The Second State of Natural Resources Report (SoNaRR2020)

Assessment of the achievement of sustainable management of natural resources: Resource Efficiency Water

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; and
- Communicating our evidence in an open and transparent way.

Title: **SoNaRR2020** Assessment of the achievement of Sustainable Management of Natural Resources: Resource Efficiency Water

Lead Author: **J Sisson**

Contributors: **T Dunford, B Hardiman, P Frost, D Gough, C Harris, L James, J Lee, K Mainwaring, S Samuel, P Spain, M Stokes, H Tidridge.**

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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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Issue 3: Monitoring of water use to manage supply and demand.

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Response: Encouraging water efficiency across all sectors will reduce the amount of energy required to treat and supply water. By encouraging the retrofit of water saving appliances, a link can be established between reduced water demand with reduction in energy bills.

Issue 5: Leakage from domestic appliances, for example toilets leak 215-400 litres of potable water every day.

Response: Must continue to raise awareness of household and non-household leakage, for example: leaky loos, taps, and showers.

Issue 6: No minimum standard or water efficiency labelling of water appliances in Building Regulations or consumer products.

Response: Evidence shows mandatory water efficiency labelling on all water using appliances linked to minimum standards increase water efficiency.

Issue 7: Abstractions may become increasingly unreliable due to climate change impact of prolonged periods of dry weather.

Response: Construction of offline winter storage reservoirs for agriculture to reduce pressure of abstraction at times when resource availability is at its lowest.

Issue 8: Currently there is a lack of awareness of water efficiency technology.

Response: Encourage use of rainwater harvesting (RWH), grey water recycling (GWR) and sustainable drainage (SuDS).

2. Introduction

The Environment (Wales) Act has placed a remit on all public bodies to maintain and enhance the resilience of ecosystems. Resource efficiency as part of the sustainable management of natural resources helps to deliver this remit.

A reliable water supply is essential for the health and well-being of all. As well as domestic use, it is an economic driver for agriculture, energy generation, manufacturing, industry and commerce. In nature, a range of ecosystems and species rely on sufficient water in the environment. Using less water helps to maintain resilience under pressure from abstraction and climate change impacts such as more frequent prolonged periods of low flow. In Wales, water also provides a variety of recreation opportunities which boost well-being and tourism.

Snowdonia is the wettest area in Wales with average annual rainfall exceeding 3000mm, comparable to the English Lake District or the western Highlands of Scotland. Areas along the coast and close to the border with England receive less than 1000mm a year (Malet-Lambert, 2020), but this is still higher than the English average rainfall of 885mm/yr. As a result, the perception persists that there is little need for water efficiency in Wales (Malet-Lambert, 2020).

This chapter identifies the need for changes to water use across all sectors to ensure sustainability of supply and demand for water and resilience of ecosystems. It will consider how changes of behaviour towards water use, water efficiency labelling, leakage control, water storage and application of rainwater harvesting and greywater recycling technologies can reduce water use. Water efficiency can help to reduce carbon footprints and help to mitigate climate change impacts by reducing the amount of energy used to heat water in household and non-household use, water treatment and for pumping water to where it's needed.

This chapter will also consider the evidence needed to support further policies or initiatives for the sustainable supply of water for current and future generations.

3. State and Trends (Aim 1)

Summary assessment and forward look

The following tables give a brief description of the past trends and future prospects for Water Efficiency. 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.

Issue: A more accurate determination of quantities, both abstracted and supplied, is required to target opportunities for water efficiencies.

Table 1 Key message – Past trends and future prospects of achieving resource efficiency targets: Leakage

Time period	Rating	Description
Past trends (10-15 years)	Improving	Dŵr Cymru report a reduction of water supply from 1000 megalitres per day (Ml/d) to 800Ml/d. This has been due to a reduction in industry uptake and a reduction in leakage.
Future Prospect (Outlook to 2030)	Improving	Dŵr Cymru are projected to increase their spending on water efficiency measures in the period 2020-25 by £2.368m. Dŵr Cymru and Hafren Dyfrdwy have set a 15% reduction in leakage by the end of 2025.
Prospect to meet policy objectives/ targets in 2030	Largely not on track	Achievement of objective is largely dependent on change towards water use across all sectors.

Robustness of data: Water companies have set a reduction of leakage target in their Water Resource Management Plan 19 to meet OFWAT target of 15% by 2025 and will set a further target to 2050.

Table 2 Key message – Past trends and future prospects of achieving resource efficiency targets: Metering

Time period	Rating	Description
Past trends (10-15 years)	Improving	There has been a voluntary uptake of water meters by 40% of households.
Future Prospects (Outlook to 2030)	Mixed picture	Water companies will be taking a more pro-active role in encouraging uptake of water meters with a target of 70% uptake by 2050.
Prospect to meet policy objectives/ targets in 2030	Largely not on track	Coupling the reduction in water use with energy savings is likely to encourage uptake of metering. Leakage is a barrier to the uptake of metering.

Robustness of data: Projection is part of the water companies' water resource management plans targets.

Table 3 Key message – Past trends and future prospects of achieving resource efficiency targets: New Authorisations

Time period	Rating	Description
Past trends (10-15 years)	Improving	Historically several types of abstraction have not required an abstraction licence. To qualify for a licence, called a Transitional licence, abstractors had to be operating during the period 2011-17 and provide evidence of abstraction. This could be 7 years to a few months of data. Abstractors can continue to abstract at the rate applied for until their application is determined by 31 December 2022. If the abstraction has been operating for more than 7 years, it is assumed that this will reflect the trend for 10-15 years.
Future Prospects (Outlook to 2030)	Improving	From January 2020 previously exempted licences required an abstraction licence.
Prospect to meet policy objectives/ targets in 2030	Largely not on track	Bringing previously exempt abstractions into the licensing system means this abstraction data can be included in water resource availability assessments. Sustainability issues will be highlighted by this assessment, Catchment Abstraction Management Strategies (CAMS) process, and addressed through River Basin Management Plans. New permitting and monitoring measures will help to identify demand hotspots to better manage supply and where environmental resilience maybe an issue.

Robustness of data: Applications for New Authorisations are to be assessed by NRW Permitting following the December 2019 deadline. Once these licences are determined, returns data, in other words the actual quantities used, will have to be submitted which will be mapped to improve evidence of abstraction hotspots. Applications not received before the deadline have to apply through the standard application process.

Issue: Perception that water efficiency is not an issue in Wales.

Table 4 Key message – Past trends and future prospects of achieving resource efficiency targets: Water Labelling

Time period	Rating	Description
Past trends (10-15 years)	Improving	Water efficiency as a way of managing water use has not been a major priority in Wales until water company business plans 2015-20.
Future Prospects (Outlook to 2030)	Improving	The Wales Water Efficiency Group (WWEG) was formed in November 2019 to co-ordinate communications and awareness raising of the need to conserve water in Wales. WWEG links into the UK Water Efficiency Strategic Steering Group (UK WESSG). Both groups are led by Waterwise.
Prospect to meet policy objectives/ targets in 2030	Largely not on track	WWEG will liaise with UK WESSG to promote UK wide initiatives such as water efficiency labelling of white goods. The group will also identify evidence gaps and commission research such as the Cost/benefit Analysis of Water Labelling in Wales (Energy Savings Trust, 2020).

Robustness of data: Priority projects within water planning period 2020-25 have been identified by UK WESSG. Projects specific to Wales will be coordinated by WWEG.

Table 5 Key message – Past trends and future prospects of achieving resource efficiency targets: Small Water Storage

Time period	Rating	Description
Past trends (10-15 years)	Improving	Just over 61% of abstraction licences for agriculture are for water storage for seasonal use for spray irrigation. Virtually all of these licences are in Pembrokeshire.
Future Prospects (Outlook to 2030)	Mixed picture	It is likely that climate change will lead to more prolonged dry periods across Wales. This may result in more applications for abstraction licences for irrigation across Wales which will likely increase the need for off-line storage.
Prospect to meet policy objectives/ targets in 2030	Largely not on track	Subsidies could be considered to support on farm storage across Wales to offset change of land use to reduce pressure on watercourses, especially during dry periods.

Robustness of data: UK climate change projections 2009 show latest projected changes in climate for Wales. Regional temperature is projected to increase by 0.9 to 4.5ºC and winter precipitation between 2 to 31%. Projections are taken from medium emission scenario, 1961-90 baseline.

Table 6 Key message – Past trends and future prospects of achieving resource efficiency targets: Circular Economy

Time period	Rating	Description
Past trends (10-15 years)	Mixed picture	Water naturally recycles but, in the future, this may not occur with the desired frequency.
Future Prospects (Outlook to 2030)	Mixed picture	In 2019 Welsh Government commissioned research into multi sector water use. This will help to identify opportunities for water recycling measures across sectors.
Prospect to meet policy objectives/ targets in 2030	Largely not on track	Increased understanding of water use across all sectors will signpost where and what type of water efficiency measures such as rainwater harvesting and greywater recycling will be most effective in delivering an overall reduction of water use. Innovative recycling technologies continue to be investigated.

Robustness of data: Arup consultants on behalf of Welsh Government, supported by NRW, are reviewing opportunities for water efficiency measures as part of the regenerative economy through stakeholder engagement across non-public water supply sectors.

Issue: Reduction of carbon emissions through water efficiency.

Table 7 Key message – Past trends and future prospects of achieving resource efficiency targets: Reduced CO_2 emissions

Time period	Rating	Description
Past trends (10-15 years)	Mixed picture	89% of the total CO_2 emissions from households are associated with water use. This needs to be extended to the manufacture of appliances as standard.
Future Prospects (Outlook to 2030)	Improving	Campaigns to reduce water use will reduce carbon emissions and energy bills. Retrofitting of water efficiency products to water appliances is being carried out by water companies as part of their water use audit.
Prospect to meet policy objectives/ targets in 2030	Largely not on track	Increased water efficiency will reduce the amount of energy required to treat and supply water and reduce the need for tankered supplies during dry periods. Increasing emergency storage facilities on a catchment basis should also be considered.

Robustness of data: Water companies to supply data of reduced household and multi-sector use and associated energy use, in other words a reduction in energy bills.

Issue: Consistent water efficiency standards as part of Wales's building regulations.

Table 8 Key message – Past trends and future prospects of achieving resource efficiency targets: Building regulations

Time period	Rating	Description
Past trends (10-15 years)	Improving	The Building Regulations in 2010 for England and Wales required that domestic water use be no more than 125 litres per person per day (l/p/d).
Future Prospects (Outlook to 2030)	Mixed picture	Introduction of Part G to building regs, 2018, proposed new efficiency standards of 110l/p/d for new dwellings and 125l/p/d for change of use to a dwelling.
Prospect to meet policy objectives/ targets in 2030	Largely not on track	Further changes are required to increase overall water efficiency of buildings, domestic and non-domestic, such as retrofitting of water saving appliance, rainwater harvesting and grey water recycling, and reduction in use per person.

Robustness of data: Water company monitoring data on water use in domestic and non-domestic buildings.

Current scale of resource use

Natural Resources Wales (NRW) is responsible for issuing licences for water abstractions above 20m^3/day from lakes, reservoirs, water courses and aquifers (NRW, online). The need to abstract and the quantity requested are assessed to ensure abstraction has a minimum impact on the environment.

There are also a significant number of private abstractions, mainly for domestic use, which are below the 20m^3/d threshold and therefore don't require a licence. Only private abstractions for drinking water must be registered with the local authority which tests for water quality under the Drinking Water Inspectorate (DWI) Regulation 6 (2016). The quantities of below threshold private water supply abstractions are not recorded and are not represented in these tables.

Multi sector uses

The largest proportion, 78% of overall abstractions megalitres/year (Ml/year), are for energy production. These licences are mostly for hydropower and are considered to be non-consumptive, meaning that the water is not used up and is returned to the local environment. However, these abstractions may result in a considerably depleted reach of the watercourse.

Water is also abstracted by other sectors such as water supply, agriculture, business and commerce. Table 9 and Figure 1 show the relative amounts of water abstracted per sector.

Table 9 Licensed abstraction quantities in megalitres per year by sector (NRW, 2018).

Sector	Abstraction quantity (Ml/year)	Percentage of total abstractions
Water Supply	1684859	16
Production of Energy	8286004	78
Amenity	15838	<1
Industry/Commerce/Public Services	528800	5
Environmental	36580	<1
Agriculture	63494	<1
Total	**10615575**	**100**

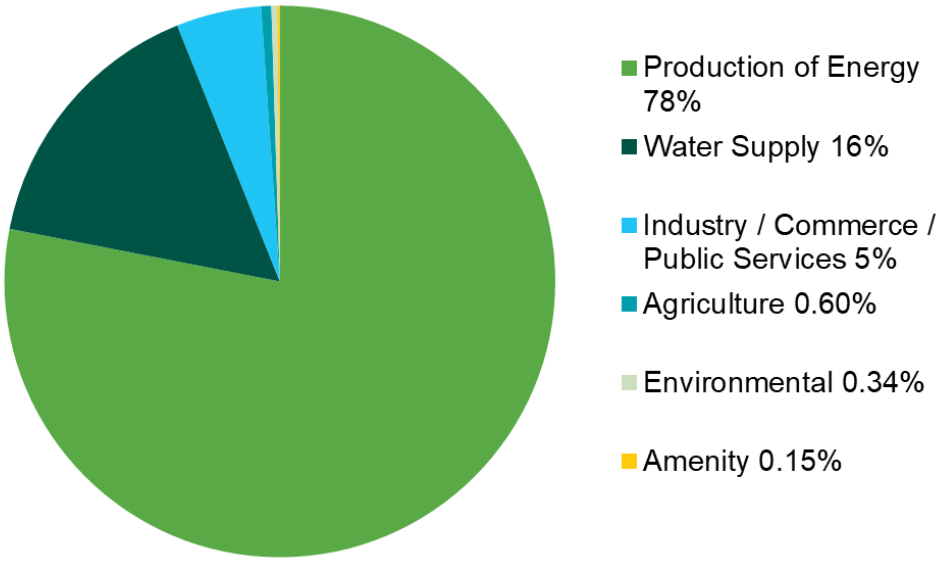

Figure 1 Percentage of water abstraction by sector (NRW, 2018).

Table 10 and Figure 2 show the quantities of licenced water abstractions by sector which are classed as consumptive, where water is not returned to the local environment. Non-consumptive uses such as hydropower and flow-through for fish farms have been removed.

Table 10 Consumptive abstractions in megalitres per year (Ml/year) by sector (NRW, 2018).

Sector	Abstraction quantity (Ml/year)	Percentage of consumptive abstractions	Number of licences
Water Supply (Private and Public)	1684859	76	222
Industry/ Commerce/ Public Services	526694	23	275
Environmental	308	<1	5
Agriculture	2997	<1	370
Total	**2214858**	**100**	**872**

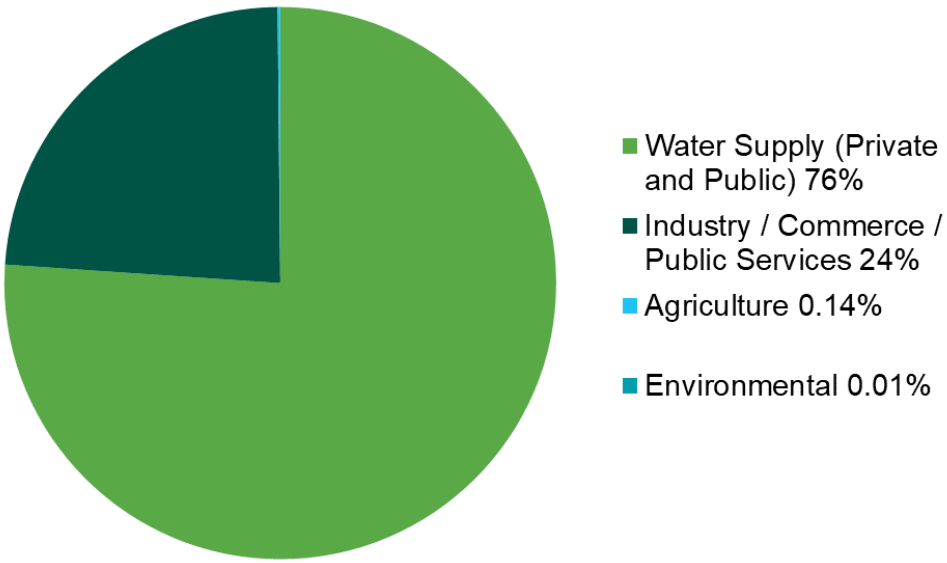

Figure 2 Consumptive abstractions by sector (NRW, 2018).

Water supply

The largest consumptive abstraction activity is for water supply, which in the case of public water supply for domestic use and all other sectors may be piped for use several miles away and is not discharged to the same water source.

Licensed private water supplies are less than 1% of the total (NRW, 2018) usually these occur where mains water is not available. Table 11 shows the relative licensed quantities abstracted for private and public water supply.

Table 11 Licensed private and public water supply abstractions (NRW, 2018).

Water supply type	Abstraction quantity (Ml/year)	Percentage of total abstractions	Number of licences
Private Water Supply	598	<1	49
Public Water Supply	1684261	99	173
Total	**1684859**	**100**	**222**

In order to sustain the large abstractions required for public water supply, some rivers are regulated. This can mean that stored water is released to support abstractions downstream. These rivers are unlikely to have additional water available for anymore consumptive licences, as in the Afon Dee (NRW, 2015a) or, can only support further consumptive licences if they are severely restricted, as in the Afon Wye (NRW, 2015b) where they may only be able to operate at higher flows. The Afon Tywi (NRW, 2014a) does have water available for further, limited, consumptive abstraction licensing.

Groundwater abstraction makes up about 6% of public water supply (NRW, 2018) and many groundwater supplies work in conjunction with surface water sources, for example, the River Clwyd Augmentation Scheme (NRW, 2015c) where water is abstracted from the river for public water supply and flows are augmented from borehole abstractions.

New authorisations

Some abstractions have historically been operating outside of the licensing regime. Water abstractions above 20m^3/day needed to apply for a transitional licence before the deadline of the 31st December 2019. They will now need to comply with new licensing regulation requirements referred to as New Authorisations (NRW, 2019)

These abstractions include those operating within previously geographically licence exempt areas, or activities which until now did not require a licence:

- Water transfers from one inland water to another in the case of, or as a result of, operations carried out by a navigation, harbour or conservancy authority.
- Abstractions into internal drainage districts but not including land drainage activities.
- Dewatering of mines, quarries and engineering works
- Warping, in other words abstraction of water containing silt for deposit onto agricultural land as a fertiliser.
- All forms of irrigation, except for spray irrigation which is already licensable, and the use of land drainage systems in reverse, including transfers into managed wetland systems, to maintain field water levels.
- The majority of abstractions by the Crown and visiting forces exemptions

Inclusion of water abstracted for these activities will help to plan where and how water efficiency measures can be best used to mitigate future demand. The deadline for processing these applications is December 2022. These abstraction quantities are not included in Table 9 and Table 10.

Reservoir storage

There are approximately 152 reservoirs for water supply in Wales managed by water companies. Water storage is vital to maintain water supply and meet peak demands. Some were specifically built to supply conurbations in England such as Vyrnwy-Liverpool and Elan-Birmingham.

Water suppliers

Of the four water companies operating wholly or mainly within Wales, Dŵr Cymru is the largest, supplying just over 3 million customers. Hafren Dyfrdwy, a subsidiary of Severn Trent Water, supplies approximately 220,000 customers in mid and north east Wales. Using bulk supplies from Dŵr Cymru, Albion Eco supply Shotton Paper mill in North Wales and Leep Utilities supply a small area in south Wales. Together, they supply 3.2 million people in homes and businesses across Wales.

Private water supply

Based on Drinking Water Inspectorate Annual Report 2018 (DWI, 2018) data there are 14,707 exempt, below 20m^3 per day, private water supply sources across Wales with an estimated demand of 5,022 megalitres per year, or 13.8 megalitres per day, with the highest demands in the Wye and Severn Corridor areas. These figures are likely to be significantly underestimated due to lack of data availability. This is recognised by Welsh Government as an evidence gap, see Summary assessment and forward look and Synergies and trade-offs. Identification of the extent of these exempt abstractions will help to locate abstraction hotspots, where the local environment may be subject to reduced resilience, especially to climate change impacts such as periods of prolonged dry weather. See Table 12 and Table 13.

Agriculture

Although agriculture accounts for the larger proportion of licences, the quantity of water abstracted is less than 1% of the overall total. The majority of these abstractions are for irrigation, a highly consumptive activity. See Table 10

Long term trends

By 2050, pressures on water resources from climate change, population growth and maintenance of water quality standards in Wales are expected to increase, see Freshwater chapter. UK Climate Projections, 2018, research shows that, across the UK, the period from 2009 to 2018 has been 1% wetter than the period 1981 to 2010 and 5% wetter than the period 1961 to 1990 (Met Office, 2018). The total rainfall from extremely wet days increased by 17%.

Previously, climate change projections have been derived from data based on resolutions of 12 km, Regional, 25 km, Probabilistic, or 60 km, Global. The UK Climate Projections 2018 have now also issued projections based on 2.2 km resolution, akin to that used in local weather forecasts. This has resulted in local climate change projections such as those given for central Wales in Table 12 and Table 13. These figures are Local precipitation change and Local temperature change projections, based on high and low emission scenarios.

Table 12 Projected changes to rainfall by the 2070s. High emissions 2061 to 2080 relative to 1981 to 2000 (Met Office, 2018).

Emissions	Summer	Winter
Low	39% drier to 3% wetter	2% drier to 19% wetter
High	56% drier to 2% wetter	No change to 29% wetter

Table 13 Projected changes to temperature by 2070s. High emissions 2061 to 2080 relative to 1981 to 2000 (Met Office, 2018).

Emissions	Summer	Winter
Low	No change to 3.3^{o}C warmer	0.1^{o}C warmer to 2.4^{o}C warmer
High	0.9^{o}C warmer to 5.9^{O}C warmer	0.7^{o}C warmer to 4.1^{o}C warmer

Whilst the intensity of hourly rainfall is projected to increase in the future, overall summers are projected to become drier. This has implications for how water is managed. Projections from the Office for National Statistics (2020) predict that overall Wales's population will increase by 400,000 by 2050 adding to the pressures on water resources, see Main pressures affecting resource use.

Future resource efficiency and sustainable management of natural resources

Public Water Supply

Future pressures on water resources in Wales means the amount of water used per person on a daily basis must be reduced. Dŵr Cymru has set a target to reduce the average water use per person in the home from 145 litres per person per day (l/p/d) to 138 l/p/d by 2025 and to 100 l/p/d by 2050 (Dŵr Cymru, 2019a) Hafren Dyfrdwy to 123 l/p/d by 2045 (Hafren Dyfrdwy, 2019). The water companies have also committed to improving water efficiency as part of their Business Plans 2020-25 (Dŵr Cymru, 2019b; Hafren Dyfrdwy, 2018)

Over the last 25 years Dŵr Cymru has been able to reduce water supplied from 1000Ml/d to 800Ml/d (Dŵr Cymru, 2019). This has largely been due to reduced demand from industry, but also because of a reduction in leakage. They have more than doubled spending on water efficiency from £2.2 million in the business period 2010-15 to £4.568 million in the business period 2020-25 with a target, set by Ofwat (Ofwat, 2017), of 15% leakage reduction by 2025.

In 2009, Defra updated their 1998 review of water charging which recommended that for new homes, and those substantially altered since 1990, metering should be the normal charging method (Walker, 2009). The Water Industry Act 1999 brought legislation concerning metering provisions into force on 1st April 2000. It does not enforce the uptake of meters in Wales and does so only in some areas of England and, then, only where the area has been declared one of water scarcity by the Secretary of State.

Dŵr Cymru and Hafren Dyfrdwy have introduced water metering to households and businesses to help reduce demand. Dŵr Cymru expect an increase to 70% from the current 40% of metered customers by 2050 (Dŵr Cymru, 2019), whilst Hafren Dyfrydwy report a 60% meter uptake in north west Wales with plans for pro-active meter installation across its supply area by 2035 (Hafren Dyfrydwy, 2019). Meters help customers to better understand their water use and help water companies to target measures to reduce water use, fix leaks and help predict future supply demand. The 2018-19 figures (Discover Water, undated a) comparing metered consumption to non-metered consumption show a marked difference in litres used per day per customer for each of the major water companies, see Table 14 and Table 15, which also show the UK average of metered and non-metered use in litres per person per day for the same period.

Table 14 Metered and non-metered use, 2018 to 2019 in litres per person per day (Discover Water, undated a).

Water Company	Non-metered use (l/p/d)	Metered use (l/p/d)
Dŵr Cymru	169	135
Hafren Dyfrydwy	155	131
Average UK consumption	167	133

Table 15 Metered and non-metered use, 2019 to 2020 in litres per person per day (Discover Water, undated a).

Water company	Non-metered use (l/p/d)	Metered use (l/p/d)
Dŵr Cymru	176	131
Hafren Dyfrydwy	158	128
Average UK consumption	171	129

The rise in non-metered use for 2019 to 2020 can be partly attributed to COVID-19, both the formal lockdown and changes to behaviour before that, more people staying home, an increase in cleaning and handwashing. In the Hafren Dyfrydwy supply area, measured per capita consumption (PCC) in March 2020 was 140 litres per person per day, a 10% increase on the previous month and 8% higher than March 2019.

There is also the long-term drift, as smaller households tend to opt for a meter to save money which leaves proportionally more higher water users on unmeasured tariffs.

It is likely that these figures will be higher for the period 2020-21 as a result of the first major COVID-19 lockdown.

Currently customers can choose to switch to a metered supply, but CCWater (formerly Consumer Council for Water) have found that leakage in water supply infrastructure was a significant barrier to the uptake of a water meter in domestic households (CCW, 2019). See Main pressures affecting resource use.

Welsh Government's Water Strategy for Wales (2015) recognises that any proposed approach to metering needs to be aligned with a responsible charging and tariff structure to ensure that households with affordability issues are protected. The Strategy states:

> 'Reduction in water use will reduce energy used in the treatment and delivery of drinking water, thus helping to reduce our carbon footprint. It can also help households reduce their energy bills through use of less hot water, for example.'

Raising awareness of how saving water can reduce energy bills will be a significant factor in future campaigns for introducing water saving devices such as smart showers.

Non water industry abstractions

As much as 76% of consumptive water abstraction is by water companies for supply to both domestic and non-domestic customers. The remaining 25% is abstracted directly for use by other sectors, industry, commerce, business, public services, environmental activities and agriculture (NRW, 2018).

Guidance on how to use water efficiently is provided in Optimum Use of Water for Agriculture and Business (Mathieson, 1998). More recently, The Code of Good Agricultural Practice (Welsh Government, 2019) provides guidance on sustainable practices for using and conserving water such as switching from spray to trickle irrigation and using harvested water for activities not requiring treated water.

Intense rainfall events cause soil loss, which leads to increased use of fertilisers, nutrient loading of rivers and lakes and an increase in the cost and energy required for water treatment.

NRW will continue to work with the agricultural sector and the Welsh Government Farming Connect Advisory Services to improve advice on pollution prevention, land management practices and water efficiency measures such as rainwater harvesting and storage ponds to reduce pressure by abstractions. This will help to support the resilience of local ecosystems, especially in periods of low flows.

In 2019, Welsh Government in conjunction with Natural Resources Wales commissioned Arup to carry out a research project to further understanding of future water demands from sectors other than the water industry (Arup, 2021). The report recommended further investigation into water use by exempt private water abstractions to identify abstraction ‘hot spots’ where water efficiency measures may provide resilience for those most vulnerable during periods of prolonged dry weather.

The report also recommended investigation into water use within the agricultural sector to identify where the introduction of water efficiency measures would be most effective.

Water efficiency

Many different organisations and individuals have a role in water efficiency; Welsh Government, CCWater, water companies, public service boards, the farming community, housing associations, building control, manufacturers, retailers, plumbers, builders, and universities, to individual businesses and households. This diverse range of stakeholders needs to have a common understanding and shared responsibility if water efficiency is to be delivered effectively and successfully. There is also a need to better understand how to influence behaviour towards using water efficiently, improve understanding of the value of water and develop innovative technologies to reduce water use across all sectors.

4. The impact of resource use on ecosystem resilience and ecosystem services

Stocks of natural resources are safeguarded and enhanced (Aim 1)

Abstraction licencing

When an abstraction licence is issued, the supply of water is not guaranteed. Licences may have conditions to reduce or cease abstraction when flows are at, or below, a certain threshold to protect the environment. Licences may be issued with constraints such as 'Hands off Flow' (HoF) usually set at Q95 flow, the amount of flow present 95% of the time. In some cases, such as abstractions from the Afon Wye, designated in 2008 as a Special Area of Conservation (SAC). HoF are applied at higher flows to protect the river's designated species which include lamprey, white-clawed crayfish and bullhead.

One abstraction licence application requirement is that the applicant must justify the amount of water and demonstrate that it will be used efficiently. Most licence holders are required to submit returns data, the amount of water actually abstracted over a specified period of time, to NRW. These abstraction quantities are tracked. Where there is persistent under abstraction, NRW will investigate how these unused quantities can be relinquished, reducing the need to license additional water from that source.

Augmentation

NRW has a duty to redistribute and augment water resources where necessary. Schemes are often operated to support flows to enable more reliable abstractions for public water supply, navigation requirements, power generation, irrigation demand and to meet environmental needs.

They include:

- Large scale water transfer schemes, such as the Ardudwy Leat in the Afon Eden catchment which conveys water for storage in Llyn Trawsffynydd for hydroelectric power generation.
- Large scale strategic river augmentation from groundwater schemes, for example the Clwyd Augmentation scheme.
- Reservoir releases, to meet environmental requirements such as freshet flows for fish, for example the spate releases from Aled Isaf.
- Water is released from Llyn Brianne dam in the upper Twyi catchment to augment flows in the Afon Tywi SAC for abstraction for public water supply further downstream. HoFs for new consumptive licences protect SAC species, meeting EU Habitats Directive requirements.

Water resources management plans and drought plans

The Water Act 2003 requires water undertakers to produce water resources management plans (WRMP) every 5 years. WRMPs are strategic plans setting out the planned investments required over a 25 year planning horizon to develop and maintain a safe, efficient and economical system of water supply. Their business plans are also produced every 5 years, presenting how the undertakers will maintain, upgrade and build new infrastructure.

Water companies in England and Wales are also required to prepare and maintain drought plans under the Water Industry Act 1991, as amended by the Water Act 2003. A drought plan sets out how water companies will supply water to their customers during periods of low rainfall when water supply becomes depleted, whilst minimising any negative impacts of their actions during a drought. It should set out the short-term operational steps they will take before, during and after a drought. See Dŵr Cymru Draft Drought Plan; Hafren Dwfrdwy Drought Plan.

NRW are statutory consultees of WRMPs, drought plans and associated environmental assessments such as Strategic Environmental Assessments (SEA) and Habitats Regulations Assessments (HRA) for WRMP schemes or drought management options.

NRW carry out compliance and enforcement activities of abstraction licences and operating agreements and report on environmental performance. This ensures that water is used efficiently and is not adversely impacting the environment.

Ecosystems are resilient to expected and unforeseen change (Aim 2)

Water plays a vital part in ecosystem resilience, too much or too little can devastate the broad habitats identified in this report. Future predicted scenarios of climate change include more prolonged dry periods and more intense rainfall events (Met Office, Undated). Wales has few major aquifers and surface water storage facilities so most water runs quickly to sea. It is increasingly important that measures are in place to maintain ecosystem resilience, not least by managing water resources.

The Water Act 2014 puts a duty on Welsh Ministers and Ofwat to further the ‘resilience objective’ in England and Wales. Ofwat (2015) define it as:

> “the ability to cope with, and recover from, disruption, and anticipate trends and variability in order to maintain services for people and protect the natural environment now and in the future.”

The importance of a resilient water supply is specifically championed in Wales through the delivery of the Well-being Goals, a more Resilient Wales, a more Prosperous Wales and a Healthier Wales, as defined in the Well-being of Future Generations Act 2015 and in the Environment Wales Act 2016 section 3 (2): “to maintain and enhance the resilience of ecosystems and the benefits they provide”. Section 6 (1) and (2) of the Environment (Wales) Act stipulates that all public authorities “must seek to maintain and enhance biodiversity in the exercise of functions in relation to Wales, and in so doing, promote the resilience of ecosystems,

so far as consistent with the proper exercise of those functions". In particular the following aspects:

(a) diversity between and within ecosystems
(b) the connections between and within ecosystems
(c) the scale of ecosystems
(d) the condition of ecosystems (including their structure and functioning)
(e) the adaptability of ecosystems

The Environment (Wales) Act also requires all public bodies to produce a plan every three years detailing how they will carry out these duties to promote resilience.

In the 21st century, as well as climate change and a rising population, an additional pressure on water resources management is to meet environmental standards set by European legislation. These standards protect and enhance environmental resilience. Licences abstracting from Special Areas of Conservation (SAC) or where abstraction is thought to be impacting on the resilience of the local environment, have been reviewed. If found to be adversely impacting designated features, the licences have been varied, mitigated or revoked. Maintaining sufficient flows to support the ecology of all, not just designated, water bodies is a requirement of the EU Water Framework Directive. That is: to strive for and maintain a recognised standard of Good Ecological Status (GES) which enhances resilience.

One of the key findings of the Arup study into water demand in Wales (2020) commissioned by the Welsh Government and NRW, was a need to further the understanding of water needs, including seasonality, of current and potential abstractors across the different sectors in Wales, for example agriculture and industry. Recommendations include updating the Optimum use of water for Agriculture and industry (Mathieson, 2002) with current Welsh specific datasets from each sector. Once these needs are understood, water efficiency measures can be recommended.

Without mitigation measures to manage water, climate change is likely to derogate existing ecosystems. Projected impacts include reduced resilience to flood and drought conditions due to prolonged periods of either. Lowered water tables may also lead to saline intrusion.

In Wales, catchments draining to the north, south and west have relatively high levels of rainfall. This area has most of the 49% of water bodies in which new licences are calculated to be reliable 95% of the time. For 27% of water bodies, found mostly in the catchments to the east and south east which have less rainfall, new abstractions will only be reliable for 30% of the time or less (NRW, 2016). This only applies to abstractions which are consumptive, where water is not returned locally.

The reliability of abstractions contributes to the resilience of the local socio-economical dynamic. It can impact the benefits from the environment, especially those described as Provisioning Ecosystem Services, in the Well-being of future generations Act, such as public and private water supplies.

Where an abstraction is found to be impacting on the aquatic environment, especially those water bodies with features designated under the Habitats Directive,

or are failing to meet Good Ecological Status under the Water Framework Directive, NRW undertakes a review of the licence. Measures to mitigate, revoke or reduce that abstraction are then put in place. It is likely that in the future if river levels fall more abstraction licences will have to be reviewed to restore sustainable abstractions. NRW will work to promote local stakeholder catchment groups to deliver integrated land and water management. The groups would work with natural processes to help restore catchments, whilst also building environmental resilience and water efficiency measures, moving away from the single point abstraction model of restoring sustainability. This way of working is a closer fit to delivering the Environment (Wales) Act 2016 Sustainable Management of Natural Resources principles.

Successful water resources management relies on forecasting scenarios which may require changes to supply, such as prolonged dry periods or to meet environmental objectives when water supply is compromised due to contamination or major leakage. Having the adaptability to increase the extent over which water can be deployed, increases resilience and efficiency. Where infrastructure does not support switching supply source, water companies have previously resorted to tankered supplies, increasing their carbon footprint (Fredenham, 2020).

The water requirements of the local ecosystem vary depending on the nature of the watercourse and the ecology it supports. Licences for abstractions over $20m^3/d$ should not cause a decline in the ecological status of the watercourse. Usually, to ensure resilience, conditions are added such as Hands off Flow (HoF). When flows fall below the HoF threshold abstraction is limited. This applies to most consumptive abstractions such as public water supply, most industrial processes and agricultural uses such as spray irrigation.

Non-consumptive abstractions, such as cooling and hydropower schemes, usually return the water within the same water body as the abstraction point. These abstractions may also have conditions to reduce or stop abstraction if flows are below the HoF threshold.

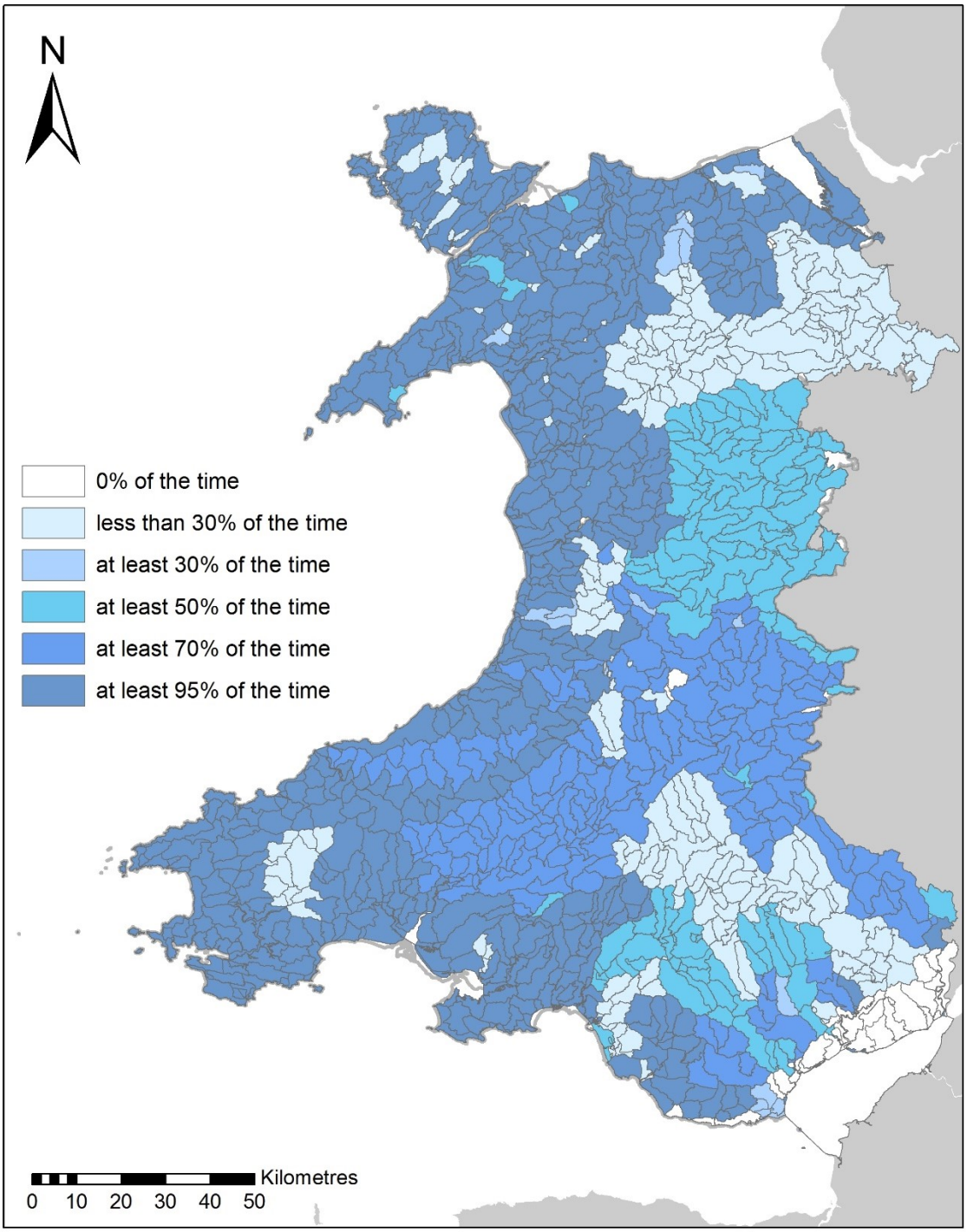

Figure 3 Reliability of further consumptive licences in Wales (NRW, 2016).

Table 16. Reliability of further consumptive licences as a percentage of water bodies in Wales (NRW, 2016)

Number of Water bodies	Reliability (%)	Percentage of Water bodies (%)
35	0	2.5
280	less than thirty	20
36	at least thirty	2.5
170	at least fifty	12
204	at least seventy	15
668	at least ninety-five	48

Wales has healthy places for people that are protected from environmental risk (Aim 3)

The Well-being of Future Generations Act 2015 bestows a remit on public bodies to improve the social, economic, environmental and cultural well-being of Wales through delivery of its seven Well-being goals, see Figure 4. It also defines sustainable development, that public bodies must act in a manner which seeks to ensure that the needs of the present are met without compromising the ability of future generations to meet their needs. As a public body, it is NRW's remit to ensure this principle is embedded in both our own and joint enterprise work.

Risks to water resources, whether to quantity or pollution from a point or diffuse source, are managed through legislation, both European and domestic, including the Water Framework Directive and Water Acts. Water suppliers must comply with section 68(1) of the Water Industry Act 1991 a duty to supply wholesome water. In Wales wholesomeness requirements are set out in the Water Supply (Water Quality) Regulations 2001.

Regular monitoring, by water companies and NRW, and enforcement checks, by NRW, ensure current and future generations and the environment have access to sufficient, safe water.

Many of Wales's water storage facilities also serve as sport amenities, providing opportunities for well-being through access to the outdoors.

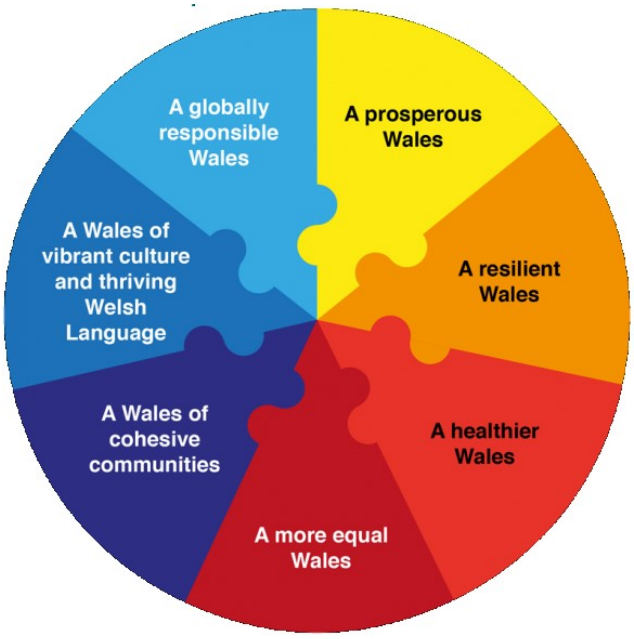

Figure 4 Well-being Goals as defined in the Well-being of Future Generations Act 2015. Source: Welsh Government

Contributing to a regenerative economy (Aim 4)

In the UK, there has been an increasing realisation that the usual linear model of take-make-waste is not sustainable. This also applies to water use in water management, where the linear model can be described in terms of abstract-use-discharge. To manage water resources more sustainably, a move to a more regenerative economy model is beneficial.

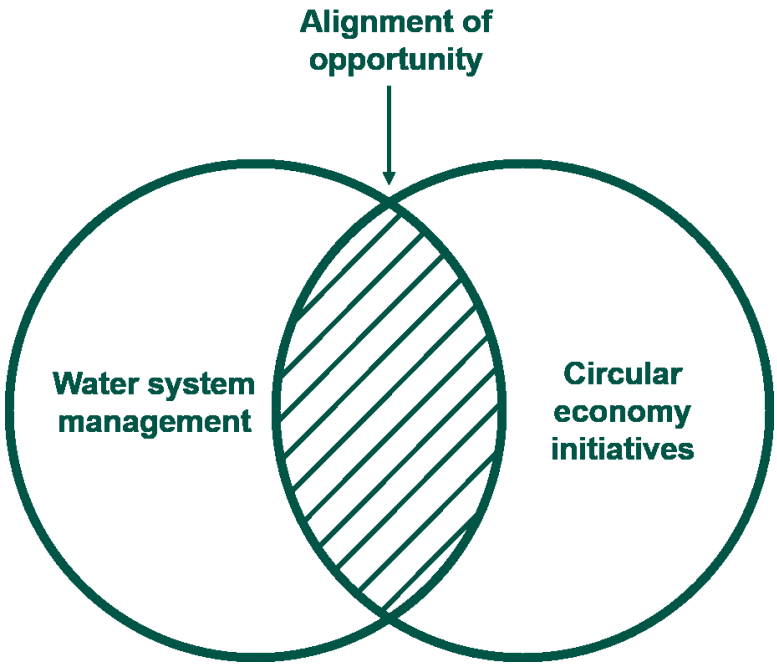

Figure 5 Alignment of circular economy opportunities with water system management (Based on figure from: Ellen Macarthur Foundation, 2018)

Where innovative ways of managing water resources overlaps with regenerative economy initiatives, Figure 5 illustrates how cost effective and environmentally sustainable opportunities for water efficiencies can be realised.

In a natural catchment, the water cycle re-optimises-reuses-replenishes water. In a managed catchment this natural cycle is altered. Tahir et al., 2019, produced a diagram to present the difference between natural and managed water systems, see Figure 6.

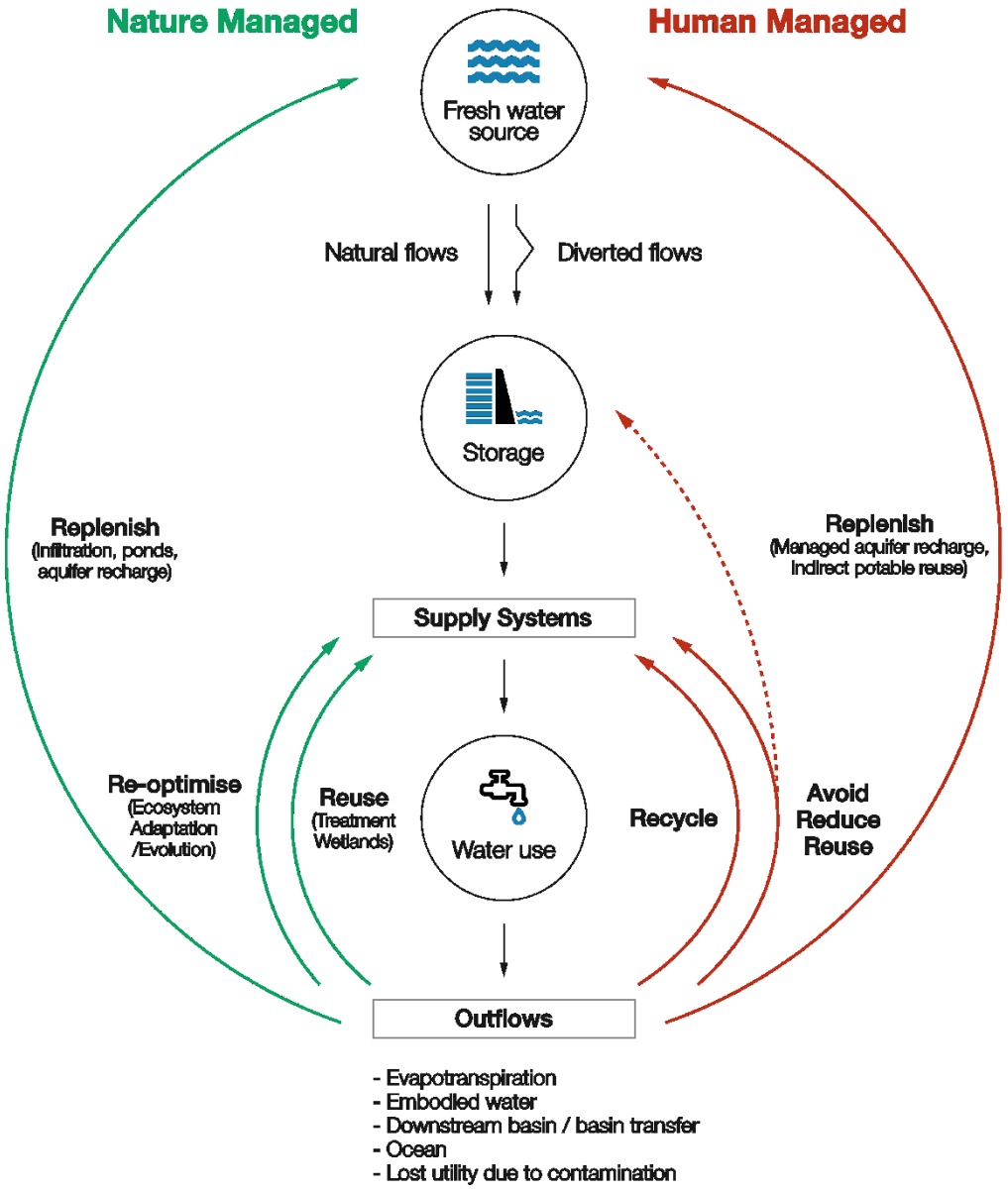

Figure 6 Difference between natural and managed water systems in terms of the circular economy (Tahir et al., 2019).

The circular economy model is broadly based on three principles:

- design out waste and pollution
- keep products and materials in use
- regenerate natural systems

Welsh Government's Water Strategy for Wales (2015) outlines how these principles will be delivered through a range of key objectives and supporting actions for the short, 2020 medium, 2020 to 2025, and long term, 2025 onwards. These include:

- reviews of existing, and the introduction of new legislation
- collaboration to deliver more sustainable and efficient use of water
- new standards on sustainable drainage systems (SuDs) and leakage targets
- address water poverty through a review of tariffs
- improve water quality by working with sectors to reduce pollution at source

Water labelling

The European Commission has given support to the introduction to a Unified Water Label (UWL) proposed by the Bathroom Manufacturers Association. Bathroom product manufacturers selling into the European Union (EU) have until 2021 to comply with the criteria of the voluntary UWL, otherwise, the EU or individual governments will step in and introduce a mandatory label to inform customers of a product's water and energy efficiency (KBB Review, 2019).

The UWL is a voluntary scheme that is currently used by over 155 brands and registered with more than 13,200 products across Europe but does not cover non bathroom products nor is it linked to any minimum standards.

Currently, 60% of manufacturers selling into the EU are compliant with the label's criteria, but a key requirement of the UWL is that 80% of the market must be using the label for it to be formally accepted in Brussels.

In 2018-19 the water industry's Water Efficiency Collaborative Fund (Dŵr Cymru, n.d.) and Waterwise, with support from Defra, commissioned the Energy Savings Trust to assess and evaluate the costs and benefits that a water labelling scheme could have on domestic water and energy consumption in England (EST 2012). This would look similar to the energy consumption labelling scheme established by the The Directive 2010/30/EU, which requires all electrical white goods to demonstrate their energy efficiency using an efficiency class from A-G. Based on data from labelling schemes around the world, such as Australia's Water Efficiency and Labelling Standards scheme, the EST report recommended that the most cost-effective scenario would be a mandatory label on all products and appliances using water, such as taps, showerheads, toilets, washing machines and dishwashers, linked to building regulations and minimum standards for products and appliances. Welsh Government has commissioned EST to assess and evaluate the costs and benefits that a water labelling scheme could have on domestic water and energy consumption in Wales.

A Water UK 2019 report which looks at long term reduction of consumption concluded that over 25 years, this option will reduce water usage by 31 litres per person, every day. In the same period, it will also save 55.9 million tonnes of carbon dioxide – the equivalent of taking 23 million cars off the road for a year (Waterwise, 2019).

The Environment Bill 2020, Part 3 section 50, confers power on the devolved authorities to make regulations about resource efficiency requirements and confers power on them to regulate enforcement of such requirements.

It is recognised by the UK Water Efficiency Strategic Steering Group (UK WESSG) that greater water efficiencies will be made if there is a consistent, co-ordinated approach to water efficiency labelling on appliances in the UK.

The current Unified Water Label (Bathroom Manufacturer's Association, 2020) and the Waterwise CheckMark, Figure 7, do not apply to washing machines or dishwashers in the UK.

"At the urging of Defra, the BMA (Bathroom Manufacturer's Association) have devised a water efficiency rating system that is clear, easy to understand and has been enthusiastically taken up by manufacturers. Showers with a flow rate of between 10 and 13 litres/minute are rated as poor while showers with a flow rate greater than 13 litres/minute are in the red zone. Under the CERT scheme, energy companies are being paid to send households flow regulators that reduce flow rates from existing showers to less than 8 litres/minute. There are some good measures around to reduce hot water use in existing dwellings, to ensure that there is a greater choice of water efficient appliances on the market and that they are easy to identify. It's a shame there is no requirement to fit them in a new dwelling." (Hassell, 2010)

The UK currently has the European Unified Water Label and the Waterwise CheckMark to help identify water-efficient products - but these aren't universal to all stores and products.

Figure 7 Waterwise checkmark

Energy reduction through water efficiency

Water is a heavy element to move around and often requires energy to do so; as a result, water industry activities contribute to 6% of the UK's annual carbon emissions. Water companies assess the energy required for pumping and treatment as part of their carbon footprint. This may vary depending on the amount of rainfall. For example, the energy use for groundwater abstractions increases if the pump has to be lowered as water levels fall. As the population rises, demand increases and climate change impacts reduce water levels this practice is likely to become more common.

In the period 2018-19 Hafren Dyfrydwy reported emissions of 133 kilograms of carbon dioxide equivalent per megalitre (kgCO_2e/Ml) Dŵr Cymru 13 kgCO_2e/Ml (Discover Water, undated b) for the volume of treated water. Both these figures were an increase on the previous year which may be due to the exceptionally dry period in 2018 where low river levels resulted in increased treatment and low water tables in increased pumping. This example highlights how prolonged dry periods will lead to increased energy use. Reduction in demand through more efficient use of water will help mitigate this impact.

A significant proportion of the energy associated with water consumption is a result of heating water in the home. It shows that of CO_2 emissions of domestic water use, 89% is associated with heating water in the home, while 11% of emissions result from abstracting, conveying and treating domestic water outside the home (Energy Savings Trust, 2012; Clarke et al., 2009) See Figure 8.

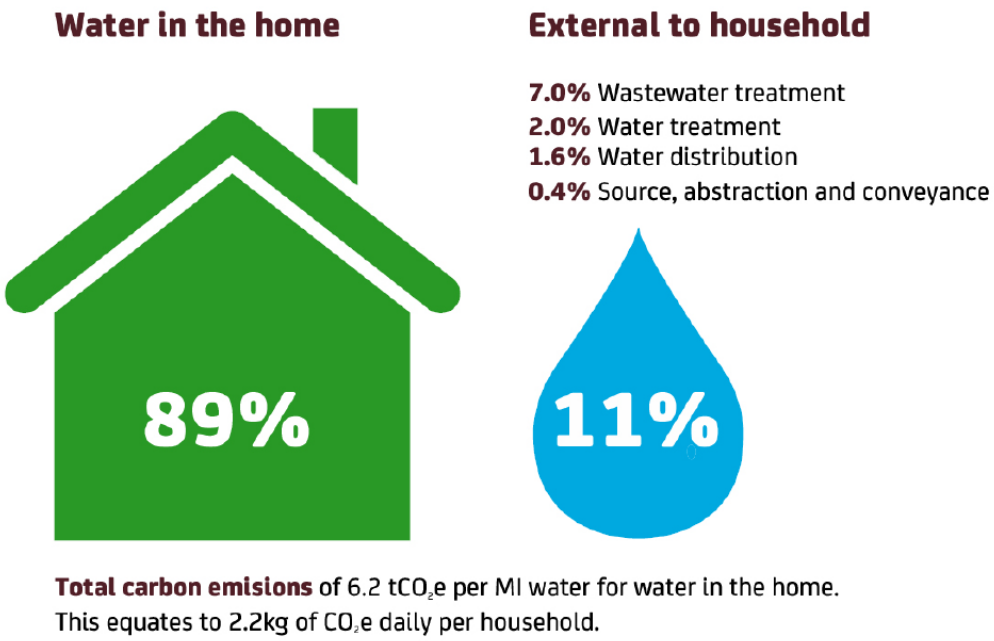

Figure 8 Origin of CO2 emissions associated with domestic water. Guidance on water and associated energy efficiency (Clarke et al., 2009).

The Water Efficiency Strategy for the UK 2017 makes recommendations to include water efficiency measures in energy efficiency, fuel poverty retrofit and advice programmes and develop indicators and targets around water use per person and best practice (Waterwise, 2017). The guidance sets out the key reasons for saving water in social housing and details what providers can do in procurement and retrofit programmes. Retro fitting of water efficiency products to water appliances is being carried out by Dŵr Cymru, for a target of 30,000 customers by 2025 (Dŵr Cymru, 2019).

As well as raising awareness of the need for water efficiency labelling of larger water appliances such as washing machines and dishwashers, Working with Waterwise, UK WESSG and Wales Water Efficiency Group (WWEG) are advocating that items including taps, shower heads are manufactured with water efficiency fittings as standard (Waterwise, 2019)

Due to relatively high rainfall, there is a perception in Wales that there is little need for water efficiency. Initiatives to reduce water use, and thereby carbon emissions, in the home are likely to be more successful if the benefits of water efficiency for future water security is linked to a reduction in household energy bills.

Overall, these energy savings could be considerable. Guidance on water and associated energy efficiency for the Welsh Housing Quality Standard for retrofit programmes in 2012 estimated that if every social housing property in Wales had water-efficient taps and a retrofitted toilet and shower, combined energy and water bills could be reduced by £3.5 million a year.

The water companies are working with businesses to reduce energy use by reducing water use. Dŵr Cymru provide a domestic audit, of taps, sinks, toilets, and a process audit, of water used as part of business processes, to identify where savings can be made, This will enable the business to develop a water efficiency plan (Dŵr Cymru, undated).

Rainwater harvesting and grey water recycling

The Water UK long-term planning framework (2016) stated that a 'twin-track' approach of increasing supply and reducing demand is needed in order to secure the resilience of water supplies over the next 50 years. To achieve a significant reduction in water use developers will need to go beyond traditional water efficiency measures such as low flush toilets and low flow showers. Rainwater harvesting (RWH) and greywater recycling (GWR) technologies offer a potential solution and are increasingly being considered at the building-level as a means for addressing water scarcity and storm water attenuation (Fredenham et al., 2020).

In February 2020 a research project into an independent review of the costs and benefits of RWH and GWR options in the UK was initiated by UK WESSG (Fredenham et al., 2020). The study found that to date, both rainwater harvesting and grey water recycling systems have been implemented with mixed experience in the UK. Technical concerns regarding water quality, potential cross connections and issues around the social acceptability of using recycled water have all been barriers to uptake. Furthermore, a 2010 a joint UK Government (Environment Agency) Report (2010) on the carbon implications of these systems suggested that due to pumping and treatment they are often more carbon intensive than the public water supply. Additionally, the payback periods and return on investments can be a limiting factor for some systems but may benefit from economies of scale if they are introduced at a development scale or centralised within an existing community.

Rainwater harvesting, whether small scale, such as water butts, or large scale, such on-farm winter storage ponds, reduces the pressure of abstraction on watercourses and mains water use at times when source supplies are low. Grey water recycling similarly reduces the need to use potable water for non-potable uses such as flushing the toilet. RWH and GWR fit the circular economy model of Avoid, Reduce, Reuse, Recycle and Replenish, see Figure 6.

5. Forward look and progress towards policy targets

Main pressures affecting resource use

Water efficiency, climate change, and population growth

As part of their water resources management plans, water companies must set out the risks to supply and demand for water with regard to demographic and population changes and climate change.

Climate change is expected to restrict the supply of water whilst population growth will add to demand. The population in Wales is projected to increase to 3.3 million from the current 3.1 million by 2043. Figure 9 shows the projected percentage increase in population across Wales by 2043 (Office for National Statistics, 2019).

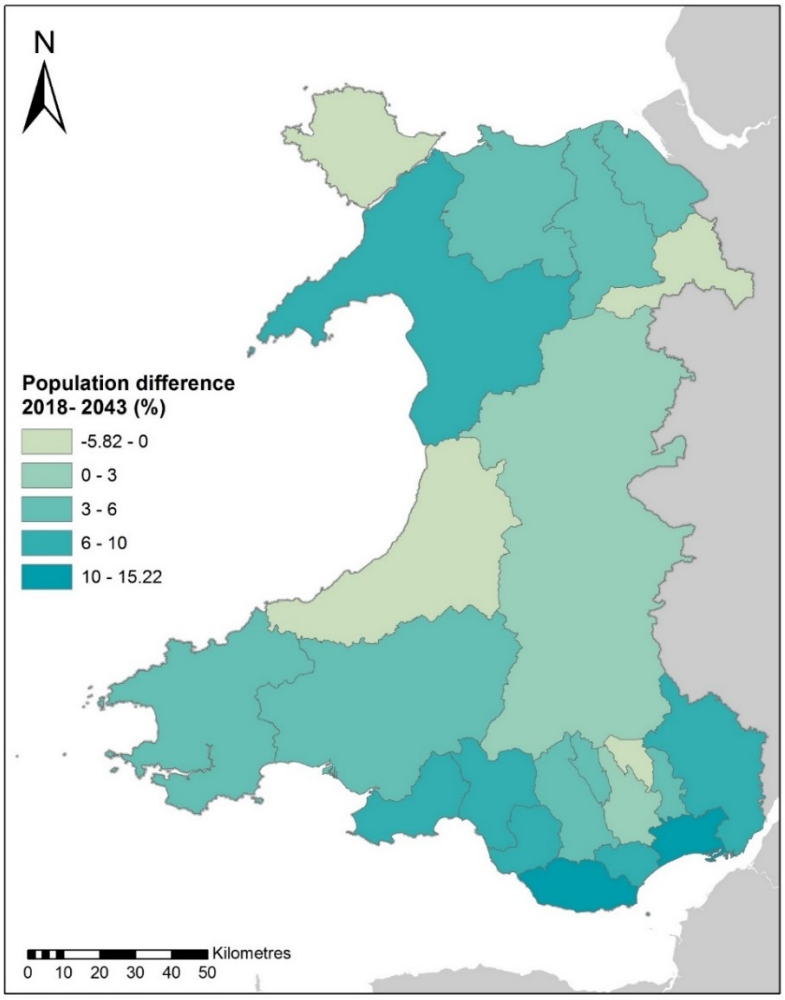

Figure 9 Population growth in Wales by 2043 (Office for National Statistics, 2019).

Table 17 and Table 18 show the respective projected percentage changes to population for each of the water resource zones managed by Dŵr Cymru and Hafren Dyfrydwy to 2050.

Figure 10 shows only two Dŵr Cymru water resource zones are likely to have deficit of supply in 2050 (Dŵr Cymru, WRMP 2019) and that there is no projected deficit for Hafren Dyfrydwy water resource zones to 2045 (HD WRMP, 2019). The deficit calculations have been based on the projected increase in population for each zone and an overall decline in the demand for water as a result of working with customers to increase water efficiencies and reduce leakage. Dŵr Cymru has set out in its WRMP the measures it will take to ensure a secure supply of water to its customers in these two zones.

Table 17 Percentage increase in population per Dŵr Cymru water resource zone

Water Resource Zones	**Projected Increase Population by 2050 (%)**
North Eryri and Ynys Môn	5
Clwyd Coastal	2
Alwen Dee	6
Bala	10
Tywyn Aberdyfi	4
Blaenau Ffestiniog	6
Barmouth	4
Lleyn Harlech	6
Dyffryn Conwy	6
South Meirionnydd	7
Tywi	7
Mid and South Ceredigion	8
North Ceredigion	5
Pembrokeshire	10
Ross-on-Wye	5
Elan Builth	7
Hereford	6
Llyswen	10
Monmouth	4
Pilleth	7
Brecon Portis	5
Vowchurch	3

Water Resource Zones	Projected Increase Population by 2050 (%)
Whitbone	4
SEWCUS	4

Table 18 Percentage increase in population per Hafren Dyfrydwy WR Zone

Water Resource Zones	Projected Increase in Population by 2050 (%)
Llandinam and Llanwrin	-13
Llanfyllin	16
Saltney	-12
Wrexham	8

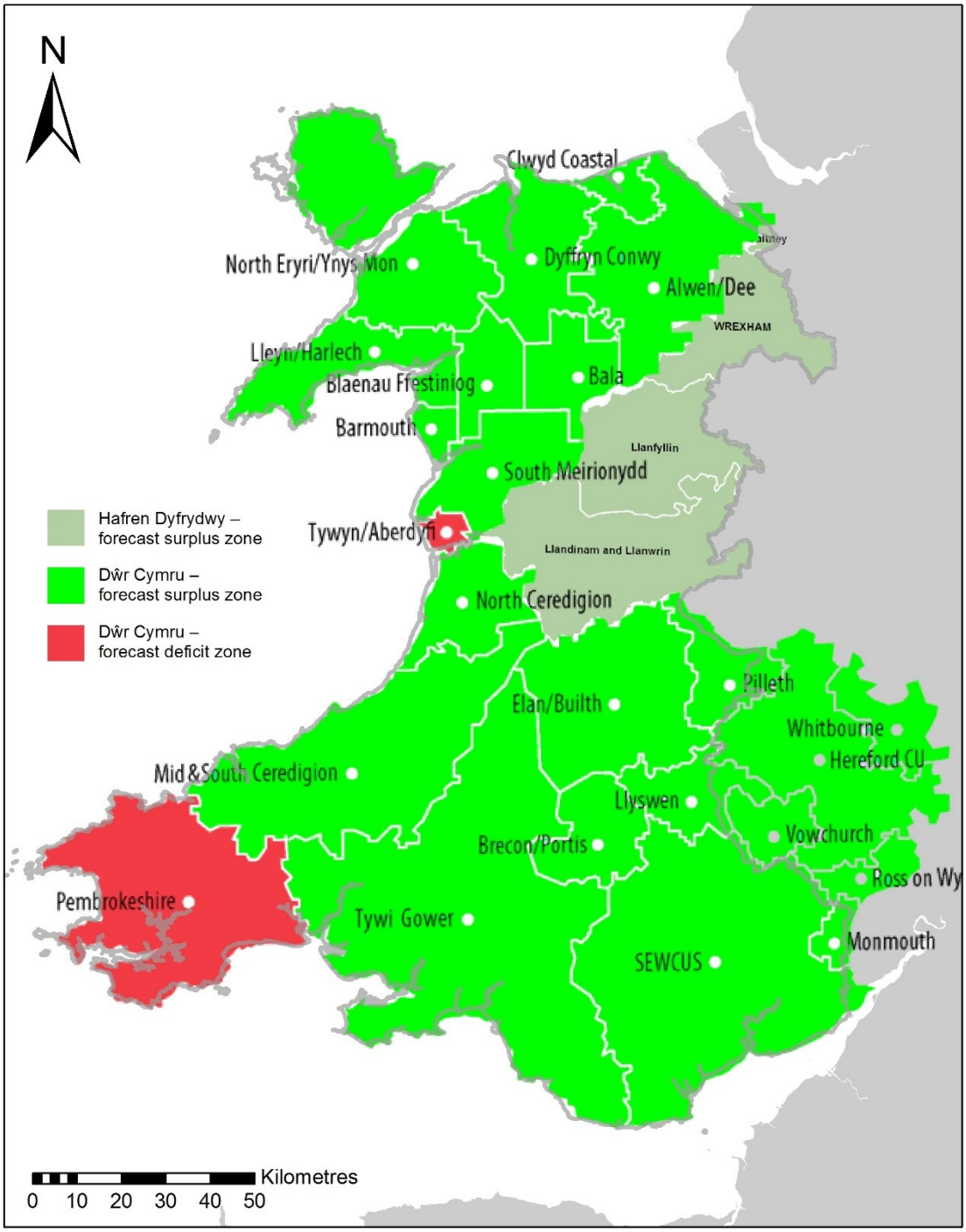

Figure 10 Dŵr Cymru: Forecast deficit zones 2050 in bright green and red (Dŵr Cymru, 2019a) and Hafren Dyfrydwy: Forecast deficit zones 2045, in darker green (Hafren Dyfrydwy, 2019).

The majority of 28 water resource zones in Wales are projected to remain in surplus ensuring a sufficient supply of water to meet future demand for water until the 2050s, even under a high population and high climate change scenario, with only two zones reporting deficits of more than 5 megalitres per day.

Climate change risk assessment 2 scenario projections show an increased variability of river flows across seasons with increased average winter flows and reduced spring and summer flows (HR Wallingford, 2015). The Climate Change Risk Assessment 2017 Summary Report for Wales identified the need for more action to address potential changes in rivers, reduce pollution, tackle over-abstraction, and improve the ecological condition of water bodies (ASC, 2016). These issues are largely being addressed as actions within the EU Water Framework Directive River Basin Management Plans. See Freshwater chapter.

Changes to the river environment due to climate change can severely impact on fisheries, reducing the extent of spawning grounds and increasing stress and its related lowered immunity to disease. To reduce the risk of higher water temperatures, less dissolved oxygen and the need for a greater degree of adaptation, permission to abstract always allows for environmental needs.

Land use changes to reduce pollution run-off and soil erosion, caused by an over dependence on pesticides or compaction by livestock or farm vehicles, will also reduce the amount of treatment required for abstracted water. This will reduce the cost and overall carbon footprint of the supply process.

These changes would also allow for more water to be retained in the soil *in situ*. This water will then provide seepage during dry periods, maintaining some base flow for water courses.

It is likely in the medium term that more seasonal abstraction permits for irrigation will be sought as longer, drier periods become commonplace. In the long term, compromises may have to be made to environmental protections in order to continue to meet the demand for water unless mitigation measures and behavioural changes to water use are implemented in the short and medium term. It is likely that the construction of offline winter storage reservoirs will be required to be able to meet demand at times when resource availability is at its lowest.

Leakage

Ofwat has set a target for water companies to reduce overall leakage by 15% by 2025, but only where it is cost effective to do so. CCWater have reported supply leakage as a significant barrier to the uptake of water metering by customers (CCW, 2019)

Dŵr Cymru and Hafren Dyfrdwy have also committed to reducing leakage by 50% by 2050 (Dŵr Cymru, 2019; Hafren Dyfrdwy, 2019).

Leakage within the home is a major loss of clean drinking water. The Waterwise summary statement on leaky loos, 2019, states that between 5 and 8% of, mostly, dual flush toilets leak on average 215 to 400 litres per day of drinking water. Around 400 million litres of water are estimated to leak from UK toilets every day, which is

enough water to supply 2.8 million people, equivalent to the populations of Edinburgh, Cardiff, Belfast, Manchester, Sheffield, Liverpool and Bristol combined (Waterwise, 2019).

The losses are comparable to the proposed reduction in consumption per person per day for the period 2020-2025 by water companies in England and Wales. There is a need for manufacturers to remove the problem through improved designs and a need for regulators to ensure that the testing and enforcement regime is robust.

Water legislation

The strategic, efficient management of water resources is critical to ensure resilience of supply and to meet environmental standards, especially given the increasing pressures of climate change and population increase. There is also the potential risk that future droughts may be worse than the historic droughts.

Water companies set out in their water resources management plans how they will provide a secure, sustainable supply of water to their customers and businesses over at least the next 25 years and beyond. Along with meeting the pressures of increased population and helping to protect the environment, the water companies in Wales ensure that they plan for more challenging, plausible range of events beyond the worse historic droughts. They must set out the levels of service they plan to provide for their customers over the planning period. Water companies describe the frequency that they plan to restrict water supplies for their household and non-household customers using temporary use bans, non-essential use bans and emergency drought orders. They also publish drought plans that set out short term measures they may take during a drought.

It is essential therefore, that water is managed in a consistent and sustainable way. The majority of water legislation governing water management in Wales is devolved from Westminster. Welsh Ministers have the power to change legislation for Wales, but it mostly remains joint with England which allows for a high degree of consistency across all aspects of water management in the UK.

Licensing for abstracting water was introduced in 1965. At that time, some abstractions were considered low risk and were exempt from needing a licence. The Water Act 2003 included provisions to deregulate licensed abstractions under $20m^3$ per day, enacted 2005, and to remove licensing exemptions in England and Wales, see Summary assessment and forward look

Where the locations of these previously exempt abstractions were known they were included in calculations of resource availability. These tended to be the larger abstractions as the locations of the smaller exempt abstractions are mostly unknown. The introduction of New Authorisation, see Summary assessment and forward look, legislation will bring successful applications for those abstractions above $20m^3$ per day into future resource availability calculations. As abstractions below $20m^3$ per day are exempt, the extent of these abstractions is largely unknown. Proposed studies by both the Welsh Government, due 2021 into the location of these exempt abstractions will inform how water is managed efficiently with regard to future abstraction applications in these watercourses. This may mean a capped abstraction availability or more stringent than usual Hands off Flow conditions.

Environment Permitting Regulations

The Welsh Government remain committed to moving Water Resources into the Environmental Permitting Regulations as stated in the 2014 consultation ‘Making the Most of Every Drop’ (Defra, 2014). The move into Environment Permitting Regulations (EPR) will mean that abstraction licences will be replaced with permits for which the operator will have to detail measures taken to ensure water is used in an efficient manner. NRW expect to move abstraction and impoundment licensing into EPR by 2023.

Water policy in Wales

The Welsh Government Water Strategy for Wales, 2015, presents Wales’s priorities and principles for water resources and how these principles will be delivered through a range of key objectives and supporting actions for the short, 2020, medium, 2020 to 2025, and long, 2025 onwards, term (Welsh Government, 2015). It aligns catchment-based approaches to water management and water resource planning with other land management activities, such as less livestock per area to reduce compaction, and better slurry storage to reduce polluted run-off thereby reducing the need for water treatment. The strategy recognises the need for green growth and makes important links between energy use and related carbon emissions and the chemicals used in water treatment. Using resources efficiently is important in order to reduce carbon emissions, save money and keep water bills affordable.

SoNaRR will provide evidence to inform the Natural Resource Policy which prioritises sustainable management of natural resources which will be embedded in the delivery of Area Statements place-based initiatives.

The EU Water Framework Directive sets standards for water across Europe. In Wales, these standards are monitored by NRW and plans and actions to improve standards are presented in River Basin Management Plans (RBMP). NRW has responsibility for the Western Wales RBMP and joint responsibility with the Environment Agency for the Dee and Severn RBMPs. NRW recognises that environmental water issues are best addressed at a smaller, catchment based, scale.

Abstraction pressures on water courses are measured as part of the NRW Abstraction Licence Strategies. These strategies set out the amount of available water resource once existing abstraction licence allowance has been allocated and environmental needs are met. The consumptive factor, the amount of water used up and not returned locally, usually expressed as a percentage of the abstracted amount, of a new, potential licence is also part of this calculation.

The abstraction, storage and use of water is regulated by NRW through routine abstraction licensing, asset inspection, water sampling and analysis.

6. Synergies and trade-offs

Some of the changes required to combat climate change, population increase and pressures to meet water quality standards will improve habitats and their ability to deliver ecosystem services. Other changes may mean increased environmental risk.

Water transfers

Climate change projections show that pressures on water resources will increase over the next 50 years. Some areas of the UK, including Wales, have relatively high rainfall, a natural resource which is likely to become increasingly scarce in some parts of the UK. As a result, it may become necessary for more water to be transferred across catchments and even political borders. This is only likely to occur when there are surplus resources.

The new Regulators' Alliance for Progressing Infrastructure Development (RAPID) will make sure regulation enables strategic schemes to improve resilience of water supplies into the future. These schemes might include transfers between regions in England and Wales and developing joint infrastructure, such as shared reservoirs.

Historically the transfer of water, especially across borders, remains controversial.

Compared to England, Wales has relatively less arable land and is largely dependent for farmed food on more fertile areas of the UK, such as Norfolk, Midlands and South East England. A successful harvest is heavily dependent on irrigation where water is at a premium due to relatively less rainfall than that on high ground. A future trade-off is likely to be water for food security of domestic crops.

Invasive non-native species

Transference of water across catchments increases the risk of spread of invasive non-native species (INNS). The benefits of water transfer may well be outweighed by the cost of infrastructure to ensure there is no mixing of water from different regions. See the INNS chapter for more information.

Environmental risks

Changes to the natural water systems are carefully managed to reduce risk of environmental damage. Environmental Flow Indicators (EFI) are calculated for each water watercourse, this is the amount of flow below which the riverine environment may be adversely affected. Abstractions are not allowed to reduce the river flow below this threshold. A percentage of the flow over the threshold to the natural flow level may be licensed depending on the sensitivity of the watercourse to abstraction. In future scenarios, in order to meet demand for water, there may be a case for reducing the EFI threshold for some water courses. This may reduce the pressure to abstract from more sensitive watercourses, maintaining their Good Ecological Status (GES).

De minimis abstraction threshold

Abstractions below 20m^3 per day do not require an abstraction licence, regardless of the size of the source. To protect the resilience of, especially smaller, water courses, it may become necessary to consider reducing this *de minimis* threshold so that smaller abstractions are liable for permitting.

Flow augmentation

There are some longstanding borehole abstractions in Wales for the purpose of mitigating surface water abstraction. Wales does not have extensive aquifers but where they exist, recharge is good and the water table tends to remain high. As part of climate change mitigation these aquifers may become more significant water sources as a way to compensate surface waters which would otherwise be reduced during prolonged dry periods. Pumping boreholes requires energy, unless artesian, thereby increasing carbon footprint.

Water storage

Climate change projections of more frequent periods of prolonged dry weather will require implementation of some mitigation measures such as on farm water storage for irrigation to reduce pressure on water courses during dry periods. This will involve a likely trade off of other ecosystem services such as a potential reduction in grazing area, but without adequate water larger areas of crop land will not be viable.

At present Wales's large reservoirs provide most of public water supply in Wales. As water stocks dwindle, especially in England and, at a time when the importance of food security of food provision has been demonstrated by the COVID-19 pandemic, additional storage facilities may be needed for transfer of water. This will be difficult to address, displacement of communities for these facilities would be extremely divisive.

Rebound effect

Conservation and more efficient use of water should reduce the cost of supply and treatment. If this commodity becomes cheaper, its value diminishes, and there is the possibility of a rebound effect where water is not used efficiently because it is perceived as affordable.

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

How can resource use be made more sustainable?

Sustainable abstraction

Anticipating future pressures on water resources, licences issued since 2000 have been time limited, to no less than 12 years, and are subject to review before reissue. In order to renew the licence, licence holders must demonstrate a need for and efficient use of water.

The introduction of the Water Framework Directive (WFD) standards for flows which protect riverine ecology and water quality, have meant that some abstraction licences issued before WFD standards were implemented may be impacting on these standards. These licences have been reviewed under the NRW Restoring Sustainable Abstraction programme. Those abstractions found to be having an impact can have conditions of abstraction changed or added to the licence, mitigation measures implemented or, in extreme cases, the licence can be revoked.

Section 61(4) of the Water Resources Act 1991 allows an abstraction licence that is unused for four years or more to be varied or revoked without the payment of compensation.

Metering

People in Wales have been voluntarily moving to a measured supply at a rate of 3% per year since 2009, with 40% of customers in Wales requesting a meter to be fitted, compared to 34% in England by 2016. Of the 40% that chose to move to a measured supply, 81% did so to save money (CCW, 2019).

Metering is key to delivering long term demand reduction, both Dŵr Cymru and Hafren Dyfrydwy will in future be adopting a proactive metering strategy. Dŵr Cymru have set a target of meter uptake by 70% of households by 2050, Hafren Dyfrydwy will begin proactive metering campaign from 2025 onwards, with an expected 10% reduction in water use (Dŵr Cymru, 2019; Hafren Dyfrdwy, 2019).

CCWater have provided a water meter calculator for customers to calculate if they will in fact, benefit by having a water meter. To date a barrier to metering uptake has been leakage in supply. Both major water companies are committed to reducing leakage by 15% by 2025 (Dŵr Cymru, 2019; Hafren Dyfrdwy, 2019).

Building regulations

The Welsh Government Building Regulations G2 Sanitation, hot water safety and water efficiency 2018 section 36 stipulates that when new dwellings are erected there is a requirement to supply 110 litres per person per day of wholesome water. Where existing buildings are converted to dwellings the requirement is for 125 litres per person per day. Evidence of how sanitary appliances and white goods are used in the design calculation for a property must be presented to comply with the G2 water efficiency criteria.

Social housing is just over 16% of the total housing stock in Wales. To embed the need for improved water efficiency in this sector, Welsh Government's Housing Quality Standard for retrofit programmes 2019 advocates that:

- Water efficiency should be included in social housing standards, such as Decent Homes and Welsh Housing Quality Standard
- Any retrofit or upgrade of existing social housing should include the installation of showers in homes where there is only a bath
- Voluntary guidance and partnerships with water companies should be developed
- Resources should be combined, the water companies and the Met Office, UK Centre for Ecology and Hydrology, EA, NRW and Scottish Environment Protection Agency to provide a water information system for the UK that includes drought and water supply, to inform customers and policy makers.

Water recycling

Rainwater harvesting and grey water recycling reduce the pressure of abstraction from water courses by implementing a regenerative economy approach to water use. Recycling technologies continue to evolve. Waterwise and UK Water Efficiency Strategic Steering Group (UK WESSG) have commissioned a report from Ricardo on the cost effectiveness of current technologies for rainwater harvesting and greywater recycling. The report is due in 2020.

Water labelling

Australia's Water Efficiency Labelling and Standards scheme has shown that a mandatory water labelling scheme led by government saves at least five times as much water as a voluntary scheme, with government able to mandate removal of the least efficient products over time (Australian Government, 2017).

The Artesia study into deep reductions in household use found that stakeholders including water efficiency champions in water companies, consumer organisations, regulators, academics, consultancies, and new service providers strongly supported a mandatory water label (Artesia Consulting, 2018).

Where labelling is linked to minimum fittings standards for water using products used in new and existing houses it more than doubles the impact of the water label as it helps embed water savings into new build and existing housing stock. The level of savings increases at more ambitious efficiency standards.

Retrofitting of water using appliances

There are a range of devices which can be retrofitted to reduce water use, such as fitting a shower which uses an aerated shower head and aerated taps and reducing the size of the toilet cistern or adding hippo bags to reduce flush.

Communications and awareness raising initiatives

Success of the circular economy approach will depend on behavioural changes. NRW will work to broaden community involvement in the development of water policy through the Wales Water Management Forum, previously River Basin Management Liaison Panels, and at a local, catchment scale, through Area Statements.

The Wales Water Efficiency Group (WWEG) will co-ordinate initiatives hosted by the Welsh Government, water companies, NRW and CCWater, to ensure consistent messaging around water efficiency in Wales. Waterwise provides the link to UK Water Efficiency Strategic Steering Group to promote best practice across the UK.

Catchment management

Improving overall catchment management and sustainable land use can limit the amount of water lost to run-off. See freshwater and land use and soils chapters.

Domestic use

Evidence from Water UK study, Pathways to long term PCC reduction (Artesia Consulting, 2019) shows that small changes to water use within and outside the home can make a big difference.

Indoors:

- Turning off the tap when brushing teeth can save 20 litres of water over two minutes
- Older toilet cisterns use 9 litres of water per flush, more modern toilets use 6 litres. Use a ‘hippo’ or save a flush bag in the cistern to reduces the amount of water flushed.
- A five-minute shower uses about half of a bath of water, unless it is a power shower which in five minutes uses the same as a bath.
- New showerheads and taps can have aerators fitted. These add air to the water and use much less water than standard taps and showerheads.

Outdoors

- Sprinklers can use a 500 to 1000 litres of water an hour, a watering can will hold about 10 litres.
- Use a water butt to collect rainwater to water plants, especially in dry periods.
- Use water from washing up and paddling pools to water the garden.
- Consider planting more drought resistant plants which need less water.

What are the barriers to achieving this?

The major opportunity to achieving significant gains in water efficiency across all sectors in Wales is the potential for a coordinated effort from suppliers, regulators, users, and policy makers. In November 2019 Wales Water Efficiency Group was formed to prioritise water efficiency needs across Wales. The Group identified the following potential barriers to delivery of positive outcomes:

- Communications
- Shared data and information
- Behavioural changes to water use
- Leakage
- Incentives
- Monitoring
- Tariffs
- Water labelling
- Government lead

How can these barriers be resolved?

The Wales Water Efficiency Group (WWEG) was formed to improve and co-ordinate the efficient use of water in Wales. The group has representatives from the Welsh Government, Welsh water companies, CCWater, NRW and Waterwise. WWEG links into the UK Water Efficiency Strategic Group (UK WESSG) to share research and best practice. WWEG provides a forum through which government, customer watchdog, regulator and suppliers can communicate effectively. Through collaboration, they can prioritise a programme of research and projects to meet the challenges of projected climate change impacts, population growth and environmental standards through the sustainable management of natural resources.

Upland areas of Wales have relatively higher annual rainfall compared to most of the UK, resulting in the widely held perception that there little need to use water efficiently. Arguably, the biggest barrier to improving water efficiency is a need for behavioural change towards usage across all sectors. As part of UK WESSG NRW are able to carry out UK initiatives to raise awareness of the need to change water use behaviour through videos, social media and talking to customers. In Wales a locally based approach can be taken to changing behaviours through embedding efficiency measures into regulation and compliance of licences and permits and into delivery of Area Statement initiatives.

CCWater has identified leakage of supply water as the biggest barrier to acceptance of the need to conserve water (CCW, 2019). Water companies have committed to reducing supply leakage where it is cost effective to do so and provide advice and tips on how to reduce leakage and water saving measures within the home. Dŵr Cymru supply free ‘hippo bags’, to reduce flush in toilets, and leak detection strips to monitor leaky loos, one of the largest causes of household water wastage.

NRW has achieved the Waterwise Checkmark accreditation for efficient water use in several of our offices and visitor centres, as of 2020. This accreditation will be rolled out across the remaining NRW properties and those shared with other agencies.

Using evidence of our water and energy savings we will encourage our customers in business and commerce to also seek accreditation.

Monitoring water use will provide evidence of where to target future campaigns. Water companies are committed to being pro-active in encouraging uptake of water meters in homes and across business and commerce. Studies are planned for ways to better calculate personal use per head.

The Welsh Government has also commissioned a study to locate and map private, unlicensed abstractions to identify abstraction hot spots. Previously exempt abstractions over $20m^3$ per day are now required to apply for a licence under the New Authorisations legislation. These quantities were not previously included in availability of resource calculations. Inclusion will provide further evidence of abstraction hotspots.

In future there may be the opportunity to introduce water saving incentives such as mitigation for loss of land for on farm winter storage to reduce pressures of abstraction from watercourses, especially for heavily consumptive activities such as irrigation. NRW will continue to advise the Welsh Government and farmers' unions on which types of measures are likely to be most effective.

Waterwise, supported by UK WESSG and WWEG, have commissioned a report (Fredenham et al., 2020) into the cost effectiveness of rainwater harvesting and grey water recycling. Recommendations from the report will be used to advise on reduction of reliance on mains water in the agricultural and construction industry.

NRW have made recommendations that the Optimum Use of Water in Agriculture and Business (Mathieson, 2002) is reviewed to provide clear guidance to these sectors on efficient water use.

In 2020 WWEG began working with Welsh Government to review building regulations to ensure that water saving measures and appliances are fitted to a minimum standard.

UK WESSG, supported by WWEG, have highlighted the need for UK Water Efficiency Labelling of water appliances.

8. Evidence Needs

The removal of water from the natural environment can lower the resilience of aquatic species and habitats to changes in flows and temperature. We need to ask what, where and to what extent, are the impacts on resilience and how they can be addressed.

This strategic research will help to prioritise our response, directing resources to those areas most in need. For example, location of abstractions which are exempt from licencing, below $20m^3$ per day, and New Authorisations, previously exempt abstractions over $20m^3$ per day, will identify abstraction 'hotspots'. Implementing water efficiency measures in these areas will reduce the need for abstraction and consequently reduce pressure on the local environment.

We need to ask what the climate change projection scenarios of more low flow events will look like and what the extent of those impacts will be. Ongoing monitoring of river flows, species and habitats, provide data to model potential changes in the short, medium and long term. This evidence will help to deliver management plans, policy and legislation to prevent or mitigate damage.

Analysis of recent studies has identified where there are evidence gaps such as:

- how cost effective are new water efficiency technologies such as those for rainwater harvesting or grey water recycling?
- are some types of technology dependent on scale of use such as sustainable urban drainage schemes?
- to what extent does using water efficiently link to savings on energy bills?

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