A SOIL EROSION AND NON-POINT P-TRANSPORT AT DIFFERENT SCALES – FROM PLOT TO CATCHMENT

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Abstract
Results from plot experiments in a semi-arid mediterranean climate show the significant differences in characteristics for the varying types of runoff. On the plot scale, the low discharge and less turbulent flow of infiltration excess runoff tends to result in lower erosion rates and sediment/nutrient deliveries. Accordingly, a differentiation of runoff types within an entire catchment is important for the identification of sediment and nutrient source areas. Data from the small experimental catchment "Schaefertal" in Germany demonstrate the necessity to identify the runoff generating processes for the characterisation of source areas of sediment and nutrients. The modelling tool WASIM/AGNPS/SMEM/ANIMO was developed to estimate the erosion and nutrient loads of a catchment, with special emphasis on runoff generation and spatial heterogeneity of source areas. The model has the ability to plausibly model the spatial heterogeneity of runoff generation and identify and quantify source areas of sediment, particular nutrients and soluble phosphorus. The application of the model tool shows reliable results for a German and Russian catchment with respect to hydrology and sediment/nutrient yield. A first test of the model tool is conducted for a subcatchment of the Shixia small watershed, Beijing, China.

Additional Keywords: plot experiments, small catchment, model, WASIM, AGNPS, SMEM, ANIMO

Introduction
The main runoff generation processes at the hillslope scale and small catchment scale are well understood. However, runoff mechanisms show a high temporal variability and spatial heterogeneity. Similarly, the sources areas of nonpoint pollution are characterized by a high process dynamic.

Materials and Methods
Field sites
Runoff and erosion plot experiment were conducted in the central western Mediterranean. The site was located on a hillslope with a typical Xerochrept in south-west Sardinia / Italy. Approximately 40 runoff events were recorded of which 10 caused erosion. Catchment monitoring concentrating on discharge and nutrients is conducted in the 1.44 km² in central Germany (150 km SW of Berlin). Additionally data for model application were used from the Shixia catchment, near Beijing, China.

Model
The modelling tool WASIM/AGNPS/SMEM/ANIMO was developed to estimate the erosion and nutrient loads of a catchment, with special emphasis on runoff generation and spatial heterogeneity of source areas. The four core models are linked passively or coupled actively on different computation levels. Results of the soil water simulation from the hydrological model WASIM, for example, is used as input for the phosphorus cycling in ANIMO, estimation of surface runoff volume triggers the erosion model SMEM as well as sedimentation and channel processes in AGNPS.

Results and Discussion
Runoff on a slope is generated either as rainfall excess or infiltration excess. The results from the plot experiments in a semi-arid mediterranean climate show the significant differences in characteristics for the varying types of runoff. In general, runoff generated by rainfall excess has a high time variability with higher maximum discharge than that from infiltration excess. Also, the related erosion and nutrient loss varies depending on runoff characteristics (Figure 1). On the plot scale the low discharge and less turbulent flow of infiltration excess runoff tends to result in lower erosion rates and sediment/nutrient deliveries.

Data from the small experimental catchment "Schaefertal" in Germany demonstrate the necessity to identify the runoff generating processes for the characterisation of source areas of sediment and nutrients. The spatial distribution of soil moisture in a cross section through the valley shows high values in the bottom of the valley and

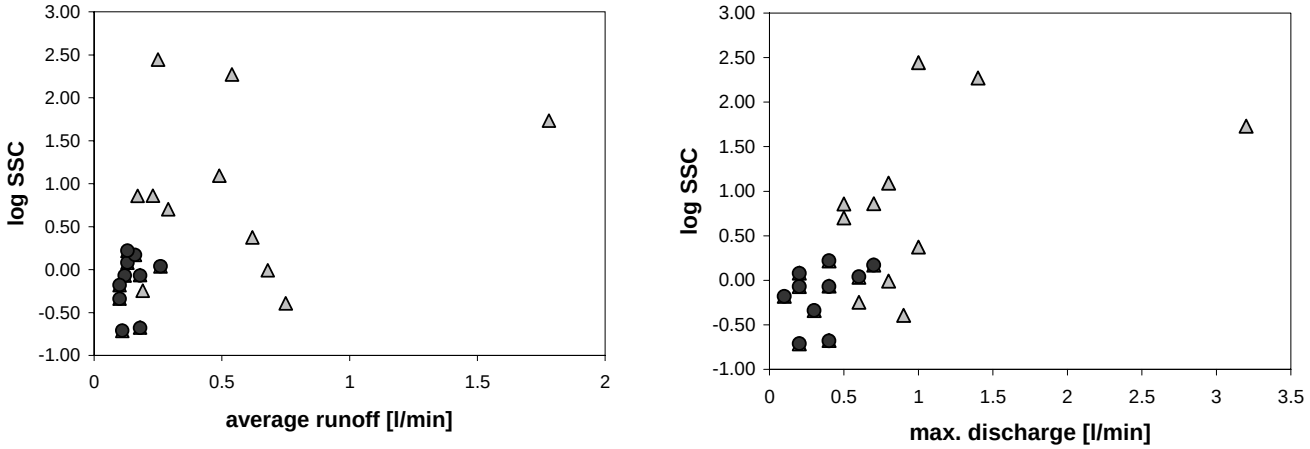

Figure 1. Runoff characteristics and sediment concentration for different runoff generation, results from plot experiments. (black circles – infiltration excess; gray triangles – rainfall excess)

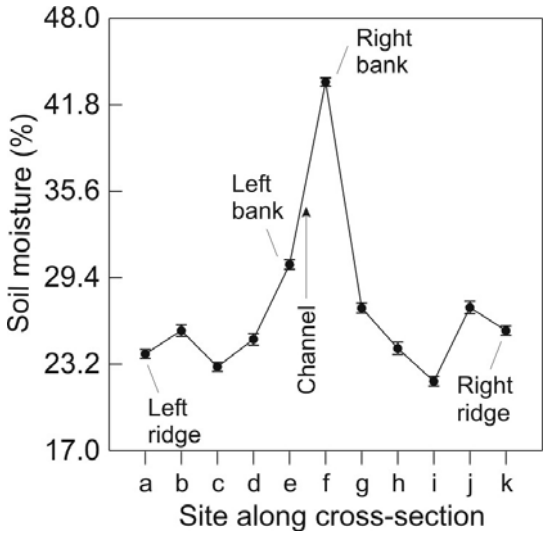

Figure 2. Average soil moisture values from 1.5 years of daily measurement

in the ridge areas (Figure 2). This indicates runoff generation with different mechanism. Typically, saturated overland runoff is generated in the valley near the stream with a high possibility to reach the waterway. Due to longer distances and accelerated processes of sedimentation this is different for the runoff generating areas on the slopes. Accordingly, the pathways and connectivity to the channel for particulate and dissolved phosphorus differ in time and space.

The observed spatially distribution of runoff generation is also reflected in the results of the hydrological model (Figure 3). In combination with the model part AGNPS a complex pattern of sediment and soluble phosphorus transport is achieved (Figures 4 and 5). The simulated source areas and pathways differ significantly for particulate and soluble matters. An application of the model system in the Shixia catchment characterizes the agricultural areas as source areas for sediment and nutrients. However, due to the low slopes in these regions most of the particular matter is accumulated in these relief positions (Figure 6).

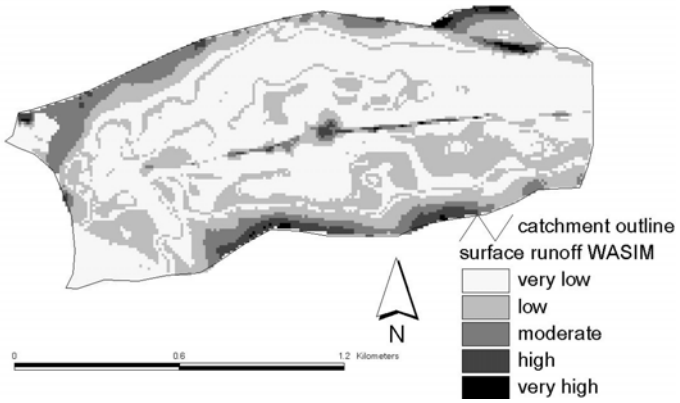

Figure 3. Distribution of surface runoff in the "Schäfertal"; WASIM output

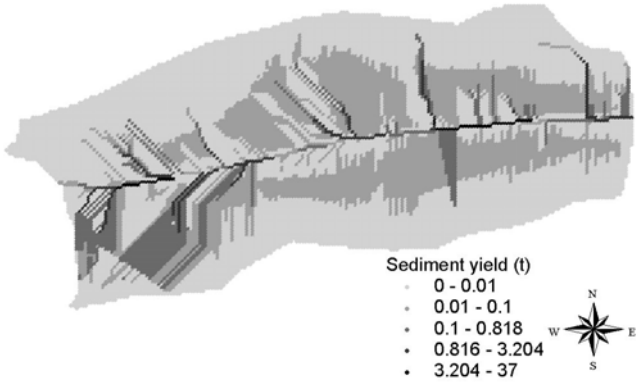

Figure 4. Distribution of sediment yield in the "Schäfertal"; WASIM/AGNPS output

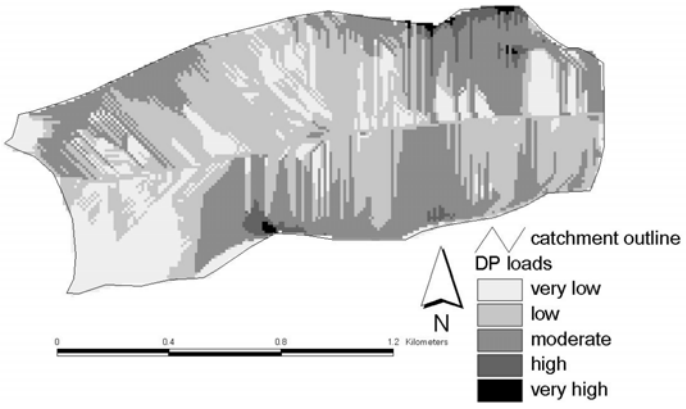

Figure 5. Distribution of soluble Phosphorus yield in the "Schäfertal"; WASIM/AGNPS output

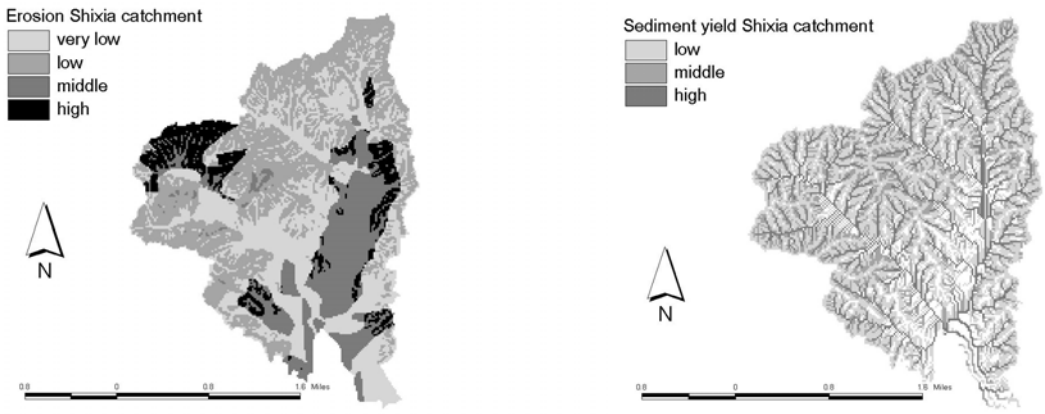

Figure 6. Results of the model application, Shixia catchment

Conclusions

The knowledge about runoff generating mechanisms is of high importance for the characterisation of diffuse pollution source areas and transport pathways. The temporal variability and spatial heterogeneity of runoff processes at a catchment scale triggers the loads of particulate and soluble matter differently. The presented modelling tool has the ability to distinguish between different runoff types, plausibly model the spatial heterogeneity of runoff generation, identify and quantify source areas of sediment and particular nutrients, and model the dynamic character of soluble phosphorus source areas. The application of the model tool shows reliable results for a German catchment with respect to hydrology and sediment/nutrient yield.

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