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Kaspersen, Per Skougaard; Drews, Martin

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Authors: Per Skougaard Kaspersen and Martin Drews
Department of Management Engineering, Systems Analysis Division, Technical University of Denmark (DTU).

Lead section (50 words)

This paper investigates the accuracy of medium resolution (MR) satellite imagery in estimating impervious surfaces for European cities at the detail required for pluvial flood modelling. Using remote sensing techniques enables precise and systematic quantification of the influence of the past 30-40 years of urban development towards the impacts of high-intensity rainfall.

Main Section (400 words)

In recent years, it has been demonstrated that cities globally have become increasingly exposed to the impact of pluvial flooding (Field et al., 2012). There is evidence that the observed change in risk may have been caused by a combination of large increases in the extent of urban cover and climate change (Field et al., 2012) (Angel et al., 2011). Urban environments are dominated by impervious surfaces (IS), which are sealed areas through which water cannot penetrate, as road infrastructure, buildings and other paved areas occupy a main share of the urban land area (Weng, 2012). Hence impervious surfaces are often used as an indicator of urbanization. Changes in the quantity of impermeable surfaces (IS) have important implications for the hydrological response of a catchment. Replacing natural land cover with artificial surfaces causes a reduction in infiltration capacity and surface storage capacity (Butler, 2011)(Parkinson and Mark, 2005). Water moves faster over sealed surfaces than over natural surfaces, and high IS cover subsequently increases run-off volumes, peak flows and flood frequency. MR satellite imagery offer a complete spatial and temporal coverage of global urban land cover changes during the past 30-40 years, and can be used as a basis for accurate quantification of small scale changes in IS. This research addresses the accuracy and applicability of medium resolution (MR) remote sensing estimates of IS fractions, e.g. for urban hydrological modelling. A main objective is to show that NDVI may be an accurate measure of sub-pixel imperviousness for urban areas at different geographical locations, and that it can be applied for cities with diverse morphologies and climatic conditions. For this purpose the accuracy of NDVI based estimates of IS have been examined for eight different cities in Europe at 30m and 60m spatial resolutions. The impervious surface fractions are estimated using pixel-based Ordinary Least Squares (OLS) regression models between Landsat 8 Maximum Value Composite (MVC) NDVI and actual imperviousness, which is measured manually from high resolution images. The potential spatial transferability of the city-specific regression models was addressed by examining the homogeneity of the models. This was done by quantifying the absolute mean errors and biases between all possible combinations of regression models and urban areas.

Conclusions (100 words)

The results of the accuracy assessment show that the absolute mean errors of the NDVI based IS estimates are 6-11% and 5-9% for the analyses with 30m and 60m spatial resolutions respectively. The low variability in accuracies across geographical locations suggests that an equally strong relationship between NDVI and IS fractions exists for many other urban areas, both within and outside of Europe. The findings of this research indicate that MR satellite imagery can be used to provide accurate estimates of the quantity and location of IS and changes herein, for cities at different geographical locations, and at the detail required by pluvial flood models.

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