15.04.2016

Contribution of Earth Observation for deriving soil information in the biodiversity context

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One of the focal areas in the discussion of Essential Biodiversity Variables are Ecosystem services that comprise provision of food, fibres, clean water and clean air, just to name a few. The basis required for such ecosystem services depend among other factors on soils (Turbé et al, 2010). The importance of soils has been realized by several communities, most importantly by experts working in the field of agriculture and food security. 2015 has been declared as the International Year of Soils by the Food and Agriculture Organization of the United Nations (FAO) underlining the importance of the ecosystem functions of soils.

The remote sensing community can provide information about the status and evolution of soils. As an example, soil moisture is one of the abiotic factors affecting and impacting the soil biodiversity. Soil moisture directly affects the dielectric properties of target “soil”. The simple law “the higher the moisture, the higher the dielectricity” leads to a stronger backscatter in the microwave spectrum. Special radiometer missions like SMAP (Soil Moisture Active Passive) and SMOS (Soil Moisture and Ocean Salinity) measure this response in order to derive the moisture content (Adams et al., 2015). These missions provide soil moisture estimations every 3-5 days on a global basis.

Additional contributing parameters are soil structure and texture, soil salinity and pH value of soils, all regulating the micro-, meso- and macro fauna of soils. Soil structure geometrically takes place in the range of a few centimeters, which is the range of the microwave spectrum used for Synthetic Aperture Radar sensors. The special range projection of this sensor type even increases its sensitivity for surface characteristics. Numerous studies already showed that the brightness values of the backscattering as well as polarimetric parameters are directly linked to surface roughness (Marzahn and Ludwig, 2009). With the new Sentinel-1 mission of the European Space Agency the temporal resolution of C-band SAR acquisitions will rapidly increase to about one image per week until the end of this year. Therefore, extremely dense time series will be available in the foreseeable future in order to compensate the remaining deficiencies.

Parameters such as soil texture are since many years in the focus of the optical and thermal remote sensing community. Soil texture classes distinguish the particle-size distribution of soils naming the relative proportions of sand, silt and clay. Various studies using hyperspectral data have been carried out to determine the quantitative abundance of minerals that determine the texture of soils (e.g. Chabrillat et al, 2002, Bayer et al., 2012). Further, hyperspectral data contain sufficient spectral information to quantify other important mineral groups such as iron bearing minerals that impact the pH-value, texture and structure of soils (Bayer et al., 2012).

Soil organic carbon (SOC) impacts the physical properties of the soil. Here, the soil color is often used estimate SOC that can be measured with different accuracies depending on the sensor systems. Hyperspectral data provide a much finer spatial resolution in the VNIR wavelength region enabling to consider the shape of the reflectance curve. Moreover, spectral indicators in the SWIR region can be used to identify and quantify carbon constituents such as lignin and cellulose. However, also multispectral sensors can be used. Especially the European Sentinel-2 sensor system is appropriate due to the very small spectral bands in the VNIR that allows for soil color estimation.

However, observations of soil constituents using optical, thermal as well as SAR data is often hampered by the coverage of soils by permanent (forests) and temporary vegetation (crops) or artificial surfaces such as in urban areas. Further, depending on the ecosystem, the sensed reflectance signal is intermixed with other land cover types such as dry and green vegetation depending on the spatial resolution of the Earth Observation systems. Due to the wide and free availability of multispectral Earth Observation data, new multitemporal techniques are currently under development to maximize the data source for soil related remote sensing analyses. Examples are given for a mid-European area where exposed soils are rather rare. In a semiarid area of South Africa, unmixing techniques (Rogge et al, 2012) have been developed to reduce the influence of vegetation on the mixed pixel signal.

The presentation gives a rough overview about the current drawbacks and opportunities of providing soil information using Earth Observation and present selective techniques under development that are focused on large scale soil information retrieval to provide a basis for further EBV discussion.

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