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A Water Balance Model for Hill reservoir – Aquifer Exchange Water Flux Quantification and Uncertainty Analysis – Application to the Kamech catchment, Tunisia

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In Mediterranean regions, food and water demand increase with population growth leading to considerable changes of the land use and agricultural practices. In North Africa, particularly in the Mediterranean zones, hill reservoirs are water harvesting infrastructures that have been increasingly adopted to mobilize runoff and create alternative water resource that can be used to develop agriculture. Hill reservoirs are also used to prevent from silting of downstream dams. Management of water resources collected in these infrastructures requires a good knowledge of their hydrological functioning. In particular, the rate of water exchanges between the reservoir and the underlying aquifer, called surface-subsurface exchange hereafter, is still an open question.
The main purpose of the study is to better know the hydrological functioning of hill reservoirs in quantifying at the annual and intra-annual time scales the flux of surface-subsurface exchange and the uncertainty associated to the flux. The approach is based on the hydrological water balance of the hill reservoir. It was applied to the hill reservoir of the 2.6 km^2 Kamech catchment (Tunisia), which belongs to the long term Mediterranean hydrological observatory OMERE (Voltz and Albergel, 2002). The dense monitoring of the observation catchment allowed quantifying the fluxes of all hydrological processes governing the reservoir hydrology, and their associated uncertainties. The water balance was established by considering water inputs (direct rainfall, waddy and hillslope runoff, surface-subsurface exchange), water outputs (evaporation, spillway discharge) and hill reservoir water volume changes. The surface-subsurface exchange component was deduced as the default closure term in the water balance.
The results first demonstrate the ability of the proposed approach to estimate the net surface-subsurface exchange flux and its uncertainty at various time scales. Its application on the Kamech catchment for two hydrological years (09/2009-08/2010 and 09/2010-08/2011) shows that the net surface-subsurface exchange flux is positive, i.e. the infiltration from the hill reservoir to the aquifer predominates the discharge from the aquifer to the reservoir. Moreover the surface-subsurface exchange constitutes the main output component in the water balance. The annual surface-subsurface exchange flux appeared almost constant from one year to the other one whatever the hydrological conditions variability over the catchment. Moreover, the analysis of the intra-annual variability shows that the flux was nearly constant within every year.

Reference:
Voltz , M. and Albergel , J., 2002. OMERE : Observatoire Méditerranéen de l'Environnement Rural et de l'Eau - Impact des actions anthropiques sur les transferts de masse dans les hydrosystèmes méditerranéens ruraux. Proposition d'Observatoire de Recherche en Environnement, Ministère de la Recherche.