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Complex Terrain and Ecological Heterogeneity (TERRECO): Evaluating Ecosystem Services in Mountainous Landscapes

Soil erosion and management measures in the Haean catchment of Korea

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Introduction

Soil erosion by intense rainstorm events is a crucial problem with respect to economics and environment, especially in regions dominated by agricultural land use. On one hand it leads to large losses of fertile top soil, which is essential for agricultural productivity. On the other hand, large amounts of fertilizer and biocides are transported by surface runoff and sediment into streams, lakes and reservoirs and can therefore decrease water quality significantly. Thus erosion control is a precondition for environmentally sound and sustainable agriculture, and plays a key role in the conservation of surface water bodies.

Especially with respect to a much higher probability of extreme rain events in the course of climate change effective soil protection measures will be indispensable.

The primary aim of this project is the quantification of soil loss and sediment transport from agricultural areas within the Haean catchment (Fig. 1) and to detect the factors influencing soil hydrology and erosion. Further erosion control measures shall be developed for long term protection of soils and agricultural land, as well as to increase water quality in streams and the adjacent water bodies

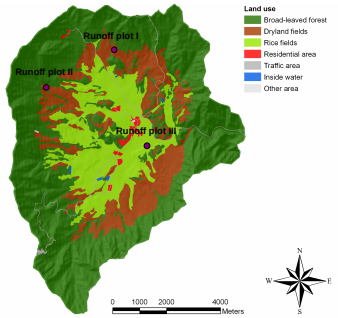

Fig. 1: Land use map of Haean catchment and locations of the three runoff plots

Methods

Runoff plots (Fig. 2) were installed on three field sites to measure the amount of surface runoff and transported sediment by rainstorm events. The entire surface runoff with eroded soil material from the subplots was collected and directly transported into the water tanks below. By measuring the water volume and sampling the suspension in the tanks after each rainstorm event the amount of soil loss from the subplots can be quantified. Physical and chemical analysis of sediment samples give information about the amount of particle bound nutrients and preferentially transported soil texture classes.

Each site consists of four subplots with the same conditions regarding initial soil material, crop and slope, but they differ in the treatment of the topsoil. Soil stabilizing polymers (PAM), Black Carbon (BC) and a mixture of both PAM and BC were mixed in the upper 5 cm of the soil (1.0 g/m² PAM and 0.5 kg/m² BC) in order to investigate their effects on soil hydrology and erosion susceptibility.

On two positions within each subplot (upslope and downslope) tensiometers and TDR sensors were installed in three different depths in order to measure continuously soil hydraulic potential and water content.

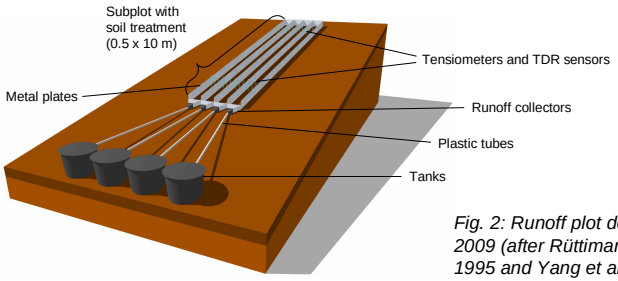

Fig. 2: Runoff plot design 2009 (after Rüttimann et al. 1995 and Yang et al. 2007)

Preliminary Results

Fig. 3 shows soil loss by rainstorm events on the three runoff plots in Haean for the measuring period in 2009. At the beginning, PAM shows a potential to decrease erosion susceptibility (especially in combination with BC) but after the first weeks break of plastic cover and increasing edge effects as a result of the small plot size decreased reproducibility of the subplots. Spatial variability might have had higher effects on water flow, soil displacement and sediment transport than soil treatments.

The field on which plot I was located was harvested on 02.08.2009. Removing plant cover, plastic and disaggregation of top soil caused much higher erosion compared to other plots where crops were remaining until the end of the measuring period.

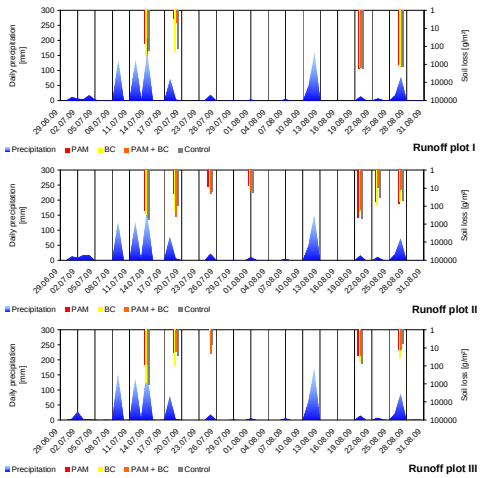

Fig. 3: Rainstorm events and soil loss from runoff plots in Haean catchment (columns belong to current and previous rain events)

Field work 2010 and outlook

For the following season large runoff collectors will be installed in different directions on field sites (Fig. 4) in order to consider preferential water flow along the plastic covered ridges, which are typical for Haean agricultural management. Flow divider systems (Pinson et al. 2004) will be used to handle large amounts of runoff and sediment from the contributing area above the collectors.

In addition, small runoff plots without plastic cover will be placed on the same field sites for investigating the effects of different treatments on bare farmland soil (randomized block design with three replicates for each treatment and control).

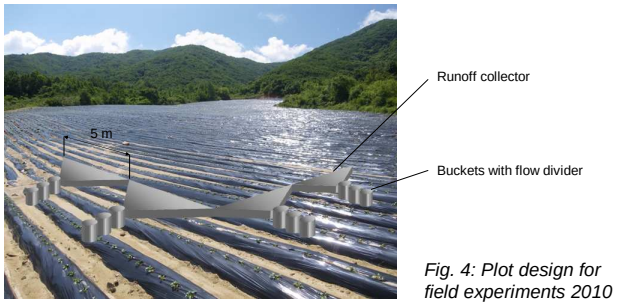

Fig. 4: Plot design for field experiments 2010

By using physically based soil erosion model EROSION 3D (Schmidt 1991) and the hydrological model SWAT 2005 (Bracmort et al. 2006), the total amount of soil loss and sediment export from Haean catchment will be simulated.

Results from erosion measurement and sediment export data with the runoff plots are used to validate these models. Additional infiltration experiments and continuous monitoring of soil hydraulic conditions on test sites during intense rainfall periods will be conducted in order to achieve best model adaptation.

Based on a modeling approach close to reality different scenarios regarding changes in land cover, cultivation measurement and climate will be simulated. This provides the framework for future predictions of soil erosion and for deriving measures to protect agricultural land and surface waters.

References

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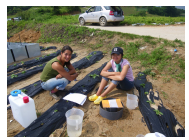


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