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Modelling biomass in meadows and pastures using Landsat-5 TM data in a Mediterranean mountain region (Vall Fosca – Catalan Pyrenees)

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Mountain farming is an important activity to be maintained not only because its economic and social function, but also for its active role in landscape conservation and biodiversity protection. Livestock breeding has shaped mountain landscape for millennia, thus configuring a mosaic on which many ecological processes depend.

Extensive stockbreeding in Catalan Pyrenees is strongly determined by grassland availability in meadows and pastures. Satellite images together with on-site data sampling are often used to quantify herbaceous resources in terms of biomass production. Biomass calculation is defined as the amount of vegetation matter which is found at an exact place and in a given moment.

This study aims to model biomass production in Mediterranean mountain meadows and pastures (Vall Fosca – Catalan Pyrenees) by using a set of 11 Landsat-5 TM images acquired in 2008 and 2009. For that purpose, aerial biomass has been sampled along 11 different field campaigns which were programmed for the period between May and September 2008 and 2009. Field-determined variables ("fresh weight", "dry weight") have been then related to several vegetation and humidity indexes calculated from the time-corresponding Landsat-5 TM images. The vegetation indexes chosen were NDVI, EVI and the Greenness component of the Tasseled Cap Transformation. For humidity, NDWI and Wetness component of TCT were used.

Landsat-5 TM images have been first corrected by means of conventional techniques based on first order polynomials taking into account the effect of land surface relief using a Digital Elevation Model, obtaining an RMS (Root Mean Square) error of less than 30 m. Radiometric correction of Landsat non-thermal bands has been done following the methodology proposed by Pons and Solé (1994). This method allows to reduce the number of undesired artefacts that are due to the effects of the atmosphere or to the differential illumination which is, in turn, due to the time of the day, the location in the Earth and the relief (zones being more illuminated than others, shadows, etc).

Field variables have been separately related to the vegetation and humidity indexes by means of a multiple regression model. Model's predictors have been selected on the basis of Malows' Cp. After the model being built, it has been validated following the jackknife method, thus obtaining the value for RMS error.

Results from the statistical analysis are not uniform among the different field campaigns. R2 values range from 0.33 to 0.90 for the "fresh weight" variable (RMSE values ranging from 262 to 173 kg of fresh biomass/pixel) and R2 from 0.21 to 0.68 for the "dry weight" variable (RMSE values ranging from 30 to 60 kg of dry biomass/pixel). Such variations reflect the high dynamism which characterises the system under study, as well as the effects of the changing environmental conditions. Biomass maps have been obtained for the areas of interests -meadows and pastures- and for every field sampling date.

Key words: biomass, meadows and pastures, vegetation and humidity indexes, mountain livestock breeding, Landsat-5, Remote sensing, Pyrenees.