Geophysical Research Abstracts
Vol. 17, EGU2015-2018, 2015
EGU General Assembly 2015

Alternative biomass sources for thermal energy generation

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Traditionally, renewable biomass energy sources comprise forests, agriculture and other large vegetation units. With the increasing demand on those landscape elements, including conflicts of interest to nature conservation and food production, the research focus should also incorporate smaller vegetation entities. In this study, we highlight the availability of small-scale features like roadside vegetation or hedges, which are rarely featured in maps. Roadside vegetation, however, is well known and regularly trimmed to allow the passing of traffic but the cut material is rarely harvested. Here, we combine a remote-sensing-based approach to quantify the seasonal biomass harvests with a GIS-based method to outline optimal transportation routes to, and the location of, storage units and power plants.

Our main data source will be ESA's upcoming Sentinel-2 optical satellite. Spatial resolution of 10 meters in the visible and near infrared requires the use of spectral unmixing to derive end member spectra of the targeted biomass objects. Additional stereo-matching and LIDAR measurements allow the accompanying height estimate to derive the biomass volume and its changes over time.

GIS data bases from the target areas allow the discrimination between traditional, large features (e.g. forests and agriculture) as well as previously unaccounted for, smaller vegetation units. With the mapped biomass occurrence and additional, GIS-based infrastructure information, we can outline transport routes that take into account local restrictions like nature reserve areas, height or weight limitations as well as transport costs in relation to potential gains. This information can then be processed to outline optimal places for power plants.

To simulate the upcoming Sentinel-2 data sets, we use airborne data from the AISA Eagle, spatially and spectrally down-sampled to match Sentinel 2's resolution. Our test scenario is an area in western Germany, the Kirchheller Heide, close to the city of Bottrop-Kirchhellen in the state of North Rhine-Westphalia. This region consists of nature reserves, forests, farmland and a few villages. To present a qualitative comparison between simulated and true biomass volume, we conducted field work by mapping the spatial extent of the desired biomass occurrences in the area. First results indicate a qualitative match of about 75%.

Our research highlights the small-scale biomass features that have not been incorporated in previous biomass estimates. With the regular trimming and the accompanied raw material that becomes available, a new sector of thermal energy generation can be outlined. An automated quantification using satellite and GIS data will allow a regular monitoring of the vegetation growth and an assessment of the transport routes and costs as well as the location of the prospective power plants. In the endeavour of creating a sustainable energy supply, these biomass units should not be neglected, especially since the usage of the traditional units is limited due to competing interests in food production and nature conservation.