Regional and Global Spatial Distribution of Biomass Potentials

Review on Estimation of Biomass Potential using Remote Sensing Data

K.P. Günther, M. Schroedter-Homscheidt, M. Tum
German Aerospace Center (DLR-DFD)

German Remote Sensing Data Center (DFD)

In the frame of the project "Global and regional spatial distribution of biomass potential" sponsored by the Federal Ministry of Transport, Building and Urban Affairs (BMVBS) and coordinated by the German Biomass Research Center (DBFZ) the German Aerospace Center (DLR) was in charge of presenting an overview of the possibilities for deriving biomass potentials using remote sensing data and products.

Biomass energy is of growing importance as it is widely recognized, both scientifically and politically, that the increase of atmospheric CO_2 has led to an enhanced efficiency of the greenhouse effect and, as such, warrants concern for climate change. It is now accepted that climate change is partly induced by humans notably by using fossil fuels. For reducing the use of oil or coal, biomass energy is receiving more and more attention as an additional energy source available regionally in large parts of the world. Effective management of renewable energy resources including bio-energy is critical for the European and the global energy supply system.

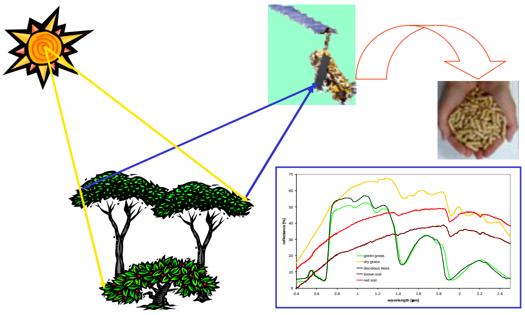

Figure 1: Schematic set-up for biomass monitoring using satellites working in the optical domain.

Satellite-based remote sensing has been evolved as a successful tool to assess geo-information on different temporal and spatial scales. Satellite technology is currently changing from an experimental status towards operational systems with a long-term perspective of delivering data and information products. A typical measuring set-up is shown in figure 1 using the reflectance spectrum of vegetation to extract information about green biomass.

The correlation of remote sensing data and biomass inventory data using statistical parameterizations allows to derive biomass potentials. In figure 2, a biomass map of Russia is shown based on the analysis of MODIS bi-directional reflectance distribution function (MOD43B4) and inventory data at selected sites (Houghton et al. (2007).

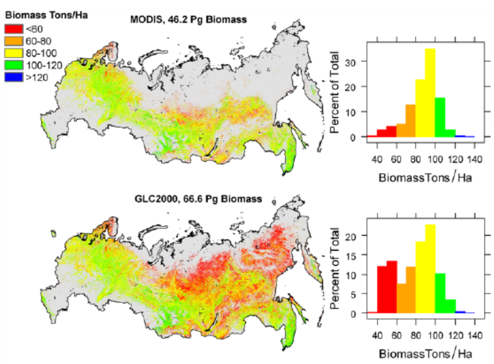

Figure 2: Forest biomass map derived from MODIS data.
Source: Houghton et al., Mapping Russian forest biomass with data from Satellites and forest inventory, Environ. Res. Lett. 2, 2007.

Satellite-based remote sensing using active techniques as e.g. radar is another powerful tool for deriving biomass potentials. Depending on the emitted wavelength, different biomass contributions can be estimated from the back-scattering signal. Using a short radar wavelength (e.g. 3cm, X-band) the biomass of tree crowns can be determined while longer radar wavelength (e.g. 23cm, L-band) allow the measurements of the biomass of stems and trunks. On the left side of figure 3 a schematic view of a multi-frequency radar remote sensing system is shown. Another active remote sensing system for biomass estimation is based on the back-scattering of short light pulses (from the ultra-violet to the near infrared). The height as well as the tree structure can be determined from the analysis of the back-scattered waveform. Those systems are called lidar systems shown on the right side of figure 3. Actually, lidar systems are mainly operated from aircrafts.

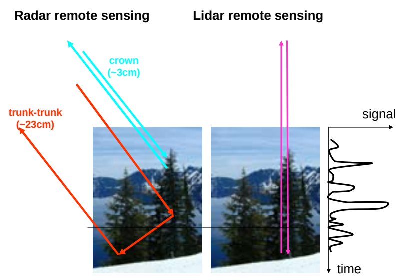

Figure 3: Schematic set-up of active remote sensing systems (left: radar, right: lidar). On the right side, a typical back-scattering waveform is also shown.

As shown in figure 4, with a multi-frequency radar system, the height of trees can be determined with high accuracy. The study came to the conclusion that the highest coefficients of determination are reported for forested areas using the mean annual NDVI derived from VEGETATION (r^2=0.95) and for radar backscatter derived from SIR-C on the Space Shuttle (r^2=0.94). Nearly all experiments were conducted over forested areas. Only one measurement is documented for deriving herbaceous biomass from the backscattering signal of ASAR on ERS-2 (r^2=0.65) and only one test was performed for deriving biomass for corn (r^2=0.71) applying AVHRR products (VCI).

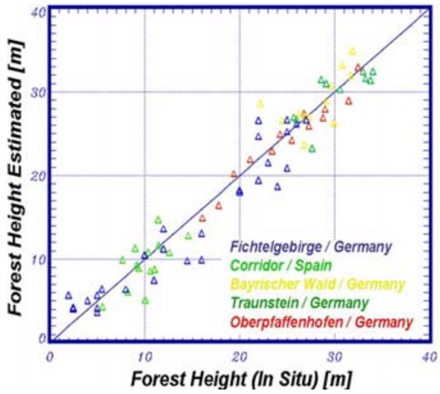

Figure 4: Estimated height of forest trees using polarimetric SAR interferometry
Source: Presentation of Papathanassiou et al. at the ESA POL-InSAR workshop, 2005.

References:
Houghton R.Aet al., 2007. Mapping Russian forest biomass with data from satellites and forest inventories. Envi-ronmental Research Letters, 2, 045032, 7pp.
Papathanassiou K., et al., 2005. Forest Height Estimation by means of Polarimetric SAR Interferometry: Actual Status and Perspectives. Proceedings of 2nd ESA POLInSAR Workshop, Frascati, Italy, January 2005, http://earth.esa.int/workshops/polinsar2005/

Sponsored by: Bundesministerium für Verkehr, Bau und Stadtentwicklung
Project executing organization: Bundesamt für Bauwesen und Raumordnung
Coordination: DBFZ

Deutsches Zentrum für Luft- und Raumfahrt e.V. in der Helmholtz-Gemeinschaft

Deutsches Fernerkundungsdatenzentrum
DLR Oberpfaffenhofen
D-82234 Wessling
Internet: www.dlr.de/caf