Geophysical Research Abstracts
Vol. 13, EGU2011-8326-1, 2011
EGU General Assembly 2011

Field measurements of surface runoff in lowland catchments

Willemijn Appels and Sjoerd van der Zee
Wageningen University, Soil Physics, Ecohydrology and Groundwater Management, Netherlands (willemijn.appels@wur.nl)

In groundwater dominated lowland catchments the larger part of precipitation on drained agricultural fields recharges the groundwater or reaches surface waters through subsurface drains. However, shallow subsoil structure deterioration due to sealing or compaction, shallow groundwater tables and long and intense precipitation events facilitate ponding of water at the soil surface. During a rainfall event, the ponded area on the field expands and surface runoff reaches the field boundaries when one or more series of ponds form continuous flow paths to the channels and ditches surrounding the field. To understand catchment discharge characteristics it is important to quantify the relative contributions of different flow routes in a catchment. Also, as surface runoff is the main contributor of pesticides and one of the main contributors of phosphorus to surface-water bodies, it plays an important role with regard to the contamination, the eutrophication, and the implications for ecological functioning of aquatic ecosystems.

The field measurements performed in this study are part of a project that aims to quantify the size of the surface runoff contribution to the local and regional water balance in lowland catchments. At two agricultural fields in the Netherlands we installed gutters close to the ditches surrounding the fields from which we measured the flow rate and quantity of surface runoff. We operated TDRs, tensiometers, and piezometers to monitor the moisture conditions in the field before, during, and after surface runoff events. In addition to the measurements during the natural events, we also performed a rainfall simulation event at one of the fields to study the formation of ponding and spilling in more detail.

During the 1.5 years of operation of the equipment, surface runoff was observed in four periods. At both sites surface runoff reached the field boundaries only when the soil in part of the field was saturated and the lag time between rainfall events was small. Hortonian runoff on a relatively dry soil was observed, but not measured as the water infiltrated before reaching the measurement gutters. Similarly, prolonged ponding (> 1 day) was observed at parts of the fields, but water spilling from the ponds reached the measurement gutters only on a few occasions.

The differences in the development of the surface runoff events at the two locations originated mainly from the microtopography and soil composition.
At location 1, surface runoff developed from the spilling of a large shallow depression. The filling of this depression was enhanced by (1) its location a bit further away from the ditches where the groundwater level was close to the surface in winter and (2) the deposition of fine sediments when ponding occurred, that decreased the infiltration capacity of this part of the field. The surface runoff flow eroded a preferential flowpath towards the ditch, that remained present after next season's tillage operations. This was also observed in field experiments at similar sites in the Netherlands.
At location 2, surface runoff developed more evenly on the field as (1) spatial variations of soil moisture content were small in its shallow (< 1.5 m) unconfined aquifer and (2) the microtopography was more random (field was grazed by cows) and the field slope of 1.5% larger than that of location 1. Surface runoff started close to the measurement gutters and the contributing area expanded during the rainfall events. No preferential flowpaths were eroded because of the grass cover.
The results of the field experiments were combined with conceptual modelling that investigated the development of hydrological connectivity at the fields as a function of microtopography and soil characteristics.