Indicators and trends

Monitoring climate change adaptation

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Indicator name				Version
BW7 Customers and zones vulnerable to supply deficit				**10/03/16**
Indicator type:	**Risk/opportunity**	**Impact**	**Action**	
	X			

SCCAP Theme	SCCAP Objective	CCRA risk/opportunity
Buildings and infrastructure networks	B2: Provide the knowledge, skills and tools to manage climate change impacts on buildings and infrastructure N2: Support a healthy and diverse natural environment with the capacity to adapt	BD15 Increased societal water demand WA5 Public water supply-demand deficits

At a glance
• Long-term changes in Scotland's weather due to climate change may impact water availability • Since 2003, there have been just four occasions with risk of significant loss of water supply • The number of zones in deficit has fallen from 128/230 in 2007/8 to 77/196 in 2013/14 • Scottish Water estimate that there will be 113,000 new properties connected to the system between 2015-2021, and this is likely to increase overall water demand • Scottish Water plan to invest in water resources for the next regulatory period (SR15) and have committed to improving the availability of drinking water. £24m will be spent on improving the Security of Supply Index (SOSI) for 47,000 customers during periods of dry weather

Latest Figure	Trend
2013/2014: 77 out of 196 (39.29%) zones had a supply deficit based on the Supply Demand Balance (SDB). The number of customers in zones in deficit was 297,846.	There is a decrease in zones with a supply deficit as based on the Supply Demand Balance (SDB) between 2007/2008 and 2013/2014. Zones in deficit fell from 128 out of 230 (55.65%) in 2007/2008 to 77 out of 196 (39.2%) in 2013/2014. In the same period, the customers served by zones in deficit fell from over 1.5 million to under 300,000.

Why is this indicator important?

Although Scotland is a relatively water rich country, there are not unlimited resources for treatment and supply (Scottish Water, 2012). It is predicted that climate change and population growth will place increased pressure on Scotland's water system, and on the available resources (Scottish Water, 2014). This may increase the likelihood of a long term interruption to customers' water supply. Interruptions are typically caused by extreme adverse weather conditions or when a strategic part of the water supply system is disabled due to failure, or external impacts such as malicious activity or other unexpected events (Scottish Water, 2014). However, long-term changes in weather patterns, as predicted to occur with climate change, may also impact on water availability.

Year-by-year forecasts of water demand from customers (average and peak daily use), and the available volumes of water for supply, are used to inform water resource planning (Scottish Water, 2015b). Zones are used by Scottish Water to identify areas of supply to customers.
The Supply Demand Balance (SDB) used in this indicator gives a summary of the surplus / deficit position for each zone, based on the surplus / deficit position during the critical period for each zone. Zones with large storage have a critical period based on annual averages; while for smaller sources the critical period will be 'peak week'. Further details of this calculation are included in the methodology section. Monitoring the SDB is important because it provides a measure of the vulnerability of the water supply under climate change.

Related indicators:
BW6 Water leakage and losses
BW8 Domestic water usage
BW9 Non-domestic water usage
NB27 Summer low flow events in Scottish rivers

What is happening now?

There are currently 196 water resource 'zones' (Scottish Water, 2014). Supply is limited by the raw water volume (yield) from water sources, the permissible abstraction limits (abstraction licence), and the physical asset base (water treatment works (WTW) capacity and raw water transfer infrastructure). The yearly forecasts are then examined to assess if there is a potential supply surplus (enough water) or deficit (not enough water). An individual water resource zone relies on the same resources, thus all customers within a zone share the same level of service (dictated by the water balance for that individual zone) and the same risk of supply failure. Where a supply deficit is forecast, this can be addressed by: managing leakage at the economic level (including offsetting alternative supply-side investment), improving the way in which water is distributed to customers and between zones, improving the way water is treated, increasing the supplies of water available and helping customers to reduce their demand for water (Scottish Water 2015b).

77 zones recorded supply deficits during 2013-2014, with a mean deficit of -0.230 Ml/d. These zones serve 297,846 people, almost 6% of Scotland's population (5,116,705).

What has happened in the past?

Since 2003, Scottish Water has identified four occasions during which there has been a risk of significant loss of supply due to low rainfall. Each time, customers were asked to use water wisely, while Scottish Water took steps to augment supplies and / or reduce leakage. The events were:

a) 2003-2004: Tayside, 250,000 customers at risk
b) 2010: Dumfries & Galloway, 55,000 customers at risk
c) 2012: Highlands & Western Isles, 35,000 customers at risk
d) 2013: Fife, 350,000 customers at risk

These events demonstrate that the water supply is vulnerable to unexpected events, failure of critical assets or extreme events, which could result in supply interruptions (Scottish Water, 2014).

Table 1 Changes in the Supply Demand Balance between 2007/8 and 2013/2014

Year	No of zones in deficit	Mean deficit across all zones in deficit, Ml/d	Population served by zones in deficit
2007-2008	128/230	-0.91	1,527,223
2008-2009	120/227	-0.61	1,000,369
2009-2010	111/220	-0.76	1,358,417
2010-2011	106 /214	-0.71	1,670,423
2011-2012	85 /212	-0.52	777,502
2012-2013	79 /199	-0.51	722,041
2013-2014	77 /196	-0.23	297,846

Scottish Water produce figures on the SDB during a critical period in each data zone on a yearly basis, allowing them to identify zones that record a deficit during this period. Table 1 summarises data for SDB for the period 2007/2008 to 2013/2014 (2007/2008 is the earliest date from which Scottish Water could supply consistent data). The table shows that the number of zones in deficit has fallen over the period and the mean deficit across the zones has also decreased. The number of customers served by zones in deficit has fluctuated over the seven years, but over the last 4 years there has been a marked decline, with numbers falling from over 1.6 million in 2010/2011 to less than 300,000 in 2013/2014.

Due to restructuring, the total number of zones has fallen from 230 to 196 over the monitoring period. To allow for this, Figure 1 illustrates the percentage of zones at risk, and the percentage of customers served by these zones. This shows that the percentage of zones at risk has decreased each year from almost 56% in 2007/2008 to just over 39% in 2013/2014. The percentage of customers at risk fluctuated from 2007/2008 to 2010/2011 but has decreased each year since. In 2013/2014, less than 6% of the population were served by zones that recorded a deficit in the SDB.

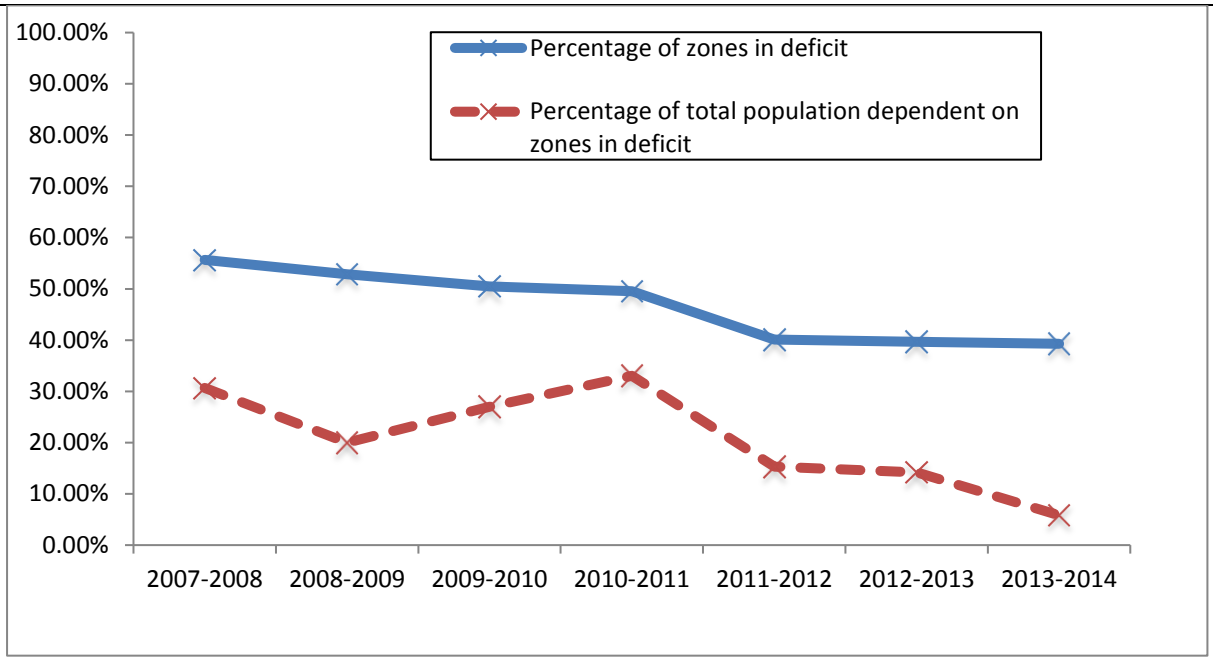

Figure 1 Percentage of zones in deficit and percentage of population served by zones in deficit

What is projected to happen in the future?

Climate change and population growth will place increased pressure on the water system, and on available resources. Scottish Water estimate that there will be 113,000 new properties connected to the system across 2015-2021, which will increase overall water demand. In addition, climate change is expected to increase the variability of rainfall patterns across Scotland, which will impact on water availability (Scottish Water, 2015b). Scottish Water recently completed a vulnerability assessment of future water availability for 2040. This assessment applied Met Office climate change projections to 11 equally probable climate change scenarios. The outcome suggested a range from 'little impact' to up to 45% of customers being affected to some degree, suggesting the possibility of more frequent water shortages for some customers (Scottish Water, 2015b).

Scottish Water's 25 year water resource plan (Scottish Water 2015b) and SR15 business plan (Scottish Water, 2014) include actions to help manage the supply of water in a sustainable way and to help maintain quality. For example, Scottish Water is engaged in sustainable land management activities to help manage catchment run-off and the impact on raw water resources, and will also work with farmers and landowners to prevent pollution. They also plan further investment in water resources for the next regulatory period (SR15) and have committed to improving the availability of drinking water. £24m will be spent on improving the Security of Supply Index (SOSI) for 47,000 customers during periods of dry weather. This is part of a larger plan for investment which includes £54.8m to improve resilience of supplies to extreme events (Scottish Water, 2014).

To support this process, a Resilience of Supply Index (RoSI) will be developed over the next few years in order to provide a measure of the overall resilience of supply for customers, taking account of all the wider resilience risks associated with a loss of supply from source to tap (e.g. flooding, physical security, critical asset failures) (Scottish Water, 2014; 2015).

Furthermore, Scottish Water has used a different mechanism to determine zones at risk under climate change, looking at risk in the longer term, and from this has identified 53 zones at risk of supply deficit. These 53 zones are not at immediate risk and include some that are currently in surplus

(Scottish Water, 2014). The zones were determined based on a Scottish Water risk assessment and the application of climate change projections, focusing on zones that are vulnerable because the availability of the water source/resource may be at risk, for example where the source is a smaller river. This means that across the next Scottish Water investment period (2015-2021), these 'at risk' zones will be subject to full hydrological modelling with the 11 future climate change scenarios. This will establish future 'yield' data projections and will show where deficiencies (due to climate change) might be. This determination is done only periodically, and is not comparable with 'zones at deficit' as defined by SDB or SOSI. Scottish Water already has plans to make improvements to 11 of the zones identified as at risk using this measure. These water supply zones are located in the Highlands and Islands of Scotland.

Patterns of change

It is predicted that climate change will increase variability in Scotland's rainfall patterns, which may have an effect on supply levels. In addition, an increase in demand is predicted due to population growth (Scottish Water, 2014). However, Scottish Water is investing in water resources, and they aim to have resilient water supplies available to all customers by 2040 (Scottish Water, 2014).

Interpretation of indicator trends

Both the number of zones in deficit, and the number of customers served by these zones has fallen between 2007/2008 and 2013/2014. Scottish Water attributes these improvements to two main factors. Firstly, their programme of investment in improving water resources, which impacts on the Supply side of the SDB, and secondly, leakage reduction to the economic level which has made large improvements to the Demand side of the SDB.

Limitations

This indicator examines zones that recorded a deficit during an identified critical period. This differs from the number of zones that recorded a deficit when figures are averaged across the year, which is likely to be lower. However the current measure has greater relevance in terms of the potential impact on customers.
Scottish Water has used a different mechanism to determine zones at risk under climate change, looking at risk in the longer term, which may offer greater insight into the zones at risk in the future.

References

Scottish Water (2012). *Water Efficiency Plan 2011- 2015*. Scottish Water. Available online at: http://www.scottishwater.co.uk/assets/domestic/files/you%20and%20your%20home/water%20efficiency/swwaterefficiencyplan.pdf

Scottish Water (2014). *Scottish Water Business Plan 2015 - 2021.* Scottish Water. Available at: http://www.scottishwater.co.uk/about-us/publications/strategic-projections/copy-of-business-plan-2015-2021

Scottish Water (2015a). *Scottish Water Overview of Security of Supply Index (SoSI).* Scottish Water.

Scottish Water (2015b). *Scottish Water 25 Year Water Resource Plan.* Scottish Water. Available at: http://www.scottishwater.co.uk/about-us/publications/key-publications/25-year-water-resource-plan

Further information

Acknowledgements

This indicator was compiled by Professor Lynne Jack and colleagues at Heriot Watt University.

Katherine Beckmann, Heriot-Watt University / CXC contributed to this indicator.

Owen Bramwell, Scottish Water.

Appendix One: Indicator metadata and methodology

Table 1: Indicator metadata

	Metadata
Title of the indicator	BW7 Customers and zones vulnerable to supply deficit
Indicator contact: Organisation or individual/s responsible for the indicator	ClimateXChange
Indicator data source	Scottish Water
Data link: URL for retrieving the indicator primary indicator data.	N/A

Table 2: Indicator data

	Indicator data
Temporal coverage: Start and end dates, identifying any significant data gaps.	1st April 2007 – 31st March 2014
Frequency of updates: Planned or potential updates	Annual
Spatial coverage: Maximum area for which data is available	Scotland
Uncertainties: Uncertainty issues arising from e.g. data collection, aggregation of data, data gaps	The number and geography of the data zones fluctuates each year due to re-organisation.
Spatial resolution: Scale/unit for which data is collected	Data zone
Categorical resolution: Potential for disaggregation of data into categories	196 data zones
Data accessibility: Restrictions on usage, relevant terms & conditions	Not publicly available. Supplied by Scottish Water.

Table 3 Contributing data sources

Contributing data sources Data sets used to create the indicator data, the organisation responsible for them and any URLs which provide access to the data.
The number of zones in deficit is based on the supply demand balance (SDB) data spreadsheet supplied by Scottish Water. The contact is Owen Bramwell.

Table 4 Indicator methodology

Indicator methodology The methodology used to create the indicator data
The number of zones in deficit is based on the supply demand balance (SDB) data spreadsheet supplied by Scottish Water. This gives a summary of the surplus/deficit position for each zone, based on the surplus/deficit position during the critical period for each zone. Some zones with large storage will have a critical period of annual average, where fluctuations in demand can be balanced by the storage. However for smaller sources, the critical period for the zone will be 'peak week', and so this demand is applied. This results in a larger number of zones in deficit than in the standard Security of Supply Index (SOSI) calculation which uses annual average demand for all zones. **Supply Calculations** The Supply side of the balance is represented by Water Available for Use (WAFU), which represents the minimum of the three major production constraints: Water Treatment Works (WTW) capacity, Hydrological Yield, and Controlled Activity Regulations (CAR) Licence (these are the well-defined maximum volumes of raw water abstractions allowed by licencing arrangements with SEPA). An allowance for WTW outage is also considered, and zonal imports and exports are added as necessary (Scottish Water, 2015a). Hydrological Yield is expressed at a target Level of Service (LoS). Scottish Water has selected a 1 in 40 year target LoS, which means that if they abstract less than their defined yield, they would not expect supply failure or long term interruptions to customers to occur more frequently than the stated return period. The calculation of the WAFU is limited by the LoS, so the SDB effectively becomes a model of a drought condition of the same severity as the 1 in 40 year LoS. This means that every modelled year is a 'dry year' (Scottish Water, 2015a). **Demand Calculations** Reported annual average Distribution Input (DI) is used directly in the demand calculations. "Demand forecasts for investment and planning purposes derive a future DI based on a forecast methodology applied to detailed Water Balance components. For example, Unmeasured Household demand is forecast by multiplying a forecast of Per Capita Consumption (PCC) by the expected future populations, including growth predictions. To maintain parity with the drought condition of the Supply side of the SDB, various uplift factors are added to DI to simulate the expected drought response; Scottish Water expect that customer behaviour will add an extra 3% to overall demand in a dry year. Once this uplift is included, the demand scenario is referred to as Dry Year Annual Average (DYAA).

In cases where small zones, including those without significant raw water storage, are susceptible to peaks in demand (usually attributable to summer tourism), Scottish Water classify the zones and having a 'Peak' Critical Period. A peak factor is applied in addition to the dry year factor, and this overall demand scenario is defined as Dry Year Critical (DYC)" (Scottish Water, 2015a).

Balancing Calculations

The balancing of the SDB includes a 'Headroom' component, which is a statistically modelled factor that accounts for 'per zone data' uncertainty across both the supply and demand components (Scottish Water, 2015a).