Towards a flood resilient Eden Catchment, Cumbria

By Paul Sayers[1] and Matt Horritt[2]

[1] *Sayers and Partners LLP and Senior Visiting Fellow, ECi, University of Oxford. Email: Paul.sayers@sayersandpartners.co.uk*

[2] *Horritt Consulting. Email: matt@horrittconsulting.co.uk*

'Resilience to flooding' is not the same as being 'defended from flooding'. It does mean however using a portfolio of responses to reduce the probability of a flood occurring, limit the exposure should a flood occur and reduce the vulnerability of those that are exposed. A critical barrier to progress in delivering such a portfolio is the lack of credible decision-relevant evidence. This lack of evidence in part reflects the short-comings of traditional modelling approaches that are often too computationally intensive to explore multiple futures and responses at a catchment scale.

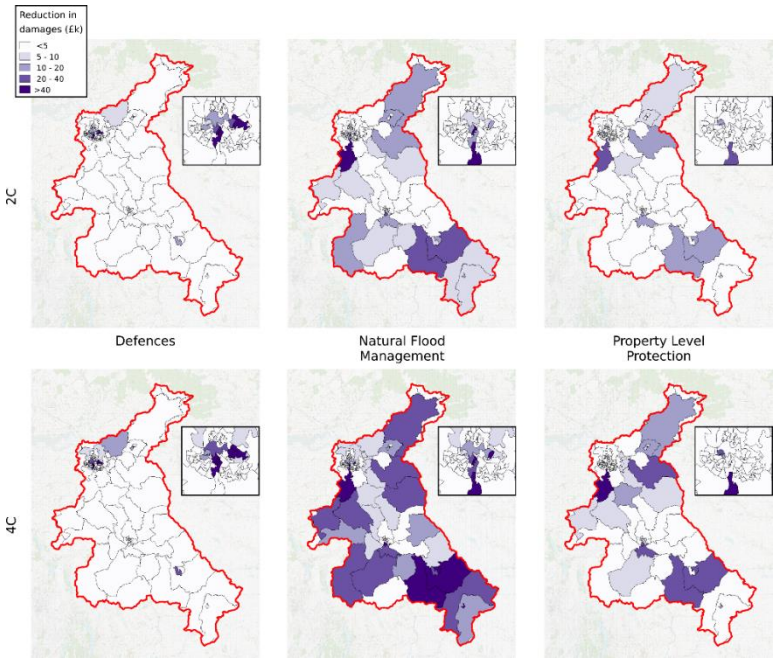
We've developed the Future Flood Explorer to fill this evidence gap – the FFE allows us quickly to explore the effectiveness of flood management measures across the whole catchment both now and in the future, under both climate change and population growth scenarios. We can also use the FFE to explore which measures are most effective at managing future risk.

What combination of measures best manage present and future risk?

We have focussed on the role of six adaptation measures and their implementation as part of two alternative strategies: (i) a continuation of the Current Level of Adaptation (CLA) and (ii) a more ambitious and innovative Enhanced Whole System (EWS) adaptation strategy. Our analysis suggests that by the 2080s, under the assumption of a continuation of CLA, direct residential economic flood risk in the Eden could **increase** by 50-160%, assuming a 2°C and 4°C increase in global mean temperature respectively. To manage flood risk more effectively an 'enhanced whole systems' approach is needed. Such an approach is shown to be capable of not only maintaining current risk levels but **reducing** them; direct residential flood risk in the Eden reduces by 30% (2°C future) or 5% (4°C future).

What contribution do individual measures make to risk reduction?

An important strength of the FFE is the insight it gives us into *which* of the measures adopted is most effective in managing risk. The map (right) compares the contribution that traditional defence measures, natural flood management measures and property level protection make to risk reduction as part of a portfolio based response. Flood defences and natural flood management deliver comparable benefits: 23% and 27% reductions in risk respectively for the 2°C future, and 25% and 37% reductions for the 4°C future. The



results show that natural flood management gives a greater benefit in a more extreme climate future. Property level protection delivers around half the benefit of defences or natural flood management (approximately a 15% reduction under both climates). As well as these headline figures, the FFE gives us important information on *where* these measures reduce risk: defences remain important responses in the urban centre of Carlisle; natural flood management and property level protection are more effective in rural areas. When we come to consider the types of communities benefitting from these measures, and not just the headline risk reductions, these spatial patterns of risk become important.

Natural flood management makes a real difference in the Eden. Why is that?

A surprising outcome of our work has been the effectiveness of natural flood management. The effectiveness of natural flood management in the Eden comes from the fact that there are large areas of lower quality agricultural land where these measures can be applied, and the hydrology of the Eden (and catchments in the north west generally) is more amenable to managing risk through these measures. We wouldn't necessarily expect to be able to reproduce these results across catchments everywhere in England.

Are the most vulnerable appropriately protected?

The level of deprivation in the Eden catchment is, on average, lower than many more vulnerable areas in the UK (e.g. Boston, Hull, Belfast). This catchment average message masks some important localised issues and the analysis highlights particularly vulnerable neighbourhoods in Carlisle with further isolated pockets in Penrith and Kirkby Stephen.

What do we conclude?

The analysis shows that if current management approaches continue future risks are likely to increase. To manage risk effectively an 'enhanced whole systems' approach is needed. As part of this approach:

- Traditional defences (albeit designed to be adaptable) are likely to play a significant role in reducing future risk, particularly in Carlisle itself;
- The Eden catchment is particularly amenable to natural flood management, and as such natural flood management presents a significant opportunity in the Eden;
- Careful consideration is needed to ensure flood risk in the most vulnerable neighbourhoods is well managed.

Future opportunities to improve the analysis in the Eden

The Future Flood Explorer is a powerful tool to explore future changes in risk. The FFE has significant potential to be taken forward to support the development of the Eden Strategy, and elsewhere in the UK. Including more local model and vulnerability data would improve the accuracy of outputs (currently national level data sets are used); better hydrology would help understand the impacts of climate change and natural flood management; more risk metrics would widen the analysis from the purely economic; quantifying the *costs* of implementing these measures would show which are the most cost effective now and in the future.