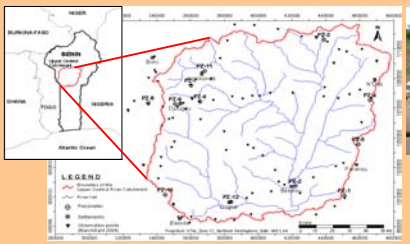
Groundwater flow in the tropical river catchment of the Upper Ouémé valley (Central Benin)

Tobias El-Fahem, Thorsten Fass & Barbara Reichert

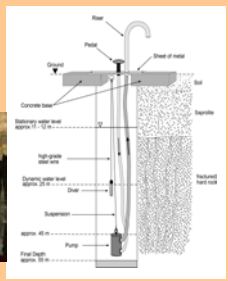
Geological Institute, University of Bonn, Nussallee 8, 53115 Bonn
elfahem@uni-bonn.de

A regional monitoring program in the Upper Ouémé catchment area (14.500 km²) was initiated in April 2004. Aim of this program is the determination of the general flow pattern inside the catchment and the localisation of the groundwater divide according to the surface watersheds. Besides snap shot measurements a continuous monitoring system was installed consisting of 12 automatic measuring water level devices (diver) into both available piezometers and pedal pumps all over the catchment area. With those divers it is possible to observe the daily drawdown and recovery during the night in detail.

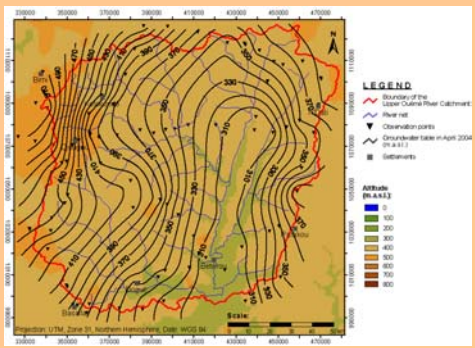


Location of the study area and position of divers and groundwater observation points.

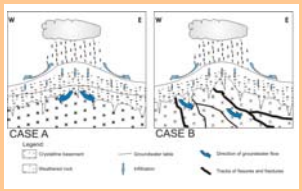
Diver installation in a bore-hole of a pedal pump (left) and in a DANIDA/ PADEAR piezometer (right). (Photos by M. Sarvan)



Scheme of a borehole (SH Djougou) showing the average diver position.



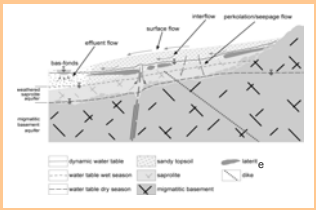
Map of groundwater contour lines (April 2004).



Possible in/out-flux over the surface water-shed due to fractures in the basement.

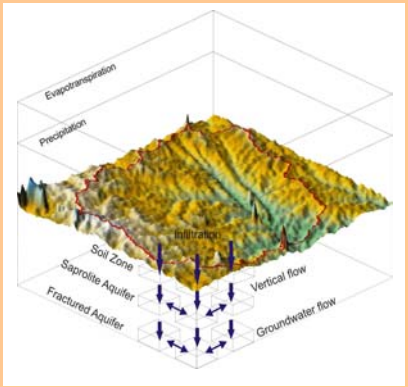
Measurements from 79 observation points were used to draw water table contour lines for the study area. Each point has coordinate references taken by a GPS in the field, which were verified in position and altitude by the digital elevation model elaborated from SRTM satellite images (resolution 90 x 90 m). A linear approximation was used for the geostatistical interpolation of the data by the kriging procedure.

The surface water net follows the structural tectonic pattern. Especially the prominent Kandi fault crossing the catchment area from NE to the S seems to be decisive. In respect to groundwater flow the fault seems to lead to a discharging effect on the groundwater table towards the south. In general the water table lines suggest that there is additional influx of groundwater from outside the catchment area.



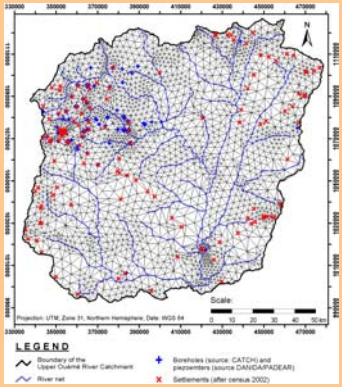
Local conceptual hydrogeological model (FASS, 2004).

Based on the conceptual hydrogeological model (FASS, 2004) developed during the first IMPETUS campaign from 2000 – 2003 and the data from the ongoing field investigations a three-dimensional finite element has been developed with FEFLOW 5.1 (WASY, 2004). The first rough model mesh will be refined step by step using the results of the ongoing data acquisition and field investigation.



Structural concept of the flow model based on the digital elevation model of the Upper Ouémé catchment.

The model area covers almost the whole Upper Ouémé river catchment. Discretisation is made by triangular elements. The element net is flexible. The size and proportion of the elements can be changed or rearranged even during the modelling phase. Information is given to the nodal points which are connecting the elements. Therefore a number nods had already been placed during the mesh generating process on the coordinates of points of information in the study area. Such locations are the villages contained in the census 2002, the diver positions and the boreholes investigated by the CATCH project. Actually the model contains 4994 elements and a number of 2592 nodes. Refinement is already given to the rivers to allow the implication of streaming routes into the model by sufficiently available data.



2D finite element net (FEFLOW 5.1). Refined discretisation around villages, known boreholes, divers and rivers.

References:
Fass, T. (2004): Hydrogeologie im Aguima Einzugsgebiet in Benin / Westafrika. Elektronische Dissertation der Mathematisch-Naturwissenschaftlichen Fakultät der Universität Bonn.
Jacquin, F. & Seygona, Z.Y. (2004): Contribution à l'étude du fonctionnement hydrodynamique des aquifères du bassin versant de la Donga. ORE AMMA/CATCH, IRD, Cotonou, Bénin.
WASY (2004): FEFLOW version 5.1, Finite Element Subsurface Flow and Transport Simulation System. Institute of Water Resources Planning and System Research Ltd, Berlin, Germany.

Acknowledgment
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