Urban Greenspace and Climate Change

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Susannah Gill

CURE, University of Manchester

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Aims

- To assess the vulnerability of urban green space to climate change at the city and neighbourhood level
- To investigate the potential of green space to adapt cities to climate change

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Methodology

- Characterising the urban environment
  – UMT mapping
  – Surface cover analysis
- Quantifying environmental functions
  – Surface temperature
  – Surface runoff
- Risk characterisation
- Neighbourhood level work

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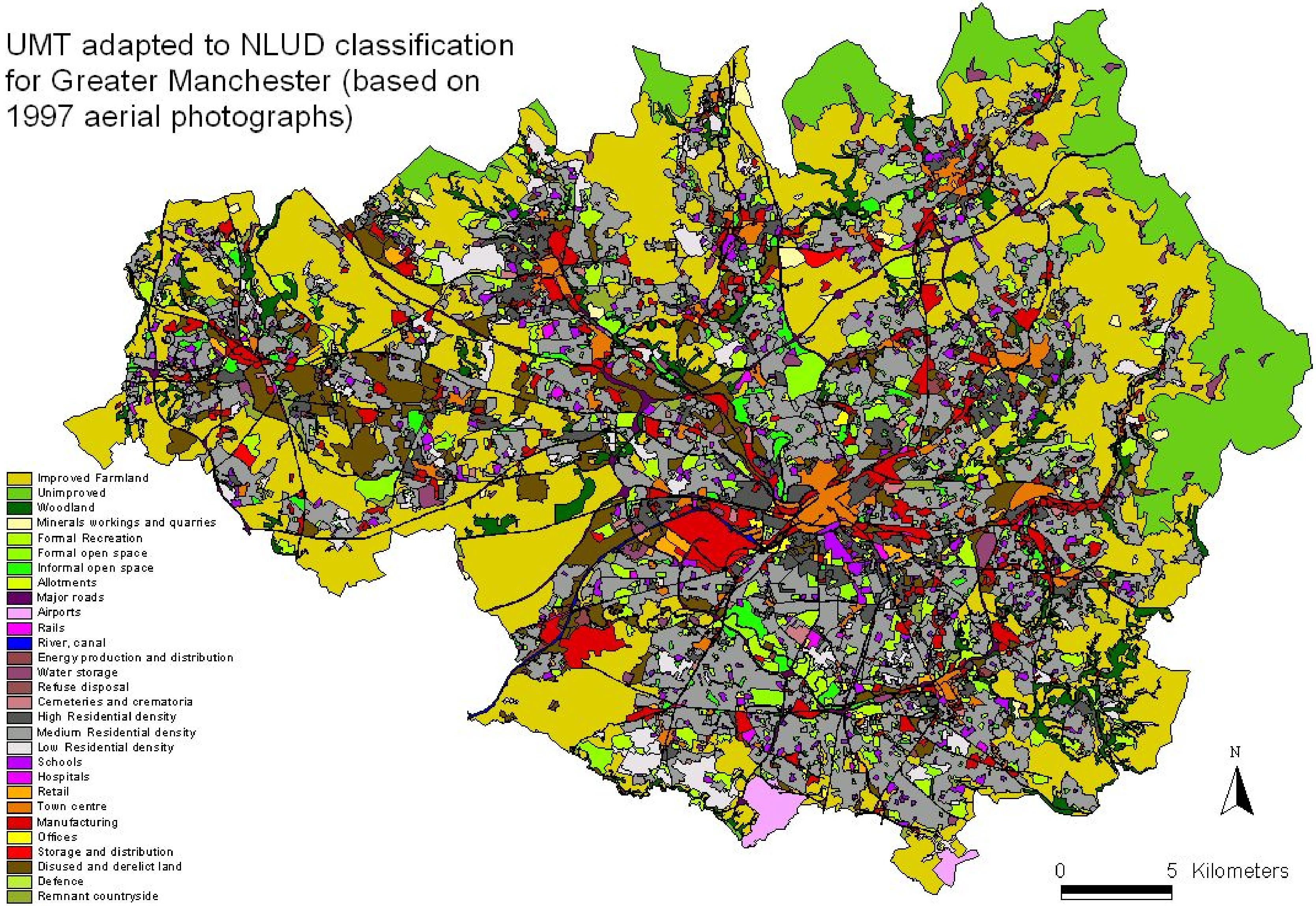
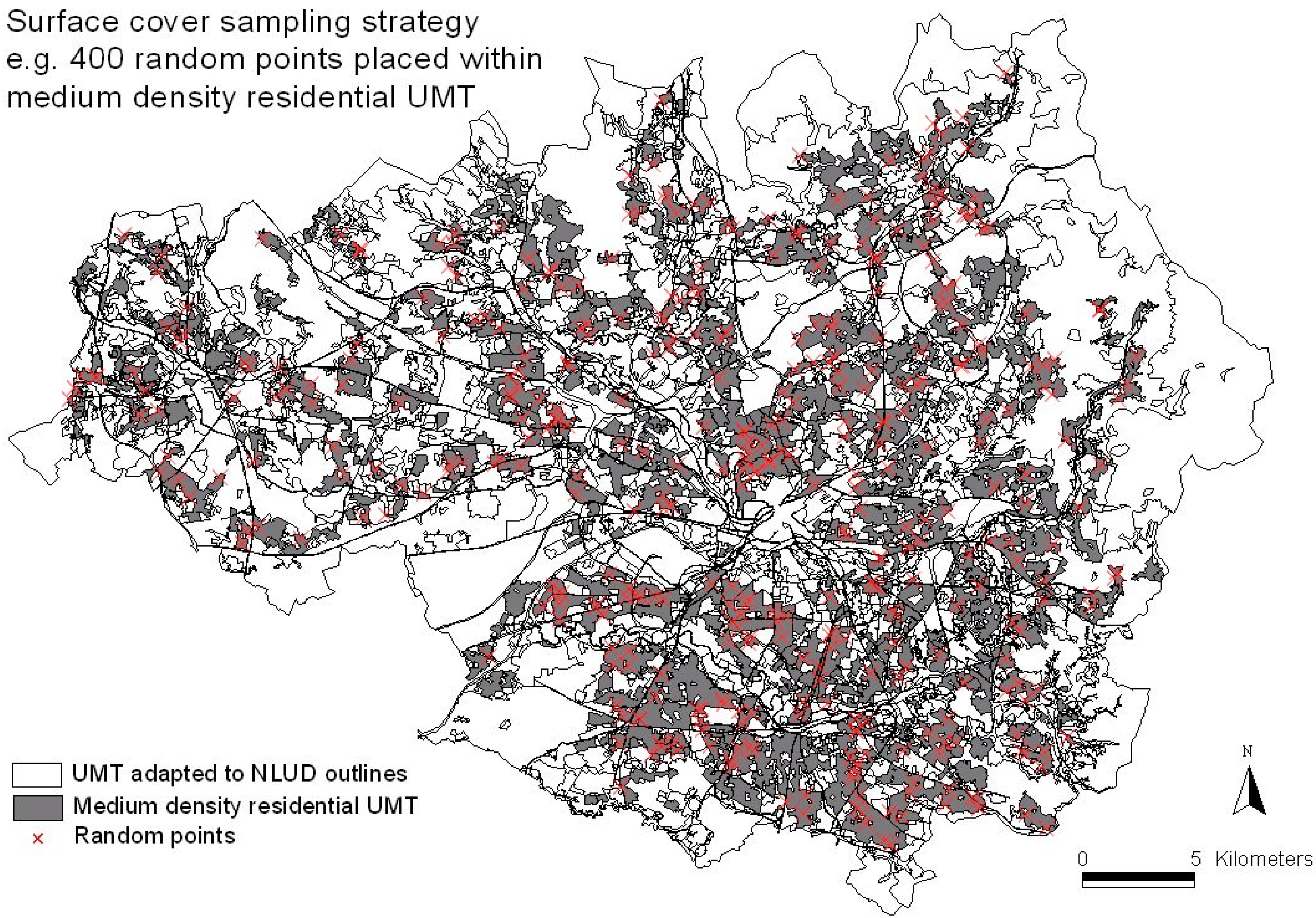
UMT Conurbation Map



Surface Cover Analysis

- To determine the proportional surface cover of each UMT category
- Stratified random sampling
- USDA Forest Service ‘Photo Interpretation’ tool
  http://www.fs.fed.us/ne/syracuse/Tools/tools.htm

Random points placed in UMTs



Surface cover types pre-determined

Building

Shrub

Cultivated

Other impervious

Mown grass

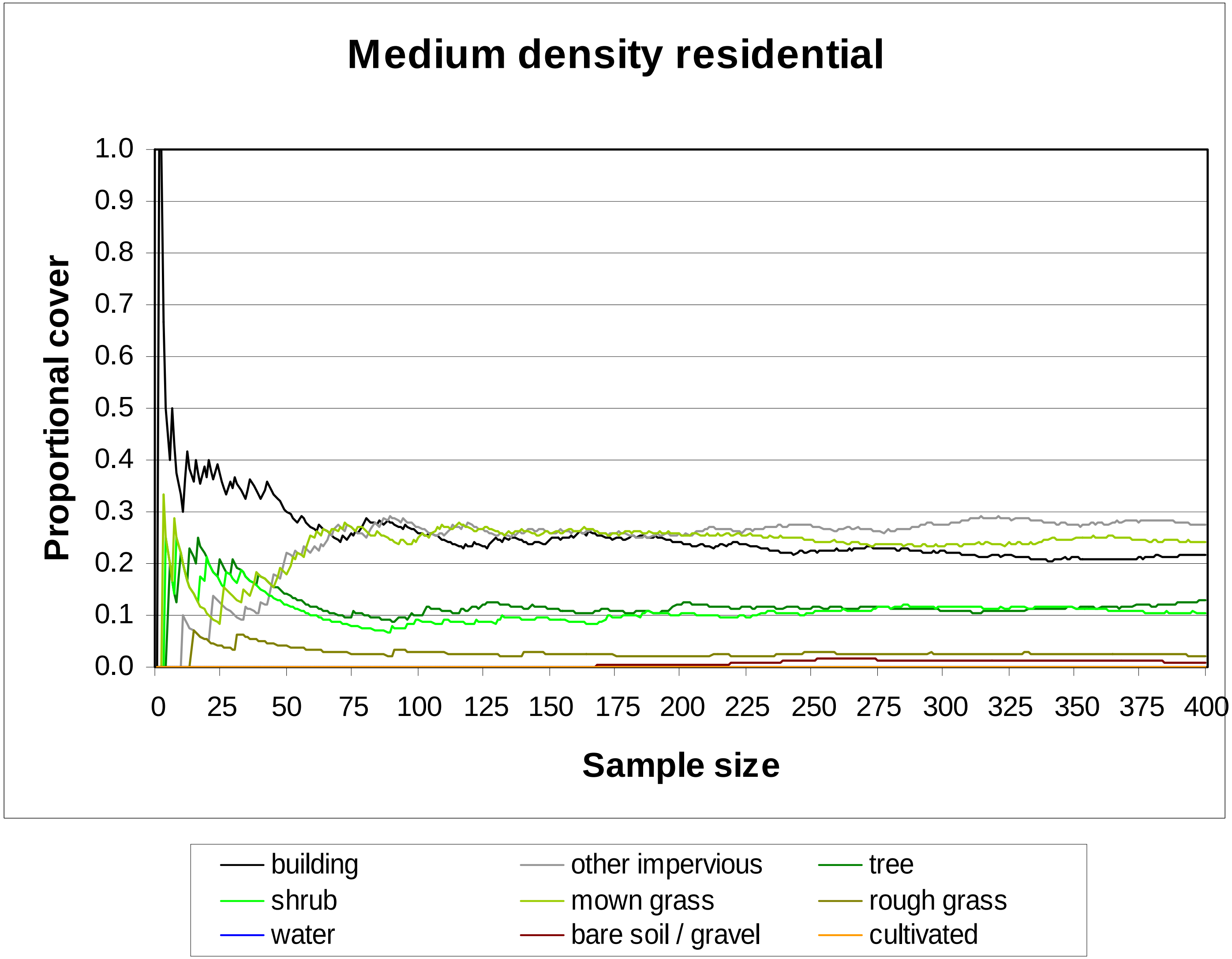
Water

Tree

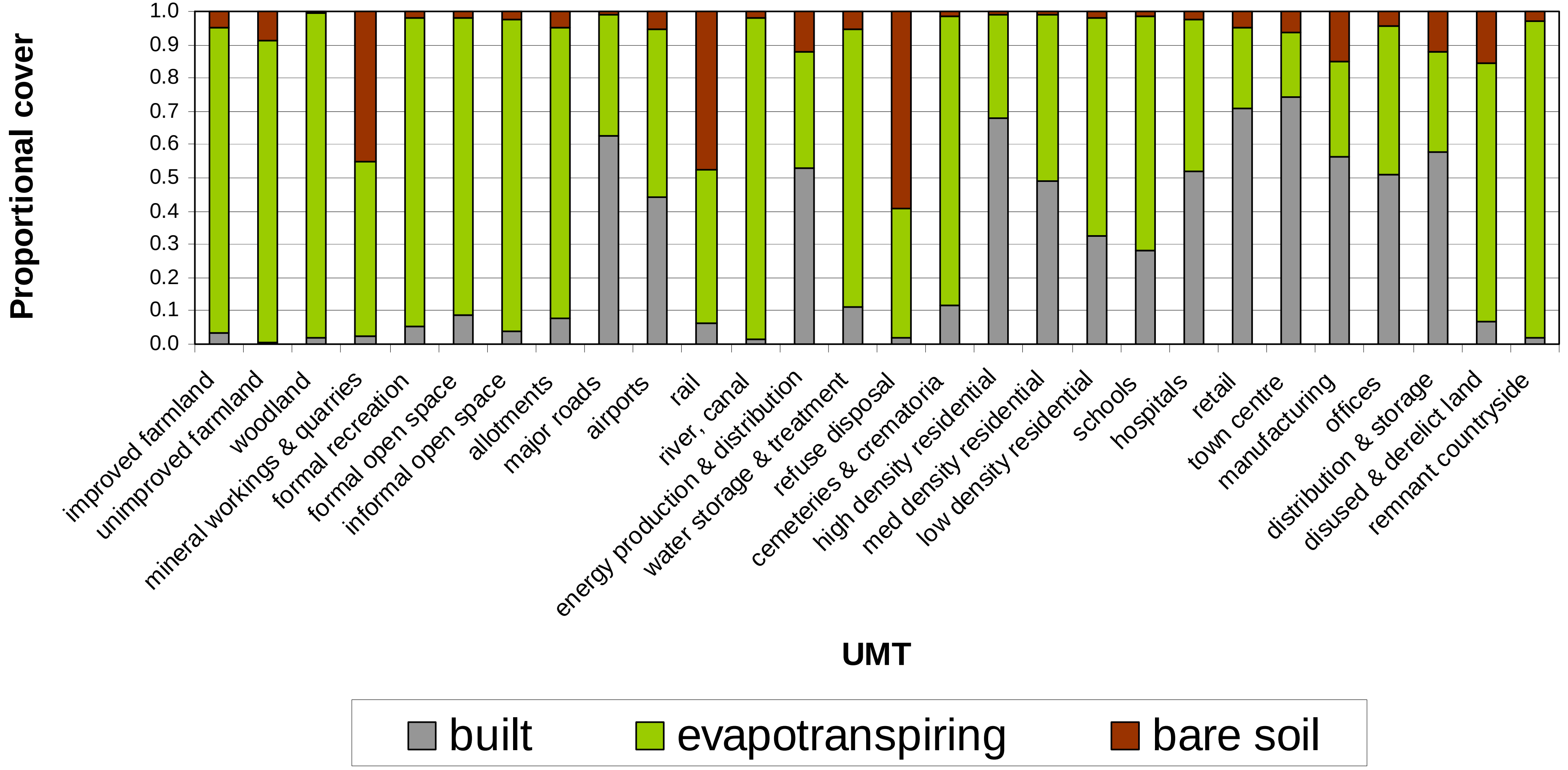
Rough grass

Bare soil / gravel

Proportional surface cover



UMT surface cover

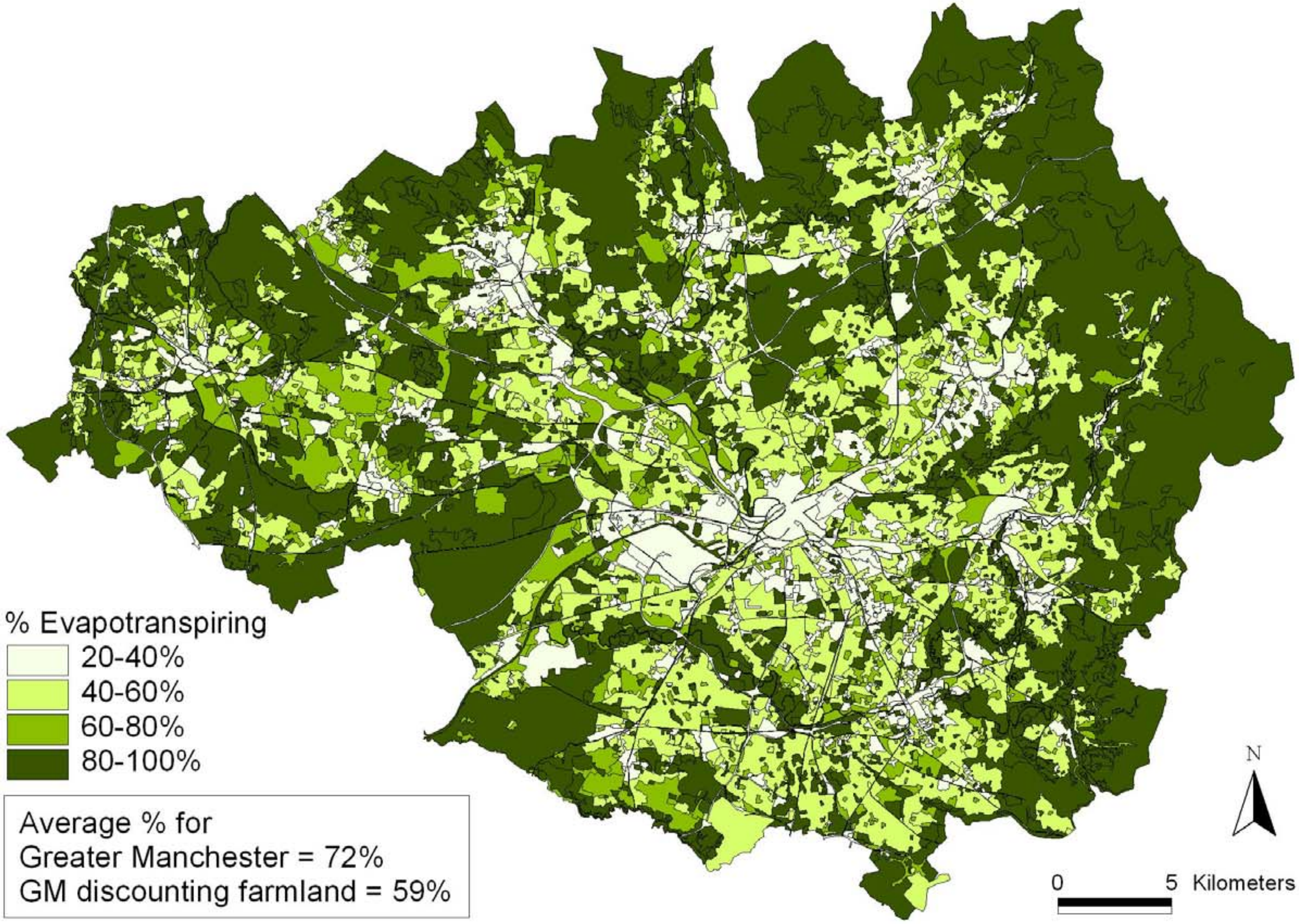


building, other impervious

tree, shrub, mown grass, rough grass, cultivated, water

bare soil/ gravel

Evapotranspiring surfaces in GM



Quantifying environmental functions

- Models developed by Whitford *et al*. (2001)
  - Surface runoff model
  - Surface temperature model

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Surface runoff model

- Storm runoff coefficient as an indicator of urban hydrology
- Dependent on:
  - Precipitation
  - Maximum potential retention of the land
    - Curve number
      - Antecedent moisture conditions
      - Soil type
      - Surface cover

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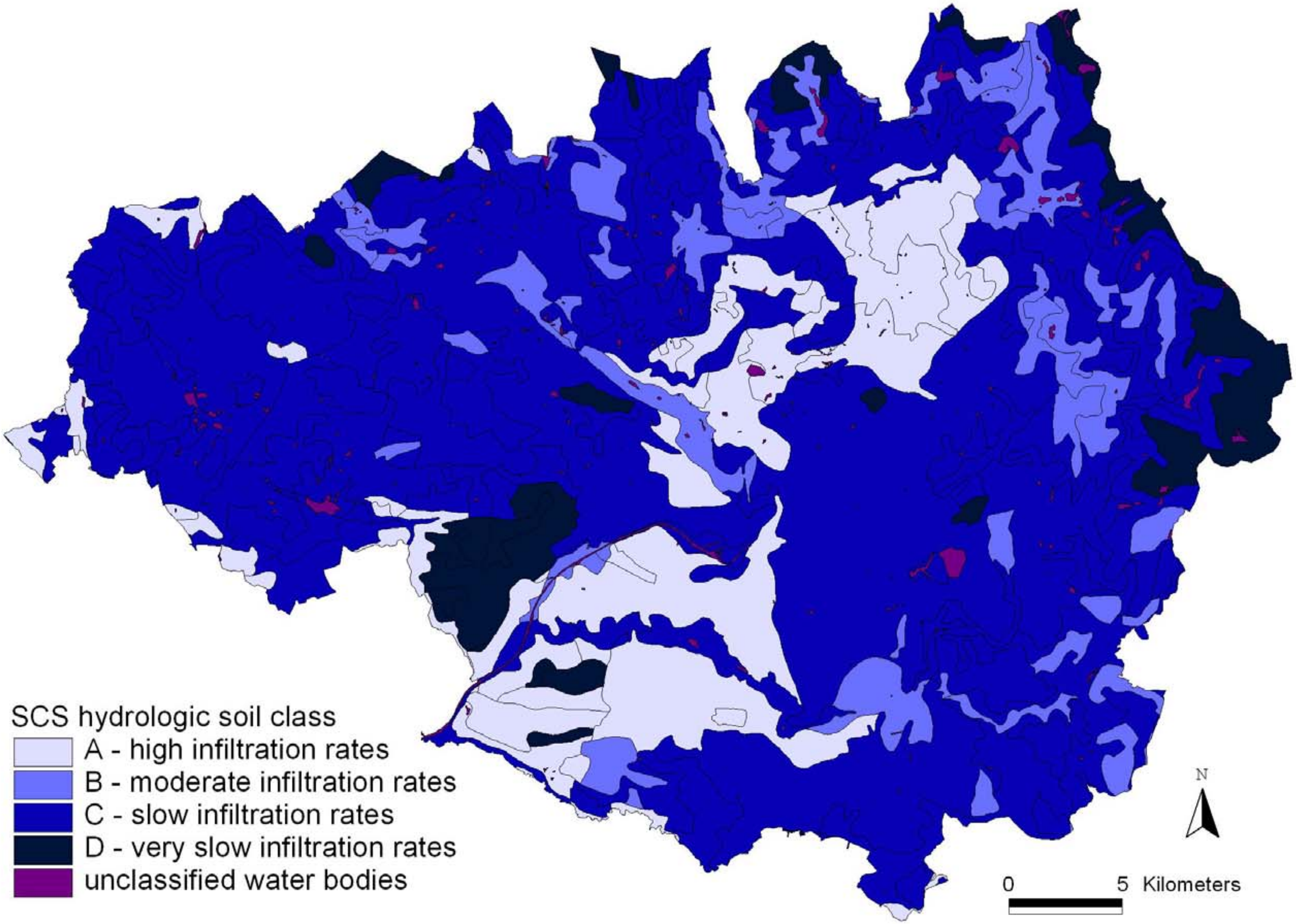
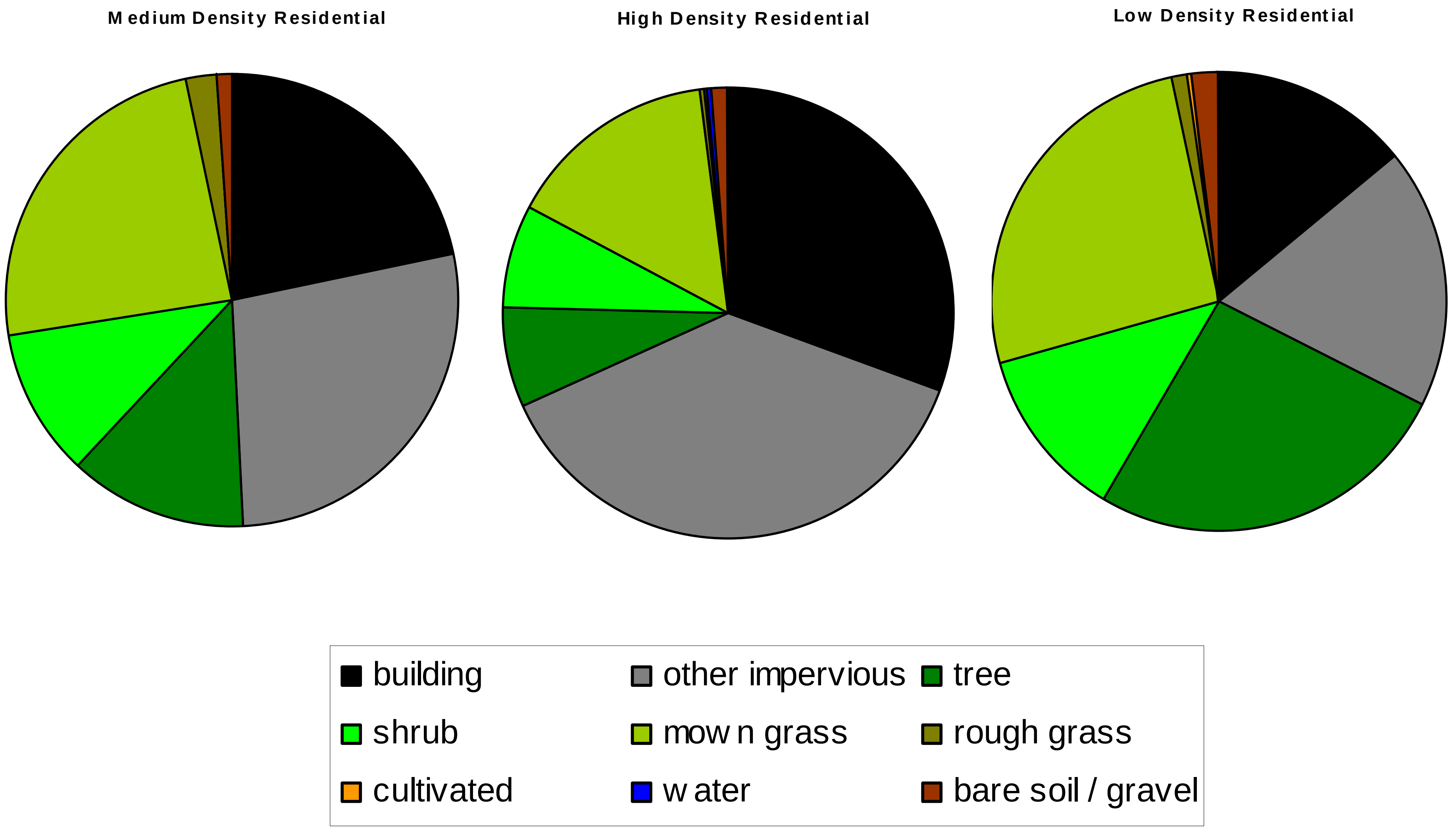
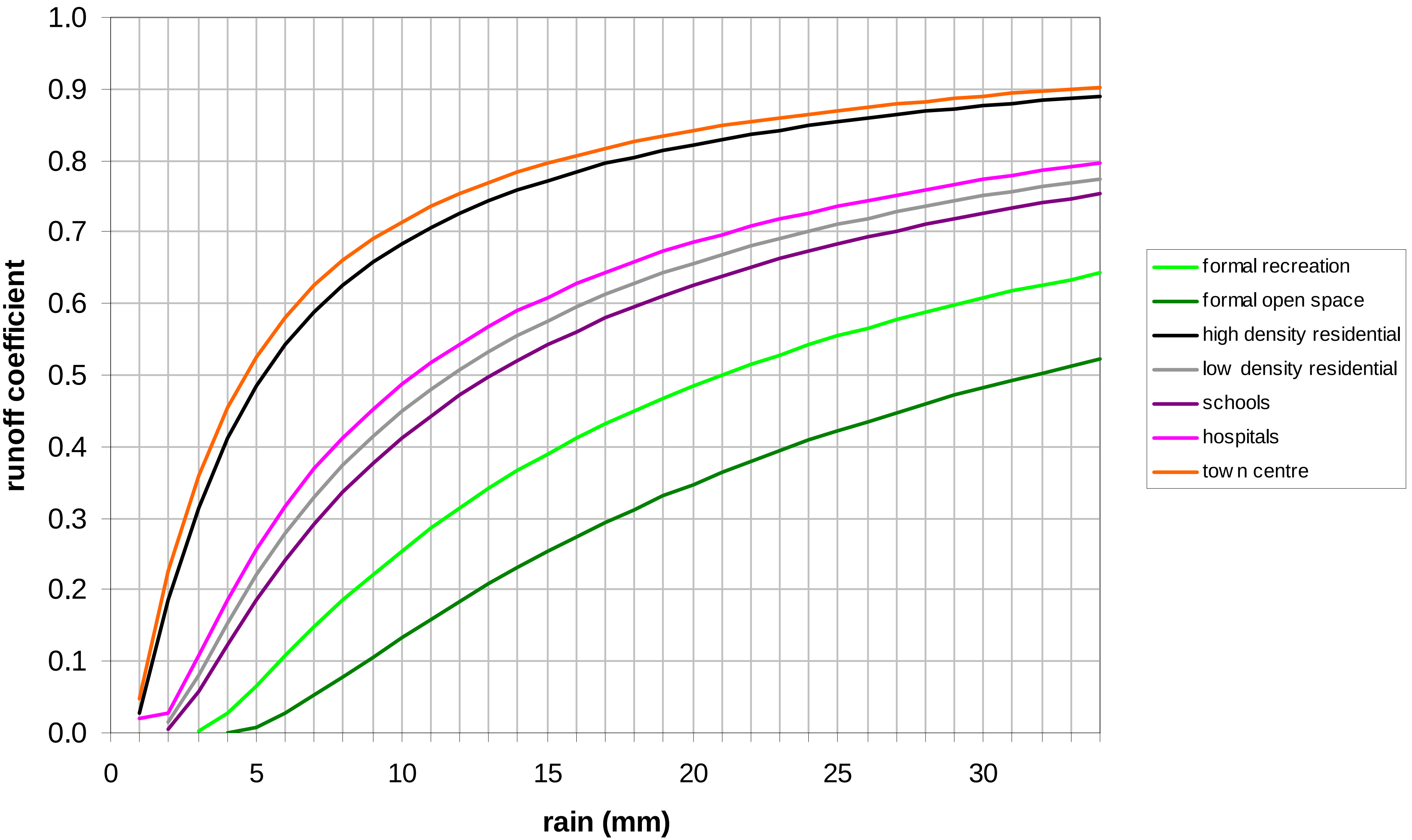
GM hydrologic soils



Surface cover in residential UMTs



Selected UMT runoff coefficients (AMCII)



Use of surface runoff model

- Find ‘typical’ heavy rainfall events for different time periods and scenarios
- Surface runoff coefficient maps for GM
- Assess performance of different surface covers
- Explore potential for adaptation

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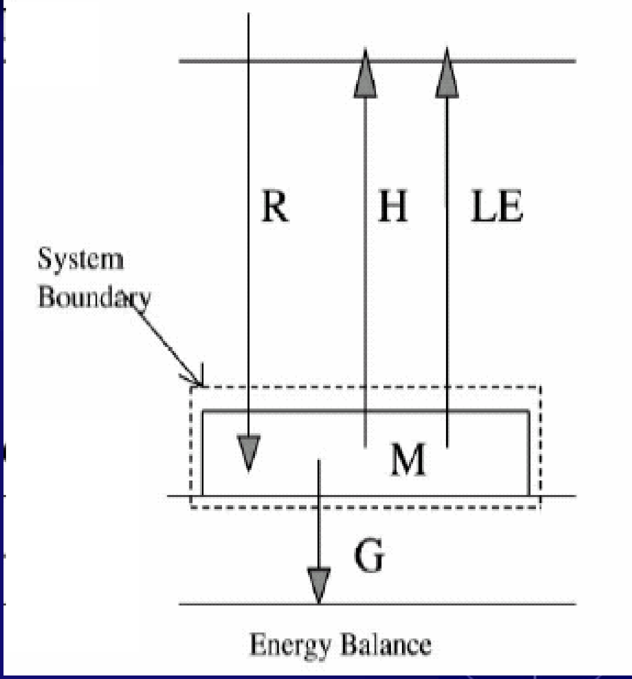
Surface temperature model

- Based on energy balance equation:
  $R = H + LE + G + M$
  - R is net radiation flux
  - H is sensible heat flux due to convection
  - LE is latent heat flux due to evaporation
  - G is conductive heat flux into soil
  - M is heat flux to storage in built environment
- Input requirements
  - Meteorological data
  - Building mass per unit of built environment
  - Proportions of surface cover types: built, bare soil, greenspace
- Output shows surface and soil temperature over time



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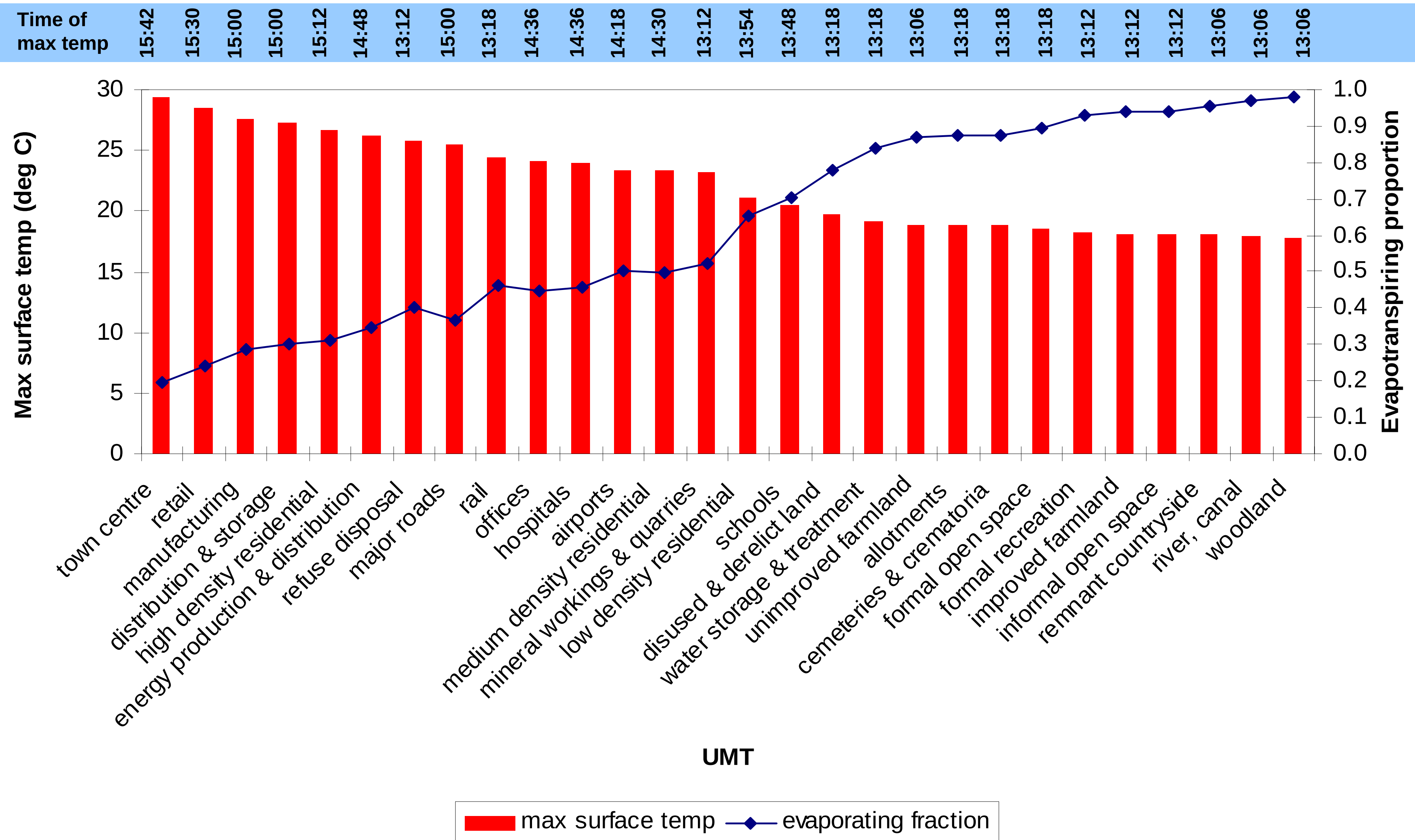
1961-1990 Surface Temp over UMTs in GM



Use of surface temperature model

- Change model inputs for
  - UMT surface cover
  - Building mass
  - Summer daily temp extremes (90th percentile) for different time periods and emissions scenarios
- Produce maps for GM of max surface temp
- Assess performance of different surface covers
- Explore potential for adaptation

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Ringway (CRU weather generator)

Time	Emissions scenario	Daily summer temp (°C)	
		Mean	Extreme
1970s	-	14.9	18.3
2020s	Low	15.8	19.3
	High	16.4	19.9
2050s	Low	16.3	20.2
	High	17.6	21.6
2080s	Low	17.6	21.5
	High	19.8	24.6

NERC ARSF Thermal flight

- Objectives
  - To analyse thermal conditions on hot summer's day
  - To validate surface temperature modelling approach
- Flights on 9th/10th Sept 2004
  - 1pm, 10pm, and 6am

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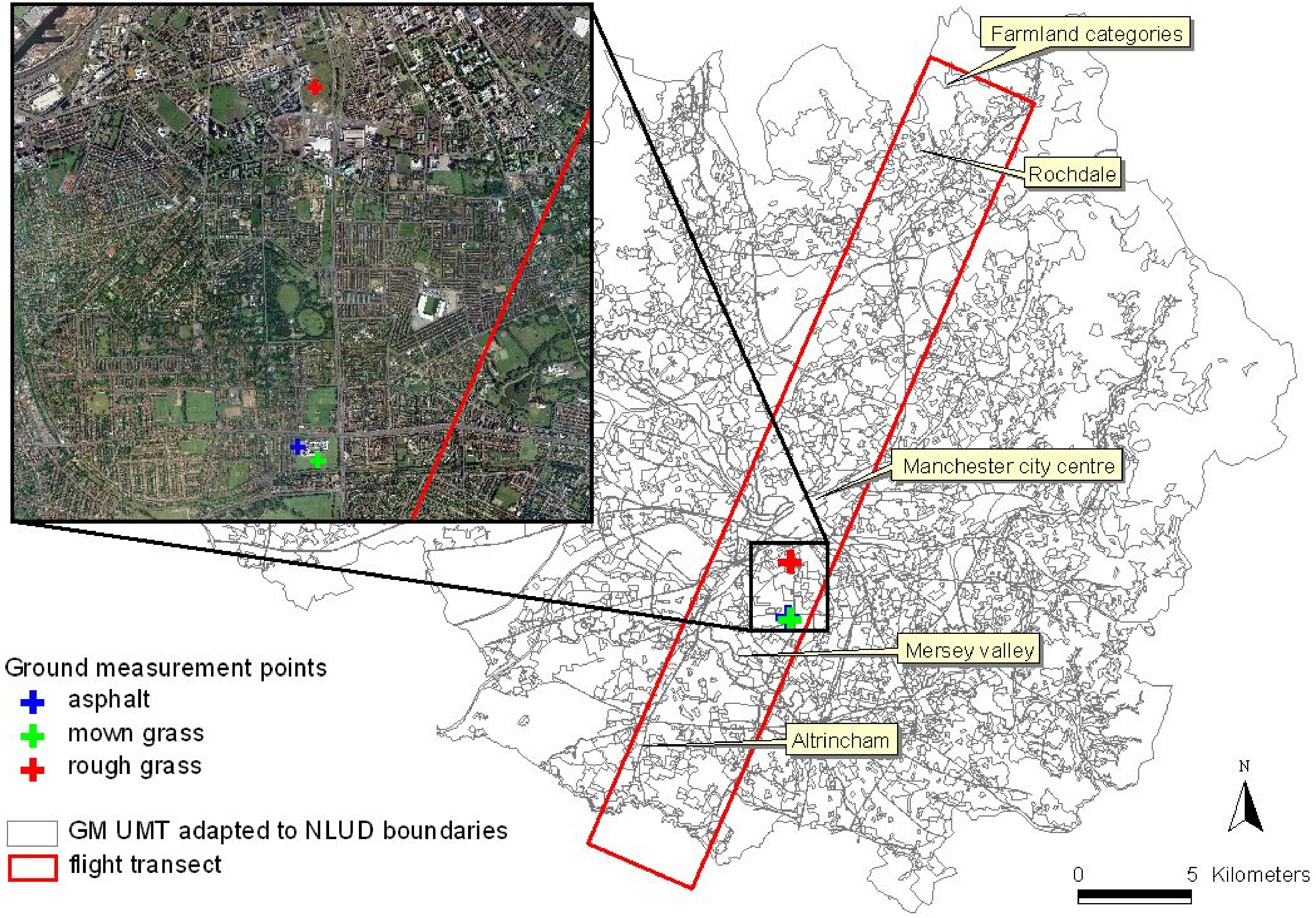
Flight Transect over GM and Ground Measurement Points



Risk Characterisation

- Conurbation level screening process to help identify areas where there is a potential risk or impact to urban greenspace as a result of climate change
- Prelude to more detailed research into adaptation strategies at the neighbourhood level
- GIS-based
- Three main phases to the risk characterisation
  - risk identification
  - risk analysis
  - risk evaluation and adaptation

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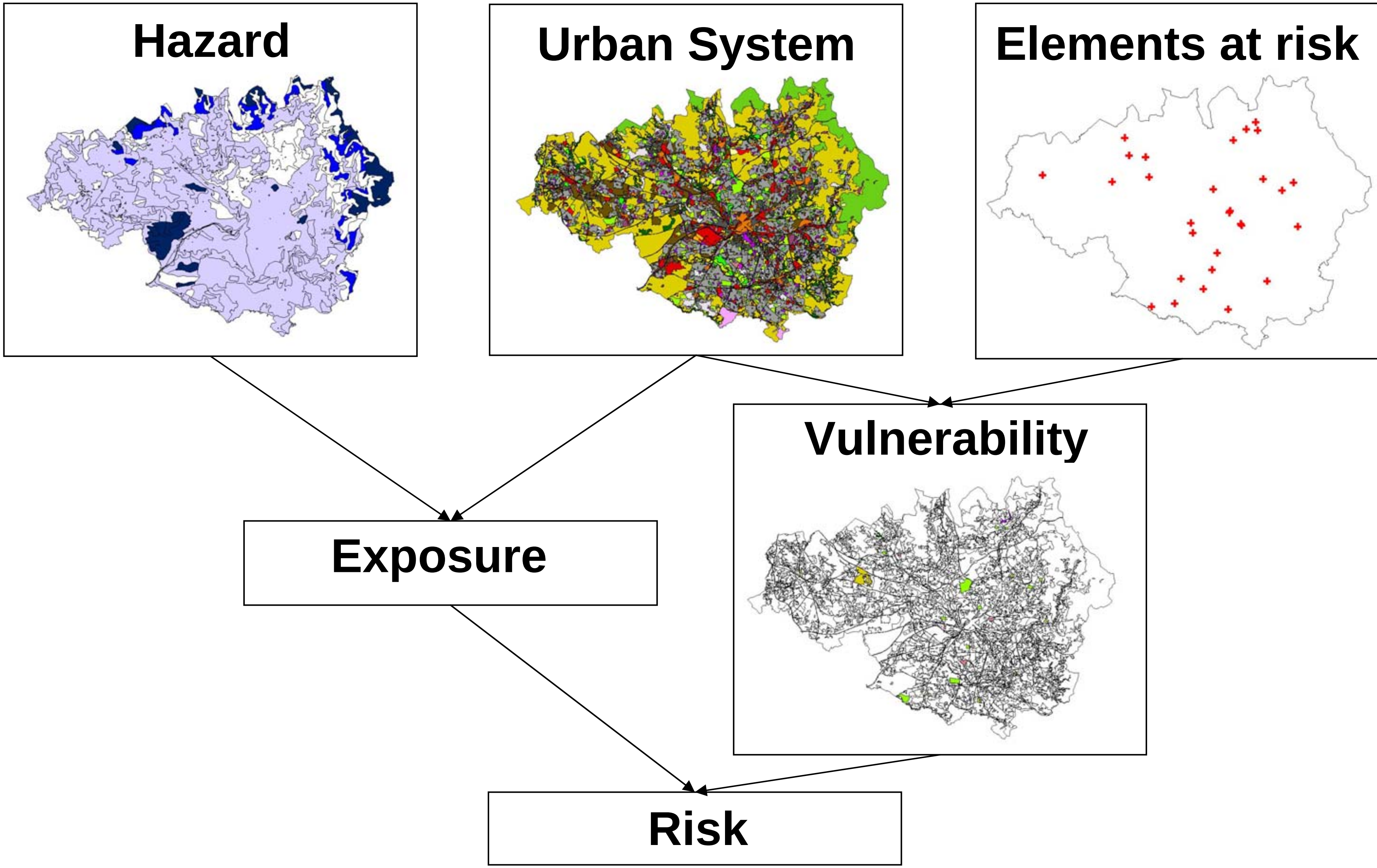
GIS-based risk framework



Risk examples: drought

- Hazard layer
  - Difference between precipitation and evaporation
- Elements at risk layer: various examples will be worked
  - Biodiversity - SSSI, LNR, SBI
  - Historic parks - EH registered parks and gardens
  - Trees - proportional tree cover
  - Ancient woodlands
  - Formal recreation
  - Grasslands - proportional grass cover
- Exposure layer: depends on the specific element at risk
  - Available soil water content
  - Available water for grass - e.g. for grass
  - Presence of groundwater / aquifer - in cases with trees
  - Built proportion of the UMT - e.g. for trees
- Vulnerability layer: depends on the specific element at risk
  - e.g. for biodiversity - weight of designation, vulnerability of habitats
  - e.g. for trees - location, age

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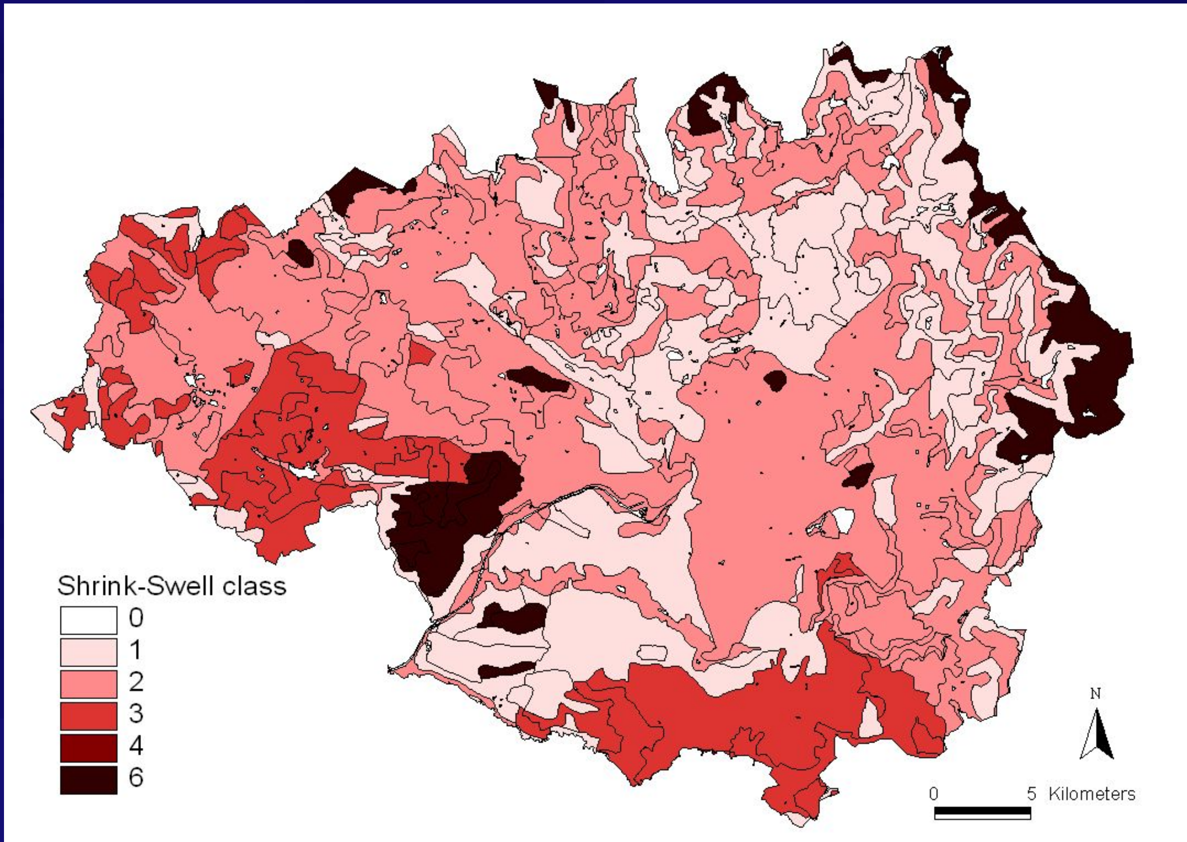
Risk examples: shrink-swell

- Risk to building infrastructure of shrink swell soils combined with trees
  - Hazard layer: rainfall
  - Element at risk layer: residential areas
  - Exposure layer: shrink-swell soils
  - Vulnerability layer: tree location & building specifics



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Neighbourhood level

- Selected according to
  - Vulnerability to climate hazards
  - Adaptive capability
- More detailed work
- Explore interactions with human comfort and building integrity
- Assess adaptation strategies such as changing proportions and types of greenspace

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