ESTIMATION AND CONDITION OF GROUNDWATER RECHARGE IN SEMI-ARID ZONE

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Abstract

In a recharge area characterized by a semi-arid or arid climate, and a low annual rainfall, aquifers can be hardly recharged adequately, as it was demonstrated by classical monthly hydrological balance computations; therefore the mathematical modeling can be difficult. The methodology proposed in this work relies on spatial and temporal interpolation of scarce climatic data. This methodology can be used to determine the recharge flow of aquifers in these zones. The Ain Sefra's syncline (Western Saharan Atlas, Southwest Algeria) forms an excellent example for this application. Three years with different annual rainfalls are chosen in this application: 1983 as dry year, 2006 as average year, and 2008 as humid one to define three conditions of groundwater level. This application requires information about the soil nature, the surface and the altitude of the recharge areas. The rainfall and the recharge flow of aquifers indicate that the principal recharge areas are the Jurassic outcrops in the humid years, when the annual rainfall exceeds 300 mm. These results helped to complete the model input data and obtained a hydrodynamic model to manage resources water in this zone.

Keywords: groundwater, arid zone, groundwater recharge, Ain Sefra's syncline.

Introduction

In semiarid areas, where the climatic conditions are extremewith irregular rainfalls and high temperatures, how could weimagine a possible recharge?

Many of physical and tracer methods to estimate the groundwater recharge are developed to determinate this parameter in semiarid zone (the chloride mass balance, the water-table fluctuation method, and the groundwater age dating method…), but all of them use many parameters. The interaction of climatic, geological, morphological, and soil and vegetation conditions are the responsible factors for the determination and evaluation of processes.

Methodology

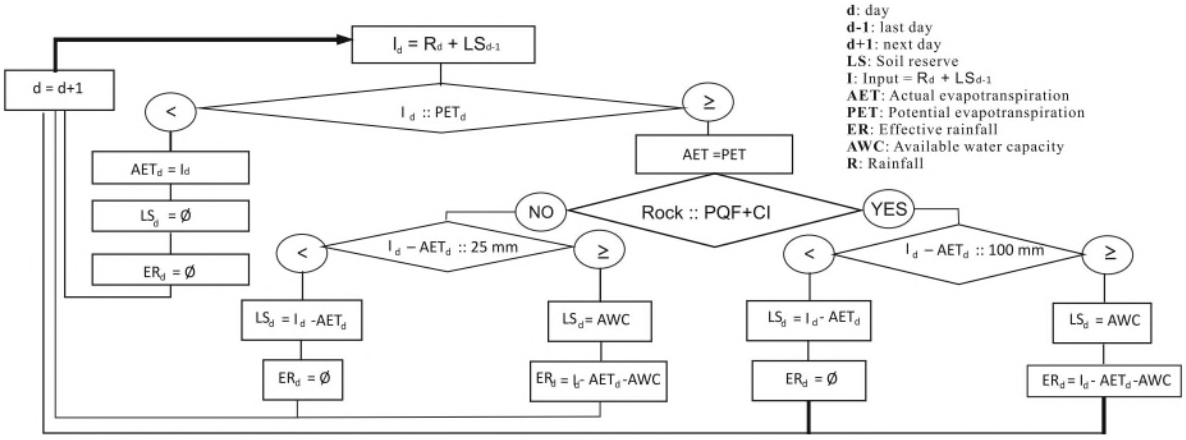
The aim of this work is to describe the method to estimate aquifer recharge subject to semiarid conditions, to define a way of filling gaps in climatic data, and to confirm that a considerable amount of recharge to depression aquifers occurs near the mountain front.

It presents an example of application in the West Algerian Saharan Atlas. This region contains an important unconfined Continental Intercalary aquifer in the large

depression (elevation: 1,050 m) surrounded by the Jurassic mounts (elevation ranging between 1,200 and 2,100 m).

The effective rainfall is a significant parameter in groundwater studies, which is not easy to determine. This is a consequence of the temporal variability of precipitations and other hydrometeorological variables in such climates and the spatial variability in soil characteristics, geology, topography, land cover characteristics, and land use. Therefore, this estimation is difficult when the meteorological data are scarce and incomplete in space and time. The methodology presented in this paper is oriented towards the estimation of effective rainfall in a catchment characterized by a semiarid or arid climate. The method couples two approaches.

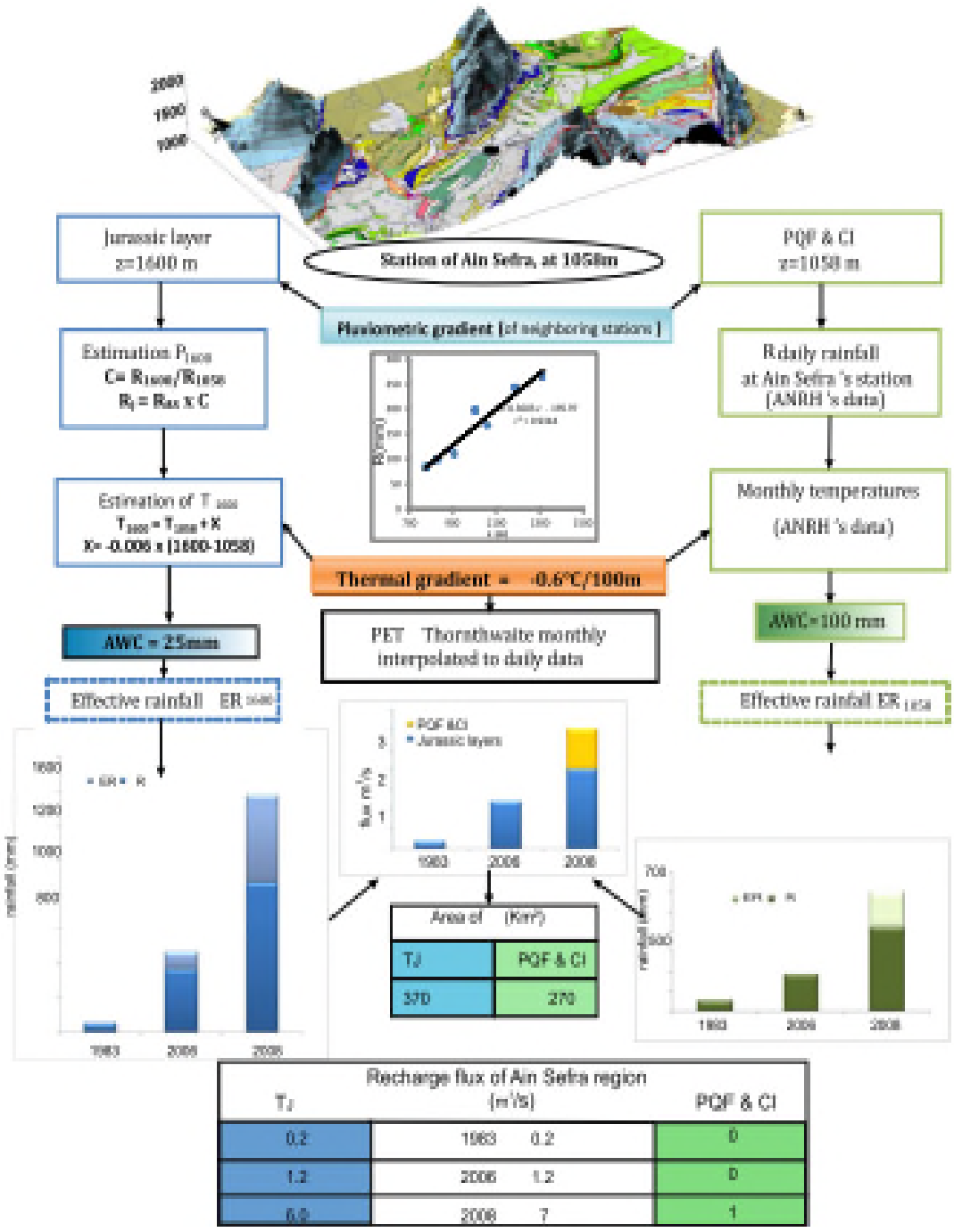
This approach has been applied to three contrasted years among the 30 studied (1982–2010): 1983, 2006, and 2008, which represent a dry year when rainfall is below 15 mm, a year with average rainfall between 0.5 and 50 mm and particularly rainy one with a total of 442 mm, respectively. The computed precipitations and temperatures at high altitudes (Jurassic with an average altitude of 1,600 m) and depressions (with an average altitude of 1,058 m) are used to determine the daily PET and effective rainfall (ER).



Flowchart enabling calculation of AET and ER

Results

From the above results, we can calculate a recharge rate of the CI sandstone aquifer of AinSefra by outcrops as well as the Plio-Quaternary formations (PQF + CI) and the Jurassic recharge area (T J). The following chart summarizes and explains the application of this approach to the AinSefra region.



Recharge flux of Ain Sefra region (m³/s)		
TJ		PQF & Cl
0.2	1983 0.2	0
1.3	2006 1.2	0
8.0	2008 7	1

Flow chart of water balance