Assessing the hydrological impacts of urban creep within Haydon Wick, Swindon

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Background

Urban creep is the change from permeable surfaces within an urban environment to impermeable surfaces, for example, through small-scale urban creep and new properties. An increase in sealed surfaces can alter hydrological processes within a catchment, through a reduction in evapotranspiration, infiltration and surface roughness. This can lead to a higher level of overland flow resulting in a decrease in lag time between precipitation and surface runoff, leading to an increased risk of flooding.

Objectives

- Quantify the degree of urban creep between 1990 and 2010 in peri-urban developments within the Haydon Wick catchment.
- Determine the hydrological impacts of potential future urban creep within the catchment.
- Identify mitigation strategies to reduce the associated increase in runoff and flood risk.

Methodology

- GIS techniques were implemented using ArcGIS to detect small-scale changes in the land use, using aerial photographs with a 0.5m resolution, from 1990, 2000 and 2010.
- A stratified random sample using a proportionate stratification was adopted for both the age and type classifications of the properties. This used a 90% confidence interval and a 4% margin for error.
- A total of 2965 properties were assessed within the Haydon Wick catchment.
- A 2 meter fishnet grid was overlaid onto the aerial photographs within ArcGIS and using a manual identification process, the new sealed areas from small-scale urban creep and new properties were measured (Figure 1).
- To identify the quantity of urban creep within each sub-catchment, the urban creep values from the sample properties were extrapolated across the non-sampled properties.
- ReFH2 (hydrological model to estimate flood peaks and the hydrology) was adopted to assess the direct hydrological impacts of the small-scale urban creep identified between 1990, 2000 and 2010, and future potential urban creep.

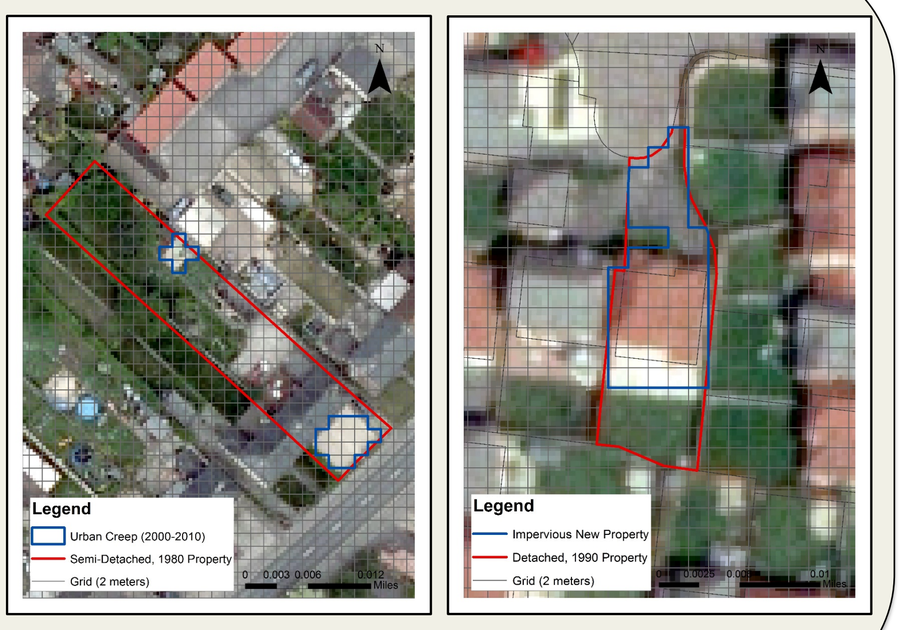

Figure 1. Identification of (left) small-scale urban creep and (right) new properties

Results

- CWS and EWS sub-catchments have seen the largest proportion of impervious increase through new developments between 1990 and 2010, with the remaining four catchments having a low level of new properties being built but a higher percentage of small scale urban creep mainly between 1990 and 2000 (Figure 2).

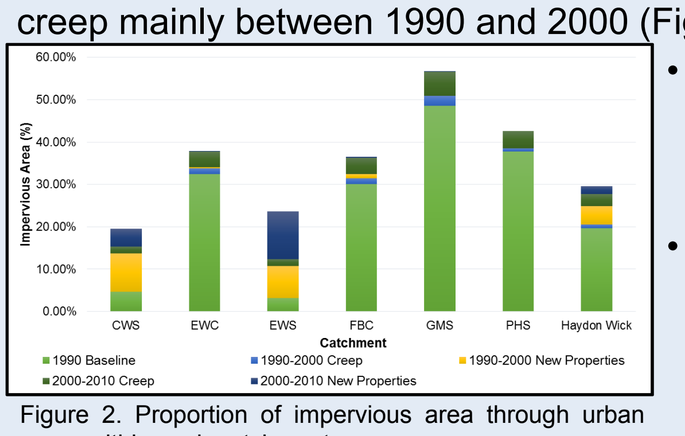

Figure 2. Proportion of impervious area through urban creep within each catchment.

- The amount of urban creep varies depending upon the type and age of the property. Bungalow and detached properties built prior to 1990 see the highest level of urban creep (Figure 3).
- Hydrological impacts from urban creep show a strong correlation of 0.96 between urban creep and an increase in peak flow and a correlation of 0.57 between urban creep and total runoff (Figure 4).

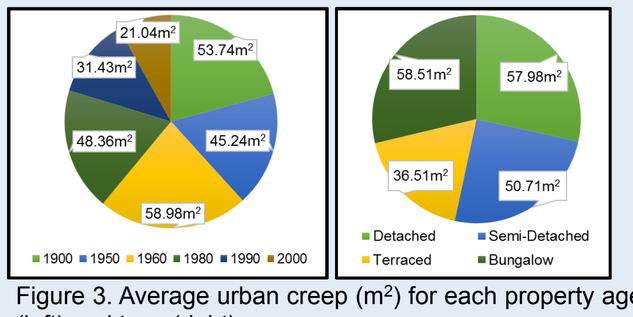

Figure 3. Average urban creep (m^2) for each property age (left) and type (right)

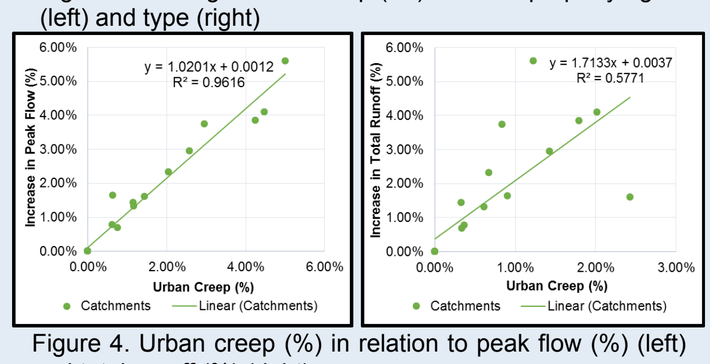

Figure 4. Urban creep (%) in relation to peak flow (%) (left) and total runoff (%) (right)

Conclusions

- The proportion of urban creep varies depending upon property age and type.
- Hydrological impacts, including peak flow and total runoff increase with the quantity of urban creep, which increases the risk of flooding.
- There is the potential that urban creep could rise to 14% in Haydon Wick if all properties in the catchment increased their impervious area. This is above the 10% urban creep allowance set out by the BSI Standards Publication (2012) for developing new drainage systems.
- Mitigation strategies through improved building regulations, hard engineering and education need to be implemented to reduce future risk of urban creep and the associated flood risks.
- Manual GIS techniques are the most effective methods to use when assessing urban creep, although higher resolution imagery would allow the surface type to be identified, permitting the use of different impervious factors within ReFH2.

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