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Influence of Overgrazing on the Runoff and Soil Loss on Hillslope

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Abstract: Overgrazing is an actual problem especially in countries where the economy is largely based on animal husbandry. Overgrazing occurs when land are exposed to intensive grazing for extended periods of time, or without sufficient recovery periods of vegetation. Overgrazing favors soil erosion, resulting in reduction of soil depth, soil organic matter content and soil fertility. These impair the land's future natural and agricultural productivity. This paper studies the influence of overgrazing on the runoff and soil loss on hillslope. The modelling is performed using WEPP software.
Keywords: overgrazing, hillslope, runoff, soil loss.

1. INTRODUCTION

Grasslands cover approximately 41% of Earth's land surface and provide livelihoods for nearly 800 million people, as well as forage for livestock, wildlife habitat, and locations for recreation and tourism. Overgrazing is one of the principal causes to grassland degradation around the world. [1]

Overgrazing is an actual problem especially in countries where the economy is largely based on animal husbandry. The definition of overgrazing is: "Overgrazing occurs when plants are exposed to intensive grazing for extended periods of time, or without sufficient recovery periods. It can be caused by either livestock in poorly managed agricultural applications, game reserves, or nature reserves. It can also be caused by immobile, travel restricted populations of native or non-native wild animals."[2]

A land affected by overgrazing can see in Figure 1. [3]

Causes of overgrazing are:
- inadequate animal/wildlife management
- drought or quantitatively insufficient precipitation
- improper land use and land management
- overstocking
- poor irrigation in arid and semi-arid areas
- inadequate irrigation methods in arid and semi-arid areas. [4]

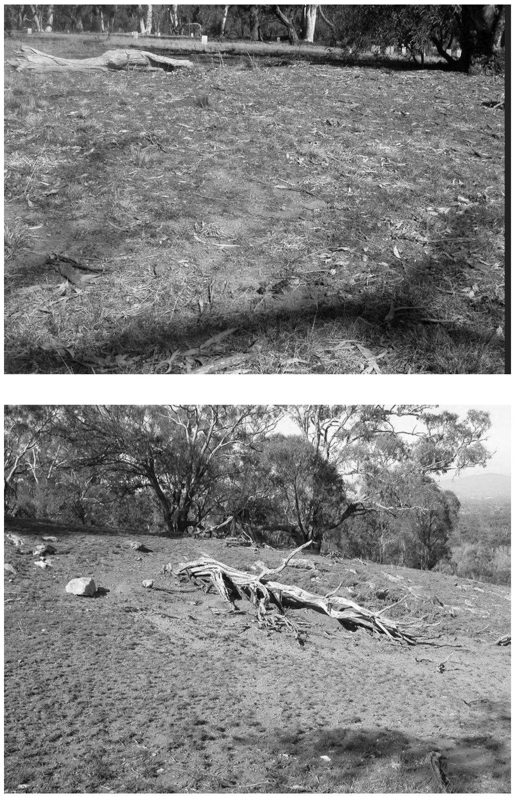

Figure 1. Overgrazing

Effects of overgrazing:
- increasing of soil erosion and runoff
- land degradation / desertification
- loss of valuable species of plants
- food shortage/famine
- death of people and animals. [4].

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Solutions for stopped or decreasing of overgrazing:
- adequate management of grazing animals
- proper land use management practices
- sustainable pasture practices. [4]

2. WEPP MODEL

WEPP (Water Erosion Prediction Project) is software for the prediction of erosion processes in watersheds, developed by USDA Forest Service, Agricultural Research Service, Natural Resources Conservation Service, Department of Interior's Bureau of Land Management and Geological Survey from USA, now days, the most used model in numerous countries. WEPP has been under a permanent development process since 1985.

The WEPP model may be used in both hillslope and watershed applications. The model is a distributed parameter, continuous simulation, and erosion prediction model, implemented as a set of computer programs for personal computers.

The hillslope component of the WEPP erosion model requires a minimum of four input data files to run: climate file, slope file, soil file and plant/management file.

The watershed component requires a minimum of seven input data files: each hillslope information file, structure file, slope file, soil file, management file, climate file and channel file.

WEPP considering the hillslope consist in numerous parallel rills; the surface erosion occurs on interrill surfaces and the dislocated soil particles are transported downhill by rill flow (rill erosion is also considered in calculus).

WEPP produces many different kinds of output, in various quantities, depending upon the user's needs. The most basic output contains the runoff and erosion summary information, which may be produced on a storm by storm, monthly, annual or average annual basis. The time – integrated estimates of runoff, erosion, sediment delivery and sediment enrichment are contained in this output, as well as the spatial distribution of erosion on the hillslope (Figure 2).

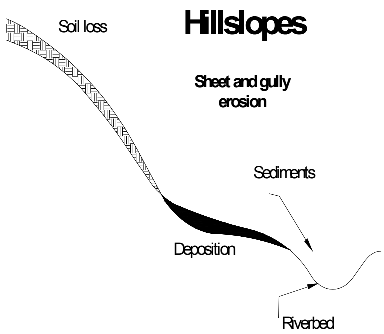

Figure 2. The WEPP Model for hillslope

The model has two basic components:
- erosion component - is based on the continuity equation for sediments – eroded soil particles, produces the soil loss quantity
- hydrology component – produces four output for the erosion component: peak runoff rate, effective runoff duration, effective rainfall intensity, effective rainfall duration. Infiltration is calculated using the Green - Ampt and Mein – Larson (GAML) equations. [5]

The principal limitation of WEPP is the small area it models (< 2.6 km^2). In larger watersheds, users will need to use advanced modeling skills to incorporate climate variability within the watershed and to combine results from runs on numerous small subwatersheds within the study area. As with all models, the quality of the model output is depend on the quality of the input data. Because of the high degree of natural variablity in soil erodibility properties, the accuracy of any erosion prediction model, including WEPP, is about plus or minus 50 % of the resulted value from simulation. [6]

3. STUDY CASE

For the study of influence of overgrazing on the runoff and soil loss on hillslope was chose a hillslope with longitudinal profile represented in Figure 3.

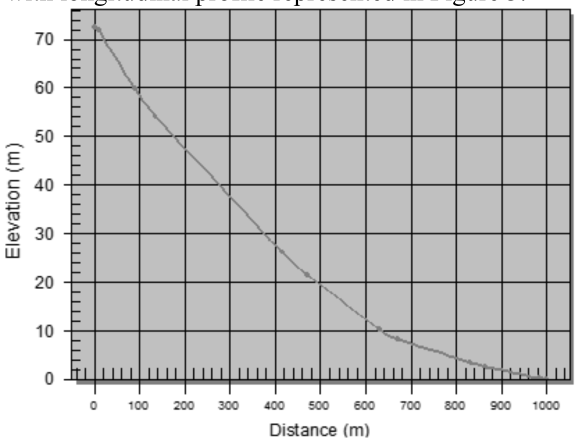

Figure 3. Hillslope profile

The case study is based on the next hypotheses:
- constant intensity of the rain on all surface of the hillslope
- the same type of soil for all hillslope area - Typic Hapludalfs (with more subtypes), having middle and heavy texture (reduced permeability), making part of hydrological group C, with initial humidity of 70%
- do not exist works for control soil erosion and surface runoff
- land use are: grass and degraded pasture (high grazing).

It was applied WEPP model for calculating the soil loses on hillslope during the torrential rain, in four hypotheses (which has resulted from charts of torrential rain repartition with assurance of 10% and having the duration of 5, 15, 30, 60 minutes, obtained from measurements and statistical works of the meteorological data on the Bega hydrographical basin area) [7]:

1 – torrential rain with duration of 5 minutes and calculus intensity i=3 mm/min

2 - torrential rain with duration of 15 minutes and calculus intensity i=1,55 mm/min

3 - torrential rain with duration of 30 minutes and calculus intensity i=0,96 mm/min
4 - torrential rain with duration of 60 minutes and calculus intensity i=0,70 mm/min

4. RESULTS AND DISCUSSION

The simulation results can be seen in the Figures 3, 4, 5, 6, 7, 8, 9, 10 and in Table 1.

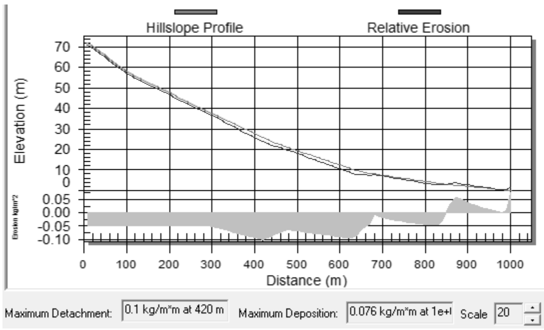

Figure 4. Soil loss graph for 5 min torrential rain duration and land use grass

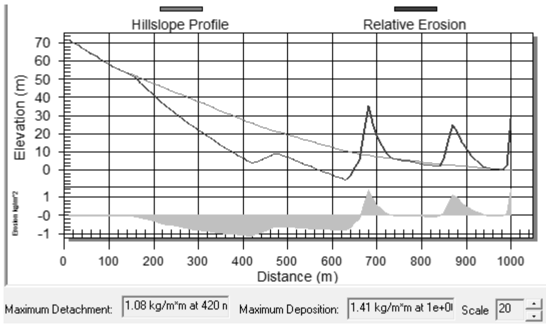

Figure 5. Soil loss graph for 5 min torrential rain duration and land use overgrazing

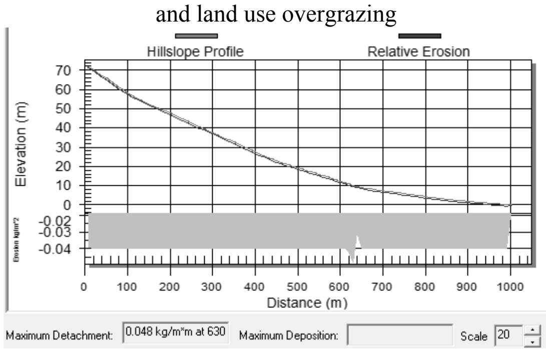

Figure 6. Soil loss graph for 15 min torrential rain duration and land use grass

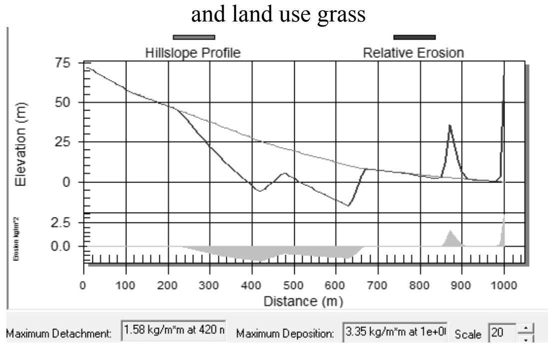

Figure 7. Soil loss graph for 15 min torrential rain duration and land use overgrazing

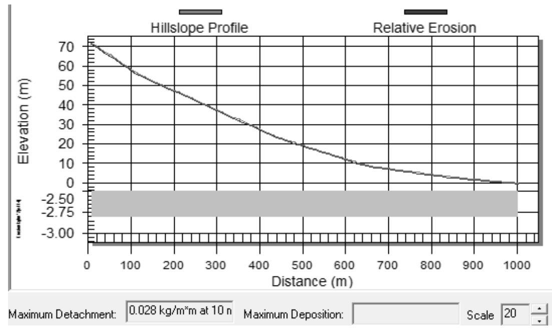

Figure 8. Soil loss graph for 30 min torrential rain duration and land use grass

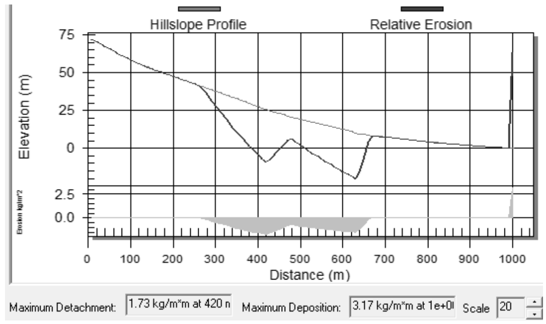

Figure 9. Soil loss graph for 30 min torrential rain duration and land use overgrazing

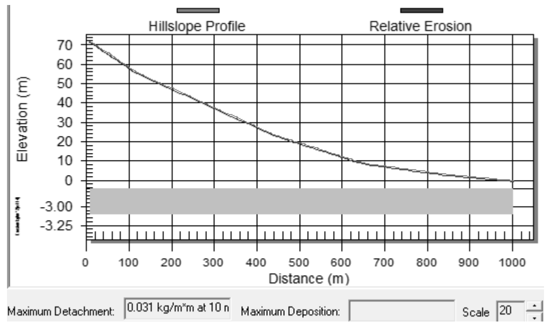

Figure 10. Soil loss graph for 60 min torrential rain duration and land use grass

The comparisons between obtained values are shows in Figures 11, 12 and 13.

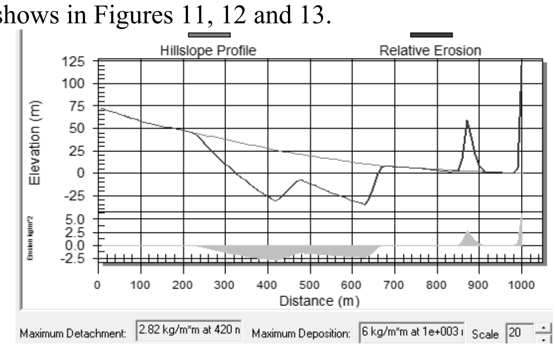

Figure 11. Soil loss graph for 60 min torrential rain duration and land use overgrazing

Table 1

Torrential rain	Runoff (mm)		Soil loss (kg/m^2)		Sediment yield (t/ha)	
	grass	over-grazing	grass	over-grazing	grass	over-grazing
5 min, 15 mm	8.67	13.46	0.059	0.440	0.449	2.547
15 min, 23.30 mm	13.86	20.78	0.039	0.472	0.393	3.586
30 min, 28,88 mm	15.87	25.34	0.028	0.430	0.284	3.945
60 min, 42 mm	24.12	37.18	0.031	0.858	0.314	6.400

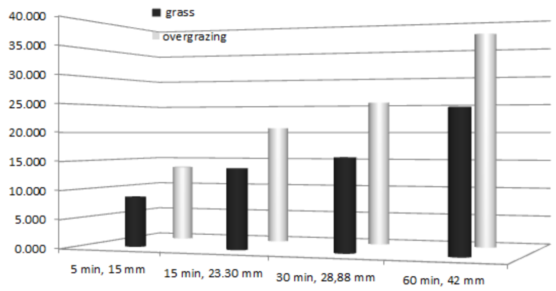

Figure 11. Runoff (mm)

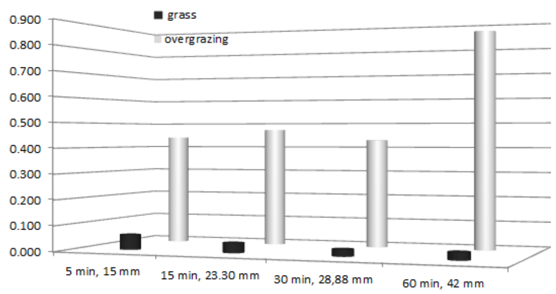

Figure 12. Soil loss (kg/ha)

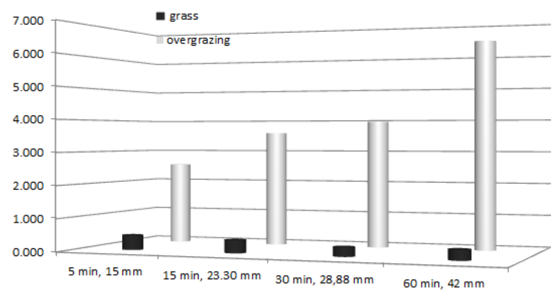

Figure 13. Sediment yield (t/ha)

From the obtained results it can be observed that the runoff is about 30% higher in the case of overgrazing, so the amount of water retained / infiltrated into the soil is smaller. This favors the emergence of rapid floods with higher discharges downstream, which can lead to significant damage; but also the emergence of desertification, due to the fact that the plants do not have enough water for grow.

Also, soil losses are significantly higher in the case of overgrazing, which leads to marked soil degradation, thus losing both productivity and economic value.

5. CONCLUSIONS

For avoid overgrazing exist several methods of grazing management that can offer effective solutions to overgrazing, like rotational, cell, and mob grazing. Each grazing management method and proper management of animals can help in restoring the plant growth during the entire year.

Before any land development or exploitation implementations are undertaken, the decision makers must be analyze the local and regional factors, like climatological and hydrological characteristics of area. Also, must be analyzed the implications of human activities on land.

Making the right decisions avoids the overutilization of disponible arable land and green pastures and permit easier control policies for overstocking.

Through combination of adequate grazing management methods with agroecology practices and sustainable agriculture result the most suitable grassland-based livestock production, because it increases the productivity of animals and maintains a good state of vegetation and soil.

On lands already affected by the consequences of overgrazing, it is necessary to take measures to restore the characteristics of the vegetation and the soil, such as the execution of soil fertilization works, some hydrotechnical works for water retention and to control soil erosion.

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