Assembling High Resolution Spatial Datasets for Robust Effective Imperviousness Modelling

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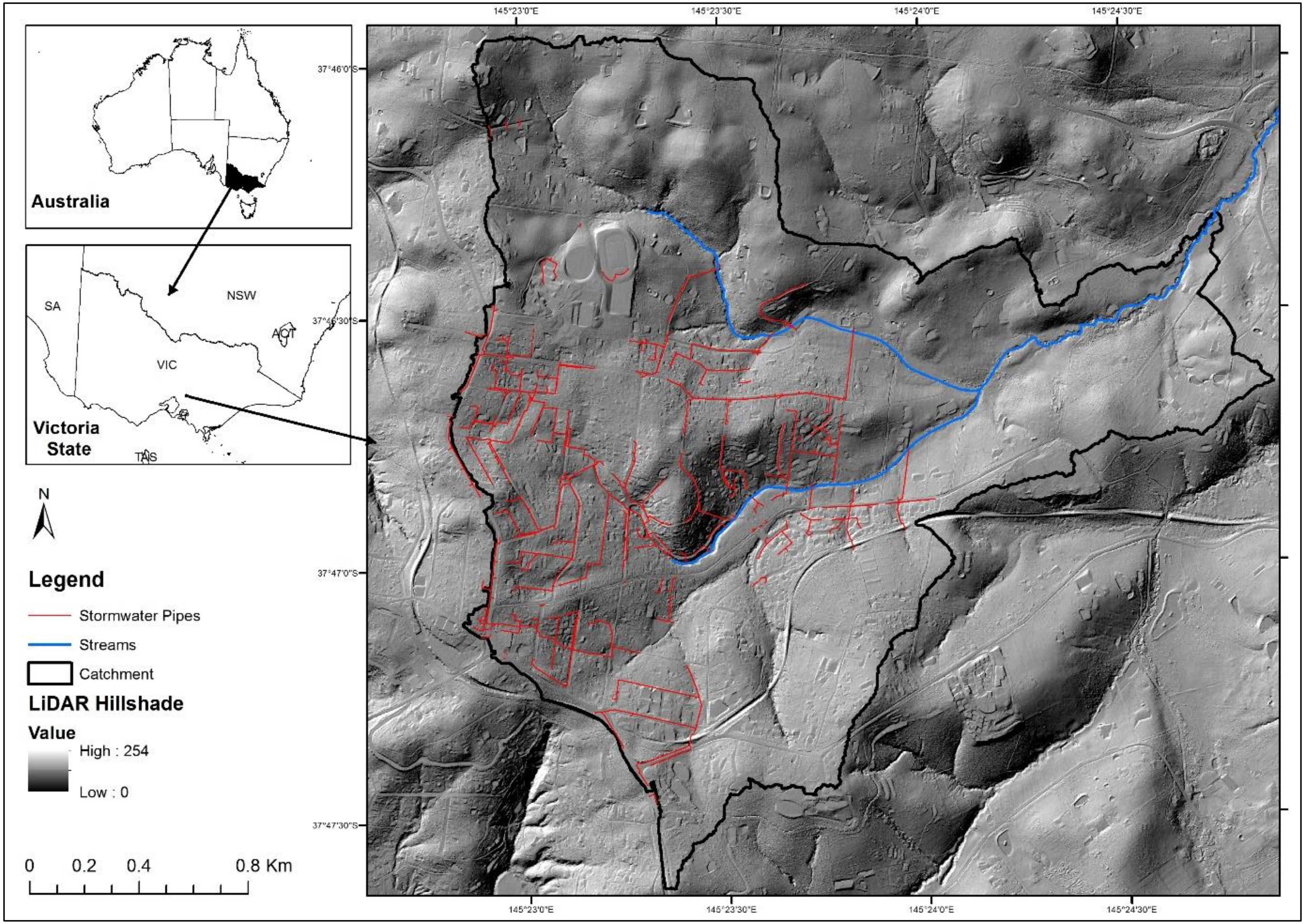
Effective Imperviousness (EI)

- EI has long been proposed as a more direct measure of urban stormwater impacts (Leopold, 1968; Ebrahimian *et al.*, 2016)
- The underlying concept:
  - Runoff from impervious surfaces will have a much larger and more direct impact on stream ecosystems if that runoff is routed to the stream through drainage pipes and sealed drains than if it is permitted to flow to pervious land, where greater infiltration and loss (to the air or deep seepage: Walsh *et al.*, 2012) is likely.

Overview

- This study describes a method
  - for mapping impervious surfaces and other land cover features and
  - estimating their flow distances to streams via pipes and overland, to permit realistic estimation of effective imperviousness.

Little Stringybark



High resolution land cover mapping

LiDAR Height Model
(Non-ground minus ground data)

Develop a non-ground polygon layer for height > 1.5m

Develop a ground polygon by removing non-ground polygon from the study area polygon.

NDVI Model
[(IR – Red)/(IR + Red)] x 100

Roofs: Select NDVI <= 0 within non-ground polygon. Perform QA and finalise.

Trees: Remove "Roofs" data from non-ground polygons to develop a tree data.

Grass Areas: Select NDVI > 0 within ground polygon.

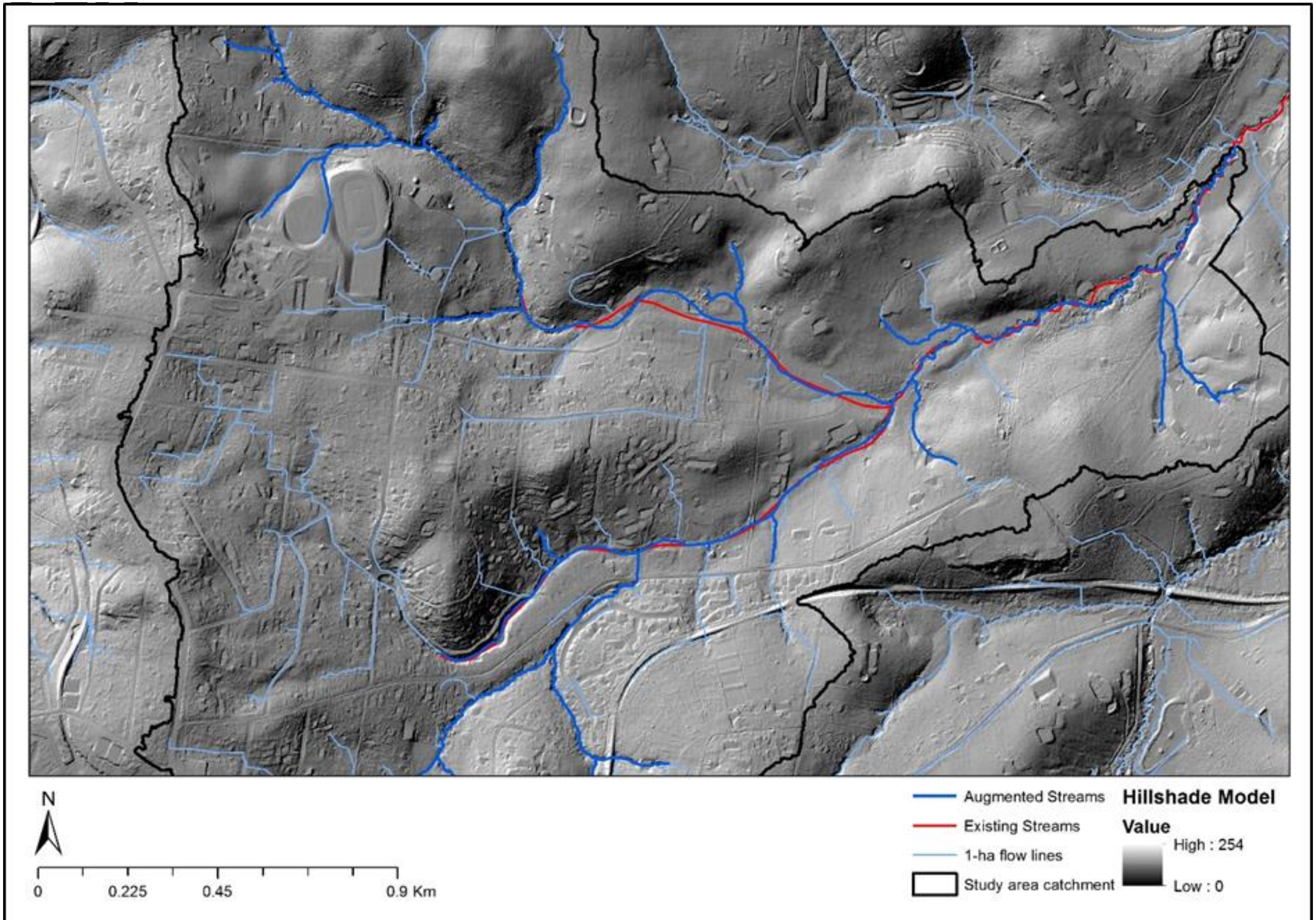
Other Areas: Remove Grass Areas data from ground polygons to develop other areas (ground impervious, bare soils, unsealed roads and water bodies).

Existing Spatial Datasets:
(Waterbodies, Roads and Planning Scheme Zones)

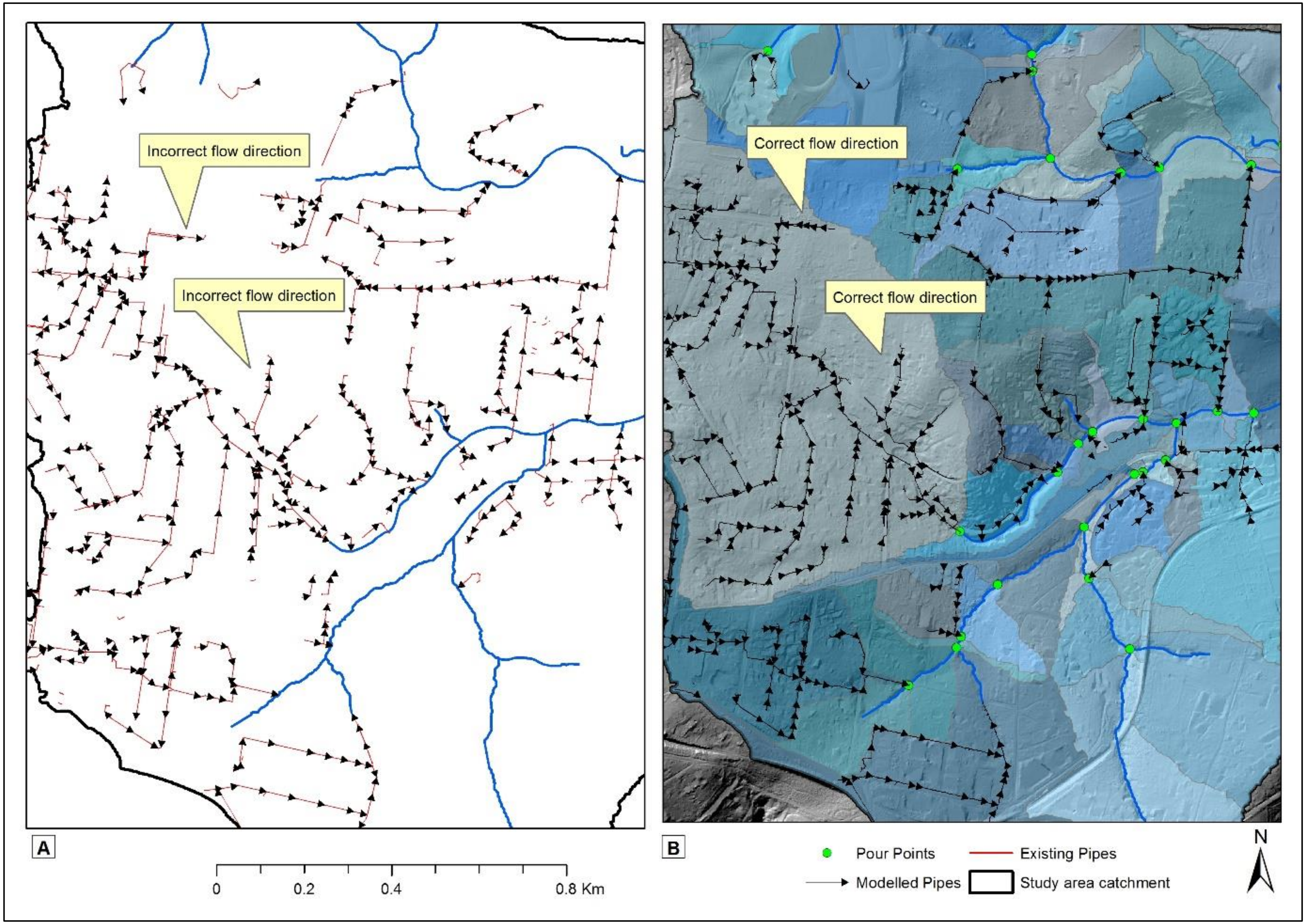
Ground Imperviousness: Remove "Water bodies" from "Other Areas". The output will still have bare soils and unsealed roads. Use road type (sealed/unsealed) from road centreline data to separate unsealed roads. Then with the help of planning scheme zone data, identify parcels which are candidate for bare soils presence and classify the respective polygons for bare soil.

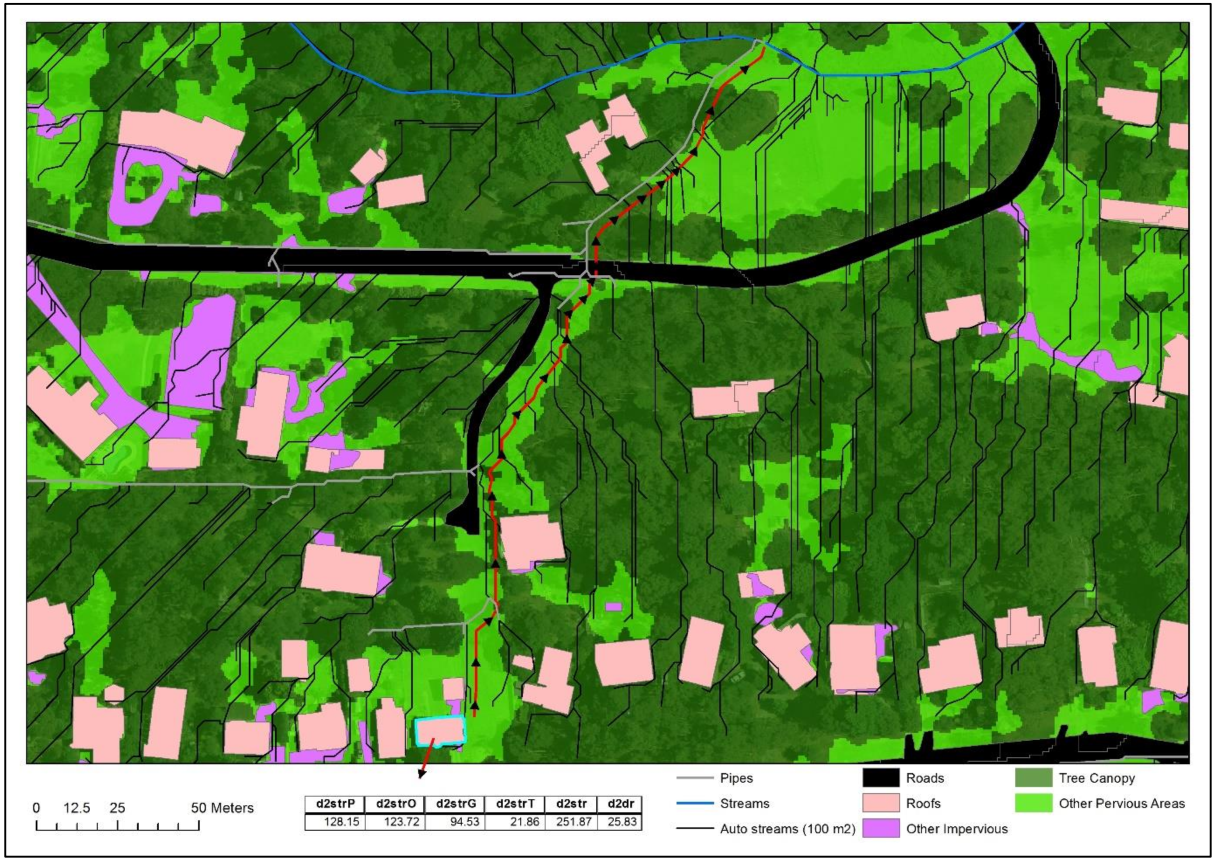
High resolution land cover mapping

Stream network augmented using the LiDAR



(A) existing pipes and (B) modelled pipes and subcatchments





An example of flow-path modelling from an impervious surface. The flow from the most downstream edge of the selected impervious polygon (outlined in blue, with flow-path indicated by a red line (offset to the right)) is intercepted firstly by a grassed area (other pervious), then by a pipe at 25.83m (d2dr). After this, the flow has passed through primarily grass area and entered again into another pipe on its way to the nearest waterway at 251.87m (d2str). During its travel to nearest stream, the total pipe flow is 128.15m (d2strP), overland flow is 123.72m (d2strO), grass flow is 94.53m (d2strG) and tree canopy flow is 21.86m (d2strT). The flow distance to the catchment outlet is 3,131m (d2O).

Total imperviousness of a reach is the sum of impervious area in a catchment divided by the catchment area. Effective imperviousness is calculated similarly, but the area of each impervious surface is weighted (by a number between 0 and 1) by determining the length and nature of flow paths between the surface and the most downstream point of the catchment (Fig. 7). Wenger *et al.* (2009) found the upper most plausible half-decay distance for weighting the area of each impervious polygon for predicting macroinvertebrate assemblage composition was 9.4 m. Thus, the weight applied to a polygon *d* m from a stormwater drain (i.e. d2dr = *d*) is:

$$W = e^{\left(-\frac{d2str}{9.4 \ln(2)}\right)} \qquad \text{Equation 1}$$

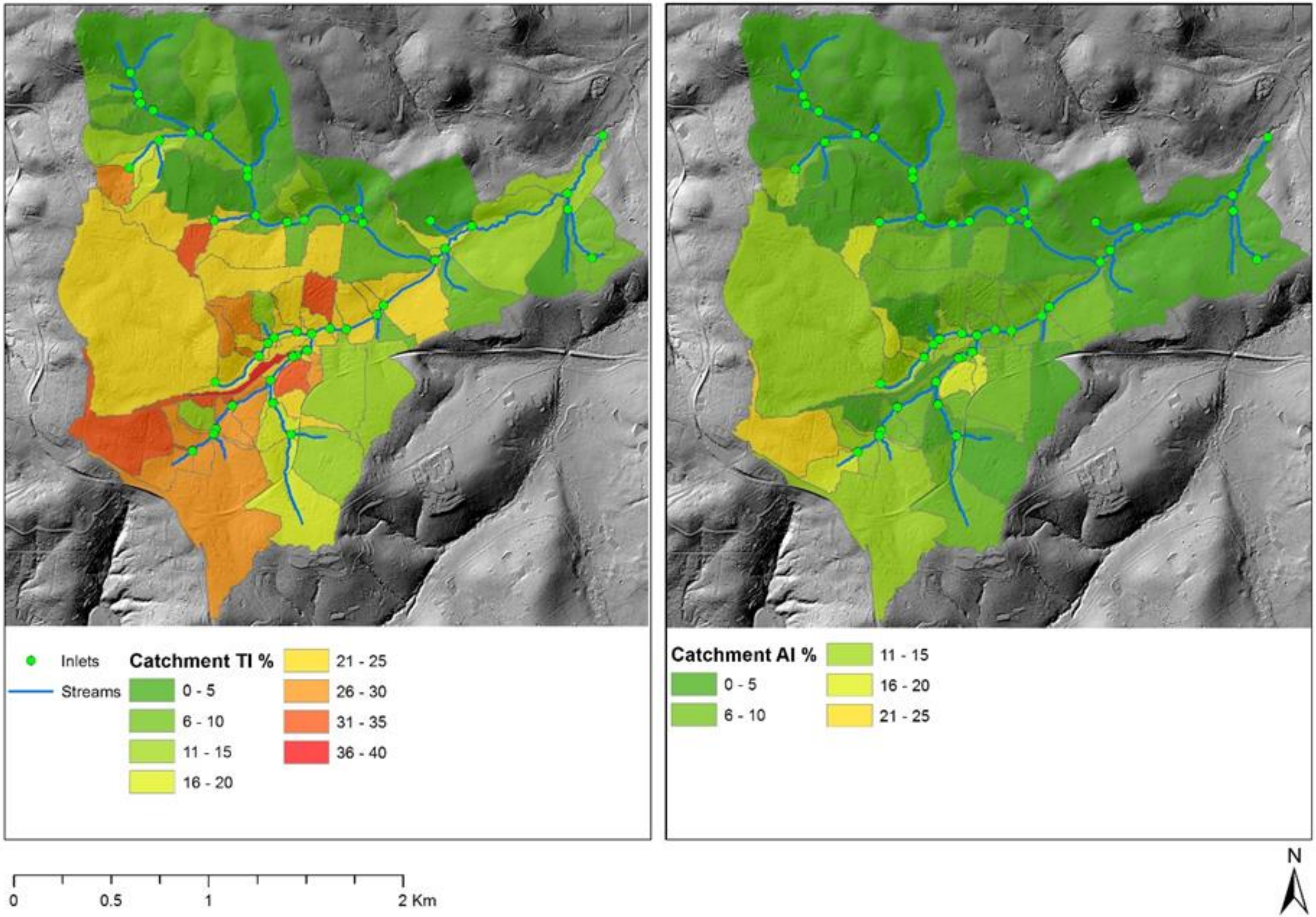
Effective imperviousness of a catchment is then calculated as:

$$EI = \sum_{1}^{j} \frac{I_j W}{A} \qquad \text{Equation 2}$$

where I_j = the area of each of the *j* impervious surfaces in the catchment, and *A* is the area of the catchment.

More complex attenuation functions are possible. For instance, it would be possible to model in-stream attenuation in addition to attenuation along natural flow paths as trialled by Wenger *et al.* (2009), or to apply different weightings to different pervious land cover classes.

E.g. Attenuated imperviousness (AI)



Thank you

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