Journal of Hydrology: Regional Studies 19 (2018) 136–163

Contents lists available at ScienceDirect

Journal of Hydrology: Regional Studies

journal homepage: www.elsevier.com/locate/ejrh

Impact of hydraulic and storage properties on river leakage estimates: A numerical groundwater flow model case study from southern Benin

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ARTICLE INFO

Keywords:
Benin
Discharge loss
Flow modelling
Groundwater recharge
Ouémé
River leakage

ABSTRACT

Study area: The coastal sedimentary basin including the Zou and Ouémé rivers in Benin.
Study focus: River discharge loss is known to occur on the Zou and Ouémé rivers in southern Benin since a couple of decades ago. The reason behind this discharge reduction remained so far unclear. In this study, we focus on creating a 3D-numerical model of the system and on evaluating the sensitivity of leakage between the rivers and aquifers to various parameters.
New hydrological insights for the region: Results show that leakages along the Zou river and Ouémé stream are tiny (i.e., ~3% of the discharge losses). This implies that the observed water loss from the Zou and Ouémé rivers is not likely caused by the leakage (infiltration) along these rivers into the subsurface. The streambed conductance is found to be among the factors that impact less the computed leakages in the study area. This study has ranked the different hydraulic and storage properties in their order of importance with respect to the computation of river leakages along the concerned rivers. The determined rank of importance of the hydraulic and storage properties can guide river leakage modelling exercises in similar regions elsewhere.

1. Introduction

In southern Benin, surface water is hardly exploited for drinking purposes. Rather, for the majority of the population, groundwater is the main source of water supply. Though surface waters are not exploited, Le Barbe et al. (1993) reported losses in water discharge along the Zou river and Ouémé stream (Figs. 1 and 2) which are located in southern Benin. Le Barbe et al. (1993) indicated that upstream discharges on the Zou river (at Atcherigbe gauging station, see Fig. 2) are higher than the discharges downstream (Dome's gauging station), meaning that there is a loss of water between these two gauging stations (Atchérigbé and Dome gauging stations). In relatively high rainy years (e.g.: 2003, 2007) the discharge loss is well pronounced. The same remark is valid along the Ouémé stream (Le Barbe et al., 1993) between Savè and Ahlan gauging stations (see Fig. 1 for the gauging stations location).

The cause of this discharge loss is so far unclear and the main motivation of this research is to share light regarding the causes of

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https://doi.org/10.1016/j.ejrh.2018.07.004
Received 25 February 2018; Received in revised form 24 July 2018; Accepted 30 July 2018

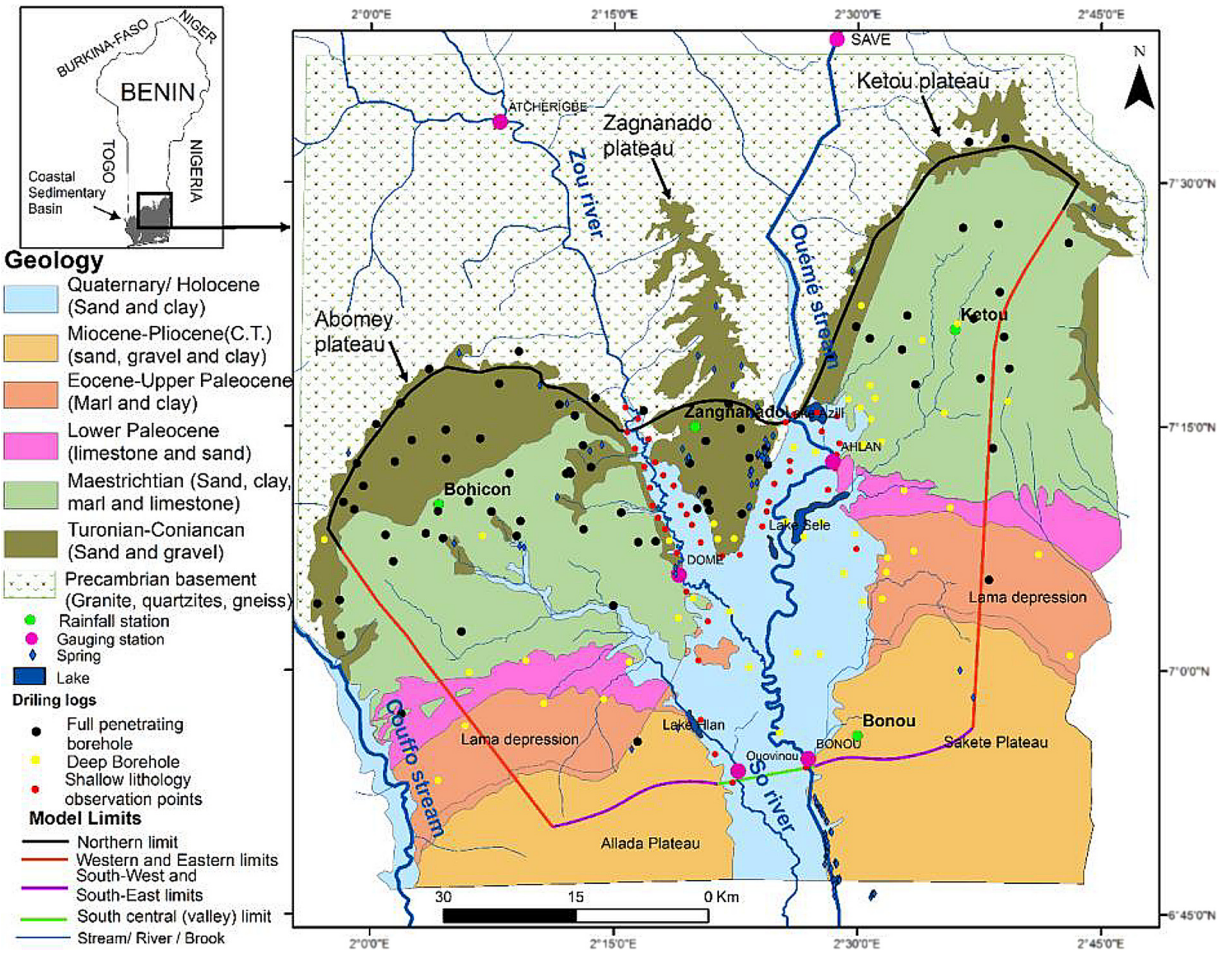

Fig. 1. Geologic map of the study area showing the location of the drilling logs used for the stratigraphic model, the model limits, rivers, lakes and springs, rainfall stations and gauging stations (modified from Kpegli et al., 2018).

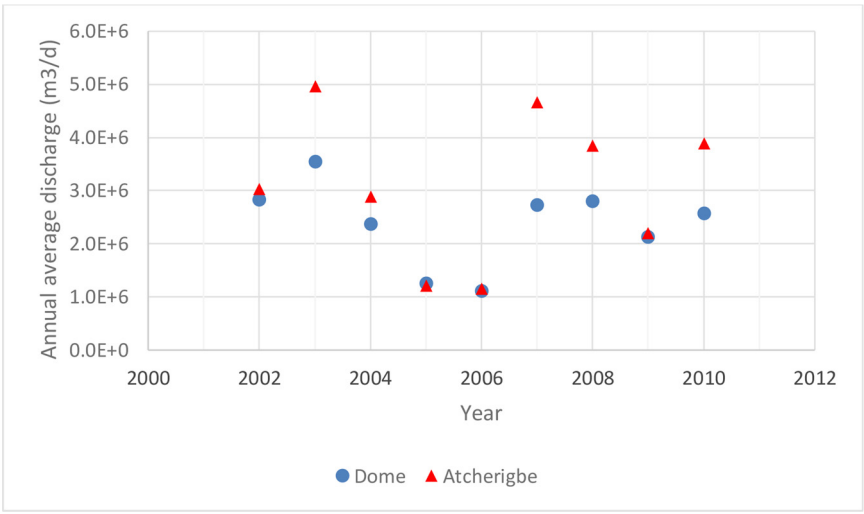

Fig. 2. Annual river discharge at two gauging stations (Dome and Atcherigbe; data source: DGEau), illustrating loss in water discharge between the two gauging stations, the location of the gauging stations is shown on Fig. 1.