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Identification of hillslope hydrological process units - Experimental studies on hillslope runoff generation in a small catchment in Germany

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In the small catchment "Obere Brachtpe" (2,5 km^2), Sauerland, central west Germany, runoff generation processes have been investigated since 2000 with a hydrometric, hydrochemical and soil physical approach. The experimental investigations have been focused on the analysis of the influence of relief, soil and soil moisture dynamics on the discharge processes at the plot and hillslope scale. A very important aim was to analyse the influence of the slope form (convergent, divergent, uniform) on the hillslope runoff processes, to identify a hillslope as a hydrological process unit and to explore what are the dominant process controls. The interactions between the different landscape units hillslope and riparian zone were analysed. Especially the flat "riparian zone" is important for the runoff generation, because this unit controls the transmission of water from the hillslope to the stream.

For the process studies four soil hydrology measurement locations and fourteen piezometers are installed in the catchment "Obere Brachtpe". The measurement locations are arranged in a gently convergent slope ranging from the upper slope to the riparian zone. They are equipped with several tensiometers installed in different depths (20 to 200 cm). The water suction is registered automatically every 10 minutes. Moreover the precipitation and the runoff are measured at the catchment outlet in a 10 min- respectively 15 min-interval. The groundwater gauges are fitted with pressure heads and dataloggers (10 min-interval) and arranged in two sections vertical to the valley. The first section is installed in a gently convergent slope, the second at the foodslope

of a divergent slope.

Based on the relationship between groundwaterlevel respectively soil moisture and the runoff measured at the catchment outlet, the hillslope catchment area can be distinguished between two hydrological systems; the “upslope zone” and the “riparian zone”. While the relationships of the gauges in the riparian zone have an exponential correlation and indicate a groundwater storage, the relationships of the gauges in the upslope zone show a linear correlation. Reason for this diversification in the relationship is the decreasing slope inclination and consequently the decreasing flow gradient in the riparian zone. The analysis of temporally high-dissolved data of the groundwater dynamics in relation to the discharge of the receiving stream during several rainfall/runoff events shows the influence of the flat „riparian zone“ on the runoff processes. Caused by the small slope inclination the velocity of water flow is reduced and groundwater from the slope is transported to the channel with a time lag. Due to this delayed groundwater flow the runoff in the receiving stream also shows a delayed increase. But the transforming reaction of the riparian zone between slope and receiving stream isn‘t always the same it rather depends on the topical moisture conditions, which are represented by the groundwater level and the soil moisture. Summarized, the laged increase of runoff at the catchment outlet can be explained by the groundwater dynamics at the convergent hillslope. Moreover the analysis of temporally high-dissolved measuring data of the groundwater dynamics contributes to a deeper understanding of the influence of relief on the runoff processes and the interactions between upslope zone, riparian zone and the runoff.