World Water Day

22nd March 2019

Exploring Scotland's Resilience to Drought and Low Flow Conditions: Short Report

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UK Centre for Ecology & Hydrology

The James Hutton Institute

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CREW CENTRE OF EXPERTISE FOR WATERS

Hydro Nation International Centre

Recent evidence indicates that climate extremes are not only becoming a reality in Scotland, but their severity and frequency is increasing. The summer of 2018 was notable, during which a drought particularly impacted the North and East of Scotland with record low flows observed in several Scottish rivers.

World Water Day 2019 brought together Scottish academics, practitioners and policy makers to discuss the resilience of Scotland to climate extremes and, in particular, to provide them with a platform to share their experiences, as well as innovative ideas, on how to build resilience in adapting to low flows and drought conditions (SDG 6 'Ensure access to clean water and sanitation for all').

Photo courtesy of Carol Taylor

After a welcome from Professor Bob Ferrier (Director of the Centre of Expertise for Waters (CREW)) and introduction from Ms Roseanna Cunningham (Cabinet Secretary for Environment, Climate Change and Land Reform), a number of presentations set the scene for subsequent carousel discussions between participants that explored the following three themes:

1. Resilience planning and adaptation strategies;
2. Emerging issues for drought and low flow conditions; and
3. Enhanced monitoring through technical innovation and citizen science.

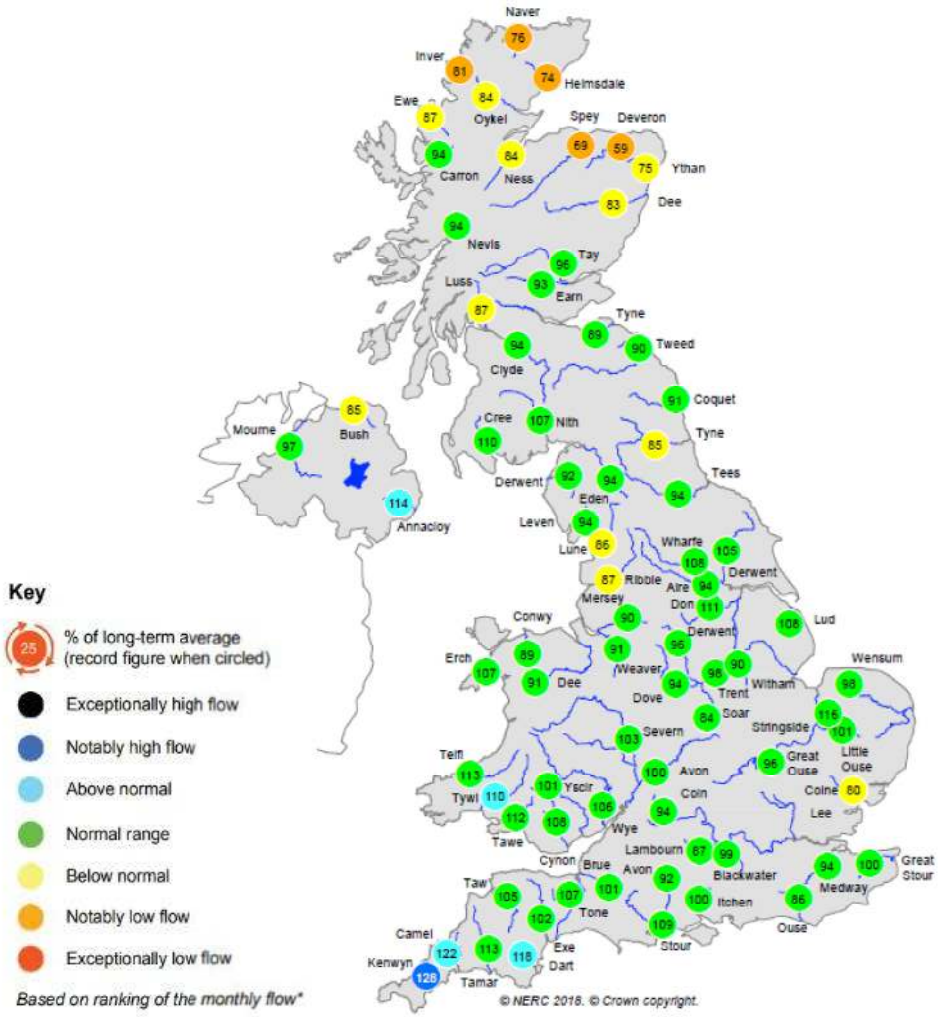
Within each challenge, lessons learned, research priorities, and support for cross-disciplinary work and community participation were discussed.

1 What areas in Scotland are most susceptible and at risk to drought and why?

Stephen Turner
(Hydrologist, UK Centre for Ecology & Hydrology)

- In 2018, areas of northern and eastern Scotland received less than 75% of long term average rainfall.
- In terms of river flows, the majority of monitored sites were in the normal range.
- However, there were a number of 'below' and 'notably below' flows, including the River Spey (a record since 1952) and the River Tweed (a record since 1969).
- Impacts of the dry weather included wildfires in Torridon and the Isle of Skye.
- Landowners reported witnessing conditions not seen in their lifetimes.
- The winter of 2018 represented the third consecutive, dry winter half-year (Oct-Mar).
- Whilst water resource concerns were allayed to some extent by rainfall in March and early April (2019), low groundwater levels and increasing evaporation rates highlight the need for additional rainfall to alleviate potential water resource pressures later in the year.

River Flows in 2018



UK Drought Portal hosted by the UK Centre for Ecology and Hydrology visualises the current meteorological conditions across the UK. It helps users to understand the severity and magnitude of drought at different spatial scales, in different regions. Data are updated monthly.

https://www.ceh.ac.uk/news-and-media/blogs/uk-drought-portal-near-real-time-updates

2 Scottish Water's Planning, Preparation and Response to the 2018 Drought

Mark Hunter
(Strategic Development Manager, Scottish Water)

Headline message

Whilst 2018 had the least rainfall in circa 40 years, Scottish Water (SW) managed to maintain raw water storage levels without impacting public supplies.

Water Resource Management - Resilience

- Continuous monitoring of raw water sources and weather forecasts.
- Proactive management of raw water sources and engagement with the Scottish Environment Protection Agency (SEPA).
- Water efficiency measures and educating customers.
- Focus on reducing leakage losses in the network and increasing resilience within the water network.
- Working with industry to reduce future water demand.

Photo courtesy of Scottish Water

Water Resource Management -Response

Local Authorities (LA) and Scottish Water supported Private Water Supply (PWS) owners:

- Investigating temporary connections.
- Bulk bottled water deliveries to LA's (400 Pallets).
- Portable water tanks (Over 100 tanks).
- Tankering water into PWS tanks.

Key Points

- Climate change mitigation is a priority for the sector.
- Whilst 2018 was very challenging there was very little impact on SW customers.
- There is a need to find sustainable solutions to managing water resources in times of water scarcity.
- Challenges: How to support PWS owners? How to deal with changing consumer behaviours? Responding to population growth/demand and the population shift from west to east.

3 Private water supplies (PWS): the consumer perspective on improving resilience and water quality

Rebecca Millar
(Policy Officer, Citizens Advice Scotland)

Aim

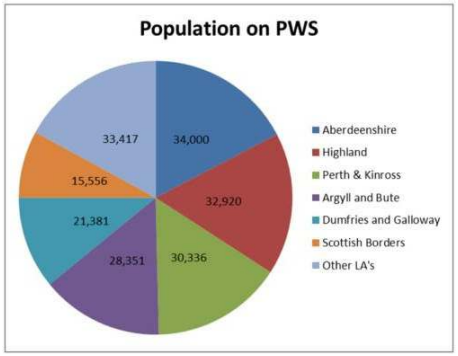
- To understand what support PWS users need to help them improve their water quality and achieve a sustainable supply of safe drinking water.
- The need for more resilient PWS was highlighted during the summer of 2018, with many such supplies running out.
- Climate change will place further pressure on such supplies.

Recommendations

- A framework of support for PWS users is required.
- There is a need for consistency in support.
- Where appropriate to do so, PWS users should have the opportunity to connect to a mains supply.
- Affordable and appropriate water treatment solutions need to be available.

Barriers to managing a safe and resilient PWS

- People are not aware of the risks.
- People don't know how to choose the most appropriate treatment.
- Installing and maintaining treatments is expensive and people have to take on the entire financial burden.
- Redress can be hard to secure when things go wrong.
- It can be difficult to get an entire community to agree, act and pay for a new PWS treatment.
- Local authorities' dual role of enforcer and advisor often ends up with PWS owners flying under the radar and not receiving help they need.
- Support from local authorities varies depending on where people live.



Drinking Water Quality Regulator, 2017

For further information contact Gail Walker (Gail.Walker@cas.org.uk)

4 The effects of drought on freshwater fish and river restoration options to mitigate impacts

Hamish Moir
(UK Managing Director, cbec) & Chris Conroy (River Director and Clerk to the Ness District Salmon Fishery Board)

"We really need to think big, as 'piecemeal' efforts dotted through a catchment will not always have an appreciable effect" (Hamish Moir).

Photos courtesy of cbec

Effects of drought/ low flows on fish and their habitats

Flows must be of sufficient quantity and quality for a) migration of adult salmon b) spawning c) support juvenile nursery areas in summer

Impacts of low flows on fish:

- Increased river temperatures affects a) timing and extent of fish migration, b) impact the salmon life cycle c) water temperatures over 25°C can be lethal for salmon.
- Fish expend energy when negotiating obstacles at low flow.
- Few refuges = increase predation, poaching, stress and subsequently disease.

Catchment and floodplain scale methods to add low flow resilience to river environments

- Climate change is likely to result in more floods and droughts.
- A process-based and catchment-scale strategy to restore natural hydrological/ geomorphic processes can mitigate this.
- Natural Flood Management actions can attenuate flood hydrographs as well as increase base flows by storing water in the catchment and gradually releasing it into the river network.

5 Drought and its effect on agriculture and irrigation practices – England and Wales

Paul Hammett
(National Water Resources Specialist, National Farmers Union)

The NFU carried out a drought survey with 750 farmers, achieving a good coverage across all regions and commodities.

The biggest common impact was the higher costs of running a business.

Farmers have few tools available to help them manage hydro-meteorological risks.

Impacts of the 2018 drought

Arable - 69% of arable farmers said yields were worse than expected.

Livestock - reduced animal fertility, heat stress, and heat related diseases, a shortage of forage.

Dairy - falling milk yields, animal welfare issues, grass and fodder shortages.

Horticulture - badly hit through a combination of insufficient allocation of water and an inability to provide sufficient water to meet crop needs. One-sixth of farmers were not taking any particular measures to manage risk of water shortage.

Policy suggestions

- More water storage capacity to secure plentiful water for use when it is scarce.
- Better soil management techniques to lock in moisture.
- A flexible approach to abstraction regulation.

  In England and Wales, NFU put in place a fodder bank and water bank to support farmers.

Continuing drought could greatly impact the delivery of home-produced primary agricultural products into the UK food supply chain at a time of trade distortions arising from our departure from the EU.

There is a strong case to recognise water needed by farmers who grow our food, as an 'essential use'.

Photo courtesy of NDSFB

6 Managing production in water dependent industries: a Scotch Whisky example

Ronald Daalmans
(Environmental Sustainability Manager, Chivas Brothers)

The Scottish Whisky Industry

The Scottish Whisky industry has annual exports worth 4 billion GBP and employs 40,000 people in the UK (10,800 of them in Scotland). Distillery usage of water is divided into two types: process water mainly from springs, which should be of high quality and steady temperature; and cooling water mainly from rivers and burns. Process water represents about 20% of a typical site's daily requirement, with 80% of the volume used for cooling. The latter is generally returned to the watercourse from which it was taken, acting solely as a carrier for waste heat that cannot be recovered on site.

Operational impacts on malt distilling during the last drought have included both slowed and ceased production due to either temperature limits having been reached or for reasons of insufficient water flows. The industry has been focussing on responsible water use by reporting process water consumption per litre across the industry and has agreed a 10% reduction target between 2012 and 2020.

- Future issues include:
  - Improved monitoring (temperature profiles/distribution).
  - Vulnerability assessments of spring supplies.
  - Updating of Future Flows Model.
  - Simple water scarcity planning framework.
  - Mitigation measures (e.g. payments for public goods).
  - Strategic development planning information.

Operational Impacts on Malt Distilling

Operational impacts of drought on malt distilling include: slowed and ceased production due to either intake water temperature limits being exceeded prior to production or low water volumes.

- During the summer 2018, out of 32 sites:
  - Low flows resulted in 4 sites with slowed production and 2 sites ceased production.
  - Temperature slowed production at 8 sites and ceased production at 3 sites.

Survey courtesy of Chivas Brothers

Photo courtesy of Chivas Brothers

7 The future challenges of environmental change on water as an economic resource in Scotland

Scott McGrane
(Strathclyde Chancellor's Fellow, Fraser of Allander Institute) and
Graeme Roy
(Head of Economics and Director of the Fraser of Allander Institute)

Scotland's Water Resources

- Climate change and population growth will place new pressures on our aquatic systems.
- There is an intrinsic interconnection between natural resources and economies.
- The "perfect storm" of growing water, energy and food demand, in conjunction with climate change, presents a unique challenge to our economic sectors.
- Drought impacts have included:
  - Increased crop prices, and reduced yields.
  - Increased cattle slaughter rates.
  - Slowed/ceased production at a number of whisky distilleries.

To best utilise Scotland´s water resources, we need to better understand what opportunities are available to reduce our external water footprint.

Assess the potential impacts of climate change at a regional level in Scotland.

Water and the Scottish Economy

- The concept that economic growth = increasing water consumption is no longer valid.
- There is an evident decoupling in water resource consumption and economic growth.
- Technological advancement (increased efficiency) and water re-use as part of a circular economy has significantly reduced consumption rates.

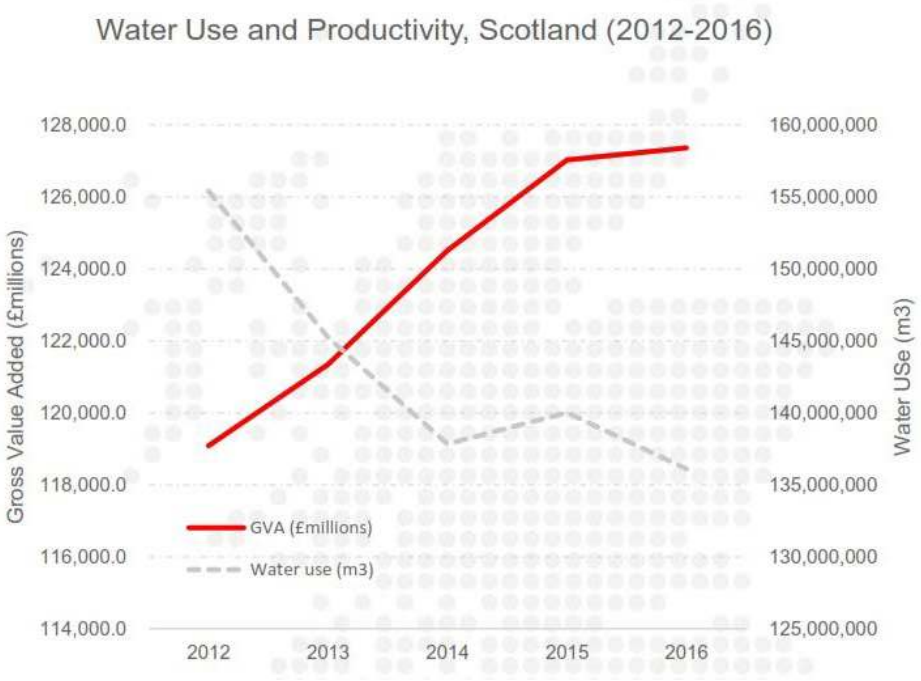


Figure produced by Fraser of Allander Institute
(using economic data from Scottish Government and water consumption data from Scottish Water)

Key Points Carousel Discussion 1:

Resilience planning and adaptation strategies

Facilitated by Kathleen Stosch (University of Stirling) and Carolin Vorstius (University of Dundee)

Lessons learned from own experience

- Drought risks are underestimated within Scotland.
- More effort should be applied to reducing water demand, rather than allowing the "environment to take a hit".
- Water consumption in Scotland is above the UK and European average. Call for action at regional and national scale for awareness raising campaigns.
- National resilience planning (2018) was effective, but in the future, agencies need to share information more effectively in the early stages of a drought.

Research needs

- Nature Based Solutions designed to slow river flows as a flood prevention measure also enhance water storage and offer greater resilience to drought conditions.
- Better quality data is required to understand:
  - Current abstraction patterns by farmers (important for regulatory authorities).
  - The effectiveness of water efficiency measures such as grey water reuse, restoring wetlands and technological solutions.

Lessons from elsewhere

- 'Slowing the flow' and storing water addresses both floods and droughts.
- Effective legal frameworks are key – a review of existing policy frameworks and recommendations for improvement of surface/ground water would be useful for Scotland.
- Monitoring of agricultural water use could be useful, even if very difficult in practice.
- Changing tariff structures can be very problematic, even though possibly necessary.

Effective collaboration to enhance resilience

- Whole-catchment thinking needs to be implemented- after many decades of research, more progress is required.
- Rural and urban communities need to become more risk aware and take responsibility regarding water use and consumption in the short and long term:
  - By allowing communities to make simple water management decisions (Garden water butts, short showers, short flush toilets etc).
- Grey water use has to be better integrated into building designs.
- Planners need a wider perspective on the whole water cycle (grey, green, blue, brown, and black water).

Key Points Carousel Discussion 2:

Emerging issues for drought and low flow conditions

Facilitated by Dr Karin Helwig (Glasgow Caledonian University) and Dr Beth Wells (Moredun Research Institute)

Lessons learned from own experience

- There is a need to monitor water quality as an input for drought plans since there is currently limited water quality monitoring during low-flow events.
- It is important to prevent pathogens reaching water bodies rather than rely on dilution from natural river flows. "The solution to pollution is not dilution".
- Pharmaceutical pollution may be subject to seasonal effects in terms of consumption and illness patterns.

Lessons from elsewhere

- Buffer strips, soil and sand filters have been used in other countries to prevent pathogenic outbreaks. A systematic review of the wider application of these measures in Scotland is required.

Research needs

- Hydrological models for high flow should be adapted to account for changes in emerging pollutants in drought conditions.
- More robust models of parasitic pollution from diffuse sources.
- Enhanced methods of water treatment, e.g. to inactivate currently resistant pathogenic bacteria. Photocatalysis is a potential candidate for this.
- Better understanding of seasonal variation and environmental impacts of pharmaceutical pollution.

Effective collaboration to enhance resilience

- The involvement of pharmaceutical industries, healthcare providers, water managers and environmental experts are required to better understand sources and pathways of pharmaceutical pollution, as well as mitigation options.

Key Points Carousel Discussion 3:

Enhanced monitoring through technical innovation and citizen science

Enhanced monitoring through technical innovation and citizen science

Lessons learned

- National-scale monitoring is useful, but most users (e.g. farmers) need local-scale monitoring.
- Citizen science has been usefully applied to:
  - Provide photographic evidence to SEPA of dried water courses.
  - Rapidly notifying SEPA, local authorities and public of algal blooms – (using the Bloomin' Algae app).
- Research questions should be co-generated with practitioners and the public to ensure outcomes have wider relevance.

Research needs – technical innovation

- How can the location and number of currently unregistered abstractions below 10 m^3/day be monitored?
- How can hyperspectral imagery be best used for automated identification of algae blooms?
- Can we use citizen science to effectively ground truth satellite Earth Observation data?

Lessons learned

- Real-time monitoring of abstractions and impacts on river ecology would help SEPA support businesses to ensure abstractions carry on as long as there is no risk to the environment.
- Create a water tracking scheme for big abstractors.

Research needs – citizen science

- How can we promote and support citizens to be more engaged in observation and recording?
- What level of training do citizen scientists need?
- How to assess and ensure the validity and quality of data collected by citizens?

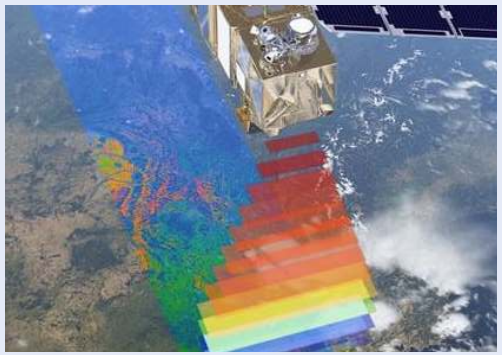


Photo courtesy of ESA Sentinel-2

Photo courtesy of Laurence Carvalho

Closing Words

Jon Rathjen
(Team Leader, Water Industry Team, Scottish Government)

The period of water scarcity in 2018 brought home the significant reality that Scotland is not always the wet place we think it is. Significant parts of the country were impacted, with both citizens and businesses affected. Although the national response alleviated the situation and active management minimised difficulties, it highlighted exactly how water scarcity could have negative consequences for both the quantity and quality of our water resources. Risk-based assessment and future consideration of national water resources planning are key to ensuring future sustainability.

World Water Day highlighted how the hydrological cycle impacts on all our lives and the importance of Scotland's ambition to become a Hydro Nation. Our reserves of water are significant. The challenge is to ensure that there is continuity between water-rich and water-poor regions. Moving forward, we need to be able to act quickly and creatively and in a manner that accepts we will need to take risks then evaluate and adjust, in order to develop innovative solutions that ensure our reserves meet demand even when water is scarce. This is a shared challenge for scientists, regulators, practitioners and the public.

Photo courtesy of Rachel Helliwell

Contributors and Acknowledgements

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The full report can be downloaded from the Hydro Nation International Centre website:
https://www.hnic.scot/expertise