RECLAIM

UNIVERSITY OF SURREY

Catchment-scale benefits (flow reduction) and dis-benefits (debris blocking risk) of green-grey infrastructure in urban rivers

Thomas Kjeldsen, University of Bath

Chris Rowlatt, University of Bath

Gianni Vesuviano, UKCEH

Alice Fitch, UKCEH

James Miller, UKCEH

Sisay Debele, University of Surrey

Simon Dooley, Cardiff City

UK Centre for Ecology & Hydrology

UNIVERSITY OF BATH

WARWICK THE UNIVERSITY OF WARWICK

PRIFYSGOL BANGOR UNIVERSITY

UKRI Engineering and Physical Sciences Research Council

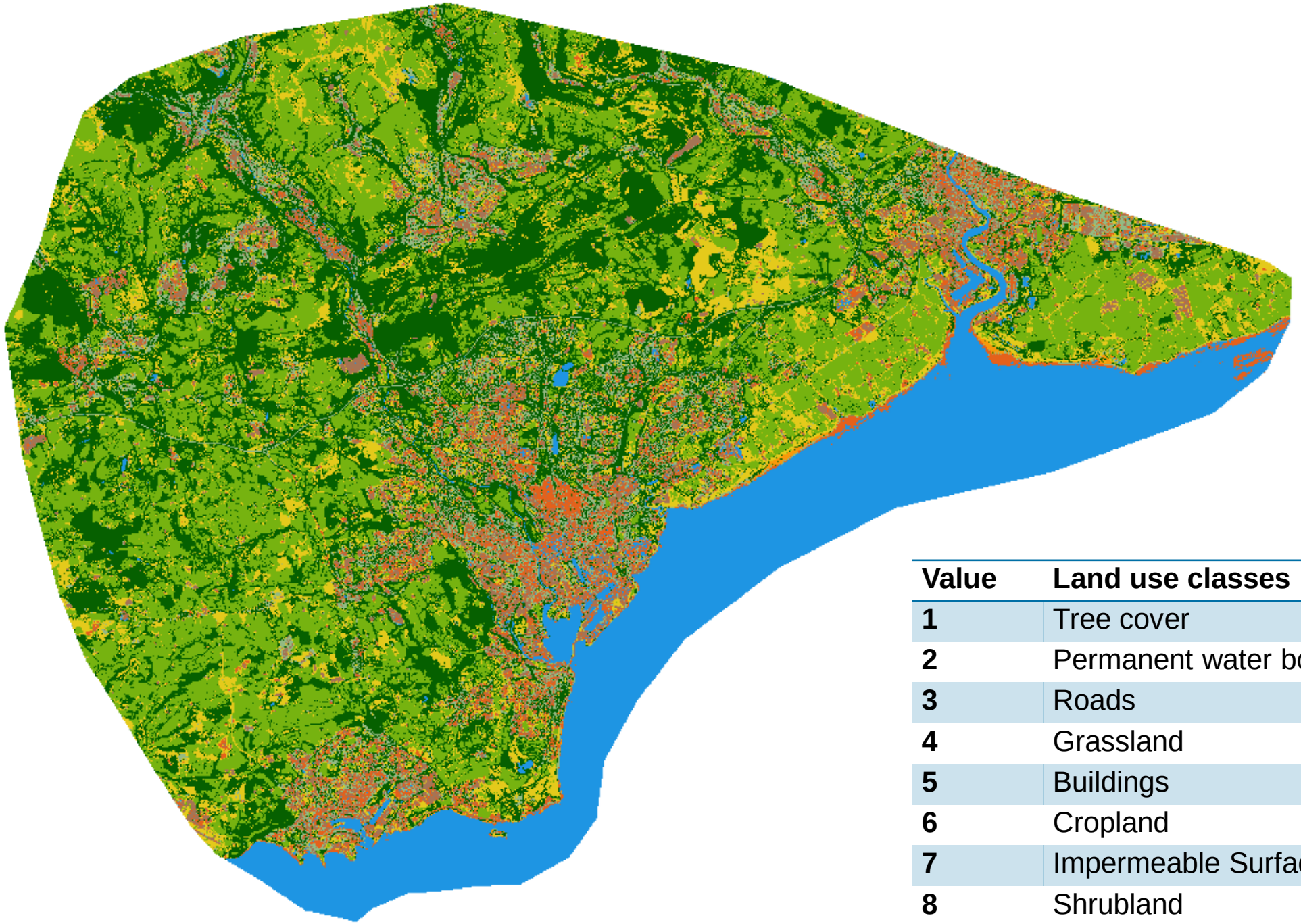
UKRI Natural Environment Research Council

UKRI Arts and Humanities Research Council

Benefits and dis-benefits

Project Aims

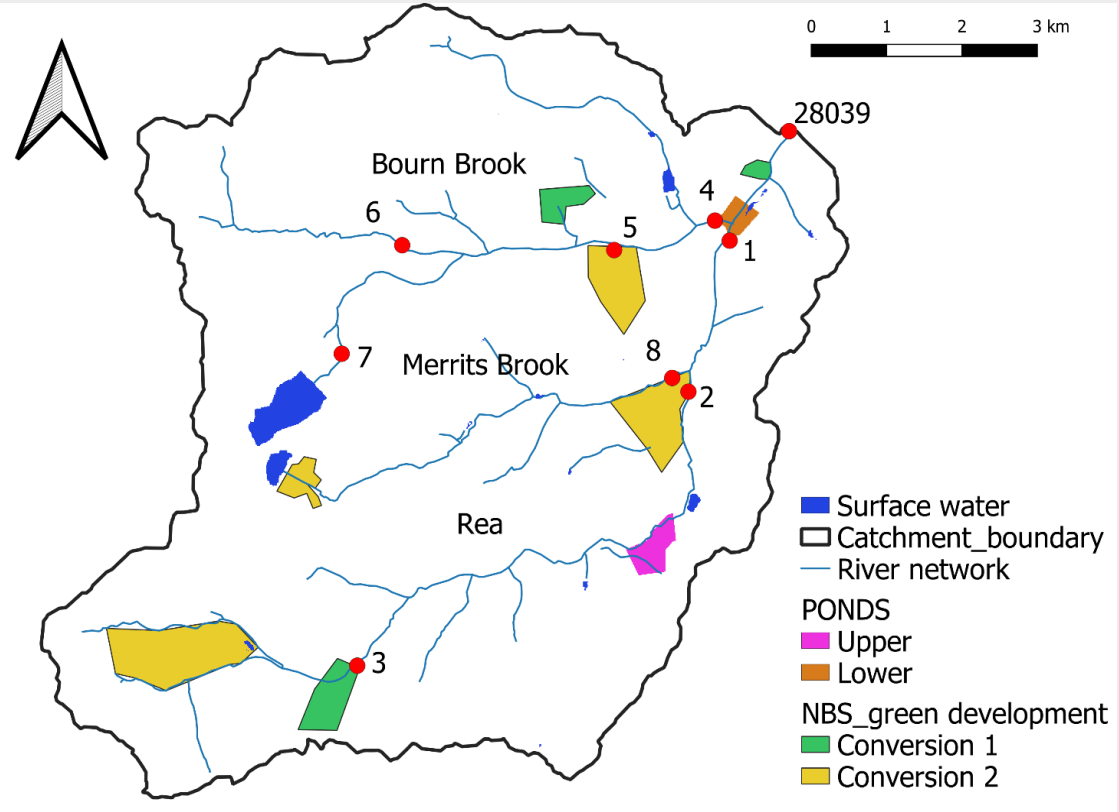
- **O1:** Using existing GIS datasets to **map green and grey land-use across urban river catchments** draining to locations in Cardiff city where trash screens have been installed.
- **O2:** Create new land use scenarios to **evaluate the hydrological benefit** (%change in flow) provided by existing GI. Parameterise and run the ANaRM model to evaluate those scenarios.
- **O3**: Develop machine learning algorithm **to identify instances of debris blocking** of trash screens based on CCTV images and existing water level recordings.
- **O4:** Use logistic regression to assess the relative contribution (statistical significance) of grey and green land-use characteristics on **the risk of blocking** across sites.



Value	Land use classes
1	Tree cover
2	Permanent water bodies
3	Roads
4	Grassland
5	Buildings
6	Cropland
7	Impermeable Surface
8	Shrubland

Adapted Nature-based solutions Rational Method (ANaRM)

Calibrated and validated in Birmingham, UK



» Rational method – urban, small catchment suitable – adapted to include *FARL*

$Qp = 0.278CiA \times FARL^{3.445}$ – gridded peak flow for any location in the catchment (m^3/s)

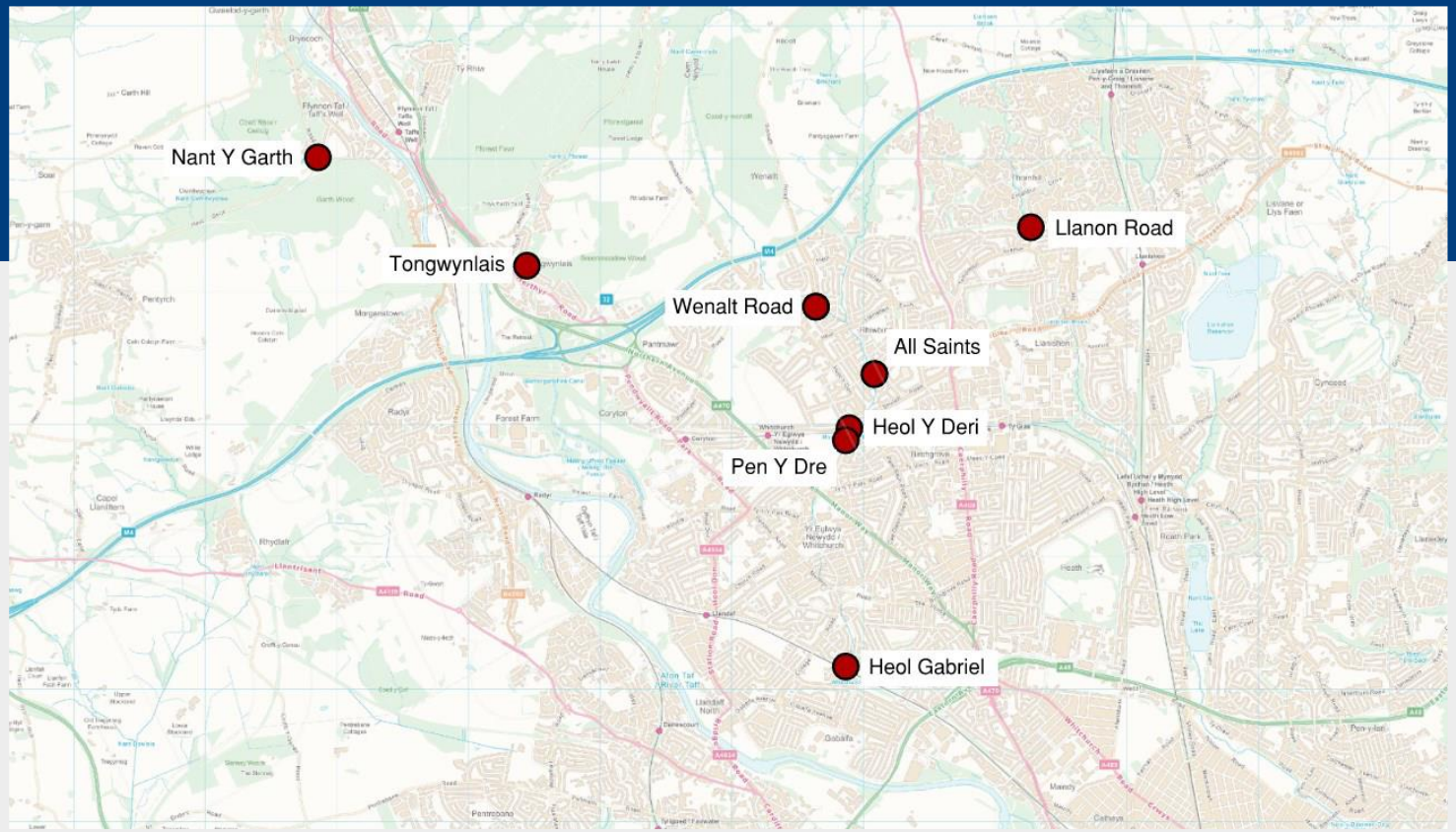
» ***C*** = 1.3 × *Cv (volumetric runoff coefficient)* – 0-1, depends on land cover type

» ***i*** = average rainfall intensity (mm/hr) > taken from FEH22 rainfall model

» ***A*** = flow accumulation raster area (km^2)

» ***FARL*** – flood attenuation from rivers/lakes (FEH catchment descriptor)

Miller *et al.* (2023) *Landscape & Urban Planning*, 104737

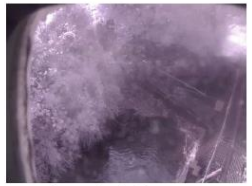



Nant Y Garth


Tongwynlais


Rhiwbina Wenalt Rd


Rhiwbina All Saints


Heol Gabriel


Llanon Road


Rhiwbina Heol Y Deri


Rhiwbina Pen Y Dre

In total, 793 images of the Tongwynlais site were manually screened and labelled.

- 80% of the data was used for training
- 20% for validation

Label images as either **blocked** or **unblocked**

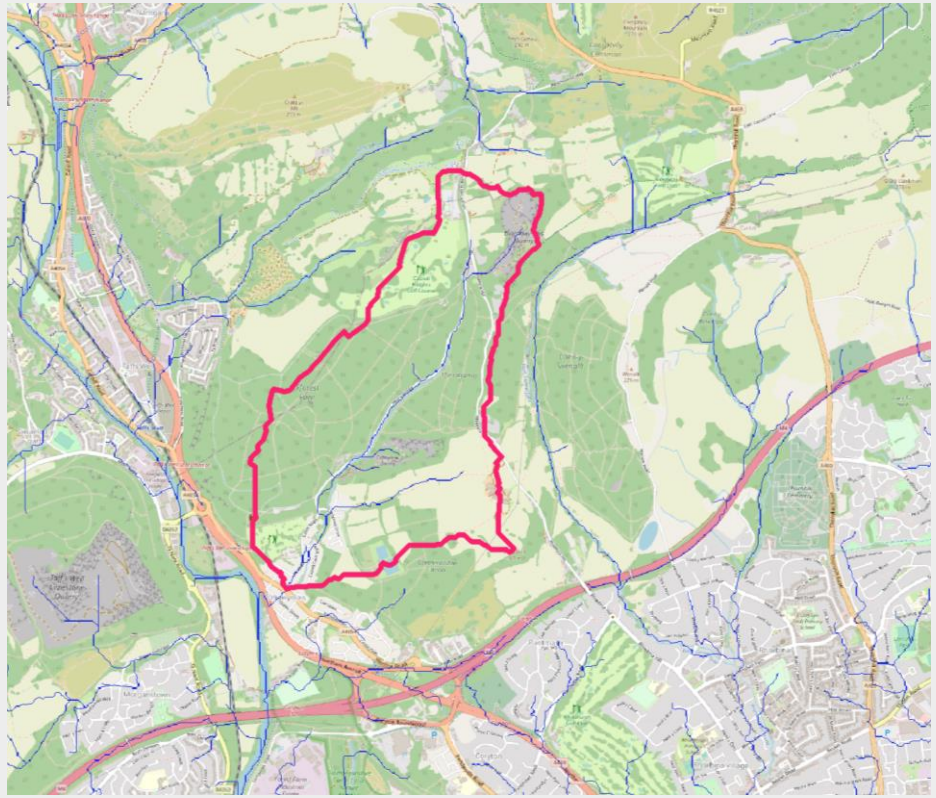
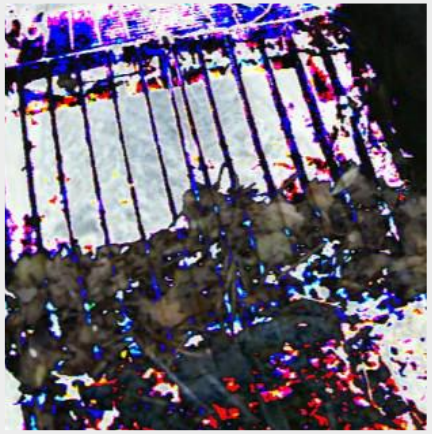
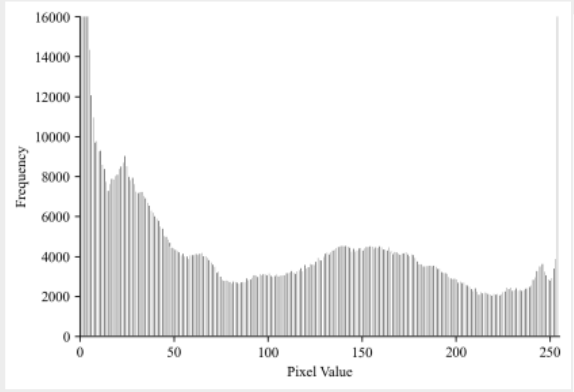
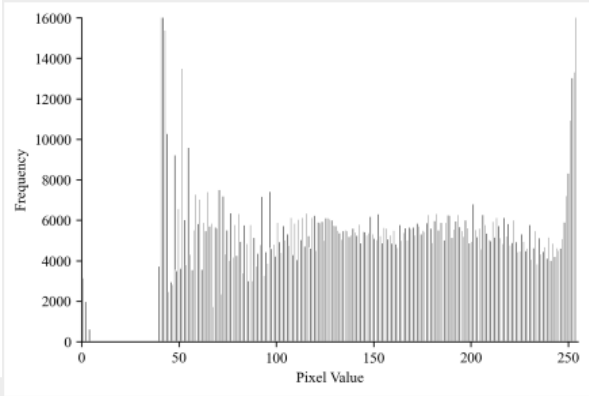


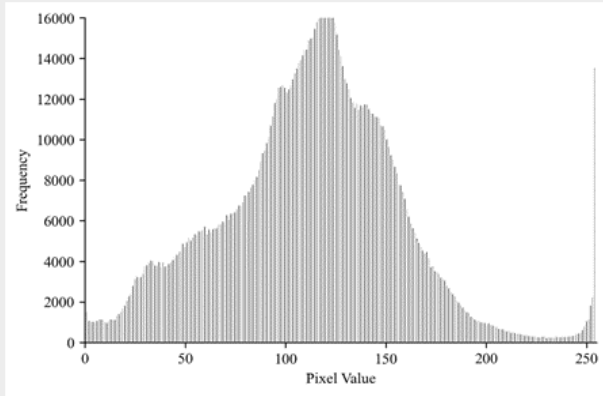
Image Subtraction

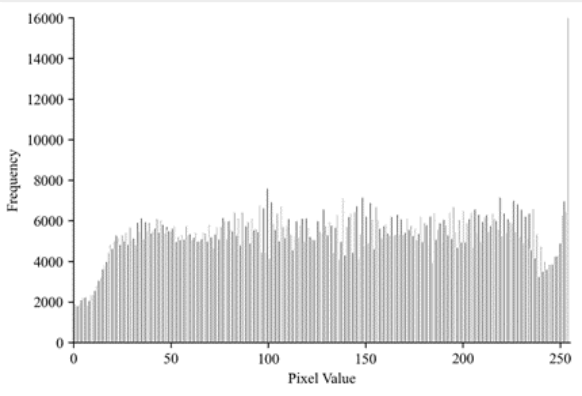


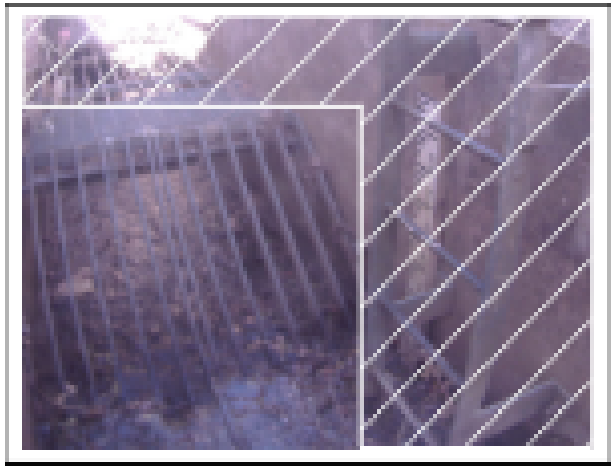
Histogram equalisation











Input image cropped to 475x475 px

Image resized by factor 0.1

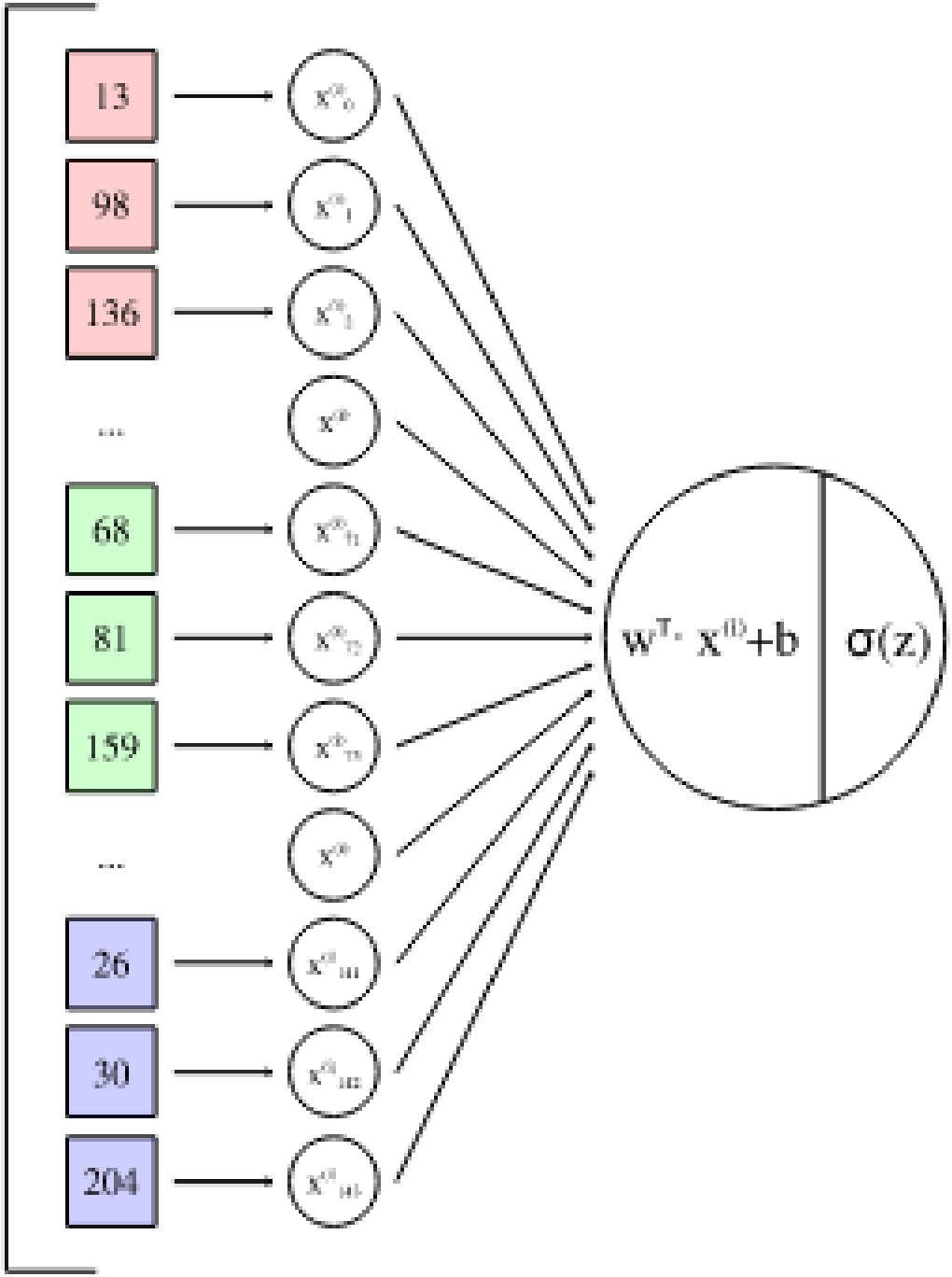


Table 4 Results of Logistic Regression and Time Taken to Train and Test Model with Dataset

Image Processing Type	Train Accuracy (%)	Test Accuracy (%)	Time Taken
M1: No additional processing	95.1	87.4	17.9 s
M2: Histogram Equalisation	97.1	**91.0**	19.7 s
M3: Canny Transformation	98.7	84.7	20.5 s
M4: Laplacian Transformation	100	89.2	23.4 s
M5: Laplacian Sharpened	100	90.1	25.9 s
M6: Image Subtraction	91.6	85.5	20.8 s
M7: Histogram Equalised Subtraction	96.2	87.4	22.4 s
M8: Canny Image Subtraction	98.0	85.6	26.8 s
M9: Laplacian Sharpened Subtraction	92.3	87.4	30.3 s
M10: No additional processing (0.5 scale)	100	**91.0**	325 s
M11: No additional processing (no scale)	100	90.1	1,470 s

Note. This Table contains results from cost function optimisations using 3000 model iterations and a learning rate of 0.01 using a Mid-range CPU (Intel Celeron N5095 @ 2.00GHz) with 16 G.B. RAM.

Next steps

- Set-up ANARM model for Cardiff and trash screen catchments
- Relate blocking frequency to land-use characteristics
- Define future land-use scenarios
- Investigate impact of land-use change -> Reduced flood peaks vs increased blocking frequency