SENSORS TO QUANTIFY COASTAL SCHEME FLOOD RESISTANCE AND RESILIENCE

Jenny Brown, National Oceanography Centre, jebro@noc.ac.uk
Margaret Yelland, National Oceanography Centre, m.yelland@noc.ac.uk
Rebecca Morris, University of Melbourne, rebecca.morris@unimelb.edu.au
Beth Strain, university of Tasmania, elisabeth.strain@utas.edu.au

ABSTRACT
In England about 5 million properties are at risk of flooding. Socio-economic growth, rising sea levels and extreme weather will exacerbate this issue in the next 100 years. Building coastal resilience is vital worldwide to save people from the impact of flooding and the costs of damage and insurance. In Australia the use of mussel reefs and mangrove forests combined with man-made structures are being trialed to see how well they protect shorelines. Ways to measure the evolving effectiveness of nature-based hazard management are now required to determine the cost-benefit over various management epochs. Using capacitance-wire technology we have developed innovative systems to measure the required field data: overtopping, wave, water level and inundation conditions at the land-sea interface.

INTRODUCTION
Flooding and erosion cause damage of over £260 million on average each year in England. Historically, flood management in the UK has been reactive to failure: in future, resilience needs to be built before it is needed (CCC, 2018). The National Infrastructure Commission (NIC, 2018) have recommended Shoreline Management Plans (SMPs) be updated by 2023 to identify how risk can be managed effectively using a combination of measures including green and grey infrastructure.

Hard defences are costly to build and have detrimental impact on the natural ecosystem. With increasing flood hazard and increasingly limited funding it is recognised that pure hard engineered structures are unsustainable and will leave a legacy of economically unviable and environmentally damaging coastal infrastructure for future generations to manage. Nature-based coastal schemes may present an effective alternative since they adapt to changes in climate and self-repair after storm impact. This means they maintain their resilience and could be cheaper over time. Natural schemes can attenuate waves, act as sediment traps and are particularly important in Port Phillip, Melbourne, because they are native habitats that have suffered decline.

When “greening up the grey” (Figure 1a) there is limited information to support management decisions when considering the costs and benefits of nature-based coastal schemes. In the UK the first step to developing a flood hazard monitoring system has been achieved with the development of a system able to measure wave overtopping in the field (Brown et al., 2018).

METHOD AND RESULTS
The design of new coastal flood defences and the setting of tolerable hazard thresholds requires site-specific information of wave overtopping during storms of varying severity. By developing a unique overtopping measurement system (WireWall) observations of wave-by-wave overtopping velocity and volumes were made at Crosby (Figure 1b), in the North West of England. The new system has collected site-specific data to enable:

1. calibration of overtopping tools used in design and cost-benefit assessments;
2. validation of flood forecasting systems; and,
3. refinement of site-specific safety tolerances to inform flood risk response plans.

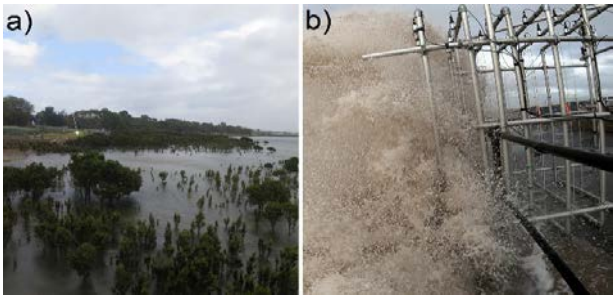

Figure 1 – a) Mangroves, Port Phillip, Melbourne and b) the WireWall system deployed at Crosby, Liverpool.

Development of this unique measurement system makes this the ideal time to initiate a step-change in coastal hazard monitoring capabilities. At Crosby, the 900 m seawall will reach the end of its design life in the next 5 years. Data from 7 deployments at this site have provided the Coastal Group with the site-specific data and calibrated overtopping tools that they need to design a new, cost-effective scheme. The data includes the inland distribution of the cumulative overtopping volume and time-series of overtopping conditions for approximately 3 hours over high water (see https://youtu.be/a5Y33SWdNU4).

CONCLUSION
Our novel wave overtopping measurement system has the potential to be developed into a hazard monitoring system. Such a system could quantify long-term changes in the flood protection offered by new coastal schemes.

REFERENCES
CCC (2018): Managing the coast in a changing climate. Committee on Climate Change report, p. 74.
NIC (2018): National Infrastructure Commission. National Infrastructure assessment report. p. 163.
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