Scientists agree: flood damages will increase dramatically across Europe over the coming decades. And as extreme rainfall events happen again and again, some places will be hit harder than others. So why is it that some areas are becoming more prone to flooding, and others not? Louise Slater explains why collecting data on river flows is so important in our efforts to find out.

CHANGING CHANNELS

We generally assume that floods happen when big storms produce more water than the rivers can hold. Yet in reality, rainfall is only part of the story. The actual capacity of rivers to contain flood flows can also change over time, for better or for worse.

A river channel's capacity is essentially the amount of water that can move through it in any given period of time, and depends on its width and depth, and on how rough or smooth the bed is. If a river gradually fills in with sediment, debris, or vegetation, it will become shallower, narrower and rougher. This reduces how much water can flow through it, and how quickly. So as a river channel's capacity decreases, the land will be inundated more frequently, even if there is no increase in rainfall.

These changes in rivers' capacity can happen naturally, as storms alter the volumes of sediment that are flushed through streams. But they also increasingly occur because of human activity. Most rivers have been 'fixed' and modified by river engineering at some point in their course. River channelisation, for example, usually involves straightening or deepening channels to make them more navigable, to claim land for agriculture, or to control flooding. But it also has less desirable consequences. Channelisation can destroy wetlands and the diverse wildlife they support, or steepen the river's slope so water flows faster, eroding the channel in places and increasing floods further downstream.

Farming practices and urbanisation also contribute to changes in flooding. When the land is deforested, compacted (for example by cattle and heavy machinery) or made impermeable through the construction of roads and built-up areas, the rainfall cannot soak into the soil, so it runs off directly into rivers. This process makes rivers much more 'flashy' – more prone to sudden increases in flow after heavy rain, and so more susceptible to flooding. The runoff may also carry soil into river channels, where it accumulates over time and reduces their capacity to contain flood flows.

Nick Everard (EA)

The ADCP remote-controlled (ARC) boat.

L.J. Slater

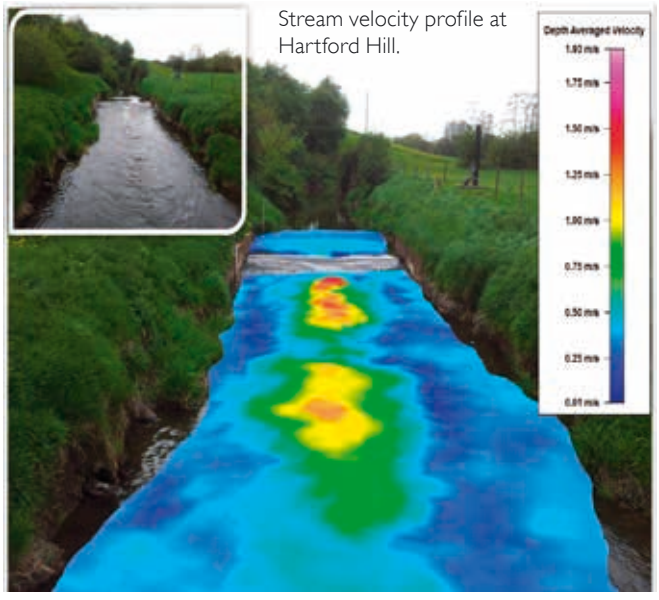
Researchers have long suspected that changes in river form affect flooding, but had never really studied this 'geomorphic' effect because they could not get hold of the data they needed to do so.

In reality, we have been measuring rivers for about a century at stream gauging stations around the world, to estimate and predict river flows. These measurements are known as hydrometric data. But it is only in the last decade or so, with the arrival of the Open Data movement, that hydrometric archives have become publicly accessible in many countries, including the UK.

Open data for flood-risk management

Now that the data can be freely accessed, we can estimate how changing channel capacity affects the risk of flooding in hundreds of rivers. To do this, we measure just how much streamflow the channels can contain at different points in time, and see how those changes modify the probability of rivers overflowing, independently from the influence of climate or people.

So how much difference do these changes in channel capacity actually make to flood risk? The data show that even very small changes in the capacity of the river channels, of about 10 per cent, can increase or decrease flooding by one to two days a year on average. These small changes are much more common than we think, and can occur gradually over several years, or abruptly after a single storm.



Stream velocity profile at Hartford Hill.

Gary Bywater (EA)

In the Midlands, for example, the capacity of river channels appears to be decreasing progressively over time, due to weeds and reeds growing within the channels. The vegetation traps silt, so the channel capacity slowly decreases. If the amount of water flowing in the stream stays the same, then floods will inevitably become more frequent and severe. Elsewhere in the country, where rivers are less prone to being clogged by weeds and sediment, we see the opposite effect: the channels are progressively eroding, and flood hazard is falling.

The effects vary greatly from river to river. For instance, channels with sand and silt banks may change their shape more often than those with stable banks, just as rivers in relatively undisturbed environments may adjust more easily to changes in flow than those in heavily-managed river basins.

Measuring these changes is vital if we wish to improve flood management systems and accurately estimate flood hazard for the insurance industry. Only by assessing the main causes of changing flood hazard – especially channel morphology, land use and climate – will we truly understand how the magnitude and frequency of floods is set to change over time.

As a society, we need to realise just how important it is to collect hydrometric data in many places. The UK's population is projected to reach 70 million in just over a decade, and more than five million people already live and work in properties that are at some risk of flooding. We must recognise the true value of our data archives, if we wish to monitor the evolution of our rivers and natural resources successfully.

In the UK we are lucky enough to have some of the best stream-gauging equipment in the world. We have some of the most advanced technology, including remote-controlled boats with acoustic Doppler current profilers (ADCPs) that can map the depth and flow speed of our rivers in some of the most difficult locations. These boats are powerful, fast and easily manoeuvrable, letting us obtain new data on changing river flows and forms in a way that was never possible before.

Our hope is that the river measurements made with these new technologies will become fully available to the public, with complete information on when and where each measurement was made. Then over time, the full 'patchwork' of data will give us a fantastic overview of how rivers across the country are evolving in space and time. In turn, we will be able to target problem areas where unstable river channels are increasing floods or undermining structures such as bridges, roads, walls and buildings.

Recording changes in river capacity and streamflow is important on so many different levels. As well as improving our ability to predict floods, these measurements also provide information that will help protect some of our most valuable resources – namely the aquatic health, water quality and navigability of our rivers around the UK.

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