Geophysical Research Abstracts, Vol. 8, 10341, 2006
SRef-ID: 1607-7962/gra/EGU06-A-10341

Monitoring Drought Impact over Austrian Grasslands Using GIS Based Model

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Over the past years, the changing climate has affected parts of Austria by drought spells of the intensity and extend that was unprecedented in previous decades. These events had a significant impact on agricultural areas, especially in the Northeast, East and Southeast of Austria. Grasslands of different types cover an area of 1.61 million hectares, which is more than 50 % of the Austrian agricultural land. They are managed by 115,000 grassland and cattle farmers, mostly running small to medium size enterprises that depend on the stability of the fodder production. Annual grassland yields, which are influenced by many factors, tend to vary within $\pm$10-20%, but during some years (e.g. 2003) these deviations can be much greater. The idea behind the GIS monitoring tool relies on hypothesis that the effect of weather conditions on the grassland production can be estimated by models that describe certain natural processes in a simplified manner and in spatialised form. The prerequisite for a country-wide analysis of grassland yields was the integration of such model into a Geographic Information System (GIS), since the model parameters have a well-defined spatial reference. The implementation was designed around geographic datasets like the Digital Elevation Model (50 meters), the Digital Cadastral Map, and the weather data of 274 stations of

Central Institute for Meteorology and Geodynamics (ZAMG).

Combination of two models was used in this project supported by the Austrian Federal Ministry of Agriculture and Forestry, Environment and Water Management. The first model deals with the soil water balance, which is the basis for the second model that accounts for biomass production. The former model is based on Penman-Montheith formula and takes into account the influence of soil conditions, which is rather important in case of heterogeneous Austrian landscape. In the first step the potential ET for grass surfaces was determined on daily basis for the entire country. The most important parameters of this model are therefore global radiation, (respectively the daily radiation balance) and the saturation deficit based on temperature and relative humidity as well as the wind. The global radiation was modeled by the ArcView extension "Solar Analyst 1.0" depending on topographic characteristics. The resulting global radiation factor represents the topographically induced changes to global radiation field and is used for correcting the potential ET, which is calculated at the individual weather stations and their elevation-dependent interpolation. The calculation that enables to establish the potential ET was base for the soil water balance model. The change of soil water balance compared with that of the day before was included as an indicator of possible drainage from the soil layers located above the given layer. The precipitation minus interception then integrated into the balance calculation.

In order to identify drought and its impact on the grassland production it is clearly necessary to examine a whole vegetation season and also to distinguish between the conditions of individual cuts. In our approach the daily soil water balance was considered to be a crop growth driving factor and was used as an inptut to a GRAssland statistical Model (GRAM). This model takes into account results of the soil water balance model and incorporates data of yield measurements at 27 grassland field trials throughout Austria over period of 3 to 40 years. It uses a multiple regression method to quantity of grassland production based on the set of independent variables including a growth factor (based on the soil water availability), cultivation intensity, cutting frequency and fertilization as well as temperature and global radiation sum over the season.

All calculations are based on the grid data model and were performed as local grid operations in ArcGIS VBA programs. Most of the intermediate and particularly the final results had to be generated in a resolution of 50 meters. These state-wide operations with a high resolution scale on a daily basis resulted in a geodata set of more than 1.5 TByte.

The results of this work will be the fundamentals of an insurance model for drought damages on grassland and will therefore help to protect the existence of grassland and

cattle farmers in drought endangered regions.

Acknowledgement : This study was conducted with support of Austrian Agricultural Ministery, Project No. 1282. Some features of GRAM model were developed with the support of the Czech Grant Agency Calim&Ro project No. 205/05/2265.