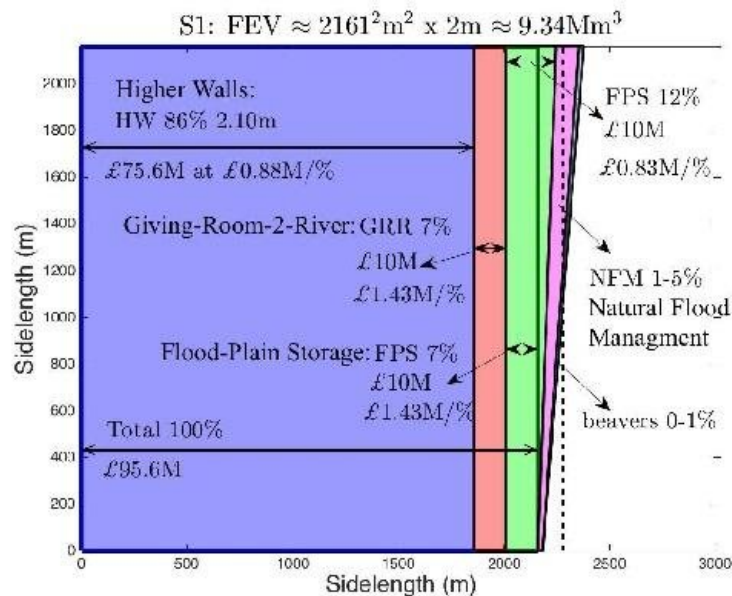


# Communicating the effectiveness of flood-mitigation plans

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The graphic shows one of those hypothetical scenarios. With colour-coded overlays, it reveals how higher flood walls, more flood plains and river widening could provide the additional capacity to stop a repeat of the scale of flooding seen in 2015. Credit: University of Leeds

A team of Leeds mathematicians and French civil engineers has developed a new way of visualizing and analyzing complex flood-protection schemes.

They have steered away from equations and scientific language and have instead devised a graphical display that shows, as a hypothetical lake 2-meters deep, the amount of water that needs to be contained in a [river valley](#) to prevent flooding.

The graphic is overlaid with the various options necessary to hold back or to capture the [flood waters](#), and how much each option will cost.

The work is a collaboration between applied mathematicians Professor Onno Bokhove, Professor Mark Kelmanson and Dr. Tom Kent from the School of Mathematics at the University of Leeds; and civil engineers Dr. Guillaume Piton and Dr. Jean-Marc Tacnet from Université Grenoble Alpes.

Professor Bokhove said: "This work started from a challenge thrown down by a representative of the Environment Agency in the UK who said mathematicians always produce equations and he wanted something that was more accessible, a way of communicating complex ideas clearly and simply, to allow the science underlying flood mitigation to be understandable to the wider fraternity involved in policy making."

The scientists revisited a concept at the heart of flood analysis. Known as flood-excess volume (FEV), it is the amount of water in a river system that cannot be contained by existing flood defenses, expressed as so many millions of cubic meters of water. However, for most people, including Professor Bokhove, that is an effectively meaningless measure that people cannot visualize.

They have described their approach in a paper, A cost-effectiveness protocol for flood-mitigation plans based on Leeds' Boxing Day 2015 floods , published in the journal *Water*.

To illustrate the idea, they used data from the floods on Boxing Day

2015, when the River Aire burst its banks in Leeds and caused extensive damage to homes and businesses estimated at around half a billion pounds.

Around 9.34 million cubic meters of water flooded from the River Aire.

That volume of flood water translates into a hypothetical square lake, 2 meters deep and with sides of 2.16 km in length. In comparison, the upper River Aire is about 50 miles long, with a valley width that varies roughly between 200 and 600 meters along its path.

Professor Bokhove added: "To have prevented the flood, you would have to somewhere deal with that volume of water. It is not inconceivable that, along the course of the river that additional [water](#) could be accommodated, either by increasing the size of flood plains, or by removing obstructions in the river, widening the river channel in places or by building higher flood walls: or, more likely, by combining some or all of those measures.

"Seeing flood mitigation this new way makes it easier for people to understand not only the interventions that are possible and the impact they are likely to have but also the costs associated with each such measure."

The researchers then used their novel graphical approach to analyze and communicate a hypothetical scheme for increasing the flood defenses in the center of Leeds to cope with not only a major flood that would be expected once in 100 years but also a one-in-200-year flood. They looked at several mitigation scenarios, their costs and their impact on river dynamics, an area of science known as fluid dynamics in which Leeds is a world leader.

Over the six years to 2021, the Government will have spent £2.6 billion

on flood schemes in England, and further investment is expected.

Professor Bokhove said: "Our approach is intended to offer a means of comparing and choosing between [flood](#)-mitigation scenarios in a quantifiable and visual manner, thereby offering a better chance of them being understood by a wide audience including the general public, stakeholders and planners."

**More information:** Onno Bokhove et al. A Cost-Effectiveness Protocol for Flood-Mitigation Plans Based on Leeds' Boxing Day 2015 Floods, *Water* (2020). [DOI: 10.3390/w12030652](https://doi.org/10.3390/w12030652)

Provided by University of Leeds

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