



Using image-based deep learning to identify river defences from elevation data for large-scale flood modelling

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National-scale flood hazard maps are an essential tool for the re/insurance industry to assess property risk and financial impacts of flooding. The creation of worst-case scenario river flood maps, assuming defence failure, and additional separate datasets indicating areas protected by defences enables the industry to best assess risk. However, there is a global shortage of information on defence locations and maintenance. For example, in the United States it is estimated that there are around 160,000 kilometres (100,000 miles) of defence levees, but the location of many of these is not mapped in large-scale defence datasets. We present a new approach to large-scale defence identification using deep learning techniques.

In the generation of flood hazard maps, the elevation depicted in the Digital Elevation Model (DEM) used in the hydraulic modelling is fundamental to determining the routing of water flow across the terrain and thus determining where flooding occurs. The full or partial representation of raised river defences in DEMs affects this routing and subsequently causes difficulty when developing both undefended and defended flood maps. To generate undefended river flood maps these raised defences need to be entirely removed, which requires knowledge of their locations. Without comprehensive defence datasets, an alternative method to identify river defences on a large-scale is required.

The use of deep learning techniques to recognise objects in images is fast developing. DEMs and other related datasets can be represented in a similar raster format to images. JBA has developed a successful methodology which involves training a U-Net Convolutional Neural Network, originally designed for image segmentation, to identify raised river defences in DEMs. Using this defence dataset, we have been able to generate true river undefended flood maps for a selection of countries including Italy, Germany, Austria and the US. We present details of the methodology developed, the model training and the challenges faced when applying the model to different geographical regions.