

Indicator name			Version
CRS54 Off-grid private water supplies at risk of flooding events			31/03/16
Indicator type:	Risk/opportunity	Impact	Action
	X		
SCCAP Theme	SCCAP Objective	CCRA risk/opportunity	
Climate Ready Society	S1/S2/ S3	FL1: Number of people at significant risk of flooding FL2: Vulnerable people at significant risk of flooding. HE16/MA2b: Incidents of human illness due to hosts and pathogens	

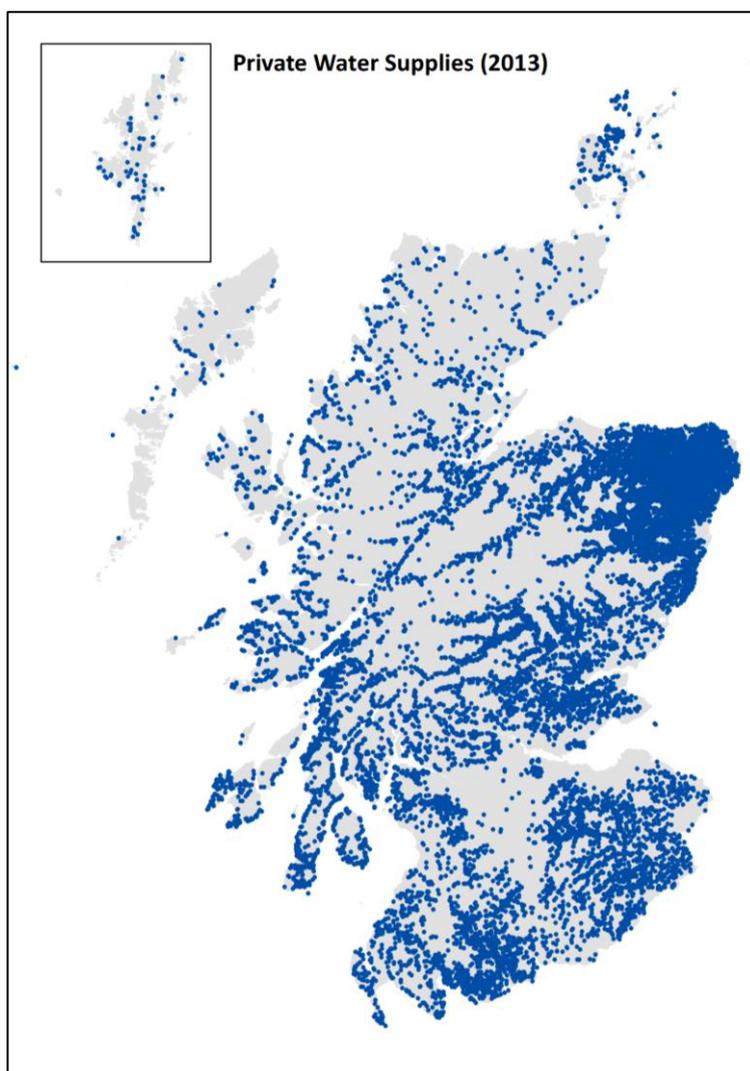
At a glance

- The number of private water supplies in Scotland has fallen by around 4% since 2003 although the proportion of the population served by this type of supply has risen by nearly two percentage points from 1.63%.
- There are 157,722 properties in Scotland reliant on a private (off-grid) water supply, servicing over 3% of the population, although many more people use private water supplies as visitors or tourists, for example, perhaps doubling the number potentially affected.
- Around 9% of these properties (approximately 14,000) are at risk from a 1 in 200 year flood event with properties in Highland and Argyll and Tayside being significantly more exposed than other regions.
- The majority of these are groundwater sources, serving residential properties. Surface water sources of supply may be especially vulnerable to contamination and/or temporary or permanent loss of supply.

Latest Figure	Trend
<p>2013 19,643 private water supplies serve 157,722 properties in Scotland. This equates to 188,230 people (3.5% of Scotland's population) being reliant on a private water supply.</p> <p>9% (14,000) of these properties are at risk from a 1 in 200 year flood event</p>	None: no historical data available

Why is this indicator important?

Private water supplies (PWS) - internationally referred to as Small Community Supplies - serve around 3.5% of the population in Scotland¹, although a significant number of visitors and tourists will also use these supplies. Water sources include surface water (streams, rivers and private impoundment reservoirs) and groundwater (wells, boreholes or natural groundwater springs). Figure 1 shows the distribution of all PWS across Scotland (2013).



Data source: DWQR, 2014

Figure 1: Private Water Supplies in Scotland 2013

The quality of the water from these supplies can present a risk to health if not properly managed. Extreme weather events exacerbate this risk through potential contamination (flooding) from sewerage and chemical and other field run-off as well as temporary or permanent loss of supply (cold, heat) due to frozen pipes and pumping equipment, for example, or loss of supply altogether during sustained periods of drought, although these particular risks are not considered further here. Neither does this indicator consider directly the risks to public health that may result from poor water quality.

For the purposes of flood risk management, Scotland has been separated into 14 Local Plan Districts. These are based on river catchments and therefore cross both administrative and institutional

¹ Compared with 1% of the population of England and Wales: <http://www.dwi.gov.uk/private-water-supply/index.htm>

boundaries (SEPA, 2011). SEPA is responsible for producing a *Flood Risk Management Strategy* for each Local Plan District by the end of 2015. Using this guidance, the 'lead' Local Authorities for each District will then develop *Local Flood Risk Management Plans*, which take the strategies and turn them into *Local Delivery Plans*, with implementation dates and corresponding funding requirements. They will also provide a mechanism to co-ordinate actions at a local level for the next six years (the flood risk management planning-cycle time); interim and final reports are to be produced in 2019 and 2022 respectively (SEPA, 2012).

Local resilience is in part dependent on access to the water provided by private water supplies. The projected impact of climate change in Scotland will see increased winter precipitation in all regions for all emissions scenarios but particularly in the West of Scotland (Met Office, 2009) with a corresponding increase in flood risk. A clear picture of exposed water supplies will contribute to our understanding of overall societal vulnerability to flooding.

What is happening now?

In 2013, there were 157,722 properties on a private water supply at 19,643 different locations across Scotland, serving around 188,230 people². Around 9% of these – some 14,000 properties - are at risk of a 1 in 200 year flood event, predominantly (73%) as a result of rivers breaching their banks.

Distributional differences are apparent across Local Plan Districts (Table 1).

- Highland & Argyll and Tay are the two areas most reliant on PWS, and over half of all at risk supplies are located in these regions (Figure 2).
- Of the 457 properties with a private water supply in the Outer Hebrides, 60% are at risk, primarily from pluvial flooding. The risk to properties with a PWS in Forth is also quite high, 25% of nearly 4,000 properties (Figure 3)
- By contrast, in other areas with high numbers of PWS – North East and Solway – the risk of flooding from any source is relatively low – 3% and 4% respectively

Table 1: Private Water Supplies by Local Plan District 2013 (DWQR, 2014)

Local Plan District (LPD)	Properties with private water supply (PWS)	% of all properties with a PWS	Properties with PWS at risk of 1:200 fluvial flooding event	Properties with PWS at risk of 1:200 pluvial flooding event	Properties with PWS at risk of 1:200 coastal flooding event	Properties with PWS at risk of 1:200 flooding event, all sources	% of all properties with a PWS at risk	% of properties with a PWS at risk for this LPD
1 Highland and Argyll	31380	20%	2602	775	344	3721	26%	12%
2 Outer Hebrides	457	0%	82	189	2	273	2%	60%
3 Orkney	1498	1%	10	0	52	62	0%	4%
4 Shetland	154	0%	2	0	4	6	0%	4%
5 Findhorn, Nairn and Speyside	4519	3%	234	247	0	481	3%	11%
6 North East	29552	19%	607	205	0	812	6%	3%
7 Tay Estuary and Montrose Basin	5184	3%	208	50	2	260	2%	5%
8 Tay	28533	18%	3571	583	3	4157	29%	15%
9 Forth	3911	2%	595	390	0	985	7%	25%
10 Forth Estuary	5614	4%	154	398	0	552	4%	10%
11 Clyde and Loch Lomond	10223	6%	1052	52	69	1173	8%	11%
12 Ayrshire	5414	3%	87	62	15	164	1%	3%
13 Tweed	8838	6%	702	70	0	772	5%	9%
14 Solway	22445	14%	572	302	12	886	6%	4%
Total	157722		10478	3323	503	14304		

² This number relates to the Scottish population only. Many more people – tourists and visitors – also would use these services.

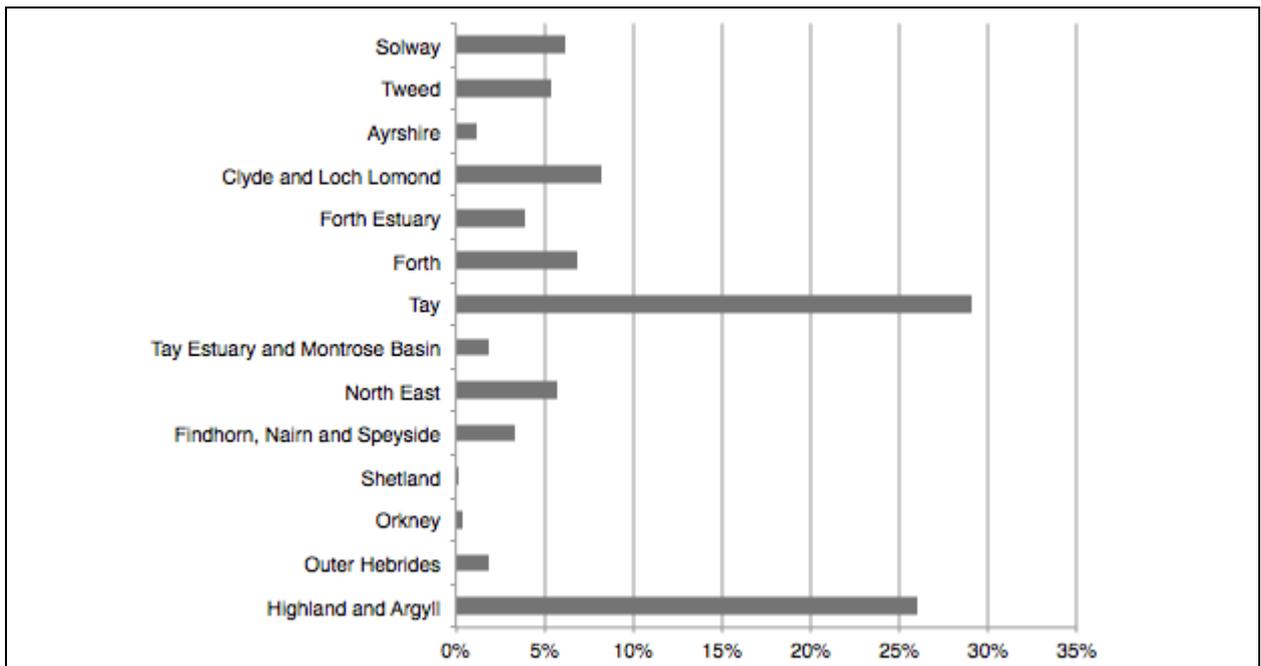


Figure 2: PWS Risk Profile – Proportion of all PWS at risk located within each LPD (2013)

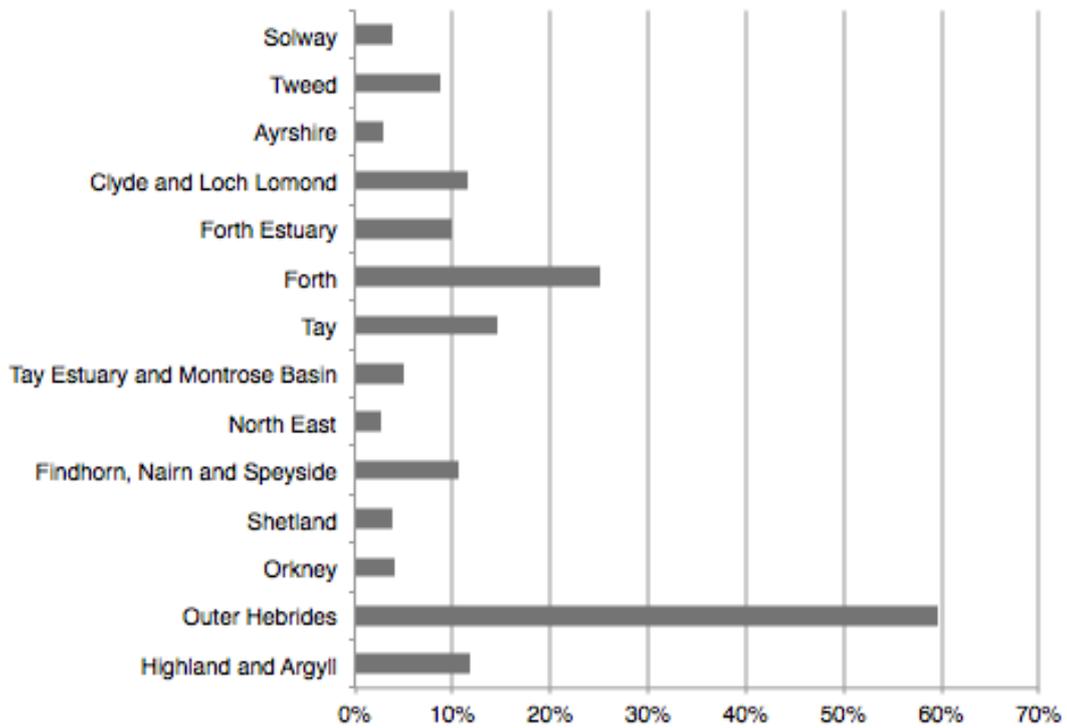
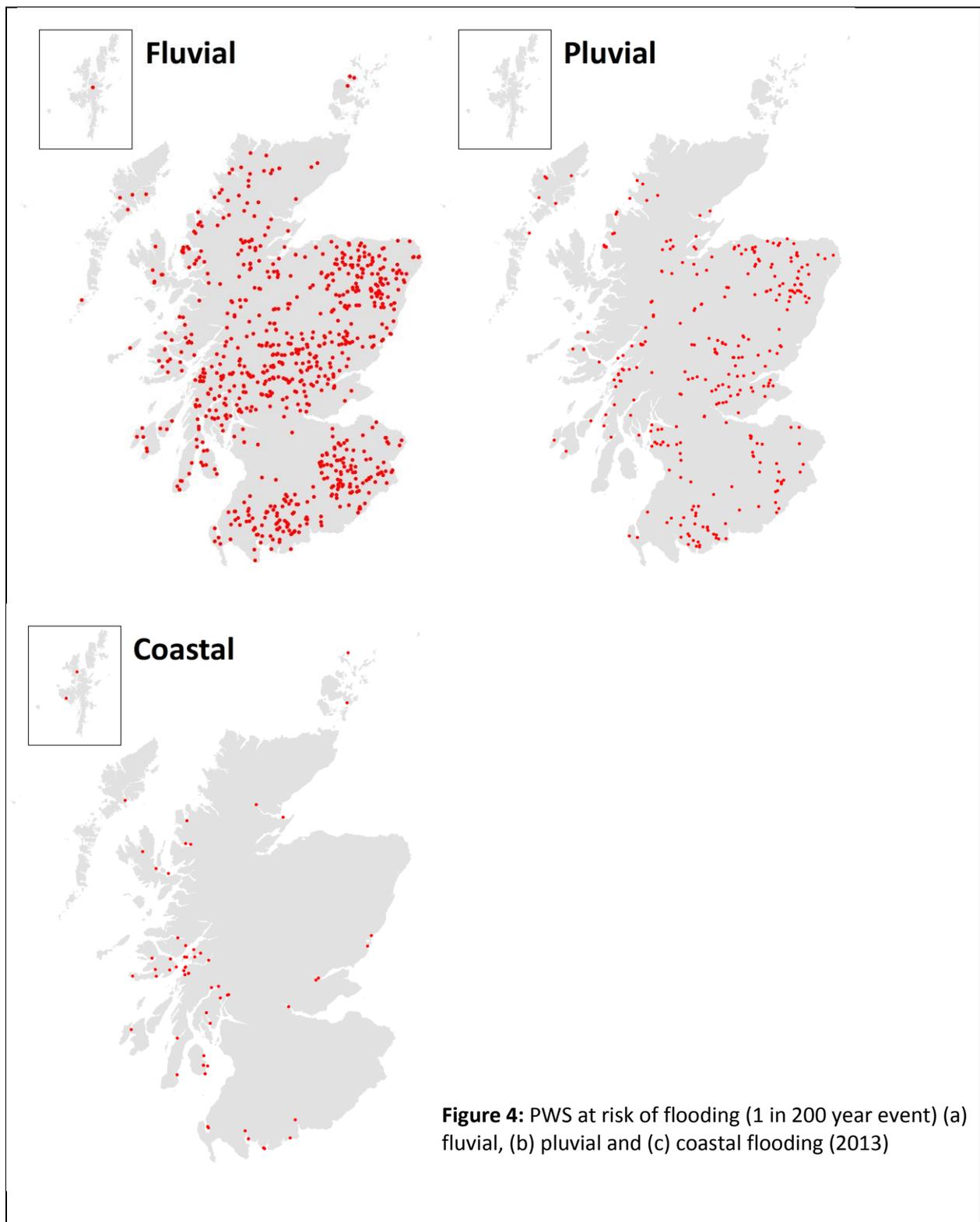


Figure 3: PWS Risk Profile – Proportion of all PWS within each LPD at risk (2013)

For most regions, fluvial flooding provides the greatest risk. The exposure of PWSs to different sources of flooding is illustrated in Figure 4.



What has happened in the past?

The number of private water supplies in Scotland has fallen by just over 4% in the 12 years since 2003, although this fluctuates year-to-year. In the same period, the proportion of the population reliant on these supplies has almost doubled (1.63% in 2003 to 3.53% in 2014). Historically, the change in the risk profile of those supplies to flooding is unknown as SEPA's flood hazard maps have only been

available since 2012, following publication of the *National Flood Risk Assessment* (SEPA, 2011). This indicator provides an initial estimate of that risk³.

What is projected to happen in the future?

The summary climate projections for Scotland are warmer and drier summers and warmer and wetter autumns and winters. However, convective storms, associated with surface water flooding, are likely to be more intense in summer months. Sea level rises and storm surges are also likely to lead to an increase in flood risk (Met Office, 2009).

The implication of these trends is that “with relatively small increases in sea level, (river) flow and rainfall, the number of properties at risk of flooding could increase substantially, particularly for the more frequent flood events.” (Scottish Government, 2014). Flooding brings with it the risk of contamination to PWSs from sewerage overspill (E.coli) and chemical and other run-off from saturated fields (clostridium perfringens, trace metals) for example (see *Limitations* below).

Against this backdrop, the Private Water Supplies (Scotland) Regulations 2006 place responsibilities for drinking water quality on a large network of stakeholders, involving the dissemination of advice and guidance and subsequent on-going monitoring and evaluation.

Currently, the Drinking Water Quality Regulator (DWQR) remains concerned that “Despite all of these activities [...] compliance with water quality standards, particularly E. coli, an indicator of faecal contamination, remains poor and the risk to health for consumers of these supplies remains of concern [...]. Given the health risks that untreated or poorly treated water supplies can pose, not least of which is E.coli 0157 this level of compliance is unacceptable for Scotland, its residents, visitors and businesses”. To gain a better understanding of the poor compliance with water quality standards the DWQR published its strategy for improvement in October 2014 (DWQR, 2014). This focuses on the quality of drinking water supply and includes a 28-point action plan, a performance review of which is due in 2017.

While none of the actions in the action plan directly considers the exposure and vulnerability of private water supplies to increased risk associated with extreme weather events, the existence of the SEPA flood hazard maps does provide a foundation for including a climate risk assessment of PWSs in the Local Flood Risk Management Plans and the corresponding Local Delivery Plans which will be developed by Local Authorities in 2016 (see above). Indeed, the work undertaken by MWH and SISTech on behalf of the DWQR built in an assumption of the need for private water supplies to be resilient to, amongst other things, “environmental factors (e.g. severe weather)” in their cost benefit analysis of the 2006 Regulations (DWQR, 2010).

Patterns of change

The number of private water supplies in Scotland has decreased by around 4% since 2003 from 21,069 to 20,193 although the proportion of the population served by these supplies has almost doubled with over 3.5% of the Scottish population now reliant on this type of supply.⁴

The Private Water Supplies (Scotland) Regulations 2006 place a duty on local authorities to risk assess all Type A (non-domestic) supplies and to review these risk assessments annually. Additionally, local

³ Clearly, equivalent distributions from previous years could be mapped to the current flood risk, if the spatial data were available.

⁴ DWQR Annual Reports: <http://dwqr.scot/information/annual-report/>

authorities must provide advice and assistance on risk assessments to those responsible for Type B (domestic) supplies on request. In 2013, 95% of Type A supplies had a 'completed' or 'reviewed' risk assessment, an improvement of six percentage points on the previous year. Assessment of Type B supplies remains rather more problematic however since the Local Authority obligation is to provide advice and guidance only *on request*. Furthermore, the assessment does not include any consideration of the exposure of supplies to flooding or indeed any other extreme weather events that would have the potential to disrupt and/or contaminate supplies.

Interpretation of indicator trends

Insufficient historical data exist to identify a trend.

Limitations

1. The Water Industry (Scotland) Act 2002 placed an obligation on the Drinking Water Quality Regulator to publish an annual report of their activities (Scottish Government, 2002). Consequently, private water supply data has been available in the public domain from 2003. Since the 2006 Regulations were introduced, the emphasis in these reports has been on the assessment of water quality (Scottish Government, 2006). The Regulations place a duty on Local Authorities, in practice Environmental Health teams, to enforce PWS legislation. Local Authorities are required to provide the DWQR with an annual data return for PWSs in their areas. The Water Industry (Scotland) Act 2002 places a duty on the DWQR to supervise the enforcement of the drinking water quality duties that local authorities have responsibility to enforce.

Risk assessments consider 14 different parameters of water quality – microbiology (coliform bacteria, *E. coli*, enterococci, clostridium perfringens, specifically in surface water contamination); alkalinity (pH); trace metals (aluminium, manganese, lead, iron); reagents (trihalomethanes); turbidity (cloudiness) and colour. Sampling statistics are provided in the DWQR Annual Reports with analyses broken out at Local Authority scale.

The 2006 Regulations require monitoring of all Type A supplies to provide microbiological and organoleptic (taste and colour) quality of a supply. In 2014, 6% (2,700) of the 44,812 Type A samples failed one or more monitoring checks. *E. coli*, for example, which has the potential to cause illness and provides an indication that faecal contamination of the supply has occurred, was detected in 13.4% of Type A private water supply samples taken across Scotland in 2014. This indicates that these supplies are either not receiving the appropriate amount of treatment before use, or that the existing treatment is not being satisfactorily managed and maintained (DWQR, 2015).

2. The 2006 Regulations introduced new categories of private water supply: Type A and Type B, broadly commercial and domestic. These are not directly comparable with the Type 1 and Type 2 categories used previously (see the discussion in the Metadata section below).
3. The quality of the data on the number of people served by PWSs needs verification: 24,230 additional people were reliant on PWSs between 2013 and 2014 according to the corresponding annual reports although the number of supplies fell by 23. This may reflect the focus on volume of water used in Type A and B categories, in contrast to the number of people served in the earlier Type 1 and 2 classifications.

References

DWQR (2010) *Cost Benefit Analysis of the Private Water Supplies (Scotland) Regulations 2006, Final Report*. SISTech and MWH, May 2010, available at: <http://dwqr.scot/media/14166/research-prev-cost-benefit-analysis-of-the-private-water-supplies-scotland-regulations-2006.pdf>

DWQR (2014). *Private Water Supplies. Strategy for Improvement. A Multi-Agency Approach*. Scottish Government, Drinking Water Quality Regulator, August 2014, available at: <http://dwqr.scot/media/9065/pws-strategy-final-version-10-15-august-2014.pdf>

DWQR (2015) *Drinking Water Quality in Scotland: Private Water Supplies*, available at: <http://dwqr.scot/media/16237/dwqr-annual-report-2014-private-water-supplies-final-report.pdf>

Met Office (2009) *UK Climate Projections 2009 Key Findings*, available at <http://ukclimateprojections.metoffice.gov.uk/21708>

Scottish Government (2002) *Water Industry (Scotland) Act 2002*, available at: http://www.legislation.gov.uk/asp/2002/3/pdfs/asp_20020003_en.pdf

Scottish Government (2006) *Private Water Supplies (Scotland) Regulations 2006*, available at: http://www.legislation.gov.uk/ssi/2006/209/pdfs/ssi_20060209_en.pdf

Scottish Government (2014) *Assessing the Flood Risk Management Benefits of Property Level Protection. Technical and economic Appraisal Report Draft v2*. September 2014. JBA Consulting for Scottish Government, available at: <http://www.gov.scot/Resource/0046/00466212.pdf>

SEPA (2011) *The National Flood Risk Assessment: Methodology*, available at: http://www.sepa.org.uk/media/99914/nfra_method_v2.pdf

SEPA (2012) *Flood Risk Management Planning in Scotland: Arrangements for 2012-2016*, available at: https://www.sepa.org.uk/media/42107/sepa-02-12-flood_risk_management_planning_in_scotland.pdf

Further information

EC Directive 98/83/EC on the quality of water intended for human consumption, available at: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:1998:330:0032:0054:EN:PDF>

Scottish Government resource - Private Water Supplies in Scotland, available at: <http://www.gov.scot/Topics/Environment/Water/17670/pws>

Water (Scotland) Act 1980 (as amended), available at: http://www.legislation.gov.uk/ukpga/1980/45/pdfs/ukpga_19800045_en.pdf

Water Quality (Scotland) Regulations 2010, available at: http://www.legislation.gov.uk/ssi/2010/95/pdfs/ssi_20100095_en.pdf

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Appendix One: Indicator metadata and methodology

Table 1: Indicator metadata

	Metadata
Title of the indicator	CRS54 Off-grid private water supplies at risk of flooding events
Indicator contact: Organisation or individual/s responsible for the indicator	ClimateXChange
Indicator data source	Private Water Supply, Drinking Water Quality Regulator for Scotland (DWQR) National flood risk appraisal baseline, Scottish Environmental Protection Agency (SEPA)
Data link: URL for retrieving the indicator primary indicator data.	None: custom extract 10 th April 2015, covering private water supply locations in 2013, corresponding to the most recently available DWQR annual reporting period at that time.

Table 2: Indicator data

	Indicator data
Temporal coverage: Start and end dates, identifying any significant data gaps.	Single year, 2013 for mapping PWS to flood hazard areas. PWS monitoring data available from 2003 although the categorisation of source types changed as a result of the 2006 Regulations.
Frequency of updates: Planned or potential updates	Annually, on request
Spatial coverage: Maximum area for which data is available	Scotland
Uncertainties: Uncertainty issues arising from e.g. data collection, aggregation of data, data gaps	<ol style="list-style-type: none"> 1. Around 14% of the PWS source types cannot be determined by the host Local Authority covering 21,791 properties. In these cases, an 'estimated' type has been derived from SEPA water abstraction datasets or by visual inspection of detailed Ordnance Survey mapping or aerial photography. 2. The quality of the data on the number of people served by PWSs needs verification: 24,230 additional people were reliant on

	<p>PWSs between 2013 and 2014 according to the corresponding annual reports although the number of supplies fell by 23. This may reflect the focus on volume of water used in Type A and B categories, in contrast to the number of people served in the earlier Type 1 and 2 classification.</p> <p>3. More generally, the categorisation of PWSs changed as a result of the 2006 Regulations, making direct comparisons between Types 1 and 2 and Types A and B uncertain.</p>
Spatial resolution: Scale/unit for which data is collected	Individual private water supply locations – see <i>Metadata</i> below for source types.
Categorical resolution: Potential for disaggregation of data into categories	<p>Local Plan Districts (used here).</p> <p>Note also: mapping PWSs to Flood Warning Areas would enable cross referencing with uptake of Floodline services (CRS34)</p>
Data accessibility: Restrictions on usage, relevant terms & conditions	<p>Data provided under the Non-Commercial Government Licence for public sector information. More information about the requirements of the license can be found here:</p> <p>http://www.nationalarchives.gov.uk/doc/non-commercial-government-licence/non-commercial-government-licence.htm</p>

Table 3 Contributing data sources

<p>Contributing data sources</p> <p>Data sets used to create the indicator data, the organisation responsible for them and any URLs which provide access to the data.</p>
<p>Private Water Supply data for 2013 provide as a custom extract by the Drinking Water Quality Regulator for Scotland on April 13th 2015</p> <p>PWS data by source type is available from the DWQR annual reports http://dwqr.scot/information/annual-report/</p> <p>Local Plan Districts from SEPA, 2011: http://www.sepa.org.uk/media/99914/nfra_method_v2.pdf</p> <p>Analysis of water quality at local authority scale is provided in the annual Local Authority Summary Tables, which have been published separately since 2013 (http://dwqr.scot/media/13816/dwqr-annual-report-2013-local-authority-tables.pdf)</p>

Table 4 Indicator methodology

Indicator methodology

The methodology used to create the indicator data

The Drinking Water Quality Regulator for Scotland provided an ArcGIS data extract in April 2015. Spatial joins were used to identify PWS locations that lie within the SEPA baseline assessment flood hazard extents for 200 year return periods (Fluvial, Pluvial and Coastal). PWS locations were also spatially joined to Local Plan District (LPD) data and LPD ID and name were added, to enable analysis by region

Metadata:

There are 6 Private Water Supply source types

Surface water: SB - Surface – Watercourse; SL - Surface – Loch; SR - Surface – Rainwater

Groundwater: GB - Groundwater – Borehole; GW - Groundwater – Well; GS - Groundwater – Spring

Estimates (estGround and estSurface) are applied to sources where the local authority has not been able to identify the source type. An estimated type has been derived from SEPA water abstraction datasets or by looking at detailed Ordnance Survey mapping/aerial photography.

Private Water Supply source class

- A1 – A supply where the volume of water supplied is less than or equal to 100 cubic meters per day
- A2 – greater than 100 but less than or equal to 1,000 cubic meters per day
- A3 – greater than 1,000 cubic meters per day
- B – a supply that only serves domestic properties and the total daily volume of water supplied is less or equal to 100 cubic meters per day
- WD – PWS is exempt from the monitoring requirements of the 2006 PWS Regulations

The 2006 Regulations define Class A supplies as those providing 10m³ or more of water a day that serve more than 50 persons or supply a public or commercial activity. In 2013 Type A supplies included 1,214 holiday lets, 163 B&Bs, 113 hotels, 102 caravan parks/campsites, 109 visitor centres, 45 community halls, 10 schools, 3 hospitals, and a range of other facilities such as restaurants, cafes and doctors'. All other domestic supplies are classified as Class B (Scottish Government, 2006).

Type A and B classes replaced the earlier Type 1 and Type 2 categories with the introduction of the 2006 Regulations. The latter included the number of people using any given private water supply in contrast to the total volume of water supplied.

Following SEPA guidance: “[... economic damages and] property counts have been rounded to 2 significant figures, and the nearest 10 for any values less than 100. Values less than 10 have been presented as ‘fewer than 10’ or ‘<10’ in text and tables respectively”