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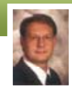
An enhanced approach for estimating grassland yield potential under various cutting regimes



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1. Introduction

Over the past years there has been an intensive search for alternative uses of agriculture land to provide sustainable sources of renewable energy. One of the more recent options is the utilization of grassland biomass for energy purposes, and thus there is a need to assess the production potential of grassland under various cutting regimes as well as its stability under various weather conditions.

The study introduces a concept that would allow assessment of the potential yield of biomass and its variability under present climatic conditions, as well as to pin-point areas having the highest production potential.

2. Materials and Methods

For model calibration and verfication, long-term trial data (1970-2003) for multiple cut regimes (including six cuts) with multiple fertilization management at Gumpenstein and Piber were used. The preparation of climatic related model predictors required a Digital Elevation Model (DEM) and geo-referenced weather data which had to be interpolated geostatistically.

The spatio-temporal implemented soil water balance model represents the weather conditions of a growing season. The reference evapotranspiration (ET_0) is calculated according to FAO Penman-Monteith. The actual evapotranspiration (ET_a) additionally includes precipitation and soil water content. The ratio of ET_0 and ET_a indicates the level of water stress. Water availability will be reduced in case of water stress and affects the growth supporting factor (see figure 1).

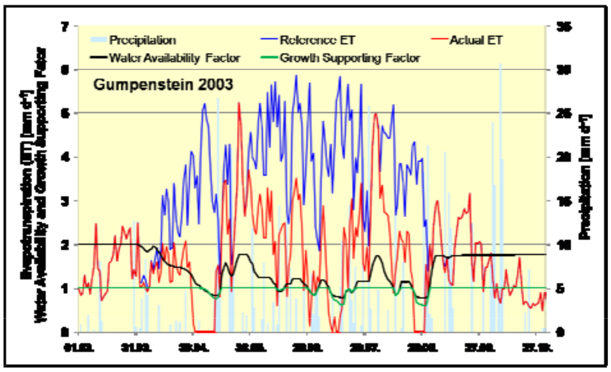

Figure 1: Example of water availability and growth supporting factor according to the ratio of reference and actual evapotranspiration at Gumpenstein in 2003

GIS

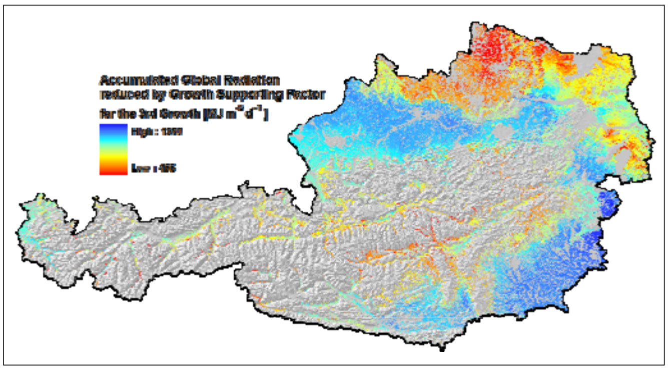

Figure 2: Example of the growth specific model predictor "Accumulated Global Radiation" implemented in GIS as a precondition for the spatial application of yield estimation

3. Results

The results of the model validation for the 6-cut regimes at Gumpenstein and Piber indicate that the model is able to explain up to 80% of yield variability caused by seasonal weather variability, differing fertilization regimes and by the effect of local conditions (see figure 3). It tends to perform better for experiments with higher doses of nitrogen fertilization and at sites (years) when water is a limiting factor.

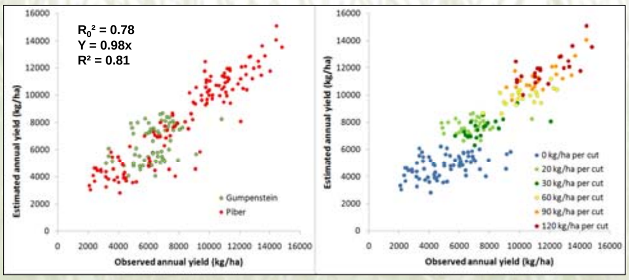

Figure 3: Performance of the statistical model at the trial sites

The growth supporting factor impacts the summation of daily temperature and global radiation (see figure 2) over the period of each growth. For example, during drought periods temperature and radiation sum acquired are reduced, which is translated to lower grassland yield estimates by the Grassland Statistical Model (GRAM).

4. Discussion and Conclusion

The implementation of a site calibrated model in Geographic Information Systems (GIS) requires continuous surfaces of all model parameters. The site based factors like climate impact or topography are comparatively simple to model. This approach includes also management factors like cut frequency, cut times and fertilization management which are extremely difficult to represent in spatial models. The results depends significantly from this input. The presently used approximations concerning spatial management information have the potential for further development.

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