Arbeitskreis Fernerkundung

Virtuelles Treffen des Arbeitskreises Fernerkundung am 08. Oktober im Rahmen der #GeoWoche2021

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Building type based estimation of relevant parameters for urban infrastructure planning using VHR satellite imagery and UAV data

Abstract

Urbanity will face great challenges due to ongoing urbanization and impacts of climate change, but as well play the key role to implement the sustainable development goals. Especially the dynamics in population and the related change in the built environment have big impacts in the demands of energy, clean water and waste treatment. Through proper planning of urban supply and disposal infrastructure, the future needs can be met. Especially, as urban infrastructure is very costly and set up for the long term, the planning process need to base on reliable and consistent data. Hereby, very high-resolution (VHR) remote sensing can contribute to the planning process, as data availability increases, and data capturing is becoming more flexible.

In this context, we present our work to provide planning information on single building level using remote sensing data. In times of deep learning methods, building detection is not the main challenge anymore, but the ability to retrieve contextual information from remote sensing data is the key to implement remote sensing approaches in the process of urban planning.

Our studies in Belmopan (Belize) have two focusses: The determination of residential building types and their relation to household consumption patterns and socio-economic indicators. Using VHR remote sensing data hereby enables to relate residential building types with planning relevant information such as socio-economic measures, electricity and water consumption. We classify eight locally adapted building types using random forest techniques. The use of ortho-mosaics from unmanned aerial vehicles (UAV) allows classifying in building types in good accuracy. Using widely available VHR satellite imagery, such as WorldView-1 data, allows to achieve good classification qualities with post-classification adaptions.

To assess socio-economic information, a household survey was conducted in Belmopan which comprises 395 interviews. Using information on highest educational degree, monthly available household income and household assets, a socio-economic classification was set up. Results show that the single building types differ considerably in socio-economic statistics. As electricity and water consumption and waste generation is correlated with the household socio-economic status, the socio-economic classification is a valuable base to characterize urban areas in different scale levels.

Confirmed by the possibility to assign specific socio-economic classes to the building types, we analyzed electric energy consumption patterns in relation to building types. This analysis showed clear differences in electric energy consumption in relation to the building type. Applying structure-from-motion techniques, VHR elevation data can be processed based on aerial UAV imagery. This information allows estimating the potential for roof-based solar photovoltaic (PV) energy production on a single building level. By differencing the PV potential with the building type related electric energy consumption, an energy balance for each building can be determined. The results for Belmopan show that with maximum two PV panels installed, the buildings achieve an average energy surplus of 179.8%. The study shows that this approach can deliver relevant information for the development of implementation strategies and policies for carbon free energy and socially equitable energy production and thus remote sensing can support urban infrastructure planning on different scale levels.