

The delayed runoff reaction of the Schaechen River in August 2005 – How can this reaction be explained?

Simon Scherrer*

*Scherrer AG – Hydrologie und Hochwasserschutz, General Guisan-Strasse 22, CH-4153 Reinach; scherrer@scherrer-hydrol.ch

The Schaechen River is a tributary of the Reuss River located in the central Swiss Alps (Canton Uri) above Altdorf. The valley altitude reaches from 450 to 3300 m asl and shows a complex geological and tectonic structure and a typical alpine geomorphology due to intense glacial, fluvial and gravitational processes. The steep morphology of the hill-slopes let assume a rapid runoff formation.

In August 2005 a large rainfall of about 200 mm during 5 days, including an intensive period lasting 2 days, has been observed in the Schaechen basin (108 km²). However, the discharge increment was rather delayed. When a precipitation volume of about 100 mm has been measured, runoff of the Schaechen started to increase, after another 100 mm of precipitation peak discharge of about 100 to 120 m³/s was reached. Then discharge declined slowly and stayed for some days on a relatively high level. The first inspection of the catchment revealed no hints for such a delayed reaction. Thus, the initiated flood study tried to bring light into this unorthodox runoff response.

Scherrer (1997) showed the crucial role of soils in runoff formation. Thus, the soils in the catchment were mapped by interpretation of topographic and geomorphologic maps of Sandri (1987), the geology described by Hantke (1961) and Brückner et al. (1987), the hydro-geological map of Jäckli et al. (1985), airborne photos and by additional field investigations. Soil type, depth and structure (texture, macropores, layers, etc.) were described. Then, the infiltration capacity and storage volumes of the soils were evaluated and the dominant runoff processes (DRP) were identified following the decision scheme of Scherrer & Naef (2003). Thus, hill-slopes with shallow soils were classified as rapidly responding due to saturated overland flow (SOF) or subsurface flow (SSF); deeper, permeable soils were evaluated as delayed reacting areas (delayed SOF or SSF). In the basin, even steep hill-slopes are covered with permeable deposits (moraine, debris, etc.), which have potential to store large volume of water. Due to the predominance of such permeable deposits extensive areas were mapped as deep percolation (DP) where water infiltrates and is temporally stored.

DRP with similar runoff reaction were summarized as runoff types (Runoff type 1 – 5), which are displayed in Figure 1. Runoff type 1: fast reaction (1.6% of basin area); runoff type 2: slightly delayed (14.7%); runoff type 3: delayed (26.2%); runoff type 4: strongly delayed (33.6%) and 5 very strongly delayed (23.9%). The distribution of the runoff type 4 and 5 with more than 56% of strongly and very strongly delayed reacting areas explains the delayed response of the Schaechen during extensive storm events.

During large rainfall events, however, these deposits start to drain and to contribute to flood runoff and get a crucial role in runoff formation. Consequently, to estimate the magnitude of extreme floods, the drainage of such permeable deposits must be considered. In the case of the Schaechen River drainage behaviour has been evaluated due to the depth and structure of these deposits, hydrograph interpretations and experience of other flood studies gained in alpine basins (e. g. Saltina, Brig). Then a rainfall-runoff model has been developed and the reaction of the basin to extreme precipitation has been investigated. In the alpine region geological deposits (e. g. moraines, talus, etc.) are quite common. To gain more insight in the mapping and the hydrological evaluation of the drainage of these deposits, additional research is required. This is one important step to improve the understanding of flood formation and to make estimation of peak flow in alpine catchments more reliable.

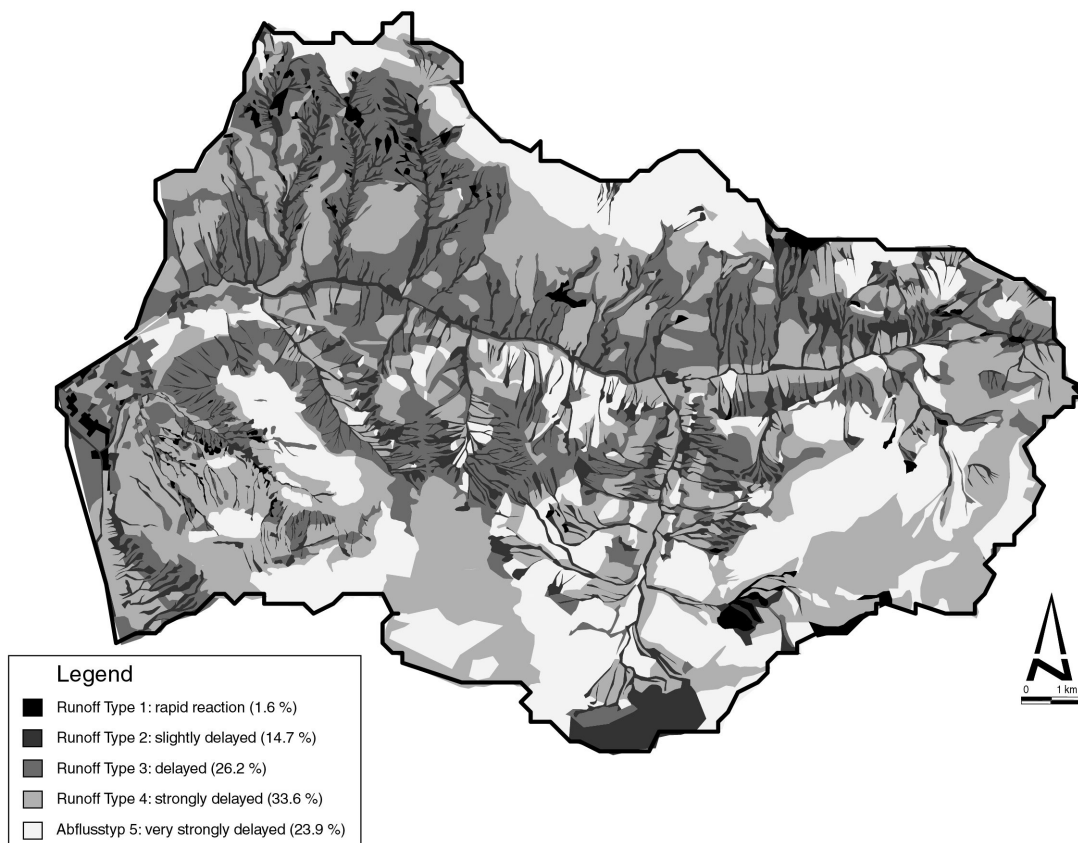


Figure 1: Distribution of the different runoff types throughout the Schaechen River basin. Runoff type 1 generates quickly runoff and covers 1.6% of the basin. Runoff type 4 and 5, which produce extremely delayed runoff, cover about 57% of the basin.

REFERENCES

- Brückner, W. & Zbinden, P. 1987: Geologischer Atlas der Schweiz, Blatt Nr. 83 (1192) Schächental.
- Jäckli, H., Bögli, A., Locher, T., Nabholz, W., Schindler, C., Weber E. & Wyssling, L. 1985: Hydrogeologische Karte der Schweiz. Blatt Nr.3, Panix.

Hantke, R. 1961: Tektonische Karte der helvetischen Kalkalpen zwischen Obwalden und dem St.Galler Rheintal 1:100 000.

Sandri, A., 1987: Untersuchungen Einzugsgebiet Gangbach, Gemeinde Schattdorf.

Scherrer, S. & Naef, F. 2003: A decision scheme to indicate dominant flow processes on temperate grassland. In: Hydrological Processes, 17, 391-401.

Scherrer, S., Naef, F., Faeh A. O. & Cordery, I. 2006: Formation of runoff at hill-slope scale during intense precipitation. Hydrology and Earth System Science, 11, 2, 907-922.

Scherrer AG (2007): Hydrologische Grundlagen des Schaechens für den Hochwasserschutz des Urner Talbodens und das Generelle Projekt Schaechen. Im Auftrag de Amtes für Tiefbau, Kt. Uri.