

Groundwater: the threat beneath our feet



Flooding on the Somerset levels lasted many months after winter 2013/14.

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Groundwater is the ultimate invisible asset. Originating in rain and snowfall that works its way down into soil and rock, it supports key ecosystems and meets the water needs of millions. But it can also pose a potential flood risk – Dr Barry Hague went to speak to researchers at NERC’s British Geological Survey (BGS) about a lurking threat that experts are hard at work understanding and confronting.

Gaining ground on flood events

David Macdonald, a senior hydrogeologist at BGS Wallingford, is part of a team shedding fresh light on groundwater flooding – and has come uncomfortably close to enduring the extreme distress this type of flooding can cause.

Back in the 1990s, David Macdonald bought a house in Oxford. Unexpectedly, his decision provided first-hand experience of what, to that point, had been a little-studied phenomenon in the UK but was destined to become a key focus of his career.

“Over the 20 years we’ve lived there, we’ve suffered six episodes of groundwater flooding,” David says. “Luckily, the water hasn’t broken into the ground-floor rooms. But it’s submerged the garden, got under the floorboards and affected the electrics and sewer system. On the upside, it’s given me a close-up view of groundwater’s role in flood events and direct insight into the difficulty of unpicking different factors that play a part in them.”

In fact, groundwater flooding – which occurs when the water table rises past ground level or begins to affect basements, cellars and subsurface infrastructure – remained largely off UK research’s radar until the exceptionally wet winter of 2000-01. This resulted in floods causing around £1bn of damage, with the culprits identified as an ‘unholy trinity’ of rainfall-related surface water flooding, river flooding and groundwater flooding. But it did deliver the jolt to develop a better understanding of groundwater flooding, which would be crucial to addressing this threat.

“Our knowledge has come a long way in the last 15 years,” says David, “but we’re not there yet. There’s still plenty to do in terms of collecting data, quantifying risk, improving forecasts and raising awareness of the potential danger to homes, businesses, communities and critical transport and other infrastructure.”

Rising concern?

The key to understanding groundwater flooding is

Around 200,000 homes could be susceptible to groundwater flooding in England alone.

to build up a bank of data and observations that can provide a bedrock of information for investigation and interpretation. From a standing start, real progress has been made and BGS has been heavily involved, pinpointing geological conditions where groundwater flooding could occur, casting light on how water-bearing rocks respond to extreme weather and examining events such as the severe floods of winter 2013-14.

“That winter,” David says, “water companies in Southern Britain spent an estimated £80m dealing with the effects of groundwater-flooded sewers. Unlike river flooding, groundwater floods can take months, rather than weeks, to disappear in the wake of a major flood event. It’s vital to keep that in mind when managing a flood.”

Somewhere in the region of 200,000 homes could be susceptible to groundwater flooding in England alone, with hotspots including towns and villages built on the chalk bedrock underlying much of the south and east of the UK, and the floodplains of major rivers such as the Thames. David adds a cautionary note though: “It’s still too early to say whether the risk of groundwater flooding is ramping up. Nor are we certain what the impact of climate change or changing land-use patterns may be. A priority for the research community is not just to gather more data but also to bring our knowledge together into unified prediction and simulation tools and avoid looking at different types of flooding in isolation.”



Flooding in Hampshire, February 2014.

David Macdonald at home in Oxford, experiencing groundwater flooding at first hand.



Thirst for knowledge

Groundwater flooding is a complex issue and this complexity has many dimensions. Partly it depends on the interrelation between different forms of flooding, partly on the way groundwater interacts with tunnels, sewers and other subsurface infrastructure and partly on changes in the amount of groundwater taken for industrial use or public water supply.

Ultimately, the challenge for the UK is to identify threats and make sure society becomes more resilient to them, while still protecting the environment. That means both acquiring more knowledge about groundwater flooding and then making it available to those who need it.

“There’s a growing thirst for information. People who are buying properties want to know more about risk levels, likely sources of problems and how they can flood-proof basements, for instance. The national maps we have produced of groundwater flood potential are one way we help meet that demand.

“People want certainty, even though it’s simply impossible to be definite when it comes to flooding predictions. But the more we can take our understanding down to very local scale, the better we’ll be able to inform targeted interventions that help protect lives and livelihoods.”

Q&A: A Winter's Tale

The winter of 2013-14 saw the UK battered by its stormiest spell of weather for two decades, unleashing devastating floods in the South West, the Thames Valley and other parts of the country. Professor Rob Ward, Director of Science: Groundwater at the British Geological Survey (BGS), found himself at the epicentre of the response to the emergency.

What made that particular winter so problematic from a flooding perspective?

The winter of 2013-14 was extremely wet as a result of the remorseless chain of Atlantic weather systems that struck us from mid-December 2013. With rainfall in December at 154 per cent of the average for the month, groundwater levels, which had only just recovered to normal levels from a drought in 2012, started to rise rapidly. Then we had the wettest January on record for southern England. As a result, groundwater levels kept rising to reach historic highs in late February as soils and rocks became saturated. Springs that had been dormant throughout living memory burst back to life. Water began to collect in fields, streets and basements. The overall picture was just as serious, with coastal, river and rain-related surface water flooding along with groundwater flooding causing severe disruption to transport networks, power supplies and thousands of lives.

When did you realise we were in the grip of a genuine emergency?

At BGS, we maintain an independent overview of groundwater conditions across the UK and make the relevant information publicly available. We use sophisticated computer models to monitor groundwater resources and associated flood threats. Around Christmas 2013 – when the flooding problems affecting the Somerset Levels were starting to hit the headlines – it became clear that groundwater levels were increasing significantly and could potentially deepen the crisis in many parts of the country if the rain didn't relent.

You were invited to Downing Street to provide urgent input to the response effort. What happened exactly?

I was driving home one evening at the beginning of February when the office of Sir Mark Walport, the government Chief Scientific Adviser, called to invite me to attend an emergency meeting at 10 Downing Street. It would bring together the Met Office, the Environment Agency and Defra, plus academics and engineering specialists including US experts who'd dealt with the aftermath of Hurricane Katrina in 2005.

At the meeting, a key focus was on the floods in the Somerset Levels and the potential effectiveness of options such as digging trenches to encourage



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infiltration into the ground.

Southern England was about to experience a sustained period of rainfall. I highlighted the likelihood that this would lead to groundwater flooding, which did indeed occur in several parts of the country and lasted right through to May. As well as homes and communities, it posed a severe threat to infrastructure such as water treatment works and power stations which house a lot of equipment below ground.

What was the outcome of the meeting?

A Scientific Advisory Group for Emergencies (SAGE) was established to support briefings at the Cabinet Office and we provided updates and forecasts that could aid decisions on where the emergency services should target their resources. At BGS, it was a real team effort to rapidly analyse data and prepare recommendations I could take to those meetings. Deadlines were tight and our work also had to cover the appearance of sinkholes and the potential for landslides to threaten roads and railways.

What were some of the key takeaways from the whole process?

One conclusion from SAGE was that pumping out basements flooded by groundwater may not be the best use of first responders' time and resources, as they'd often be called back a few hours later when the water had returned. A better strategy could be to leave the basement flooded. The damage would already have been done and the basement would act as a water store, reducing the strain on the drains if the water were pumped elsewhere.

Major groundwater flooding events aren't very common in the UK. That winter enabled BGS to sharpen our understanding of triggers and impacts and improve our ability to forecast them.

It may not be possible to prevent groundwater flooding but that dreadful, dramatic, unforgettable winter definitely helped put the UK on a stronger footing to respond to similar emergencies in future.

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