Geophysical Research Abstracts
Vol. 16, EGU2014-12783, 2014
EGU General Assembly 2014
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An Open Source approach to automated hydrological analysis of ungauged drainage basins in Serbia using R and SAGA

Nikola Zlatanovic, Irina Milovanovic, and Jelena Cotric
Institute for the Development of Water Resources, Belgrade, Serbia (zzznikola@gmail.com)

Drainage basins are for the most part ungauged or poorly gauged not only in Serbia but in most parts of the world, usually due to insufficient funds, but also the decommission of river gauges in upland catchments to focus on downstream areas which are more populated. Very often, design discharges are needed for these streams or rivers where no streamflow data is available, for various applications. Examples include river training works for flood protection measures or erosion control, design of culverts, water supply facilities, small hydropower plants etc.

The estimation of discharges in ungauged basins is most often performed using rainfall-runoff models, whose parameters heavily rely on geomorphometric attributes of the basin (e.g. catchment area, elevation, slopes of channels and hillslopes etc.). The calculation of these, as well as other paramaters, is most often done in GIS (Geographic Information System) software environments.

This study deals with the application of freely available and open source software and datasets for automating rainfall-runoff analysis of ungauged basins using methodologies currently in use hydrological practice. The R programming language was used for scripting and automating the hydrological calculations, coupled with SAGA GIS (System for Automated Geoscientivic Analysis) for geocomputing functions and terrain analysis. Datasets used in the analyses include the freely available SRTM (Shuttle Radar Topography Mission) terrain data, CORINE (Coordination of Information on the Environment) Land Cover data, as well as soil maps and rainfall data. The choice of free and open source software and datasets makes the project ideal for academic and research purposes and cross-platform projects.

The geomorphometric module was tested on more than 100 catchments throughout Serbia and compared to manually calculated values (using topographic maps). The discharge estimation module was tested on 21 catchments where data were available and compared to results obtained by frequency analysis of annual maximum discharge.

The geomorphometric module of the calculation system showed excellent results, saving a great deal of time that would otherwise have been spent on manual processing of geospatial data. This type of automated analysis presented in this study will enable a much quicker hydrologic analysis on multiple watersheds, providing the platform for further research into spatial variability of runoff.