Vortrags-Session 1

Multi-sensor approach to monitor the urban landscape – refined mapping of urban structure types and vegetation patterns by means of DOP, LiDAR and UAV data

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Abstract

In order to achieve a sustainable urban land use and an appropriate provision of ecosystem services, the monitoring of the urban built and green structure must be reflected against the background of inner urban differentiation of spatial patterns. Different kinds of vegetation and urban built structures help to explain how the urban fabric is formally organized, how this formal spatial organization characterizes urban neighborhoods in terms of socio-spatial differentiation, and how and which urban structure type can contribute to the city in terms of a sustainable development. Climate change and urban induced developments from urbanization force science and planners to continuously update their monitoring of the urban environment and to refine their pieces of information, especially when facing urban environmental challenges evoked by urban growth and climate change (Kabisch 2015).

Our hybrid approach of mapping urban structure for the City of Leipzig makes use of different remote sensing data sets: (1) digital orthophotos (DOP) at the spectral resolution of Colorinfrared Imageries (RGBI for 2012) that originally possess a ground resolution of 20 cm; (2) surface models from Airborne Laserscanning (ALS/LiDAR) to get a better picture of buildings and vegetation levels; (3) and very-high resolution multispectral images acquired by an unmanned aerial vehicle (UAV). As a sophisticated mapping tool, remotely sensed data and techniques serve to differentiate trees from other vegetation structure, as well as from buildings and further anthropogenic elements. Most recently, ALS data are used as ancillary information to identify above-ground LULC elements and distinguish spectrally similar land-use categories by their height information (O'Neil-Dunne et al. 2014). By applying these data sets for image processing, the absolute height of single elements is integrated into segmentation procedures, following the principles of object-based image analysis (OBIA), to calculate the delineated segments at a higher differentiation level, and to classify the elements of interest (Rutzinger et al. 2007). The integration of indices (e.g., LAI, sNDVI) and shape parameters strengthens the OBIA approach. Especially for ecosystem management it is understood, that a three-dimensional model with fused data from very high resolution imageries and LiDAR data sets are important to reconstruct the urban canopy layer (Chen et al. 2012; Secord and Zakhor, 2007). The remote sensing part was supported by detailed field surveys.

We could show that a hybrid use of DOPs and digital terrain models is highly beneficial for the classification of a large variety of vegetation types (trees, shrubs, grassland). By the aid of the UAV data (incl. 3D point clouds) we could develop a parameter to adjust vegetation and biomass estimations previously based solely on DOPs and ALS and to enhance our knowledge on essential biodiversity variables (EBV; Pereira et al. 2013), such as community composition and ecosystem structure. Hence, only a few and selective small-scale VHR imagery allowed us to improve the available DOP and ALS data at large scales, covering the entire city area of Leipzig. At the same time, this means that large-scale DOP and ALS helps to upscale the spatially limited UAV data.

Applying such data integration in an in-depth study, we analyzed inter-functional relationships of the urban gardens in Leipzig with surrounding structure types (brownfields, differentiated residential areas, tree diversity) through GIS analyses incorporating detailed land-cover and environmental data in order to assess climate regulation and air purification effects (e.g., cooling corridors, wind and dust mitigation). We found that urban gardens represent an important urban structure type for providing ecosystem services and tree diversity, thus supporting to the quality of life in urban areas and enhancing environmental conditions. Our work is a contribution to monitor urban built and green infrastructure at fine resolution,

which is crucial to achieve sustainable and resilient cities, also in the light of climate change mitigation and adaptation.