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TECHNICAL NOTE - CIVIL ENGINEERING

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Comment on "Distributed Recharge Estimation for Groundwater Modelling Using WETSPAA Model—Gaza Strip, Palestine" by Adnan M. Aish, O. Batelaan and F. De Smedt

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Abstract Groundwater recharge is an important component of water budget for any catchment. Quantification of recharge from rainfall is a big challenge for hydrologists, as there is no accurate and robust method to rely upon. Different methods can be found in the literature Xu and Beekman (UNESCO IHP Series No. 64, 2003), but the selection of the appropriate method depends on site characterisation and data availability. This short communication discusses the paper "Distributed recharge estimation for groundwater modelling using WETSPAA model—Gaza Strip, Palestine" by Adnan M. Aish, O. Batelaan and F. De Smedt, and the resulting groundwater recharge amount. A comparison of recharge amount and spatial distribution resulting from the paper and other studies from the literature has been made. This comparison shows that the resulting rainfall recharge of Aish et al. (Arab J Sci Eng 35(1B):155–163, 2010) in some areas is almost double that found in literature.

Keywords Rainfall recharge · Gaza Strip · WETSPAA model · Water budget

الخلاصة

إن تغذية المياه الجوفية هو مكوّن هام في ميزانية المياه لأي تجمع مياه ، حيث إن تحديد كمية إعادة الشحن لمياه الأمطار يشكل تحديا كبيرا لعلماء الهيدرولوجيا، إذ لا توجد طريقة صحيحة وقوية يمكن الاعتماد عليها. ويمكن الاطلاع على أساليب مختلفة في المرجع العلمي [1]، ولكن اختيار الطريقة المناسبة يعتمد على خصائص الموقع وتوافر البيانات.

تناقش هذه الورقة العلمية "تقدير التغذية الموزعة في نمذجة المياه الجوفية باستخدام أنموذج WETSPAA - قطاع غزة، فلسطين" بوساطة عدنان محمد العيش و بيتلان و شيمدت، وكمية تغذية المياه الجوفية الناتجة عن ذلك. وقد تم إجراء مقارنة بين كمية التغذية والتوزيع المكاني الناجم عن الورقة وغيرها من الدراسات من الأدب.

وتبيّن هذه المقارنة أن تغذية مياه الأمطار الناتجة من العيش وآخرين عام 2010 في بعض المناطق هي تقريبا ضعف تلك الموجودة في الأدبيات.

Rainfall is the main source of groundwater recharge in arid and semi-arid zones. Estimation of groundwater recharge from rainfall is not easy, as it requires much data on different parameters such as soil properties and hydrogeology.

There are various methods that can be used for rainfall-recharge estimation. These methods include, but not limited to, water balance approach, chloride mass balance, isotopes analysis, and cumulative rainfall departure [1]. Selection of the appropriate method depends on site characteristics and data availability.

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Table 1 Some results of groundwater recharge in the literature [5]

Source	Method	Value (million m^3/year)
Fink [6]	Change in aquifer storage	33–67
Melloul and Bachmat [7]	Recharge coefficients	41
IWACO and WRAP [11]	Chloride mass balance	46
CAMP [2]	Land use and recharge coefficients	37
CAMP [2]	Groundwater modelling	40–45

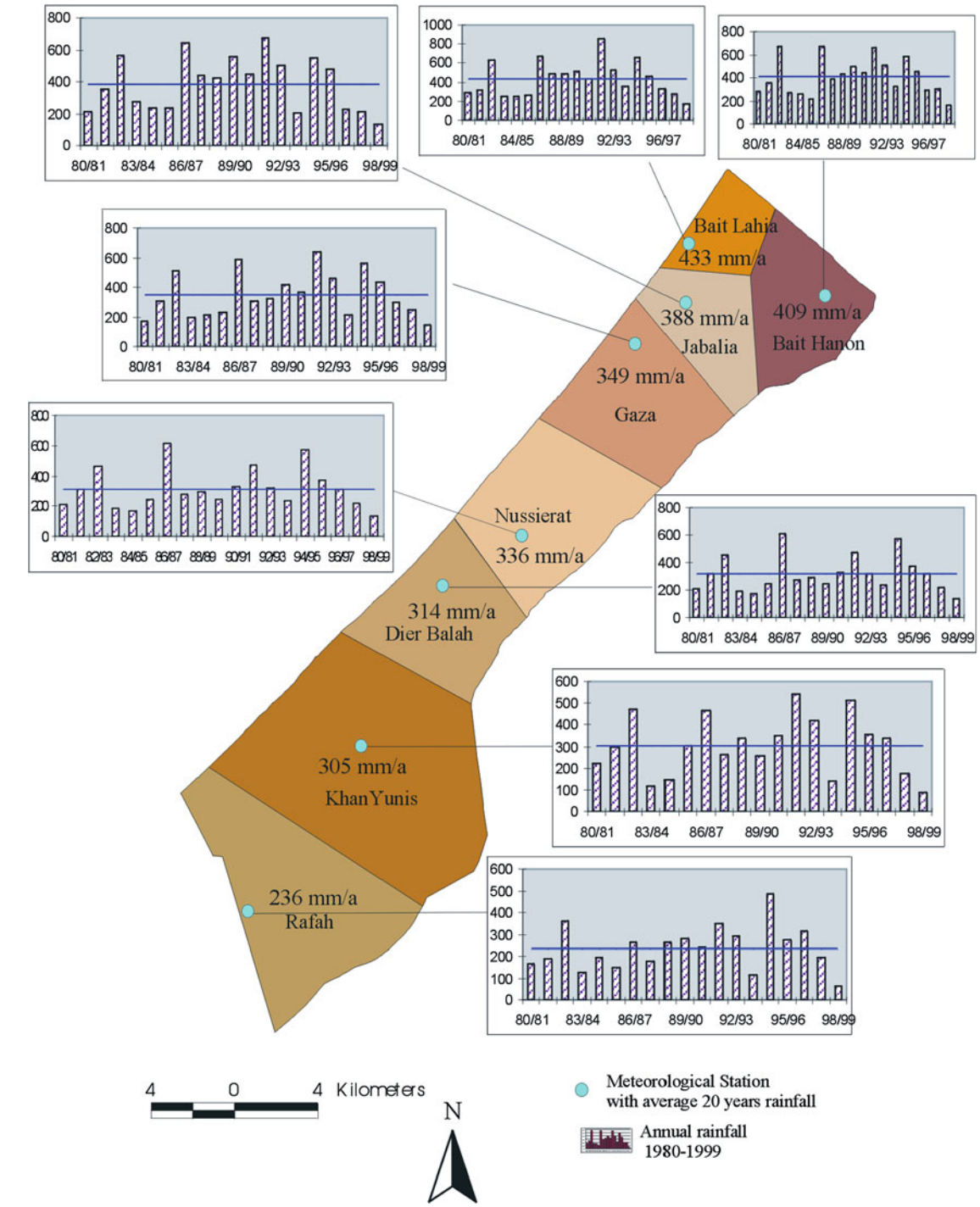

Fig. 1 Average of 20 years rainfall in the Gaza Strip [4]

The Gaza Strip is a small area at the eastern coast of the Mediterranean Sea. The area is located between the semi-arid zone in the north and the Sinai desert in the south, and groundwater is the only water supply for the 1.5 million people living there.

Many studies have been conducted to estimate groundwater rainfall recharge for the Gaza Strip [2,5,7, 11]. Among the previously mentioned studies, only one has considered the spatial distribution of rainfall recharge [5].

Results of these studies show that groundwater rainfall recharge varies between 33 and 45 million m^3 per year. As the average rainfall in the area is 320 mm/year [3] and the total area of the Gaza Strip is 365 km^2, recharge value as a percentage of rainfall varies between 28 and 38 %.

Aish et al. [10] have calculated rainfall recharge using a GIS model called WETSPAA [10], considering the Gaza Strip area as a case study. The authors contend that the steady state models are being used to analyse the groundwater system and thus a long term average is required. It should be noted that many transient models have been developed for the study area [2–4]. Moreover, the authors have not considered that after building a groundwater model, whether it is steady or transient, the recharge distribution is likely to be one of the calibrated parameters besides other parameters.

In the water balance equation (equation 1 in [10]), the irrigation return flow seems to be neglected. In addition to irrigation return flow, there are other sources of recharge such as leakage from water system, which is estimated at 30 % of the domestic water supply [3], and leakage from wastewater system and septic tanks [3]. For a regional groundwater recharge model as the one considered by Aish et al. [10], all these recharge components should be considered.

The high recharge rate at some area in [10] is probably a result of not considering these components. The paper estimated the total volume of groundwater recharge from rainfall as 39 million m^3 per year, which is consistent with previous studies (as shown in Table 1) that estimated rainfall recharge between 33 and 45 million m^3 per year [5–7].

Although there is no enough data on spatial distribution of rainfall recharge, but evaporation data and rainfall deficit/surplus show that the rainfall surplus occur only in 3 months per year between December and February [8]. Some studies were carried out in arid countries to quantify recharge as a percentage of rainfall. A chloride mass-balance approach has been used in the western part of the Saudi Arabia and shown that the recharge does not exceed 20% of rainfall [9]. The chloride mass-balance approach has been used in the northern part of the Gaza Strip [4,9] and shown that groundwater recharge does not exceed 30% of rainfall.

In their conclusion, the authors stated that recharge values vary from (0–40 to 280–320 mm/year), as shown in Figure 4 in their paper [10]. The 20 years average rainfall at different rain gauges in the Gaza Strip is shown in Fig. 1 [3]. Comparing the average rainfall with the findings of [10], the percentages of recharge in the northern area and the coastal areas of the Gaza Strip are 69 and 63 %, respectively. In semi arid areas like the Gaza Strip, the typical recharge value as a percentage of rainfall is not more than 25 %. Even in humid countries, the ratio of recharge to rainfall does not reach this level. In addition, these high levels of recharge are almost double those computed in previous studies [3,11]

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