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A model for testing the impact of grazing on soil erosion and its calibration

John B. Thornes (1), I. Fonseca (1), A.Younas (1), Ch. Evangelou (2) and V. P. Papanastasis (2)

(1) King's College, Strand, London WC2R 2LS, UK

(2) Laboratory of Rangeland Ecology, Aristotle University, GR-541 24, Thessaloniki, Greece (johnbthornes@yahoo.co.uk)

It is widely agreed that grazing, through its reduction of plant cover, can lead to an increase in soil erosion. Livestock grazing is a driving force of rangeland deterioration. The impact of overgrazing however is over emphasized and the concept of "carrying capacity" is no longer considered as a basis for optimal stocking assessment because it is too ambiguous a concept and difficult to implement in a spatially heterogeneous environment and under conditions of uncertainty. Moreover, the processes of grazing differ widely throughout the world's rangeland. In Mediterranean rangelands, for example, grazing livestock are shepherded. As a result, animal movement is dictated to a large extent by the shepherd's objectives and decisions on how to utilise a particular paddock. Additional constraints to the free grazing livestock are the often rugged relief as well as the infrastructure including watering points and the animal sheds used as an over-night base. Finally, production mode is also affecting the impact of grazing on rangelands; animals raised for milk production are often grazed in the most productive parts of paddocks or they are offered supplementary feed in the shed as opposed to the ones bred only for meat and wool. Consequently, the impact of livestock grazing on the vegetation is not uniform throughout a particular rangeland.

In this model, we seek to identify a set of grazing 'styles', to incorporate certain rules of animal behaviour and to simulate the removal of biomass by the different systems. Using simple daily and monthly weather data and spatially distributed soil characteris-

tics we also simulate the monthly growth of biomass and use the soil water balance to implement a surface run-off soil erosion procedure that depends on the biomass cover. The model differs from earlier attempts in recognising the importance of heavily used pathways, i.e. it is intensive rather than extensive. It also enables the examination of alternative infra-structural facilities, such as additional water points, fencing and forage provision. The model can also be adjusted to fit different 'grazing diaries'. The model is designed to be user friendly, run on a P.C. platform, and easy to implement at several scales on real landscapes with simple input data. It has been constructed using the principles of U.M.L. and O.O.P. and coded in Java.

The model will be demonstrated and issues of parameterisation will be considered with reference to the Lagadas area in northern Greece. For this purpose, plant cover, height and above ground biomass of rangelands were measured in different seasons of the year. In addition, the animal paths of selected herds were recorded as well as their grazing activities (feeding, moving, standing, lying, and ruminating) and animal infrastructure (sheds, watering points and resting places) was mapped. It was found that the main rangeland type was *Quercus coccifera* shrublands with shrub cover between 13 to 80%, shrub height 0.2 to 4 m and above ground biomass between 11 to 13 t/ha. The average route length that animals followed varied from 6 to 12 km per day, depending on the animal kind and season of the year, while most of the time that animals spent was allocated for grazing and moving. The essential outputs are maps of grazing intensity, changing biomass and the corresponding severity of erosion.