop and adapt; they are shaped by humans and interact with other ecosystems. They must therefore be analysed and managed like any other type of ecosystem’ (EEA, 2010).

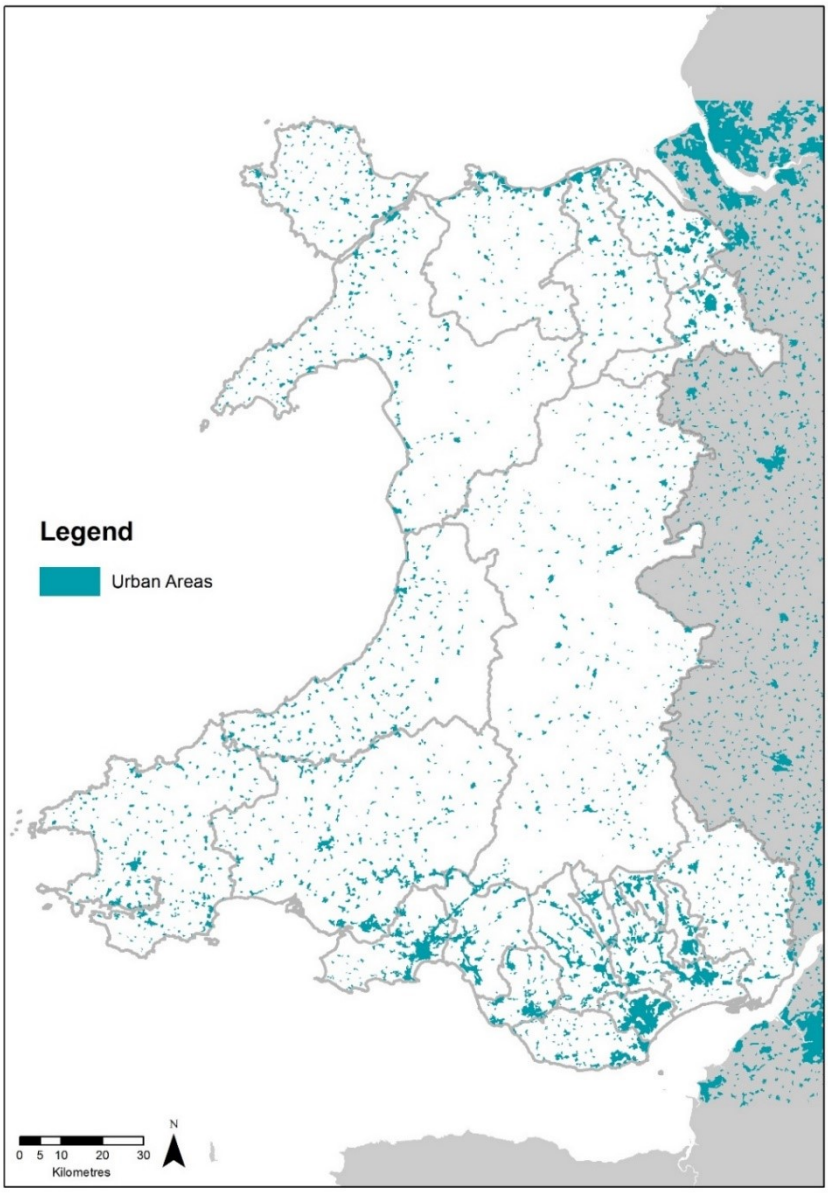

Figure 5 Map showing urban areas in Wales (Data source: Ordnance Survey Basemaps, 2020)

Figure 5 shows the urban areas of Wales and is included here to provide context. Smaller or more rural settlements also have an impact on the Sustainable Management of Natural Resources.

Transforming the urban ecosystem

The density of settlement in urban areas provides many opportunities to enhance the sustainable management of natural resources. Urban areas already have the advantage of shorter journeys to key services, more use of public transport and active travel and denser housing. This means that less energy is used for heating and less land is taken up. People living in urban areas, on average, use less energy and land than those living in rural areas.

The following are considered to be key in minimising the impact of the built environment (UKCCC, 2019):

- sustainable transport
- low carbon, energy efficient buildings
- reducing the impacts of new development

90% of the housing that Wales needs by 2050 has already been built, therefore, as well as a focus on the opportunities new developments offer, attention also needs to be paid to transforming the performance of existing housing stock.

Urban ecosystems are at the centre of thinking on how to address the United Nations' call to transform social and economic systems to meet the challenges of the nature and climate emergencies. Transforming the way people live is central to this, such as changing the energy, food and transport systems, together with the way the built environment is planned. Such changes will have positive impacts not only on the urban areas themselves, but lower the pressures they impose on rural areas in Wales and in other countries.

Multiple benefits of smart urban design

Good urban design:

- Mitigates the effects of air pollution and noise — urban green areas can filter particulate air pollution and create quiet areas.
- Improves the local climate by providing ventilation, reducing the heat-island effect by increasing green areas and reducing the level of soil sealing.
- Supports mental health by providing attractive, quiet and safe places including green areas.
- Reduces overall transport demand — the length and number of trips — and enables more sustainable transport modes, for example walking, cycling and public transport, through increased urban density, a functional mix with shorter distances to jobs and services and a convenient infrastructure for these transport modes
- Reduces energy demand through intelligent building design and urban density as multi-storey houses need less energy for heating and cooling per living area due to a lower proportion of outside walls and roof area than single family houses, for example see Danielski et al., 2012.
- Reduces land demand within and outside the city through attractive urban design, encouraging people to live in the city
- Sets framing conditions for the adoption of more sustainable lifestyles by supporting physical activities such as walking, cycling, outdoor play and sports, which can reduce obesity and cardiovascular problems.
- Supports social inclusion and equity (EEA, 2010)

A systems approach is needed to bring in transformative change. For example, cars are the largest source of noise in urban areas, a major source of air pollution and occupy a large amount of land through road space and parking. Addressing this as an issue solely to do with cars is not going to unlock the results that looking at the transport/mobility system as a whole will deliver. A wider focus which involves rethinking the need to travel will unlock further opportunities to lower emissions and create more liveable urban spaces.

As an example of an integrated approach to these issues, Cardiff Council are developing the One Planet Cardiff strategy (Figure 6) to make Cardiff more sustainable and become a carbon neutral city by 2030.

Figure 6 One Planet Cardiff © Cardiff Council

The One Planet Cardiff strategy looks at 7 different areas of focus:

1. **Energy**: Reduce energy consumption in general and our reliance on fossil fuels in particular.
2. **Built Environment**: Reduce the heat and electricity energy demand of buildings in the city by up to 60%.
3. **Green Infrastructure and Biodiversity**: Re-prioritising the city's green infrastructure to increase and connect green spaces.
4. **Transport**: Rapidly increasing the use of active travel and public transport; accelerating the use of 'clean' vehicles.
5. **Waste**: Boost recycling rates and minimise waste to play our part in making Wales a Zero Waste nation by 2050.
6. **Food**: Minimise the impact our food choices make on the environment.
7. **Water**: Preparing for extreme weather events such as flooding.

Source: One Planet Cardiff (Cardiff Council, 2020)

Urban Neighbourhoods

Recently the concept of a 15 or 20 minute neighbourhood has started to gain some momentum (Figure 7). The idea behind these neighbourhoods is that they are designed in such a way that residents can meet most of their daily needs within a short walk from home. Safe cycling and local transport options are key to this, as well as high quality public spaces, community services and housing densities that make the provision of local services and transport viable. This was pioneered in Melbourne, Australia as a way of guiding the city's development and transformation to 2050 (Victoria State Government). The Future Generations Commissioner for Wales has included a commitment to introducing 20 minute neighbourhoods into towns and cities in Wales as a policy recommendation in their Future Generations Report of 2020. This is described as providing "strong, well connected neighbourhoods where people live within a 20 minute walking distance of key everyday services" (FGC, 2020).

Figure 7 The 20 minute neighbourhood (Victoria State Government, 2020)

Construction Materials

Reducing the overall impact of new development will require a "cradle-to-grave" approach, starting with designs that minimise the use of energy and new materials to the re-use or recycling of building components at the end of the building's life.

There is scope to proactively decrease the impact of the built environment by using more sustainable building materials, such as timber instead of steel and cement. The use of timber in buildings would also contribute to short to medium term carbon storage (UKCCC, 2019).

Welsh Government are already proactively looking at ways to reduce the impact of new developments by addressing the energy efficiency of new housing stock. In this context, it may also be useful to consider the wider impacts of the construction process and for example, if the use of more sustainable building materials could be promoted.

The use of timber as a building material is particularly relevant, but the capacity of the current supply chain may need to be considered further before this is more actively promoted as a building material.

Energy Efficiency of Buildings

Greenhouse gas emissions from space heating and hot water must be largely eliminated to respond effectively to the climate emergency.

As most of the 2050 housing stock has already been built, zero carbon heating will need to be fitted to all existing properties which is likely to greatly reduce fuel poverty. Urban green spaces like playing fields can be important locations for ground source heat pumps for large schemes (Ramboll, 2020). See the Energy chapter for more information.

Driving innovation and efficiency in zero carbon heating, using appropriate technologies which do not harm local environmental quality, should also reduce the demand for solid fuel heating which increasingly contributes dangerous particulate air pollution in urban areas.

The Independent Advisory Group on the Decarbonisation of Homes in Wales put forward a list of recommendations for decarbonising the Welsh Housing Stock (DoHiWAG, 2019). These could provide a helpful starting point for addressing this issue.

As well as redesigning towns to reduce the need for travel, shifting to active travel, such as walking and cycling, and public transport, and reducing emissions from road transport requires a move to more efficient and zero emission road vehicles such as ULEVs, vehicles powered by electric batteries and hydrogen fuel cells.

Green Infrastructure

Planning Policy Wales already requires local authorities to develop green infrastructure assessments which increase ecological resilience and improve well-being outcomes (PPW, 2018). It may be worthwile to explore the potential strategic role of these assessments for considering opportunities to make the urban environment, particularly those areas that have already been built, more resilient to climate change. Challenges such as the risks of flooding and overheating, and what support would be useful to enable this aspect of assessment, need to be considered.

There is also an opportunity to explore how existing or emerging delivery frameworks can support local authorities and other landowners to encourage the management of existing Green Infrustructure (GI) to maximise delivery of ecosystem services.

Strategically planning targeted interventions can help make the urban environment more resilient to climate change. It can be said with some confidence where the greatest impacts of climate change are likely to happen (Kazmierczak et al., 2016) (see also Table 9). and there is good evidence on mitigating these impacts using urban GI (see Gill et al., 2007).

Large trees in urban areas, especially street trees, deliver ecosystem services such as shading, cooling and mental well-being improvements directly where there is greatest demand. Street trees take 60 years to reach the “break-even point” where the value of their ecosystem services exceeds their planting and maintenance costs, after that payback continues for over 100 years. However, initial costs are significant because large trees need planting in large volumes of soil in underground structures which support the road and footway (Green Blue Urban, 2018). As a result, this discourages investment in essential ecosystem services for future generations.

Accessible green space promotes physical health and mental well-being and it is strongly suspected that high quality management of this space is important (van den Berg et al., 2015). Evidence is emerging from the Covid-19 pandemic of the critical importance of access to natural green space for resilience during times of crisis (Samuelsson et al., 2020). There is great scope to improve the resilience of urban ecosystems in Wales by ensuring provision of accessible natural green space within walking distance of all homes as recommended in Technical Advice Note (TAN) 16 (Welsh Government, 2009).

Relatively simple features which promote biodiversity can be incorporated at low or no cost in the specification, design and building of new developments. For example, the inclusion of nesting spaces for swifts has been made a condition of planning approval in some areas (Brighton and Hove, 2020).

9. Evidence Needs

Evidence requirements in urban areas are broad because of these areas contain examples of many other ecosystems and because of the need to determine the effects people exert on the environment as well as its changing impacts upon them.

There are some fundamental issues with the evidence required to assess SMNR as it applies to urban areas in Wales:

- Biological data is not collected at scales which reveal what is happening in urban areas. For example, it may be shown as presence or absence in 1km squares which cut across urban boundaries.
- Species are not surveyed systematically in urban areas so it is hard to assess trends. In other words, if there is a record of a species in an urban area it may only show that someone who can identify that species lives there.
- Some issues, such as air pollution, are only monitored at sampling sites which may be insufficient in number and distributed too unevenly to reveal what is happening across the whole of the urban area.
- Data on consumption of resources may only be available at an all-Wales or all-UK level. For example, energy embedded in building construction.
- Data series which show long term trends, for example urban tree canopy cover and green space distribution, may be interrupted unless long term funding is put in place.
- Data on some important topics is patchy and has not been collected systematically, for example green space quality.

Some important aspects of urban areas have never been investigated in a way that enables us to compare the environmental performance of different settlements, nor can we predict what might happen in future. For example, urban soils are potentially important for carbon sequestration and are certainly important for allowing storm water to drain away, but they have not been studied across Welsh towns and cities. We know there are potential threats to the delivery of ecosystem services in urban areas but we have no system to assess many of these. For example, most urban trees come from a handful of species so the emergence of new pests and diseases could have a devastating effect on the ecosystem services delivered by those trees, but we have no systematic surveillance of urban trees for new pathogens. In some cases we know that climate change could have significant adverse effects on urban areas but we have not collected the data required at a fine enough scale to predict where the impacts will be. For example, we know that increasing the amount of vegetation in urban areas can defeat the build up of dangerous urban heat islands during heatwaves, but we need data collected at the scale of individual buildings to predict where to introduce new vegetation. A more coordinated, systematic and long term approach to collecting and analysing environmental data in urban Wales will help to inform policy decisions which will positively affect the lives of the majority of the Welsh population.

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