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Modeling grazing intensity of grassland

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Abstract

The land use model called 'Grass Pre' was developed to simulate the grazing intensity of alpine pastures. Model input parameters are 1) the total energy requirement of all livestock of the entire study area, which is calculated from i) the sum of all different types and number of livestock, ii) milk production, iii) duration of the grazing period, and 2) the 'attractiveness' of each polygon, for which the yield per ha is used as an indicator. The model output parameters are the used yield per hectare and the land use intensity of each polygon (see application example in the presentation of S. AIGNER).

Keywords

alpine grassland, grazing intensity, livestock.

Introduction

Since the mid of the 20th century the ongoing intensification of agriculture has led to a dramatically decline of extensive pasture land. Since the Second World War the area size of common pastures, bedding meadows and alpine pastures decreased with almost 70 %. The greatest decrease took place in the 60s and 70s of the 20th century. For example, in Austria from the 596 000 ha extensive pasture land of the 60s only 174 000 ha are left. The rest was intensified, afforested, or marked by scrub encroachment, and already reforested. The permanent grassland got an increase in area size of 713 000 ha in the last 50 years. In the patch of intensive grassland and trefoil-grasses an increase in area size of 40 000 ha is recorded. The trend of abandoning extensive pasture land can be seen in whole Europe. For example, also in Bavaria the area of permanent grassland is declined with 420 000 ha in the last 30 years. As a result the proportion of agricultural area is reduced from 42 % to 35 %. The number of dairy cattle declined with 22.5 % and the number of dairy cattle herder even with 50 %. In the same time period the milk yield of the Bavarian cows increased with 20 %. This increase is achieved by adding concentrated feed, as wells as through the use of silage, and by hot-air drying of the nutrient optimized green fodder. The increase of area and animal performance happen also in Austria. Especially in the most favored areas the livestock increased in the last five years. Whereas in the mountain regions this development is not observed due to the steepness of the areas. These regions are in particular be hit by land abandonment. Even in the succession phase to forest the biodiversity can be lower than in a usual cultivated meadow, pasture or alpine pasture (POSCH, 2005).

The most important consequences of this development are summarized here:
- Concentration of the use on well accessible and productive areas
- Extensification and abandonment of lands with marginal yields
- Increase of forest areas at the expense of extensive pasture land

Those changes have effects on the economy, on the image of a landscape and on biodiversity. In this light is a prediction of changes of animal stocks on the intensity of land use of concrete individual areas of particular importance. However, it is observed that for example the halving of the numbers of mountain livestock leads not automatically to a halving of the intensity of land use. It is rather a question that qualitative valuable and well accessible pasture areas are be eaten and be visited from the livestock slightly smaller. Whereas areas with lower quality for livestock are going to become grazed even in a smaller extent and disappear by increased lack of pasture maintenance – whereby the quality of pasture decrease even more and which finally can lead right up in an entire release from land use. Afterwards lower profitable areas are often this areas, which are in interest of nature conservation and are rated as in danger or as protected. Especially the extensive pasture land is be hit by these tendencies of land abandonment, scrub encroachment and reforestation. In return, an intensification of land use can lead by a missing offer of pastoral economically valuable pasture land to an overgrazing of extensive pasture land and with that again to a threat of scarcer and protected plant and animal species.

In the frame work of this paper the model 'GrasPre' (Predictive Model For Grassland Use) will be introduced, which predicts the intensity of land use (in large livestock unit per area; GVE/ha) of all subareas of a defined and for the grazing cattle accessible total area (e.g. alpine pasture) (see POSCH, 2005). The specialty of the pasture land use model 'GrassPre' is that it does not simply model linearly the intensity of land use by the 'attractiveness' of the individual areas. It rather determines the intensity of land use of the individual areas by considering simultaneously each attractiveness of every other subareas as well. Are there comparatively further similar pastoral economically attractive subareas available, they are tending to be grazed in a similar heavy manner. However, are there mostly pastoral economically unattractive subareas in the region, then this will accordingly be regarded in the model. Primarily, the most attractive subareas of the intensive pasture land will be grazed disproportionally intensive compared to the pastoral economically 'unattractive' extensive pasture land.

'GrassPre' is based on the evaluation model of alpine pasture, which was developed in the frame work of the research project called 'GIS based modeling of yields to optimize pasture management of alpine pastures' (In German: 'GIS gestützte Ertragsmodellierung zur Optimierung des Weidemanagements auf Almweiden') (EGGER et al., 2004). The evaluation model of alpine pasture enables a rapid and area-wide determination of the economic value of alpine pasture areas. The model output is the available quality yield per forage area. The purpose of the model 'GrassPre' is to model the land use of areas, for example of alpine pastures. The output of this model is the used quality yield per forage area. Within the frame of the symposium contribution of AIGNER & EGGER 'Application example for modeling grazing intensity: National Park Hohe Tauern', there will be presented an application of the model 'GrasPre' with more details exemplarily for the National Park Hohe Tauern.

Model design

The model simulates the decision of a grazing cattle whether and how intensive it will graze the subarea of a region. The model is based on two starting point parameters:

- Total energy requirement of a region. This results from genus of cattle, number of cattle, animal performance (milk yield, meat increase) and the duration of pasture.
- Attractiveness of the subareas. As decisive factor for this, the quality of pasture per ha is used. It can therefore be assumed that the gross energy yield (product of yield (in quintals dry mass per ha)) and the quality yield (in mega joule NEL) are pivotal for the decision of a cattle to use the area heavily, less heavily or not all.

The hypothesis of the land use intensity model is that firstly the best pastoral economically subarea with the highest quality yield will be used. With increased grazing of this subarea the attractiveness of it is also reduced. Is the quality yield of this best area decreased to the extent of the next best area, then this area will be involved in the land use (see Fig. 1). The higher the difference between quality yields of subareas the longer the time period until the next area will be involved in the land use. The inclusion of the further areas takes place by the same pattern until the whole energy requirement of the region is covered.

In accordance with an extensification scenario, a reduction of livestock (decrease of energy requirement) happens, consequently the pastoral economically less attractive areas (lower quality yield) will be only used in a smaller extent or not all. It is proceed from an unlimited accessibility of the subareas.

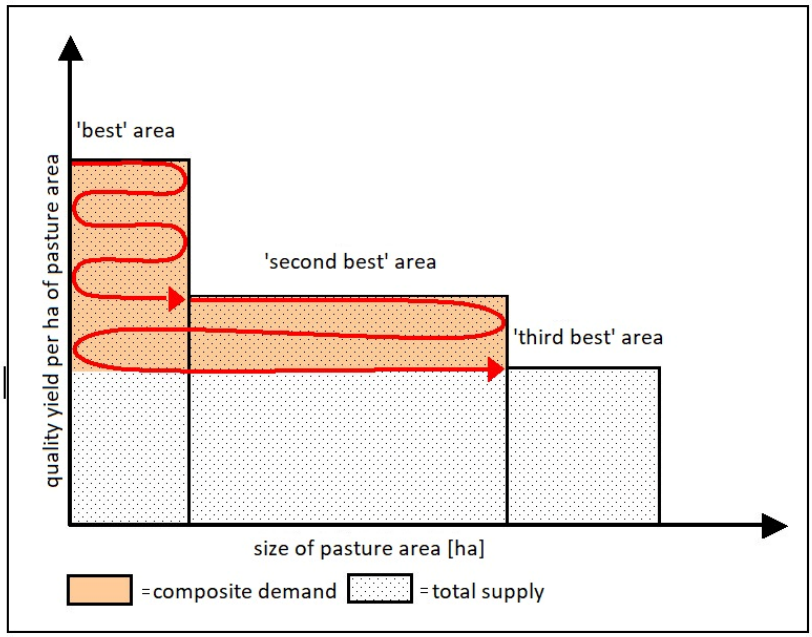

Figure 1: Schematic representation of the procedure of the land use model (modified; POSCH 2005).

The result of the simulation is the used quality yield per forage area. The coding of the model was done in Microsoft Visual Basic 6.0 in the office software of Microsoft called Excel 2000. The model output is the used quality yield per subarea or per hectare. The consequences of this is the calculation of livestock density and land use intensity (proportion of the used gross energy yield from the useable gross energy yield of the region in percentage) of the subareas. The output parameters of the model for every subarea are:

- Used quality yield absolute [MJ NEL]
- Used quality yield per hectare [MJ NEL/ha]
- Absolute livestock density [GVE] (= number of mountain cattle of alpine pastures in the region [GVE] * modeled used quality yield of the subarea [MJ NEL] / used quality yield of the region [MJ NEL])
- Livestock density per hectare and time period of alpine pasture [GVE/ha/WP]
- Livestock density per hectare and 100 days of pasturage [GVE/ha/100WT]
- Intensity of land use [%]

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