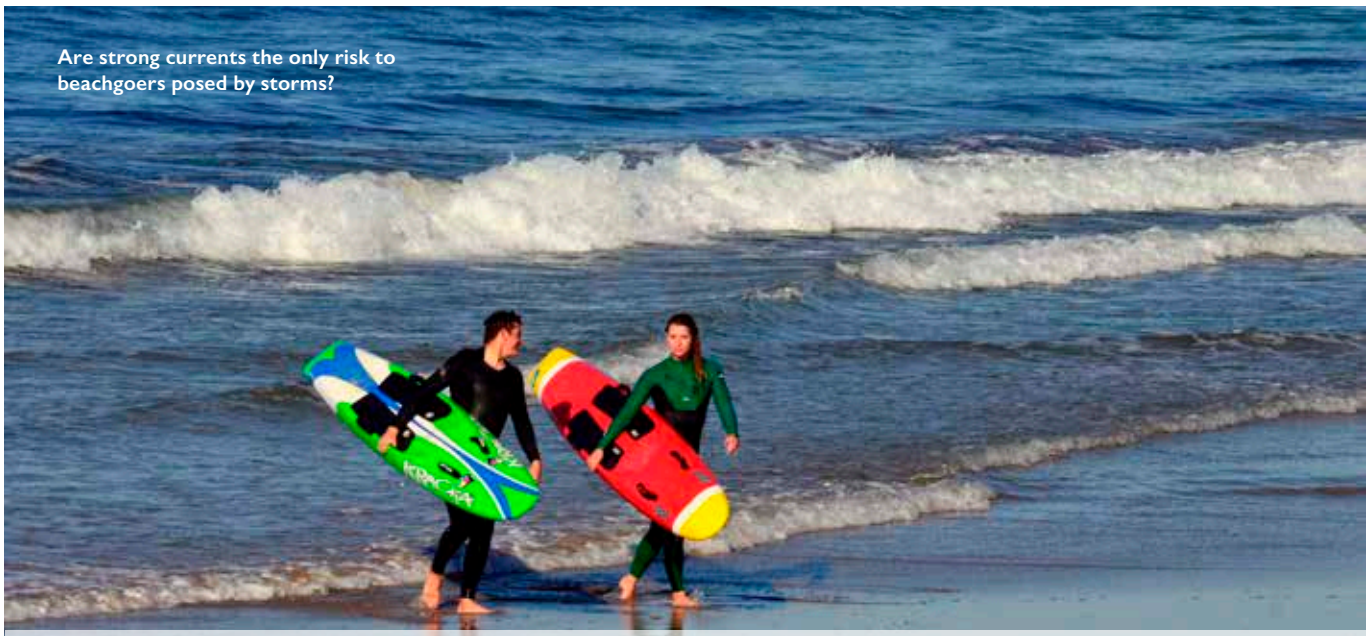

Are strong currents the only risk to beachgoers posed by storms?

Have we opened the floodgates on antimicrobial resistance?

During heavy rains, 'combined sewage overflows' are sometimes used to prevent our homes from flooding by diverting excess sewage into rivers and the sea. That means untreated sewage can end up in the waters around the coast and it's why the usual advice is: 'Don't swim in the sea after heavy rainfall.' Dr William Gaze at the University of Exeter explains how these overflows could cause us to come into contact with drug-resistant bacteria in the environment.

Chief Medical Officer Dame Sally Davies described antimicrobial resistance (AMR) as one of the greatest threats to mankind, comparing it to climate change. Whilst those issues may not appear to be linked, climate change is expected to cause increased flooding which may in turn lead to more AMR bacteria in the environment.

AMR bacteria are often found in sewage because many live in our guts. They don't usually make us ill if they stay in the gut – problems tend to arise if they enter our bloodstream or urinary tract. For example, drug-resistant *E. coli* cause around 5,000 deaths from blood-borne infections in the UK each year but unlike MRSA which we tend to catch in hospitals, *E. coli* infections often happen in the community.

In a recent project, Dr Anne Leonard, a member of my research group, looked at how often people were exposed to *E. coli* resistant to the frontline antibiotic, cefotaxime. She estimated that, in total, recreational coastal water use meant people were exposed to it over six million times each year in England and Wales.

Drug-resistant bacteria can share the genes that protect them from antibiotics with other bacteria meaning that resistance can spread within a bacterial population very quickly. As well as AMR bacteria themselves, could residues of antibiotics that enter the environment from farmland and sewage be driving more bacteria to become

What is AMR?

Sometimes, when microbes like bacteria and viruses are exposed to antimicrobials like antibiotics and cleaning products they change so that the antimicrobials can no longer kill them. These microbes that develop antimicrobial resistance are sometimes called 'superbugs'. In 2016, the Review on Antimicrobial Resistance warned that, if left unchecked, antimicrobial resistance could cause 10 million deaths a year around the globe by 2050.

resistant so they can protect themselves? I'm working on projects with BBSRC and AstraZeneca, and on a NERC-led grant co-ordinated by Dr Andrew Singer from the NERC Centre for Ecology & Hydrology, to look at this.

In 2014, Professor Elizabeth Wellington, University of Warwick, and I led research that showed some drug-resistant bacteria are much more common downstream of a sewage works than upstream. In a project funded by NERC, the three of us are now trying to find out what's causing the increased levels of AMR we see within a river catchment.

At the moment it looks like multiple factors could be driving increased levels of resistance but they may have very different solutions. We want to know if we should be focusing on any of them in particular over the others.

To find out more, Andrew is leading experiments in rivers using systems called flumes. The flumes make a 'river within the river', giving us a controlled area we can test but that is still as close to the natural environment as possible. In different channels of the flume we can change variables such as how much sewage enters the system or what antibiotics flow through.

Currently, we just don't have the wide body of research we'd need to fully inform how policy should tackle antimicrobial resistance in the environment. We've had some interesting results and the presence of drug-resistant bacteria is likely to be extremely important. Although we can't yet prove that more antibiotic resistance in the environment will mean more drug-resistant infections, I think we're at the point where it looks likely that resistant bacteria in the environment are a part of the problem so we must start working with all stakeholders if we are to slow or reverse it.

Excess sewage gets diverted into rivers and the sea to prevent flooding from heavy rains. istockphoto

We need more studies to be conducted before we can understand the number of AMR infections resulting from environmental exposure and how evolution of AMR in the environment contributes to resistance we see in the clinic. However, extreme rainfall and flooding are likely to increase human exposure to AMR bacteria in the environment.

NERC funded Dr Gaze, Dr Singer and Professor Wellington under the 'Environmental Microbiology and Human Health' programme and the 'Antimicrobial resistance in the real world' call which NERC is leading as part of a antimicrobial resistance initiative across the research councils – see www.mrc.ac.uk/amrcrosscouncil. Projects funded through the scheme are working to make sure we understand antimicrobial resistance completely so we can tackle it effectively.

www.nerc.ac.uk/research/funded/programmes/amr/