8032

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European Grassland Federation

Modelling of grassland yields in consideration of drought

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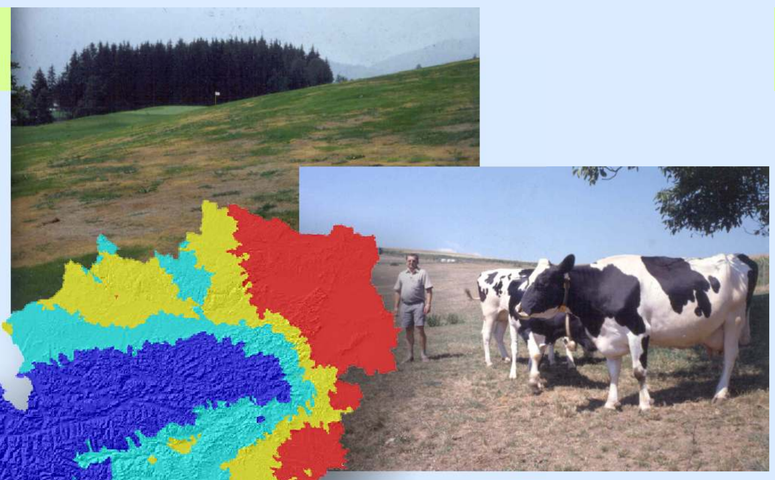
Introduction

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.

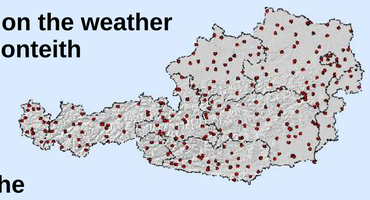


Recently, parts of Austria were affected by the occurrence of intensive drought spells, which lead to significant yield declines especially in the Northeast, East and Southeast of Austria. Damage of grassland during 2003 drought event amounted to about 300 million Euros.

The Austrian Federal Ministry of Agriculture and Forestry, Environment and Water Management reacted on that situation and charged the Federal Research and Education Centre for Agriculture Raumberg-Gumpenstein with the development of a model aiming at the determination of drought damage to grassland fodder production.

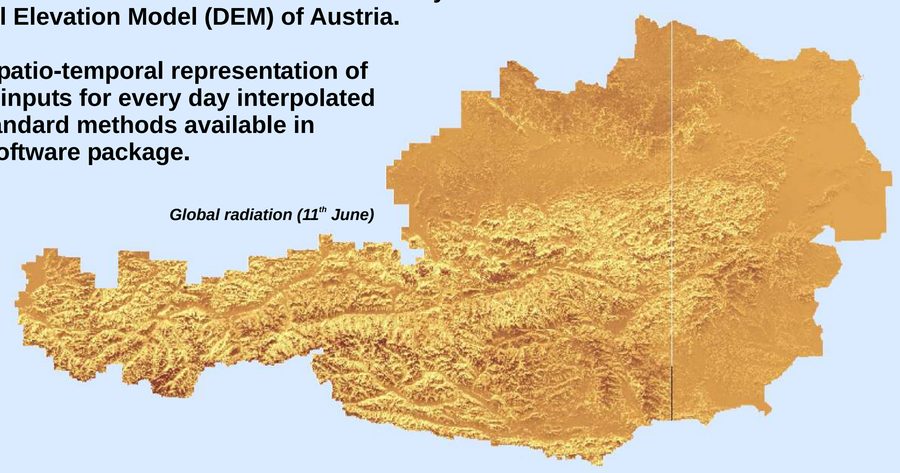
Materials and Methods

The potential evapo-transpiration (ETr) is calculated on the weather stations all over the country according to Penman-Monteith formula based on daily temperature, humidity, global radiation, and wind data.



The global radiation is modelled in high resolution based on the ArcView-Extension Solar Analyst and the Digital Elevation Model (DEM) of Austria.

The spatio-temporal representation of other inputs for every day interpolated by standard methods available in GIS software package.

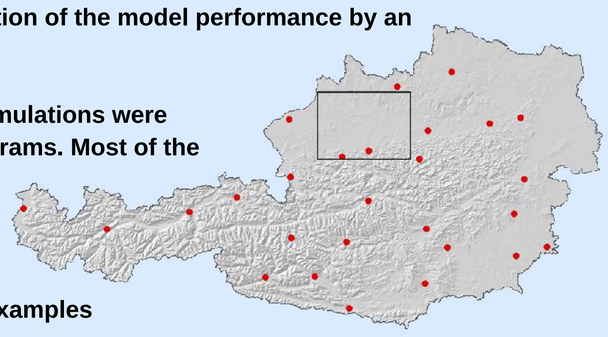


The ETr is a key driver in a soil water balance model that takes into account 3 layer soil profile with total depth of 40 cm (usual rooting depth of most grassland species). Each day the precipitation total and available water in the soil is compared with the Etr value and the daily actual evapo-transpiration (ETa) is derived.

The ratio of ETa vs. ETr is then used in routines of GRAssland statistical Model (GRAM) that assumes that the grass growth strongly depends on the soil water content in the active root zone in combination with global radiation, air temperature, management strategies and nitrogen fertilizations.

GRAM evaluation was based on 27 grassland experiments that were carried out throughout Austria over period of 3 years (2002-2004). Part of the experimental dataset 70 % was used for model calibration whilst remaining portion was left for evaluation of the model performance by an independent sub-sample.

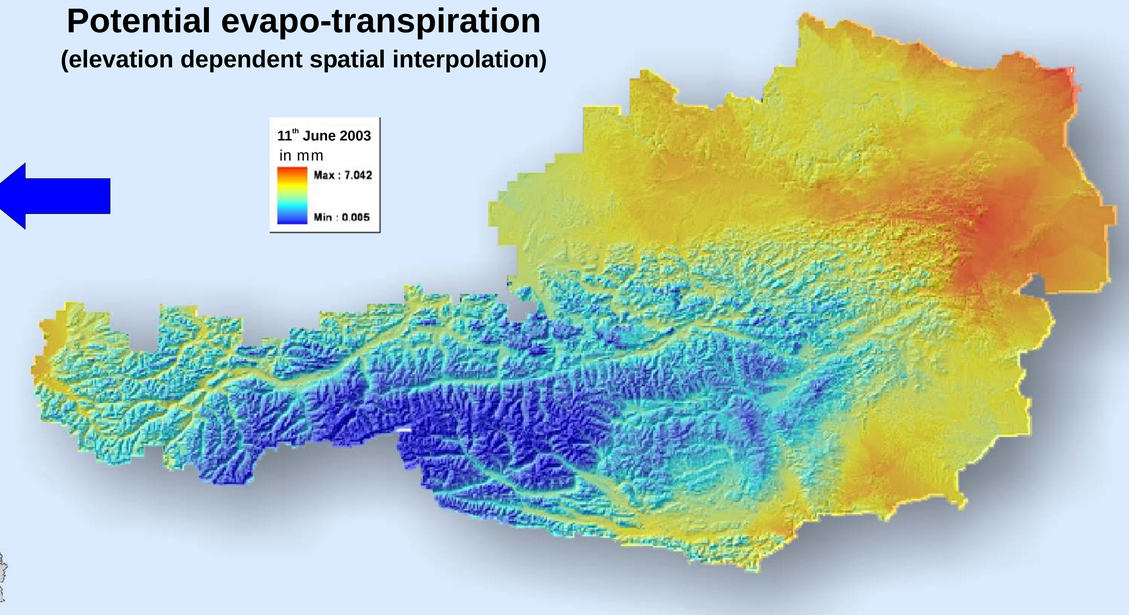
After evaluation the GRAM was run at each grid and simulations were performed as local grid operations in ArcGIS VBA programs. Most of the data and results were generated for 50 x 50 m grids on a daily basis in order to provide sufficient resolution.



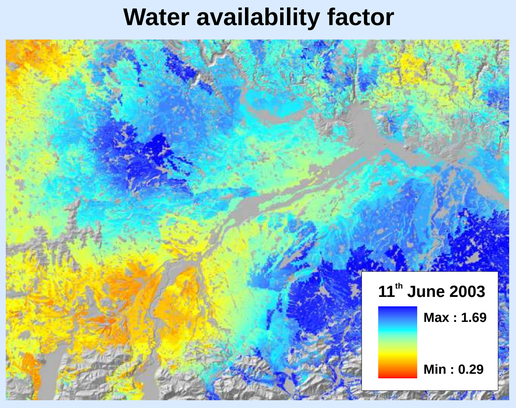
The map shows the sites of the field trials and a rectangular section which is used for presentation of examples of model results shown below.

Potential evapo-transpiration

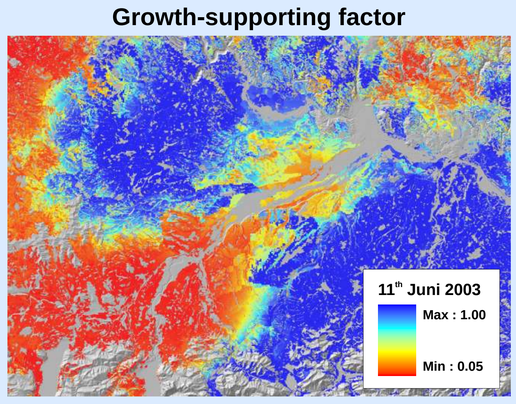
(elevation dependent spatial interpolation)



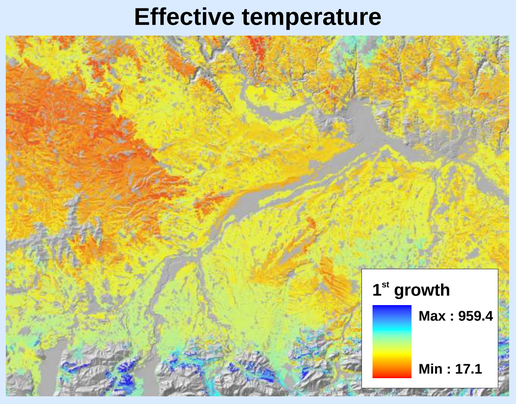
Water availability factor



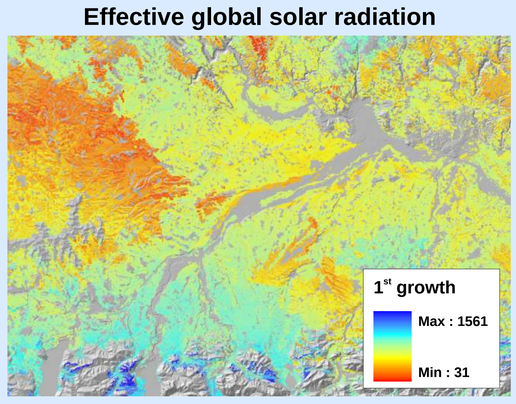
Growth-supporting factor



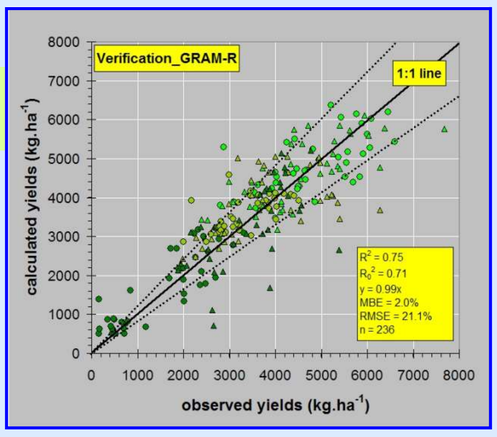
Effective temperature



Effective global solar radiation

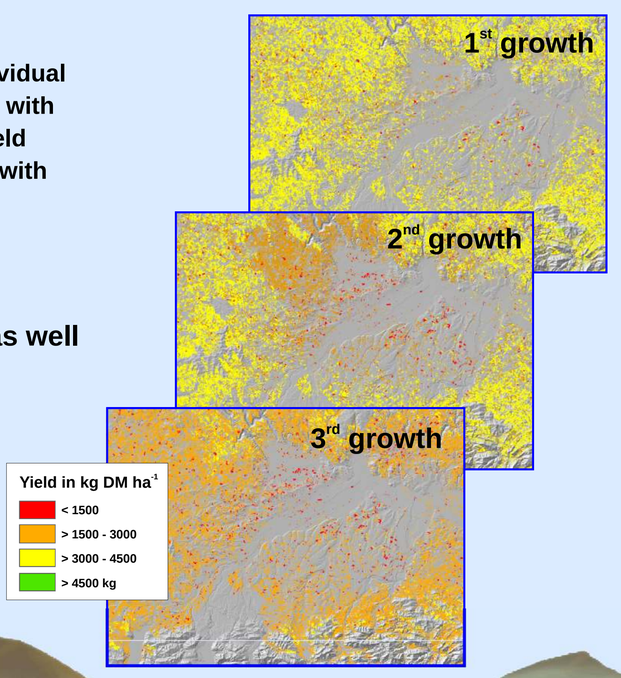


Results



In the year 2003 the yield was extremely low especially over the eastern part of Austria with many areas reporting zero production. However in the higher altitudes with sufficient rainfall the yield was above-average due to the higher temperature and global radiation during most of the year.

The model results were verified using data from individual experimental sites and show rather good correlation with observed data as GRAM explains over 70% of the yield variability. The overall outputs also correspond well with field observations across large climatic gradient.



Good quality interpolations of weather data as well as development of simple yet representative models of Grassland management and N-fertilisation remains a major goal for future development.