# Regional and Global Spatial Distribution of Biomass Potentials

## Biomass Potential Estimation from a Modelling Approach Based on Remote Sensing

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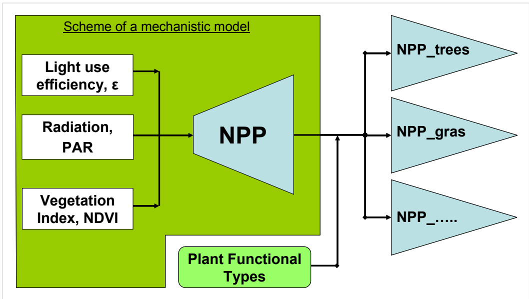
In the frame of the project "Global and regional spatial distribution of biomass potential" sponsored by the Federal Ministry of Transport, Building and Urban Affairs (BMVBS) and coordinated by the German Biomass Research Center (DBFZ) the German Aerospace Center (DLR) was in charge of presenting an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

Two different types of models for estimating biomass can be found in the literature, the mechanistic (also called deterministic) and the dynamic modeling technique.

The mechanistic models calculate photosynthesis according to a concept of Monsi and Saeki (1953) and Monteith (1965), where the carbon up-take (Gross Primary Productivity, GPP) by a plant is assumed to be unlimited (well-watered and fertilized). The carbon up-take of plants is linearly related to the amount of absorbed photosynthetically active solar radiation (APAR) with a plant-specific light-use efficiency as proportional coefficient (slope). The light-use efficiency is modified by functions determining plant stress due to temperature or water availability.




$$NPP = \varepsilon * NDVI * PAR \qquad \varepsilon = f(\text{biome, soil}) \cdot f(\text{climate})$$

Figure 1: Schematic set-up for biomass modelling using mechanistic models. Source: Richters 2005

In contrast to these simple models the dynamic models are more sophisticated approaches currently under development. They are taking into account the interaction between plants, the atmosphere and different soil types. These so called dynamic models calculate the up-take and the release of carbon by plants and soil (Net primary Productivity, NPP) in a physically consistent way regarding conservation of energy and impulse. Photosynthesis is modeled according to the ideas of Farquhar et al. (1980) and Collatz et al. (1992) taking into account the biochemistry and biophysics of photosynthesis. In addition, these models simulate the full hydrological cycle between atmosphere, plant and soil.

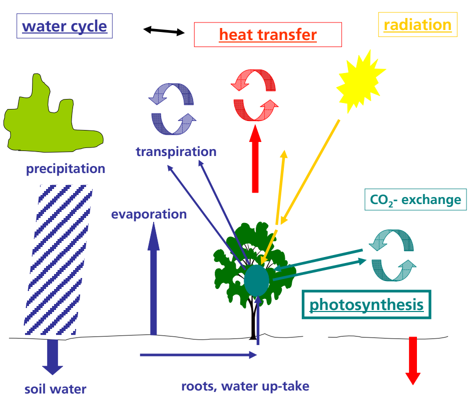



Figure 2: Schematic set-up for biomass modelling using dynamic models as e.g. BETHY - DLR.

The dynamic model (BETHY-DLR) is used for modeling biomass or NPP with a spatial resolution of typical 1km x 1km on a country level (Germany and Austria) with a good coefficient of determination (up to $r^2 = 0.86$). Remote sensing input data are time series of the Leaf Area Index (LAI) as 10-day composites derived from the French sensor VEGETATION and the land cover map from the Global Land Cover initiative 2000 (GLC2000). Meteorological input came from the European Center for Medium Weather Forecast (ECMWF). Daily maximum, minimum and average values of 2 meter air temperature are also derived from ECMWF analysis data for the parameterization of the daily cycle of air temperature. Precipitation values are taken from ECMWF forecast simulations. Daily values of photosynthetically active radiation (PAR) are calculated using ECMWF cloud cover data (high, medium and low cloud coverage). After calculating the yearly NPP of agricultural areas the straw potential can be estimated using information about the yield to straw ratio of agricultural cultivations, and the above ground to below ground biomass ratio. Figure 3 shows the straw potential for Germany and Austria for 2001 and 2002.

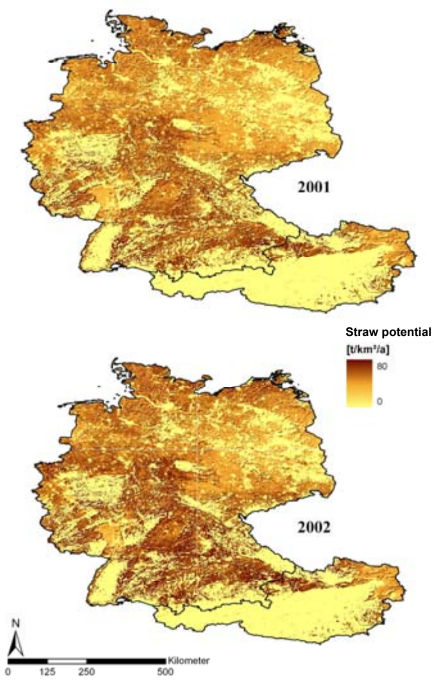



Figure 3: Straw potential of Germany and Austria for the years 2001 (above) and 2002 (below). The spatial resolution of the map is about 1km x 1km.

The overview showed that most models are used primarily with a spatial resolution of 1km x 1km at country to regional scale. The coefficients of determination ($r^2$) range from 0.31 to 0.94. The best results are achieved when the yield is compared with national biomass (NUTS-0 level) estimates using remote sensing data of spatial resolution greater than 3km x 3km as input.

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