

USING IMAGE-BASED DEEP LEARNING TO IDENTIFY RIVER DEFENCES FROM ELEVATION DATA FOR LARGE-SCALE FLOOD MODELLING

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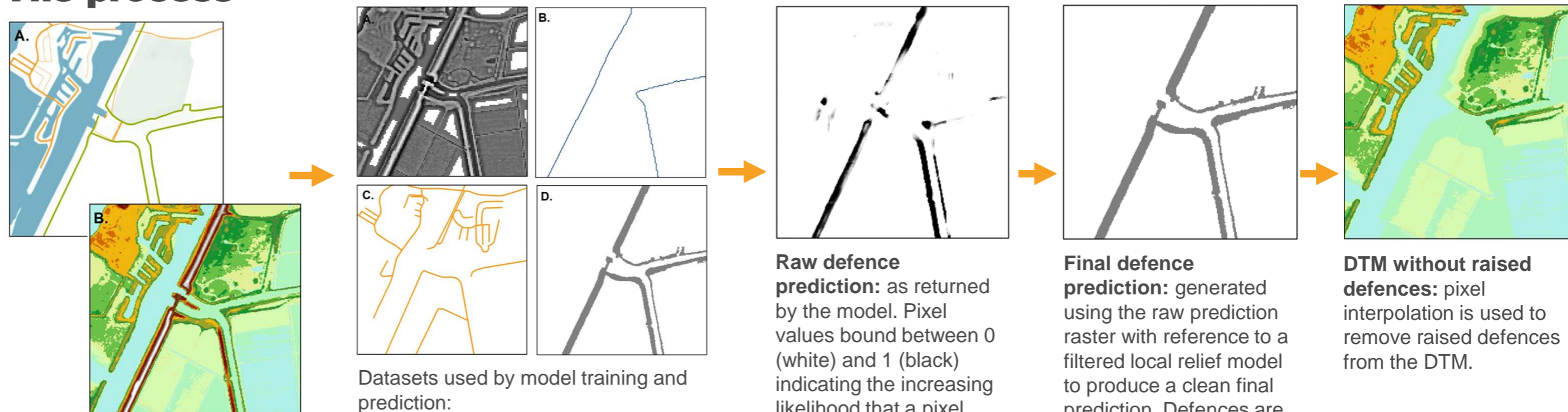
Undefended fluvial flood maps

National-scale flood maps, as produced by JBA Risk Management, are primarily used in the re/insurance markets to assess property risk. Defences protect areas from flooding but can fail. To comprehensively assess risk, the worst-case scenario is required. Raised defences occur in the Digital Terrain Models (DTM) used in the hydraulic modelling that generate flood maps. To produce undefended scenario flood maps these must be removed. Where possible third-party datasets are used to locate defences, however these are generally not available at national-scale or are incomplete. Defences can be identified manually but this is time consuming and leads to inconsistent results.

Defence identification

The identification method was based on approaches submitted to Kaggle's Eye in the Sky competition. The U-Net architecture features multiple convolutional layers, enabling contextual information to be incorporated into the predictions; in the case of defences, this could be the alignment to a nearby river or the abrupt change in surface elevation. The image-like format of multi-banded raster files enable spatial datasets to be treated like images. The method was initially developed using data from an area of Florida (US) where 112 5km square tiles with 5m-pixel resolution were used to train and test the model. Through a series of iterations the model was developed and refined, incorporating data from other geographical regions. The model has been used to produce national maps of defences in Italy and Germany.

The process



A. Example area: showing river (blue) and defences (green lines).

B. DTM: of area with raised defences visible parallel to river channels.

Datasets used by model training and prediction:
A. Local relief model: derived from the DTM highlighting relative local elevation variation.

B. River network.

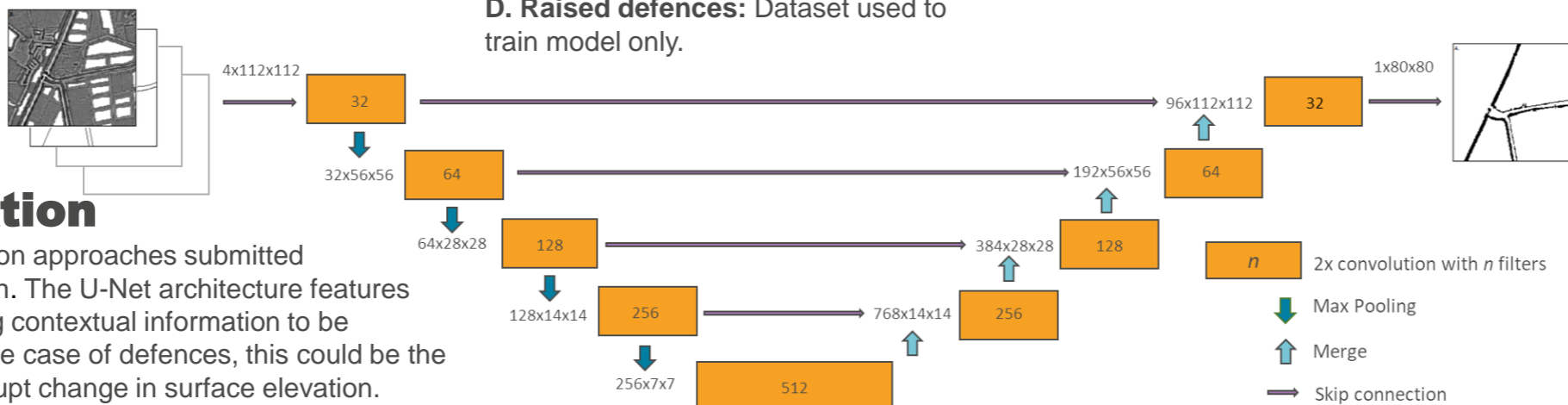
C. Transport network: Major road and rail networks.

D. Raised defences: Dataset used to train model only.

Raw defence prediction: as returned by the model. Pixel values bound between 0 (white) and 1 (black) indicating the increasing likelihood that a pixel represents a raised defence.

Final defence prediction: generated using the raw prediction raster with reference to a filtered local relief model to produce a clean final prediction. Defences are given as complete features with noise from false-positives removed.

DTM without raised defences: pixel interpolation is used to remove raised defences from the DTM.



U-Net architecture use showing convolutions and various merges.

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National defence maps



Identified raised defences (black) for (A) Florida, US, (B) Italy and (C) Po region of Italy.