Cyfoeth Naturiol Cymru
Natural Resources Wales

The State of Natural Resources Report (SoNaRR): Assessment of the Sustainable Management of Natural Resources. Technical Report. Chapter 6. Identifying Unsustainable Management

Natural Resources Wales

Final Report

www.naturalresourceswales.gov.uk

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.

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

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6. Identifying Unsustainable Management

6.1. Introduction

This chapter sets out the final part of our assessment of the extent to which sustainable management of natural resources is being achieved. So far we have looked at the state of natural resources, at ecosystem resilience and at the benefits ecosystems provide. Each of these is influenced by the way we manage them, which is in turn a response to key drivers (set out in Chapter 2).

The aim of this chapter is to better understand the issues that highlight failings or potential gaps in the way natural resources are managed. If left unresolved, these issues could hinder or undermine the sustainable management of natural resources. Future SoNaRRs will need to track these and other issues over time.

The use of most if not all of our natural resources is regulated or managed in some form or other. However, there remain failings or gaps in the regulatory framework, in management, or in the information that informs decision making. In some cases, mechanisms such as incentives to support specific policy objectives create perverse or unintended outcomes for the use and management of natural resources. These could create potential issues for the health and resilience of ecosystems and the benefits they provide. We regard these failings or gaps as additional “risks”.

We use this analysis to add to the risk register presented later in the next chapter, which draws on the risks to well-being both from the resilience of ecosystems and from the unsustainable use and management of natural resources.

6.2. Sustainably managing natural resources

The definition of “sustainable management of natural resources” set out in Section 3 of the Environment (Wales) Act covers not only how natural resources are used (in a way and at a rate) but also how action or non-action may maintain and/or enhance the resilience of ecosystems and the benefits they provide.

Therefore, the sustainable management of our natural resources is not limited to the direct use of those resources but also, for example, to the management of the impacts of production activities on the health of ecosystems or to how society can use resources more efficiently (e.g. by reusing and recycling materials) as a way of reducing the use of primary natural resources.

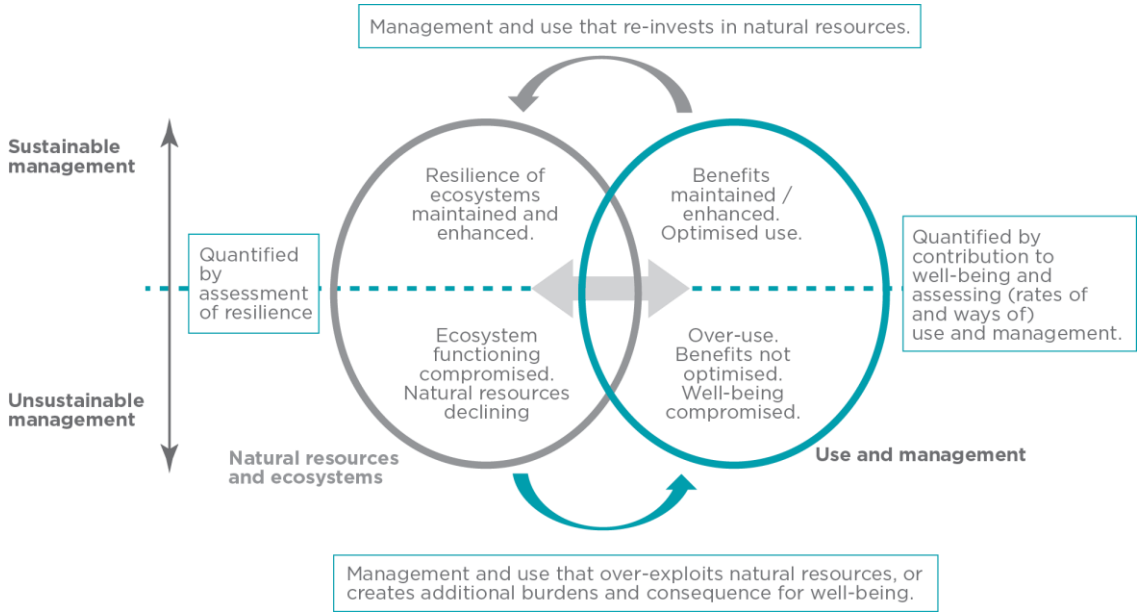

Figure 6.1 Identifying sustainable and unsustainable management.

In Figure 6.1, we want Wales to be above the dotted line, i.e. where sustainable management is being achieved. In SoNaRR, and in this chapter in particular, we are looking at where use and management activities may indicate we are falling below the dotted line. We have called these activities “issues of concern” (see below). Whilst not perfect measures, they can be explored when we analyse existing measures, management targets and thresholds that tell us something about how well we are doing (see Chapter 7 Annex 1). We also consider where management systems are putting additional burdens on well-being by virtue of their negative impacts (‘side effects’) on ecosystem resilience.

We have already considered the cumulative impacts of activities on biodiversity and the resilience of ecosystems in Chapters 3 and 4. In this part, we consider a further range of activities that, whilst not complete, reflect the diversity of natural resource use and management:

- Waste generation and management
- Managing our water
- Air quality management
- Managing our soils and land
- Managing our woodland resource
- Energy use, management and decarbonisation
- Managing our urban systems
- Managing our seas and coast
- Valuing ecosystems and their services

Whilst we have looked at the impacts of land management practices, particularly agriculture, across these activities, we have chosen not to look at agriculture and food as a whole system – as it is far too complex. However, we recognise that this is something that will need to be considered in the future.

For each activity, we look at examples of *issues of concern* and try to consider whether we have the appropriate mechanisms in place to deliver sustainable management.

As highlighted in Figure 6.1, there are certain criteria or issues of concern that we considered in the assessment of sustainable use and management of natural resources. They indicate where we are falling 'below the line':

- Natural resources are continuously declining or are being used faster than can be replenished;
- The health and resilience of our ecosystems is being compromised. This includes targets not being met or 'limits' in danger of being breached;
- The benefits from ecosystems services are not being optimised;
- The contribution to well-being of ecosystem service provision is not meeting our basic needs, or is declining.

We have flagged these criteria within the analysis below in *italics.*

Taking this approach further, meeting management targets or standards (for example air quality standards, watercourses achieving 'good ecological status', recycling targets) can be taken as an indication of sustainable management and the failure to meet them as an indication of unsustainable management. We need to be mindful that existing standards or indicators, focused around condition, may not convey information about all the aspects of resilience that need to be considered; different measures may need to be developed.

We recognise that this report is a functional based assessment – reflecting a series of 'closed systems' – based on existing ways of managing them. However, future SoNaRR reports will need better to consider the activities, across the breadth of society and the economy, which have implications for the management and use of natural resources and for ecosystem resilience. Over time the assessment may need to extend into lifestyle patterns, such as travel choices, and market and consumer trends.

6.3. Waste generation and management

Introduction

Across business and industry, farming and food production, home and office, many different forms of resources are used and wastes produced. Moving towards a circular economy[1] will help to keep resources in service for as long as possible, maximising their value when in use and then, when no longer useful to society, ensuring that those resources are captured for re-use and recycling, and recovery or reintegration into ecosystems. Innovation in the way that we use and maintain our resources can drive new businesses to find new markets and develop new services. There are still significant opportunities to reduce, reuse, recycle, and recover waste across Wales; businesses will realise appreciable reductions in costs by doing so.

What are the existing measures of sustainable use or management?

The ambition of "Towards Zero Waste" (the Welsh Government's Overarching Waste Strategy Document for Wales) is to be a zero waste nation by 2050[2]. Welsh Government's vision is one of green growth where businesses are the custodians of our natural resources and are both environmentally and socially responsible.

How are we doing?

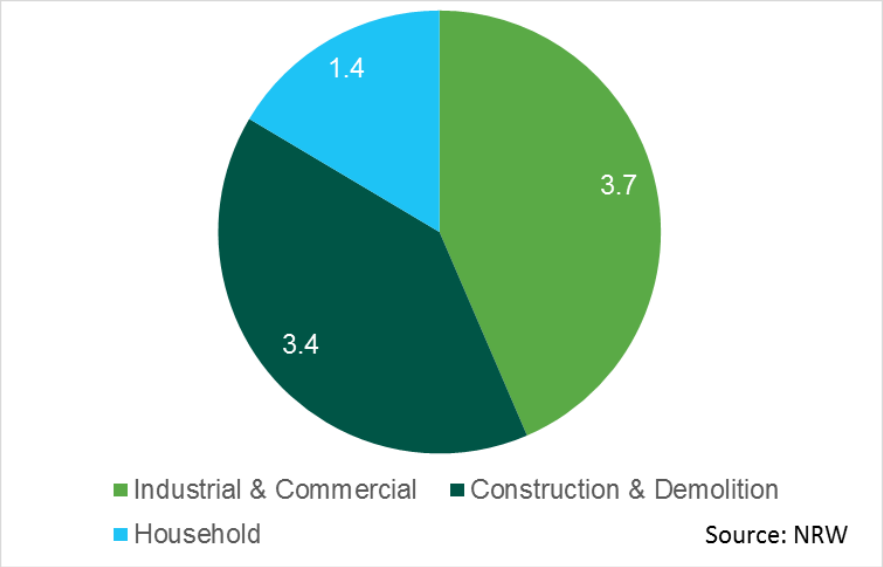

Figure 6.2 Waste generated in Wales by source 2012 (million tonnes)[3, 4, 5].

Welsh industrial and commercial sectors generated an estimated 3.7 million tonnes of waste in 2012. Welsh construction and demolition sectors generated an estimated 3.4 million tonnes in 2012[3] (Figure 6.2).

Comparing the industrial and commercial 2012 survey data to the previous 2007 survey data indicates that there were no statistically significant differences in terms of waste generation. This suggests there had been no progress in reducing waste generated by these sectors, which is a concern if we are to meet the zero waste ambition.

Following a steady historical increase, the total amount of local authority municipal waste generated in Wales peaked at over 1.9 million tonnes in 2004-05. The amount of local authority municipal waste generated has since been generally falling: to 1.5 million tonnes in 2014-15.

Management of waste generated in Wales

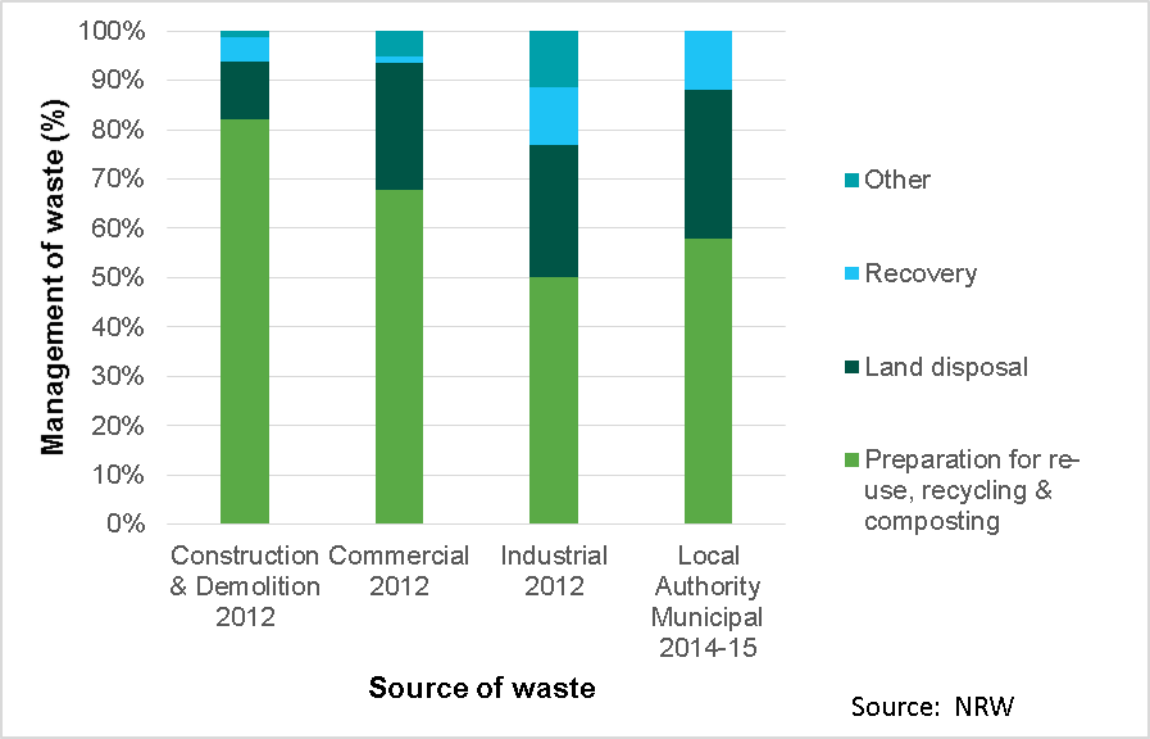

Figure 6.3 Management of Waste generated in Wales. 'Other' includes land recovery, incineration, treatment, transfer station and unknown. C&D figures exclude hazardous and naturally occurring soils and stones waste. Time series differs - I&C and C&D 2012, Local Authority 2014-15[3, 4, 5].

Wales has made major improvements in managing waste over the last decade by increasing the amount sent for recycling and reducing the amount sent for disposal (latest available data by source shown in Figure 6.3). For example, the percentage of local authority municipal waste that was prepared for reuse, recycled, or composted has continued to increase from 5% in 1998/99 to 56.2% in 2014/15[5]. During 2013, facilities in Wales managed a total of 7.9 million tonnes of waste. The amount of waste sent to landfill in Wales is continuing to decrease (2.1 million tonnes landfilled in 2013; a 52% reduction over 12 years)[6] (Figure 6.4).

However evidence indicates that there are considerable amounts of recyclable material still present within the residual waste stream[7]. For example, almost half (48.9%) of residual waste collected at the kerbside is widely recyclable. Food waste is the single biggest contributor of this so there could be significant potential for improving household recycling rates.

It is worth bearing in mind that local authority municipal waste generation accounts for less than one fifth of the total waste generated in Wales so more reduction needs

to be achieved through the Waste Prevention Programme and sector plan delivery for all waste generated in Wales.

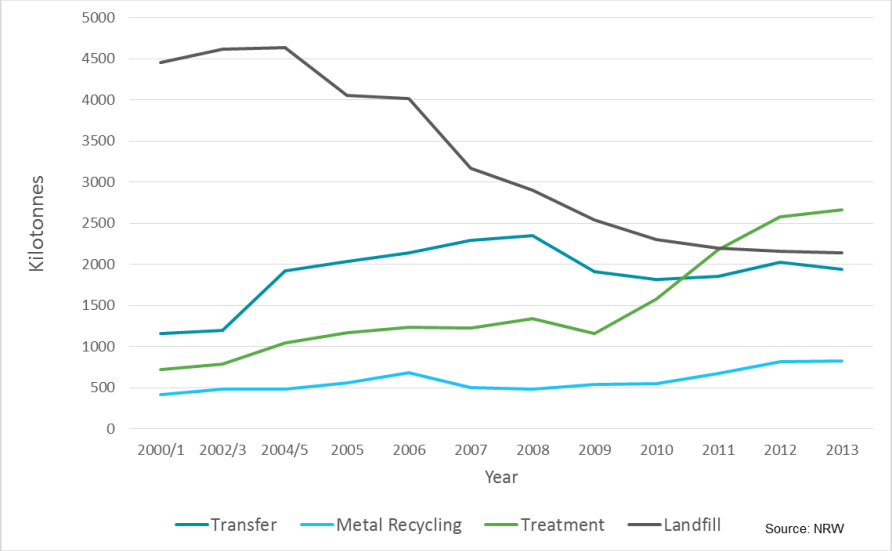

Figure 6.4 Waste management trends 2000/1 - 2013. Waste inputs shown in kilotonnes by site type in Wales[6].

"The benefits of ecosystems services are not being optimised"

One potential market opportunity for re-using and reducing waste is anaerobic digestion. Using appropriately controlled and treated biodegradable waste as a soil improver could, in some instances, replace the need for manufactured fertilisers and improve soil condition. This could also increase the capacity of the land to act as a 'carbon sink', reducing the amount of greenhouse gases in the atmosphere. Furthermore, the treatment of some wastes by anaerobic digestion also provides an opportunity to generate electricity[8].

On-farm anaerobic digestion plants provide a potential mitigation option for reducing greenhouse gas emissions from manures and slurries, alongside the potential to deliver low carbon energy to the agricultural sector. However, these are not a simple "low-tech" solution and require appropriate management skills.

Even within the residual waste stream, there are opportunities for and benefits from capturing energy from waste. Energy from waste is the most sustainable option for managing the residual waste left after recycling has been maximised. However, there are gaps in market opportunities that still need to be addressed if benefits from such a technology are to be realised.

"The health and resilience of our ecosystems is being compromised"

Waste crime takes many forms, and is committed both on a large scale by organised groups and on a small scale on the spur of the moment. Waste crime can include fly-

tipping, a waste site receiving material that is not covered in its permit, sites operating outside the permitting system, and the illegal exporting of waste. Waste Crime costs the UK £568 million each year in clean-up costs and lost tax revenues[9].

Waste sites are illegal if they do not have a permit or do not meet other legal requirements, such as a registered waste exemption. The majority of the waste industry operates responsibly, but a small proportion fails to meet the required standards or deliberately operates outside the law. These exceptions have many impacts: on the environment, on communities, on legitimate waste businesses and on the sector's reputation. They also pose a greater risk of incidents that consume a large amount of public sector resources.

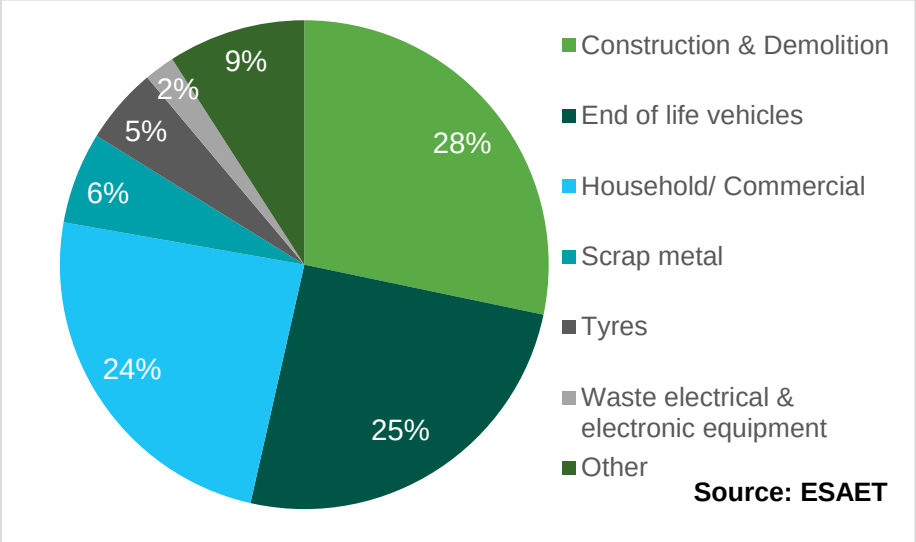

Figure 6.5 Type of Active illegal waste sites March 2013 (England & Wales)[9].

As of March 2013, there were 820 known illegal waste sites in operation in England and Wales, with 817 new sites discovered in 2012-13[9] (Figure 6.5). Any relevant updates to Wales waste crime statistics will be included in future SoNaRR updates.

The most common types of wastes managed by the known illegal waste sites are construction & demolition, end of life vehicles and household/commercial waste.

What are the key risks?

- Whilst Wales is performing well against Welsh Government's Towards Zero Waste aspirations and statutory targets, we are missing opportunities to establish a circular economy. This is a risk to the achievement of the goal of 'A prosperous Wales'
- Because an increasing population consumes more natural resources, reducing waste generation is becoming even more significant as a challenge. If we do not reduce our waste, we risk placing more pressure on our natural resources to deal with it

- A lot has been achieved with public participation in recycling at home; however, persuading more people and businesses to take part in recycling remains a key challenge, particularly for waste which is unavoidably created;
- We need to ensure that our approach to regulation and enforcement supports good business and is not disadvantaged by those intent on avoiding meeting the standards;
- Although well regulated, waste still poses potential risks to the condition (and therefore resilience) of ecosystems and the benefits they provide. Improving the management of waste as a resource will reduce greenhouse gas emissions. This would also help to deliver well-being benefits, including environmental benefits, health benefits and the avoidance of local impacts (such as landscape deterioration, littering, and local water and air pollution).

6.4. Managing our Water

Introduction

Chapter 3 has set out the condition and trends in our water resources and freshwater ecosystems, demonstrating a range of risks to resilience and well-being.

Much UK and EU legislation to manage the abstraction of water from our rivers, lakes and coastal waters, and to control the quality and quantity of water is already well established. Examples are: the Water Resources Act (1991), Water Industry Act (1991), The Water Environment (Water Framework Directive) (England and Wales) Regulations 2003, the Flood and Water Management Act (2010) and the Water Act (2014).

What are the existing measures or standards of sustainable use and management?

- Water Framework Directive (WFD) Good ecological status. Freshwater SSSIs and SACs in appropriate conservation management
- Under the Water Resources Act, all new abstraction licence applications must demonstrate the “proper” use of water resources. Benchmark water use figures are defined to inform this assessment[10,11,12,13,14]
- Number of pollution incidents
- Cross compliance attached to direct payments to farmers – for example, standards for keeping land in ‘Good Agricultural and Environmental Condition’ (In particular GAEC 1-6 in relation to water and soil management) and statutory management requirements (in particular, SMR1 in relation to Nitrate Vulnerable Zones (NVZs)) under the Basic Payment Scheme

How are we doing?

We are not yet achieving the sustainable management of water. Some of the gaps in the current management of water are being addressed. For example:

- Proposals by Welsh Government and Defra to reform the water abstraction management system to meet the challenges of climate change, population increase and changes in people’s behaviour, whilst still protecting the environment[15]. The reformed abstraction management system is likely to be implemented in the early 2020s.
- Evidence provided by NRW to Welsh Government as part of the Nitrate Vulnerable Zone review cycle has identified where nitrate levels have increased due to agricultural practices. Welsh Government will consult on these assessments in 2016 to inform their decisions on actions required and areas for designation. Actions will aim to address the extent to which agriculture is contributing to the nitrate pollution of waters.

Nevertheless, there remain significant issues of concern – in particular:

- legacy issues: minewaters and physical modifications to watercourses

- point source and diffuse pollution arising from agricultural and forestry land management
- point source and diffuse pollution arising from sewage treatment systems and urban drainage
- catchment management to address low and high flows

These are explored further below.

"The health and resilience of our ecosystems is being compromised, including targets not being met, or "limits" in danger of being breached."

Legacy issues: minewaters and physical modifications
The Industrial Revolution has left a legacy which continues to have a negative impact on the benefits provided by water resources and freshwater ecosystems. Pollution from 1,300 abandoned metal mines is why good status was not achieved in 67 (11%) water bodies which cover a total of over 700km of rivers. The remediation of metal mine sites relies on a complex combination of issues, including technological feasibility, clarity of ownership and agreement by owners to finance solutions.

Physical modifications to watercourses (such as culverts, dams and weirs) have adjusted the natural hydrology of rivers, lakes and streams which in turn can affect aquatic biodiversity and water quality. They are the reason for 237 (40%) water bodies not achieving WFD Good status. Together with partners, NRW has made alterations to the structure of hundreds of barriers in order to restore fish migration. This work is reliant on the consent of land and asset owners.

Point source and diffuse pollution from rural land uses
Agriculture and forestry are the dominant land uses in Wales. The management of farmland, especially in the dairy and intensive beef sectors, can have a major impact on water quality. Many slurry and silage storage structures are now reaching the end of their design life, creating significant risks in terms of point source pollution[16]. Figure 2.4 (in Chapter 2) showed the number of significant pollution incidents affecting water quality across Wales. Increased production on dairy and beef cattle units creates particular issues in terms of slurry storage and management: 90 water pollution incidents related to dairy and beef farming, out of a total of 139 attributed to agricultural premises, were recorded in 2015 (Figure 6.6)[17].

Diffuse pollution risks have also increased as a result of the need to spread large quantities of slurry. Diffuse pollution also takes the form of elevated levels of sediment in many watercourses, something which results from the trampling of banksides and the poaching of fields by livestock[18].

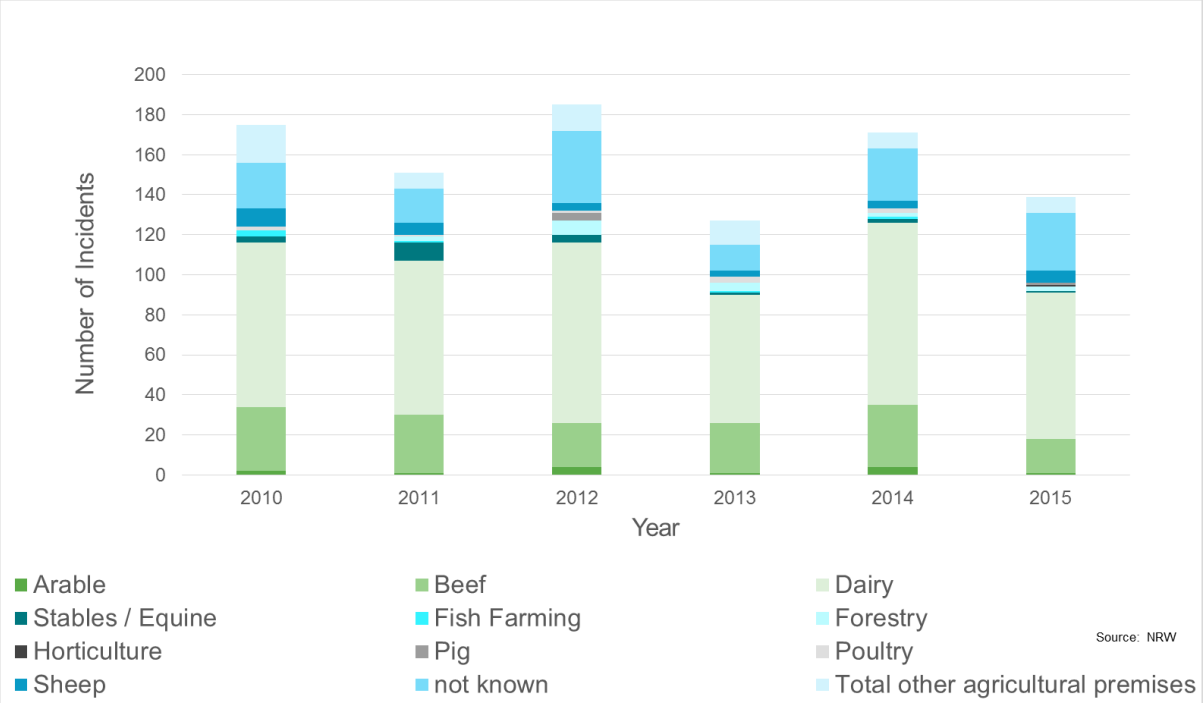

Figure 6.6 Recorded water pollution incidents (category 1 to 3) from agricultural premises 2010 to 2015.

Continued falls in market prices and reductions in profitability will further reduce the capacity of farmers to address these issues; for example, by installing new slurry management facilities and taking smaller scale actions to reduce bankside poaching by livestock. It is really important to consider these wider drivers in the identification of responses.

The impacts of poor land management practices result in nutrients, pesticides and sediments being washed off land into rivers and streams, increasing the risk of pollution. We have identified 166 water bodies failing WFD Good status because of agricultural pollution. The area of land within NVZs is expected to increase as further designations are made based on the quality of surface and groundwaters.

Private groundwater drinking supplies are particularly vulnerable to pollution, with 8.7% of tests failing to meet the standards in 2014 due to microbiological and chemical parameters.

Point source and diffuse pollution arising from waste water and urban drainage

Sewage and waste water can contain large amounts of nutrients (such as phosphorus and nitrates), ammonia, metals, viruses and bacteria, and other chemicals such as gender-changing hormones. These can have a detrimental effect on ecosystems and a significant impact on our use of water, particularly on the recreational use of bathing waters and waters supporting shellfish for consumption.

Pollutants enter the water environment through discharges from sewage treatment works and sewage overflows (either treated or untreated). WFD investigations have

identified 96 water bodies which do not achieve Good status because of water industry sewage discharges.

There are also many properties that are not connected to mains sewerage. These properties are instead served by an estimated 90,000 small private sewage treatment systems. Approximately 53,000 private treatment systems have been registered as exemptions under the Environmental Permitting Regulations, and a further 3,400 have an environmental permit. NRW performance analysis of privately operated sewage treatment works regulated by a permit with set numeric standards indicates that compliance compares poorly (64-73% compliant over the last five years) with water company permit compliance (96-99%)[19]. This is a potential threat to water quality, and is difficult and complicated to regulate. Deterioration in the quality of water can be found where there is a high concentration of private discharges even when the treatment systems are well operated.

In total, 97 (16%) water bodies are identified as failing WFD Good status because of urban diffuse pollution. Our towns and cities are paved with impermeable surfaces: concrete, brick, slate and tarmac. Rainfall collects on the surface as it cannot soak away. Drainage systems constructed for urban areas protect property from flooding by collecting rainwater and directing it into underground pipes, thereby removing the water from the site as rapidly as possible. As a result, accumulated pollutants from roads, buildings and urban land are washed into surface waters and peak flows are increased; this can damage stream ecology and increase downstream flood risk.

Impermeable surfaces also stop water draining locally into the soil and aquifers which reduces the availability of water for urban vegetation, local water features and groundwater resources. When rainwater drainage enters sewers it puts increasing pressure on the existing sewerage infrastructure. It also changes rainwater from a fairly clean state into a dilute effluent as it mixes with sewage. Ageing sewage networks together with future urban development could overload treatment works, increase the number of spills from overflows and have an impact on our freshwater ecosystems.

Increased rates of soil sealing from building developments on green spaces have led to increased surface water run-off, additional pressure on drainage and sewerage systems, and associated impacts (also see Chapter 3 urban section). Changes in weather patterns and population distribution alongside the need for new development all contribute to pressures on the infrastructure in place to deal with our sewage, waste water drainage and flood risk. We need better water sensitive urban design which can use run-off to benefit our towns, if we are to manage the risks to the resilience of freshwater ecosystems and urban systems.

Error or negligence can result in foul discharges being “misconnected” to surface water drainage systems. Where detailed studies have been undertaken across Wales, and specifically at Caswell near Swansea, one in ten of the properties tested had misconnections[20]. This lack of awareness creates water quality issues (and risks for the resilience of freshwater systems). It is not easy to manage or regulate, given the broad extent of private properties and random nature of misconnections. Whilst

legal action (including serving notice to address the problem) can be taken, it is costly and very rarely done.

The benefits of ecosystem services are not being optimised.

Catchment management to address low and high flows
Recent policy (partly driven by the Water Framework Directive) and new legislative requirements support a more integrated "catchment management" approach to help identify joined-up action to manage water quality and regulate low and high flows. One of the challenges of adopting a truly integrated approach is the need to move from more traditional functional work programmes, where action is taken to address a single issue, to measures that maximise the benefits of managing the ecosystem of the catchment as a whole.

For example, implementing natural measures to reduce flood risk by retaining water and reducing flow helps to demonstrate how integrated catchment management may be beneficial to the wider resilience of ecosystems. Many interventions designed primarily to reduce the volume of water, which are implemented to reduce flood risk, are also likely to bring about improved habitat connectivity, enhance areas for wildlife, deliver benefits for water and soil quality, and help the delivery of drought management. Natural interventions may also help to enrich the aesthetic quality of an area or may improve access and recreational opportunities, thereby helping to support delivery of health and well-being benefits. A more holistic catchment management approach can also help to improve resilience to climate change, which has much wider social and economic impacts for the people of Wales.

The extent and delivery of greater integrated catchment management will depend on how outcomes are prioritised; Chapter 7 explores how spatial mapping could be developed to address this challenge.

What are the key risks?

There are a number of interconnected risks to the services that our water cycle provides. The most significant ones include:

- less availability of water for public supply and abstraction by businesses;
- decreased drinking water quality and increased treatment costs;
- flood and drought risks;
- risks to fisheries and river ecology;
- risks to recreational uses including inland and coastal bathing waters.

An example of where decision making in other sectors of the economy is having unintended consequences for the use and management of water is evident in the response to changing prices for dairy and beef products. This is driving land managers to intensify production without necessarily investing in the infrastructure needed to manage waste. In some places this results in increased diffuse and point source pollution.

Failing to resolve agricultural pollution problems may encourage a more rigorous approach to enforcement. This would impose additional costs on farmers. Perversely, these could contribute to a further increase in the number of pollution incidents through reducing the capacity to invest in preventative measures. Nevertheless, addressing these risks, and nitrate levels in particular, should be a key priority if we are to achieve sustainable management and use of water.

6.5. Air Quality Management

Introduction

Chapter 5 has set out the impacts of poor air quality and noise on well-being. Mechanisms are in place in Wales to manage these impacts, including EU requirements such as Air Quality and Noise Directives, Habitats Directive, the National Emissions Ceiling Directive and the Industrial Emissions Directive. There are also domestic and UK requirements, such as the Environmental Permitting Regulations, the Air Quality Standards (Wales) Regulations, the UK Air Quality Strategy and the Noise Action Plan for Wales. However, there are still some gaps in our management of air quality that continue to impact on ecosystems and well-being.

What are the existing measures of sustainable use or management?

- Compliance with current air quality and noise standards.

How are we doing?

"The health and resilience of our ecosystems is being compromised, including targets not being met, or "limits" in danger of being breached"

"The contribution to well-being of ecosystem service provision is not meeting our basic needs, or is declining"

We are still finding sites that are exceeding, or are at risk of exceeding, air quality objectives in urban areas, particularly of Nitrogen oxides (NOx).

NOx related to traffic is the most common reason for the designation of Air Quality Management Areas in Wales. Increasing our understanding of how the built environment affects NOx concentrations will inform planners and help improve traffic controls and the design of urban space.

PM_{10} [1] concentrations have been monitored extensively and are well understood. There is now an air quality limit for $PM_{2.5}$ and monitoring has begun at several locations in Wales. As monitoring for this increases, it is likely to show that action will be needed to reduce secondary formation of particles. This will be challenging due to the complex formation pathways.

Current regulation is arguably doing as much as it can to minimise the impacts of point source emissions to air. Many remaining issues are due to the cumulative impacts of a combination of emissions from multiple sources in a particular place; for example, transport, industry, domestic energy. More innovative integrated measures are required to address them.

Diversification of agriculture, such as increased production of both poultry meat and eggs, is resulting in atmospheric pollution impacts which include emissions from manure through spreading and storage practices. Dense clusters of poultry

[1] PM_{10} $PM_{2.5}$ - Particulate matter with a diameter less than or equal to 10 or 2.5 microns.

developments in East Wales and Anglesey are leading to local air quality problems. Individually, many of these developments fall below the size threshold for limits on emissions, but when clustered in geographic areas their combined effects have a potential impact on resilience, particularly of sensitive ecosystems, and contribute to the amount of particulate matter that could affect well-being.

The position is similar for collectively managing concentrations of industrial, transport and other emissions. A more strategic approach to the development of new proposals, not just within the poultry sector but more widely, could bring significant benefits to developers as well as minimising the cumulative impacts on the wider environment.

What are the key risks?

- If we fail to take into account the cumulative impacts of air quality and noise on our ecosystems and their benefits, we will not be able to maintain and enhance their resilience.

6.6. Managing our Soils and Land

Introduction

Chapter 5 has demonstrated the important contribution of agriculture and forestry to the prosperity of Wales (section 5.2.2). Land managers producing food and fibre are part of complex systems, such as the common agricultural policy, industry quality standards set by food processors and supermarkets and of course contracts and prices for the supply of produce at market. Land managers have to respond to these competing drivers in their day-to day decision making, to ensure their long-term economic viability and continuity of future generations on the land. Understanding these complex inter-relationships is critical.

Chapter 3 has set out our current limited understanding of soil quality as well as the trends regarding the management of soils. Here we look at the systems that effect the management and use of soils.

What are the existing measures or standards of sustainable use and management?

- Very little exists to demonstrate the dependencies between agricultural productivity, farm incomes and natural resource use. As part of cross compliance, there are standards for keeping agricultural land in 'Good Agricultural and Environmental Condition' (In particular GAEC 4-6 in relation to soil management) under the Basic Payment Scheme. However, these don't apply to non-agricultural land (such as urban or coastal areas).

How are we doing?

Natural resources are continuously declining or are being used faster than can be replenished;

A 2015 UK parliament environmental audit committee inquiry into soil health[21] reported research which suggests that the UK's agricultural capacity is in danger and that the current rate of soil erosion is 10-100 times higher than it has been in the past. The report also concluded that more could be done to replenish or restore soil resources; for example, cleaning up contaminated land.

Given the gaps in evidence, it is very difficult to assess overall soil health. Until the Environment (Wales) Act, there was no mechanism for the integrated management of soils and land in Wales. Existing EU policies in areas such as agriculture, water, waste, chemicals and prevention of industrial pollution do contribute to the protection of soils indirectly. However, these policies were designed with other aims and are insufficient to ensure an adequate level of protection for all soils. For example, GAEC rules don't consider the majority of soil attributes, such as existing stocks, threats to soils, or degradation processes. It is fair to say that when it comes to our consideration of soil management there are gaps across the board in the current regulatory system.

A joined-up approach is required for the sustainable use and management of soil that allows us better to understand how the more headline issues of concern (for example water and waste management) interact with the hidden resource that is soil. Gaps in our understanding of soil loss and movement, condition across all land uses, and a general lack of understanding of the impact on ecosystems and the hydrology of catchments, represent a significant risk to our ability to apply adaptive management.

- *The health and resilience of our ecosystems is being compromised. This includes targets not being met or 'limits' in danger of being breached;*

There are concerns around pollution to water – nitrates in particular – and pollution to air with respect to ammonia and particulate matters – which have been addressed in others sections within this chapter.

- *The benefits from ecosystems services are not being optimised;*

There are wider benefits and opportunities from land management that are still not being optimised, such as added value for high quality produce; water storage / natural flood management, carbon management and woodland management. Whilst this is a policy aspiration there are still challenges within the mechanisms in place (such as low take up of Glastir prescriptions).

What are the key risks?

Good soil and land management is crucial to achieve sustainable management. If we fail to manage our soils then we risk the potential to:

- Maintain the basic resources for food, fibre (e.g. wool), fuel/energy and timber production, clean water and a stable climate;
- Improve resource use efficiency, for example through waste management (the treatment and recycling or recovery of waste materials such as sewage sludge on land) and land-use planning (reducing 'land take' by encouraging brownfield development and contaminated sites remediation);
- Maintain terrestrial and aquatic biodiversity, including genetic resources (e.g. antibiotics, genes for resistance to pathogens and pests);
- Reduce carbon emissions - to the atmosphere as greenhouse gases and to receiving waters as dissolved and particulate organic carbon.
- Regulate the storage and flow of water to maintain water resources, water quality and reduce flood and drought risk;
- Reduce water clean-up costs through reduction in organic carbon losses (Dissolved Organic Carbon – 'colour', Particulate Organic Carbon – 'sediment'), pesticide and nutrient pollution;
- Reduce the need for supplementary inputs for agriculture and improve crop, animal and human health[22].

Furthermore there is a wider risk related to the decline in the economic viability of farming, leading to a reduction in investment in on-farm infrastructure, increasing the

risk of point and diffuse pollution and depletion of soils. We need to look forward to help design the land management system that we want for Wales, to succeed as a sustainable nation. That can only be achieved by working with the whole system and central to that are the land managers themselves. Understanding land management and land managers in particular is essential if we are to secure healthy and resilient ecosystems to support well-being.

6.7. Managing our woodland resource

Introduction

Chapter 5 demonstrated the importance of woodlands in terms of the range of ecosystem services and well-being benefits that flow from them. Here we consider some of the challenges within the existing management systems for forestry and woodland management.

What are the existing measures or standards of sustainable use and management?

- Welsh Government target to increase woodland creation by 100,000 ha (a third of current area, see Chapter 3) by 2030 is achieved;
- A greater proportion of woodland is managed to the UK Forestry Standard (the standard for sustainable forest management in the UK), increasing the range of ecosystem services and well-being benefits that flow from woodlands;
- The future productive potential (i.e. timber and fibre supply) of the Welsh Forest Resource is secure[23];
- Woodland SACs and SSSIs are in appropriate conservation management.

How are we doing?

Natural resources are continuously declining or are being used faster than can be replenished

Forecasts of future timber availability and production show a drop in availability from current levels (see Chapter 3.9, Table 9). This gap needs to be managed at a Wales level through twin measures to:

- create new woodland capable of producing utilisable timber;
- bring more woodlands into active management, including for wood production.

However, new woodland creation rates are low: the total area of woodland in Wales has changed little in the past 20 years. New native woodland planted each year more or less balances the area of woodland permanently removed for open habitat restoration or as the result of new development.

New woodland creation is also highly dependent on public support to cover establishment costs. The value of land and the nature of public subsidy pushes woodland creation to the most marginal, less productive farming locations. This is unlikely to create productive woodland of high multi-purpose benefit, and can encourage woodland in areas which can disrupt the function and resilience of other ecosystems and that are away from where people live. This is less likely to contribute to well-being.

GMEP[24] has reported that uptake of the Woodland Creation and Woodland Management elements has been lower than expected, triggering a concern that the Welsh Government target of increasing the woodland area by 100,000 ha by 2030[25] might not be met. GMEP research[24] has identified little evidence of a conflict between land-use for agriculture and forestry; farmers across Wales appear to be open to woodland creation. They appreciate the numerous on and off-site benefits associated with increased tree numbers. However, significant challenges exist in the current Glastir scheme process[24]. Some of the issues cited include inflexible rules and confusion about what is covered or not (for example, rates for contractual labour are not included).

Benefits of ecosystem services are not being optimised

With the exception of payment for timber (and in some cases recreation), there is currently no mechanism for valuing the benefits from woodlands. The reason for this is that many woodland ecosystem services are not tangible as they do not have a market or a price. This includes, for example, carbon sequestration. If there is no mechanism by which to value the benefits of woodland in decision making, there is less incentive for land managers to consider their value when making land-use decisions. This could impact on future well-being and the range of ecosystem services delivered by woodlands.

What are the key risks?

- The existing Welsh Forest Resource is not capable of delivering both the ongoing timber resource at current levels and the added benefits that woodlands can provide;
- Therefore, if we do not create new woodland and bring more woodland into appropriate management, there is a risk that we reduce the productive potential of the Welsh Forest Resource and domestic fibre supply, as well as the wider benefits that woodlands provide;
- Unless we develop a mechanism to better understand the value of ecosystem benefits provided by woodlands, which could inform mangement decisions and ensure the flow of well-being benefits in the future, these benefits will not be realised.

6.8. Energy use, management and decarbonisation

Introduction

Chapter 5 has demonstrated how our natural resources underpin renewable energy production across Wales, supporting jobs and investment. The generation of energy as well as energy used in the home or industry has an impact on ecosystem resilience and well-being. Energy generation and consumption also contribute to the environmental impacts which result from extracting resources from natural systems, creating waste and emitting pollutants.

What are the existing measures or standards of sustainable use and management?

Decarbonisation is a key policy objective in Wales. The Environment Act sets a target for greenhouse gas emissions to be reduced by at least 80% of their respective baseline years (either 1990 or 1995) by 2050. Meeting this target will require a reduction in the demand for energy, to be achieved by measures such as helping people and businesses to use energy more efficiently. Carbon budgeting, setting specific targets by sector, and encouraging the public reporting of carbon emissions are the measures proposed to encourage organisations to become more energy efficient, and these will allow us to better assess the progress being made. The target is also a stimulus for action to increase the use of low-carbon technologies.

Meeting this target will require a massive effort from all sectors to reduce energy consumption through significant behaviour change.

How are we doing?

Natural resources are continuously declining or are being used faster than can be replenished (fossil fuels).
Resilience of ecosystems is being compromised (through impacts of climate change).
Benefits of ecosystem services are not being optimised (renewable flow resources).

Greenhouse gas emissions from Wales are set out in Chapter 2 (Figure 2.2). Energy demand management often focuses upon household consumption of electricity and fuel, but since household consumption only accounts for around one quarter of total energy consumption (and less than one fifth of greenhouse gas emissions), it will be essential to pay equal attention to energy demand in upstream producers and distributors within the supply chain, industry, commerce and freight transport [26].

The link between improved energy efficiency and reduced energy demand is complicated by the presence of multiple *rebound effects*[26]. For example, fuel-efficient cars make travel cheaper; because of this, consumers may choose to drive further and/or more often, thereby offsetting some of the energy savings achieved. Moreover, consumers may use the savings on fuel bills to buy other goods and services which require energy to produce.

Adopting a vigorous energy management process which prioritises options in an energy hierarchy will help minimise the impacts on natural resources from energy consumption and generation. That hierarchy is:

- Reduce Energy Demand - Use less energy
- Be more energy efficient - Use energy efficiently
- Use renewable and low carbon energy[27]

In essence this is about saving energy and finding ways to generate electricity at lower environmental costs. Renewable, community based, and low carbon energy will continue to play a vital role in fulfilling our growing energy needs in the future. Despite significant progress in Wales on schemes that deliver low carbon energy, there are still barriers (such as having to secure finance and permits) particularly for community renewable energy schemes[28]. Review of energy policies across OECD countries has also concluded that net impact has been rather limited to date and biased towards incremental rather than radical change[26].

It is important to assess how various energy options influence and interact with natural resources and ecosystems. For example, a large-scale move towards biomass as a Wales energy source would have to be assessed in terms of the agricultural area or forestry resource needed and the consequences this would have for ecosystems and their benefits. Decisions to substitute one energy source with another may shift the environmental burden, for example, from air to soil, without decreasing the overall impact on the environment. Imports and exports of energy from non-renewable sources is another consideration – where we may be shifting the impact globally (see Chapter 7 on a Globally responsible Wales).

What are the key risks?

- If we do not reduce our generation of energy from fossil-fuel sources (replacing it with zero/low carbon sources and reducing consumption of energy), future generations will be unable to access the resource that we have. We will also continue to increase pressure on global resources and will not be able to reduce greenhouse gas emissions to address climate change.
- Given the urgency and imperative to address climate change, there is a need to significantly increase the pace and volume of change in energy demand management and mix and supply.
- There is a need to consider the wider consequences of such energy policies on other natural resource assets to ensure benefits are maximised.

There are also opportunities. For example, NRW has developed the Energy Park concept in Wales in collaboration with Renewable UK Cymru. Energy Park aims to optimise the renewable energy opportunities on the Welsh Government Woodland Estate where such development can appropriately integrate with other land uses to deliver multiple benefits. The NRW carbon positive project is developing a comprehensive approach to carbon management to enable NRW to be an exemplar in carbon management and share best practice across the Welsh public sector.

6.9. Managing our urban systems

Introduction

Chapters 3 and 5 have highlighted the significant contribution that our urban ecosystems make to well-being. The risks from climate change, particularly risks to health and well-being from high temperatures and increased flood risk, and the pressures that these cause in towns and cities[29] mean that it is even more important for us to look at the urban system as a whole. However, we have identified that there is a significant gap in our ability to assess the resilience of urban ecosystems and how their use and management is impacting on natural resources and subsequent well-being. This is because urban systems themselves are complex.

In this section we explore how we might begin to piece together a better mechanism for monitoring the sustainable use and management of urban ecosystems.

What are the existing measures or standards of sustainable use and management?

To date there are very limited standards or 'safe limits' identified for our urban systems. Many of these are functional or linked to component parts of the whole system (such as accessible natural greenspace standards, air quality standards, or the designation of quiet areas in agglomerations (large urban areas) under the Environmental Noise Directive). Whilst these have some status within the land-use planning system, they are not brought together anywhere as a combined measure. There is a gap in how we monitor the resilience of urban systems as a whole.

It is important to acknowledge that there are a suite of national indicators now established under the Well-being of Future Generations Act. Whilst they are not specifically for urban systems, these indicators reflect the whole of Wales and will enable us to understand the contribution made by all public bodies. Furthermore, Public Service Boards will be setting objectives for their areas which offer opportunities for a more integrated approach.

We have highlighted the most relevant well-being indicators for natural resources in Chapter 7 annex 1.

How well are we doing?

"Resilience of ecosystems is being compromised "(through habitat fragmentation)
"Benefits of ecosystem services are not being optimised"
"The contribution to well-being of ecosystem service provision is not meeting our basic needs, or is declining"

In Chapter 4 we were not able to make an adequate assessment of the resilience of urban ecosystems because they are made up of many remnant and modified parts of other ecosystems and habitats. There are clearly elements of urban ecosystems, such as gardens, which provide a range of functions but are very difficult to assess

for extent, condition and trend. Therefore, it has been very difficult to build a comprehensive picture of the management of our urban systems.
Existing assessments build on limited studies from particular subject areas, such as street trees, accessible urban greenspace studies, air quality and noise maps. As resilient urban ecosystems will have a critical role to play for continued well-being, we consider this to be an important area for development.

The status of urban and street trees was set out in Chapter 3.11 and, according to a study undertaken by the Heritage Lottery Fund, the picture is similar for many urban greenspaces[30]. Furthermore, challenges in the management of privately owned land have been observed. For example, a comparison of gardens in Cardiff over 25 years shows that physical changes, such as driveways, have reduced vegetation and permeable surfaces and increased surface water run-off[20] (see case study below). Fragmentation of habitat in urban areas is also thought to be one of the reasons for the decline in hedgehog populations[31].

Population growth is likely to place additional pressure on existing infrastructure. For example sewage flows are likely to increase as a result of more people, increased run-off brought about by development reducing the area where rain can infiltrate into the soil and the impact of a changing climate.

Impact of Impermeable Developments[20]

A suburb of Cardiff in 1984 is shown on the left. The grey areas are impermeable surfaces and the drainage of the site is designated to accommodate run-off from a 1 in 30 year return period storm. On the right is the same suburb in 2009. It shows, in red, the 20% increase in impermeable area, through home extensions, conservatories and paving of gardens. Despite the increase, the drains remain unchanged. Due to these changes and the increasing rainfall predicted from our changing climate, sewer flows in Wales are projected to increase by over 1% a year. Applying Sustainable Drainage Systems (SuDS) techniques only to new developments will not address flooding on existing sites; SuDS techniques also need to be implemented on existing sites; if not, the risk of surface water and sewer flooding will inevitably rise.

The planning system provides a strategic framework to enable development in the right place, thereby helping to safeguard natural resources with mechanisms such as planning conditions and section 106 agreements. Whilst the planning system can help safeguard some of these spaces from development, it can do little more to

secure their sustainable management and use. Adapting existing urban systems to meet the challenges of climate change and to realise the full range of benefits from green infrastructure, requires an integrated approach; local planning authorities cannot be expected to deliver on their own.
Going forward we need to develop a mechanism that reflects socio-economic aspects of urban systems as well as the resilience of their environmental aspects. Examples of the inter-relationship between these may be found in transport and infrastructure, housing, and community cohesion (particularly in relation to considering an urban area's capacity to deal with future shocks as a consequence of climate change). Programmes, such as "100 resilient cities"[32] and "Resilience.io"[33] (see end of chapter 8), have developed frameworks that can help us to understand the complexity of urban systems and the drivers that contribute to their resilience.

What are the key risks?

- If we do not take an integrated approach to managing our urban systems, we will not be able to fully understand, value and therefore optimise the benefits that green infrastructure, such as parks, gardens, urban trees, provides. Risks (and costs) to well-being will be likely to increase.

6.10. Managing our seas and coast

Introduction

Over the past few decades, the marine and coastal environment has become increasingly busy as a result of a range of direct and indirect drivers (set out in chapter 2). The limited available information about our seas continues to pose a challenge to the sustainable management of marine resources.

What are the existing measures of sustainable use or management?

Until very recently, the dominant approach to managing the seas had been sectoral. Governments no longer consider this fit for purpose for an ever-busier marine environment because of the potential risk to the health and functioning of the marine environment and to our ability to maintain and optimise sustainable use. Key pieces of legislation that have now been passed are starting to address recognised challenges and should deliver a more integrated approach to planning and managing marine resources.

The Marine Strategy Framework Directive (MSFD) supports the maintenance and enhancement of our marine ecosystems by requiring us to work collaboratively with our neighbours to secure Good Environmental Status (GES) by 2020. At the UK level, the Marine and Coastal Access Act (2009) set in place a new framework to support an integrated, plan-led approach to the management of the marine environment. In particular this brings together powers, for the first time, for the development of integrated marine plans that inform a licensing regime that governs decision making to achieve the sustainable use of the marine area.

How are we doing?

Chapter 3 has set out our current understanding of the health of the marine environment. Our seas support a diverse array of species and habitats. A number of habitats and species are currently showing improvements which provides a positive picture of the current state. Historically, however, habitat loss has been a significant issue, and recovery of key species and habitats is an important opportunity to build the resilience of marine ecosystems around Wales.

“the benefits of ecosystem services are not currently being optimised”

The key issue for the sustainable management of natural resources for the marine environment is that the benefits of ecosystem services are not currently being optimised. The new legislation outlined in section 6.10.2 has been put in place to enable us to optimise the full range benefits we can get from marine natural resources in a way that does not compromise the use of these benefits for future generations.

However, this new legislation is still in the first cycle of implementation so it is not yet possible to assess its success. Both the MSFD and marine planning follow an adaptive management cycle of development, monitoring and evaluation followed by

revision where necessary. The first 6 year cycle of the MSFD is now complete and work has begun on the next cycle of activity.

The first Welsh National Marine Plan is currently being developed and will be a key focus for achieving the sustainable management of marine natural resources as well as becoming a tool for achieving Good Environmental Status in Welsh waters. Once in place, authorisation and enforcement decisions relating to the marine area will have to be made in accordance with the plan[34]. It will also be an important strategic mechanism for identifying and prioritising evidence needs to support the sustainable management of Wales' marine area. Future SoNaR reports will be part of the range of evidence and information that will inform future cycles of the marine planning process.

The marine planning process has already identified some priority cross-cutting and sectoral opportunities to optimise the benefits of ecosystem services in the marine environment, many of which are reflected in the findings set out in this report. These opportunities are also present in the developing marine plan policies:

- Taking practical opportunities to secure ecosystem recovery to support resilience
- Ensuring multiple benefits from the marine environment (maximising win-wins; understanding opportunities for co-location of activities and uses of the marine environment)
- Optimising opportunities to provide benefits to coastal communities from the marine environment (including understanding more about what these are)
- Optimising opportunities for using coastal habitats to support coastal flood protection
- Optimising opportunities for the sustainable growth of tourism and recreation
- Optimising opportunities for the sustainable growth of marine renewable energy
- Optimising opportunities for the sustainable growth of aquaculture

What are the key risks?

The MSFD sets out the pressures on the marine environment at the ecosystem scale through a series of descriptors; this forms a basis for the management of these risks in Welsh seas.

A specific and important consideration for sustainable management of the marine and coastal environment is the effective and integrated management of the land sea interface. Over 60% of Wales' population live on the coast so it is a particularly busy area where both the demands on natural resources and opportunities to enhance them are high. The planning and regulatory systems for the terrestrial and marine areas are different and this poses a challenge for integrated management.

There are several mechanisms that already directly support sustainable management over the land sea interface. They include River Basin Management Plans and Shoreline Management Plans. Area statements will strengthen and integrate management of resources over this important boundary.

6.11. Valuing ecosystems and their services

What is common to all of the issues outlined above is the lack of appreciation of the full value of natural resources and ecosystems and their benefits (monetised and non-monetised), which are not being adequately taken into consideration in various decision-making processes.

Current difficulties in realising the full value of many of these services represent a significant market failure. This is compounded by the fact that many ecosystem services are “public goods”, many of which are undervalued on the basis that they are openly available to everyone at no perceptible cost (for example, air and amenity spaces).

Provisioning services such as the production of food and timber are predominantly valued through the private market. These services generate private goods and their values are largely defined by market forces. Supporting services such as nutrient cycling and soil formation are ultimately linked to provisioning services so can be valued in a similar way. Regulating services, however, provide both public and private goods. For example, land can be managed to control water retention at the very local level in the same way as it can be managed to provide public benefit at the catchment level. Many of the provisioning services result in private goods, tradeable in the open market and subject to the forces of supply and demand. These services can operate, at least in the short term, independently of natural limitations.

Many of the cultural services result in public goods, such as aesthetic and inspirational value. These are undervalued for the reasons stated earlier. The provision of public goods is not subject to the same market forces as drive the provision of private goods. The way we value these goods differs so a clear agreement on the respective roles of private business and public bodies in their management is essential if we are to optimise benefits to well-being.

It is therefore incumbent on the public sector to recognise its responsibility not only to provide public goods, but also to regulate and incentivise the provision of private goods so that provisioning services and cultural services do not compromise one another and their supply becomes better integrated.

Regulation and market forces do offer one of the greatest opportunities to manage threats to ecosystem resilience and to maximise contributions to well-being. Until mechanisms are developed that recognise and enable the true value of benefits to be considered, it will be difficult to optimise the benefits for well-being.

Over time we have built up a range of regulations and plans which are intended to help correct this market failure and deliver more optimal outcomes for society. The National Ecosystem Assessment brought together the many different tools that have been used and will continue to be available to manage natural resources, as outlined in Table 6.1.

Table 6.1 The range of natural resources management interventions (Source: UK NEA follow-on [35]).

The range of natural resource management interventions	
statutory protected / designated areas	statutory regulation and quality standards
Levies	direct economic incentives
market-based schemes	spatial and integrated planning
good management practices	voluntary standards and quality assurance
social and cultural networks	education and knowledge exchange
partnerships and community schemes	scientific research & development
technological innovation	common law

This range of responses to market failure has developed in a piecemeal fashion and until now has not been considered in an integrated way, leading to regulatory failure. As the Welsh Government White Paper[36] which led to the Environment Act recognised:

> *This array of UK and EU environmental legislation has served its purpose, but it is recognised that it has largely developed to address changing pressures and specific environmental problems over the years and often has a narrow focus. This approach to regulation – reactive and often viewed in isolation from economic and social policy - has led to a complex mix of regulation that doesn't always work together towards a common aim of improving Wales' long term future.*

Under the Environment Act, Wales now has the opportunity to address this disjointed system and take a more strategic and integrated approach. This means identifying the opportunities to transform the interactions between our social, economic and environmental systems – taking into account the well-being goals as a key basis for considering value, and using the most appropriate responses to achieve sustainable management of natural resources. In this context the relationship between people and place is an important element of well-being. The landscapes of Wales reflect this relationship and help to inform a place-based approach to natural resource management.

6.12. Conclusion

This chapter has identified a number of failings or gaps in the management or regulation of natural resources. These are summarised in Table 6.2.

Table 6.2 Summary of the key issues relating to the use and management of natural resources in Wales, identified in Chapter 6.

Activity	Natural resources depleting or in continual decline	Resilience of ecosystems compromised	Benefits of ecosystem services not being optimised	Contribution to well-being declining
Preventing and managing waste		Waste crime	Reuse of waste stream (e.g. Anaerobic digestion)	Litter, fly-tipping and local environmental quality
Managing water	Water availability and consumption management. (Risk of drought)	Pollution incidents and risks to aquatic ecology from diffuse and point source pollution. Legacy minewaters and physical modifications. Building on floodplains. Sediment in water courses.	Lack of catchment management and sustainable drainage for multiple benefits	Poor water quality affecting recreation / fisheries / health. Costs to business and customers from increased water treatment.
Air quality management		Nitrogen deposition		Poor air quality and noise affecting health
Managing our soils and land	Declines likely in quality and quantity of soil resource through erosion, improvement, land take, and contamination	Soil sealing and compaction. Impacts on hydrology and water quality	Soil carbon management. Water regulation.	Productive potential of agricultural land.

Activity	Natural resources depleting or in continual decline	Resilience of ecosystems compromised	Benefits of ecosystem services not being optimised	Contribution to well-being declining
Managing our woodland resource	Availability of timber.	Tree health	Under managed woodlands preventing wider benefits of woodland. Supply of wood- fuel.	
Energy use management and decarbonisation	Transition to non-fossil fuels	Contribution to greenhouse gases and climate change	Underutilised flow resources	
Urban systems		Habitat fragmentation through poorly designed development. Soil sealing, poorly designed drainage systems.	Integrated management of public and private urban spaces. Water sensitive urban design	Air quality. Noise. Urban temperatures. Flood events.
Managing our seas and coasts		Coastal flood defence.	Opportunities for tourism, recreation, aquaculture and renewable energy.	

Recognising the more general, but critically important, point about addressing market failure, these issues help to pinpoint where gaps or failings in the management or regulation of natural resources are more acute. Such gaps or failings are reducing the resilience of our ecosystems and are having an adverse effect on the delivery of ecosystem benefits. This in turn is resulting in a loss of valuable benefits which contribute to our well-being.

The next chapter draws together the risks to well-being from unsustainable management and use of natural resources along with the risks to the resilience of our ecosystems identified from the assessment. It then looks at some methods for identifying opportunities for more integrated solutions to sustainable management.

References for Chapter 6

("Accessed" refers to the date the link was last accessed)

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