

UAV-based mapping of surface imperviousness for water runoff modelling

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Modelling rainfall-runoff processes in urban catchments has become an increasingly relevant issue, for instance to estimate the risk associated with urban flooding in densely populated areas. This needs hydrological models which, besides rainfall information, require good input data of detailed surface characteristics, such as imperviousness to accurately predict rainfall-runoff. One way to obtain such surface characteristics over large areas is airborne remote sensing. In this study, we assess for the first time the possibility to automatically generate high-resolution imperviousness maps for urban areas from imagery acquired with unmanned aerial vehicles (UAVs). Potential advantages of UAVs in comparison to satellite imagery or airborne remote sensing include better data quality, greater flexibility and, potentially, reduced cost. In the course of the study, the potential of UAVs for high-resolution hydrological applications was investigated, and an automatic processing pipeline with high-performance classification algorithms was proposed to extract accurate perviousness maps from high-resolution aerial images.

In a case study in the area of Lucerne, Switzerland, we generated imperviousness maps from two data sources, namely images acquired with a consumer camera on a standard micro-UAV platform and large-format aerial images acquired by swisstopo with a professional photogrammetric camera on a normal aircraft. We compared the two datasets at two levels: first we assessed the quality of the automatically extracted perviousness maps; second we showed an end-to-end comparison, in which the maps from different sources were used as input for a hydraulic sewer model (describing 1D surface runoff and hydrodynamic channel flow), previously calibrated with in-situ flow measurements.

The results from the image classification demonstrated that we are able to obtain imperviousness maps with an overall accuracy above 93% (Fig. 1). While the results for the second level are still being processed, we anticipate that using UAV images together with an automated processing pipeline, it is possible to obtain rainfall-runoff predictions at least as accurate as when using standard methods and images.

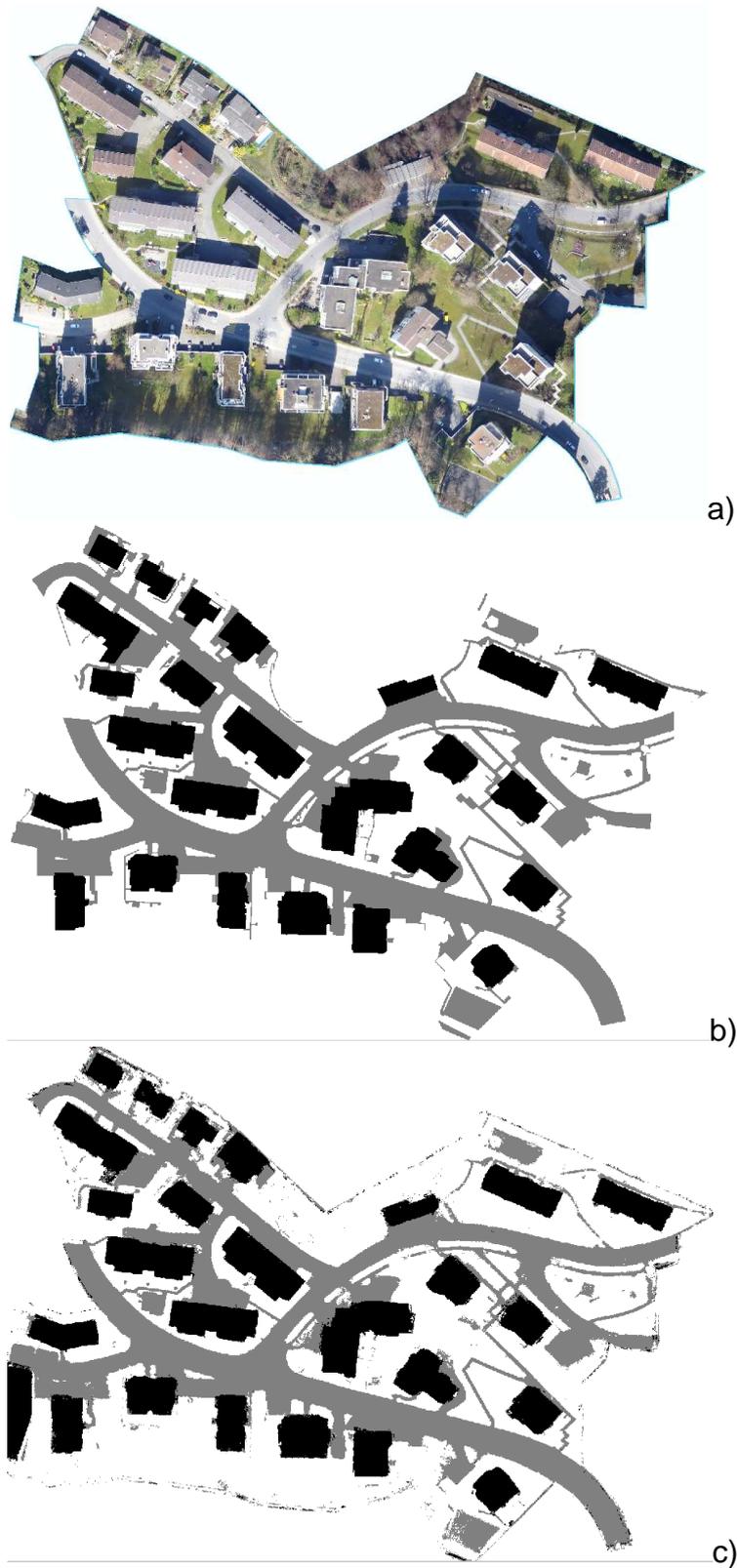


Figure 1: a) an orthophoto generated from UAV imagery over a case study area;
b) manually labeled ground truth with three (im)perviousness classes: buildings (black), streets and sidewalks (grey) and vegetation (white);
c) classification result