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Hydrological and hydrochemical impact studies in the urbanised Petrusse river basin (Luxembourg)

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On the basis of ancient topographical maps, the growing urbanisation of the Petrusse river basin (42.9 km2) has been documented on 50-year time steps since 1770. While until the 1950's urban areas remained below 10% of total basin area, they are now close to 50%. This rapid change has consisted mainly in a change from cropland into built areas. As a direct consequence of these considerable changes in landuse, the basin presumably has undergone significant modifications of both its hydrological regime and the quality of the flowing surface waters. In the framework of a national monitoring programme, the Petrusse basin has been progressively equipped with 3 recording streamgauges between 1999 and 2003. Several meteorological stations are located in the immediate vicinity of the basin.

The hydrological regime revealed by the 15-minute recordings of the streamgauges is very specific to heavily urbanised basins, i.e. characterised by quick reactions to incoming rainfall, as well as very limited contributions from sub-surface and groundwater reservoirs. A conceptual hydrological model has been used to evaluate roughly the impact of the progressive urbanisation of the Petrusse basin since 1770 on the rainfall-runoff relationship. Major changes were found for summer months, with significantly higher peak discharges and increasingly rapid reactions to rainfall events. However, the limitations of the spatial density of rainfall recordings (only 1 rainfall measurement site available between 1854 – 1949) cause severe shortcomings in the accuracy of the incoming rainfall estimations, especially in the case of convective rainfall events. This in turn also considerably reduces the accuracy of the historical rainfall-runoff simulations.

Between 2002 and 2004, several monitoring campaigns have been carried out in the Petrusse basin in order to determine the impact of sewer system contributions from the urbanised areas to the water quality within the Petrusse. The investigations have shown a very strong so-called first-flush effect. During dry sequences, numerous deposits on roads and roofs (heavy metals, oils, etc.) accumulate, before being washed away during the first minutes of rainfall events and being ultimately being transported to the Petrusse river via the sewer systems, causing considerable pollution peaks.

Current investigations target a reduction of this pollution. The involved volumes of polluted water are of such extent, that they cannot be dealt with by conventional waste water treatment systems.

The currently existing rainfall measurement network around the city of Luxembourg has a spatial resolution that is still too low to capture accurately convective rainfall events. A new rainfall measurement approach will soon be tested to estimate spatio-temporal rainfall dynamics with a high resolution above the city of Luxembourg. Based on a combination of conventional raingauges, weather radar and microwave measurements (via cell-phone networks) this approach is supposed to provide data that might ultimately contribute to a real-time management of the first flush pollutions in the Petrusse river basin.