Erosion modelling with E3D to serve of watershed managemnent in the Velence Mountains

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Introduction

The object of this study is a sub-watershed of the environmentally sensitive shallow Lake Velence (NW Hungary). The investigations are focused on the land use optimization on the 14 km^2 subcatchment of the lake with help of the modeling and measuring the erosion rate in mezo- and micro scale.

Study area

The study area is the Cibulka catchment inside of the watershed of the Lake Velence. The 150-300 m high hilly area has high petrologic, pedologic and land use variability. There are brown forest soils and rocky soils on andesite and granite with secondary forests or weak grasslands. Loess is covered by moderately eroded chernozem type soils with intensive land use. 54 % of the whole subcatchment are arable lands (dominantly winter wheat, sunflower, rape and maize) and vineyards. More than half of this area has larger slope angle than 2.5 degrees. At lower plots, in smaller patches fluvisols appear as the evidence of erosion. The pH of topsoil is neutral to moderate alkaline; it ranges from 7.21 to 8.5.

The climate of the area is moderately cool and dry. The annual average temperature is 9.5-9.8^{o}C; the volume of rainfall is 550-600 mm, with 50-55 % in form of severe summer rainstorms (Ádám et al. 1988).

Material and method

Modeling soil erosion in Hungary is happened mainly in plot scale therefore there is no usable system built up yet that can help the owners to decide the land use optimization attended to erosional, environmental aspects.

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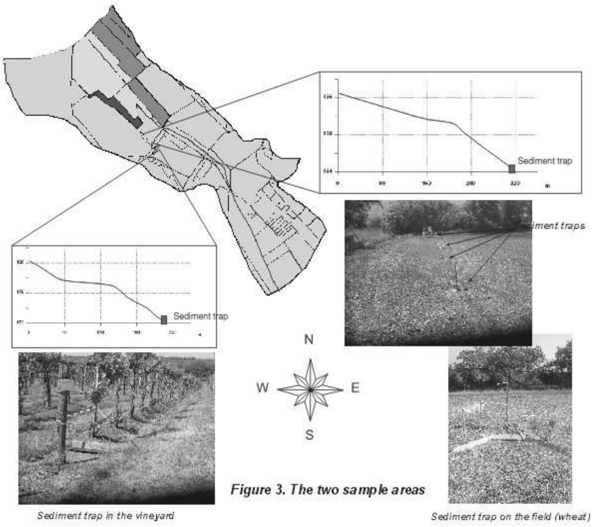
This system can be based on small catchments (5-50 km^2).
The aim of this investigation is to build up a GIS helped watershed management based on the validation and calibration of the EROSION2D/3D (Schmidt, J. 1996) model that is applied successfully in Germany.

Measurements and modeling

The basic question of the applicability of results came from the model in the land use planning is the knowledge of the connection between this simulated results and the reality. It means that validation is necessary and the modeled values must approximate the real erosion rates. That‘s why the modeling process was divided into to parts: firstly field measurements in order to make basic maps, data base for the model and to know the real erosion values, and secondly the modeling itself. This last one was realized in micro (on about 1 ha catchments) and mezo (on the whole Cibulka catchment) scale.

Field measurements

Two study plots with different land uses represented the typical agricultural activities on the watershed were chosen: a vineyard (1.09 ha) and an arable land with winter wheat (1.2 ha). (Figure 1.)



1.Figure The Study plots

Both of them contain very attractive erosion forms (rills, small gullies, etc.). Sediment traps were set to the bottom of the main rills on the two small watersheds in every 20 m and two bigger (0.5 m^3) collectors were sunk at the end of the slopes. Automatic rain gauge measured the precipitation in every 10 minutes. The sediments in the traps were collected after every erosive rainfall event, they were dried and their weights were measured.

This presentation shows the results connected to the storm on 11th July 2005, chosen from the measurement range of the rainy summer in 2005. The peak intensity of the more than one hour long rainfall event was 45 mmh^{-1}, but even the peak 30 minute intensity almost reached the 40 mmh^{-1} (37.8 mmh^{-1}). This well documented rainfall event was modeled by EROSION2D/3D. The simulated result in the vineyard was 0.018 tha^{-1} and the measured result was 0.025 tha^{-1}. In the filed measured result was 0.015 tha^{-1} and the simulated was 0.011 tha^{-1}.

The difference between the measured and modeled erosion rates was under 30 % (27 %)!

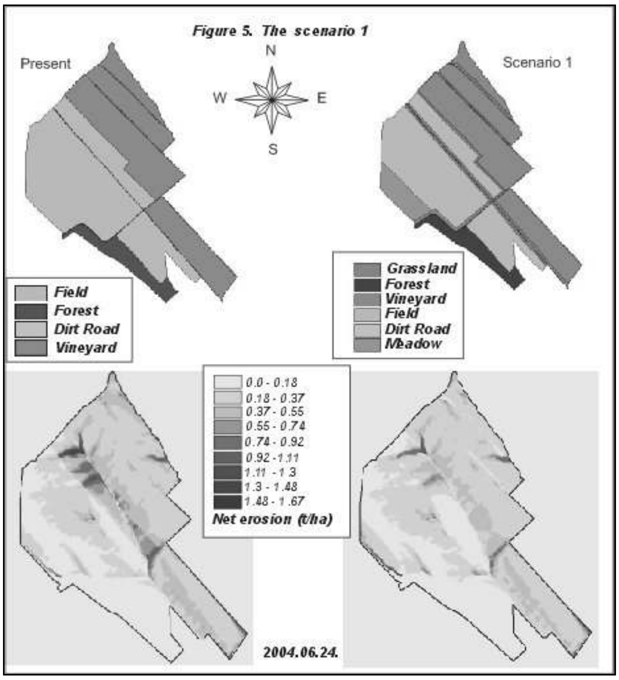
Watershed management

The erosion conditions of the Cibulka catchment were modeled under a thunderstorm in 2004. The average erosion rate was 0.0168 tha^{-1}. The aim is to reduce the erosion to change the land use structure, keeping the conventional agricultural activities.

In first step land use was uniformly changed to vineyard, winter wheat or grassland on the whole 14 km^2. The highest erosion rates were found under vineyard (mean erosion: 0.01688 tha^{-1}), the lowest ones were on grassland (mean erosion: 0.00325 tha^{-1}). Although there are significant differences in erosion rates supposed the three different uniform land uses but the spatial patterns characterized by high erosion are similar.

In the second step (Scenario 1) according to the original land use grasslands were extended and grassy edges were set around the vineyards and arable lands in width of 15-25 m depending on their areas. The upper grasslands inhibit the formation of the initial erosion and the downslope grassy belts can accumulate the majority of the moving sediment. The mean erosion rate reduced by 0.0152 tha^{-1}, but you can find much bigger reduction in the main erosion patterns.

In the third step (Scenario 2) forest plantation along the unpaved roads can reduce erosion on and on. The erosion rate was able to reduce to 0.0144 tha^{-1}.



2. Figure The scenario 1

It was kept in mind at the elaboration of the commendation that there is no reality for the reduction of the prospective agricultural intensity. The potential land use changes depend on the other demands as well, eg. recreation, industrial possibilities, etc.

Summary

In Hungary the introduction of the erosional estimation in mezo scale, ranging from km^2 to 100 km^2 watersheds can take part in planning land use optimization, which is a live practice in Western Europe. This work showed the first step of this process, left the plot scale and move towards the watershed.

References

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