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Hydrogeological assessment of a managed aquifer recharge site at the Wala reservoir, Jordan

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Introduction

- Managed aquifer recharge (MAR) plays an important role in the implementation of Integrated Water Resources Management (IWRM) in the Lower Jordan Valley.
- The Wala reservoir stores flood water since 2002 during winter season and recharges the underlying karst aquifer. This counteracts falling groundwater tables and increases the productivity of Hidan wellfield 7 km downstream (Fig. 1).

Objective

- Assessment of the impact of reservoir infiltration on the karst aquifer and development of a conceptual groundwater flow model of the test site.

Methods

Evaluation and interpretation of hydrochemical and isotopic data, recharge, abstraction and water level records from Wala reservoir and the karst aquifer. This included:

- Calculation of the water balance of Wala reservoir.
- Electrical conductivity (EC) analysis of the groundwater as an indicator for salinity changes.
- Detection of reservoir water in the wellfield using Tritium.
- Calculation of mean groundwater residence time with C-14 dating.

Results and discussion

Water balance of Wala reservoir and Hidan wellfield from 2002 to 2012 in million cubic meters (MCM).

- 136 MCM inflow
- 84 MCM storage
- 8 MCM evaporation
- 52 MCM loss via the spillway
- 74 MCM infiltration
- 129 MCM abstraction

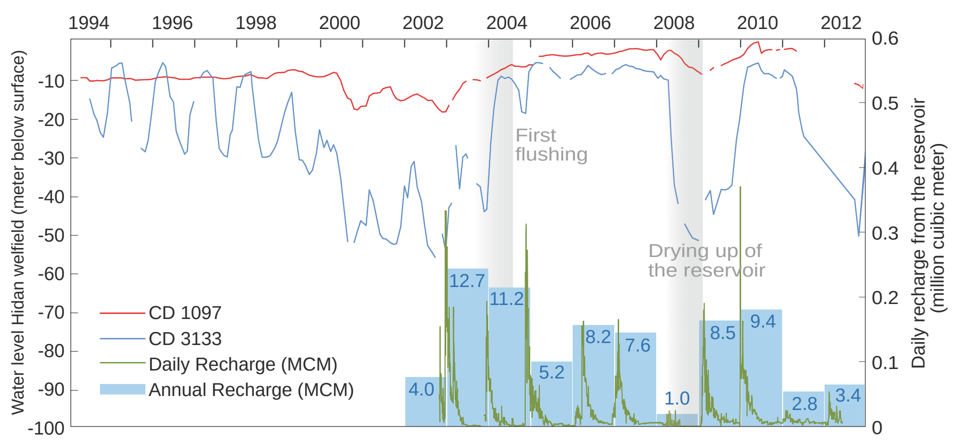

Fig. 1 Recharge from the reservoir and water level fluctuations in observation wells CD 1097 and CD 3133 of Hidan wellfield. Infiltration rate is successively reduced through sedimentation (modified after Xanke et al., 2015).

Electrical conductivity (EC) at Hidan wellfield and Wala wells increases from 2002 to 2004. In 2008, EC drops almost to values before 2002.

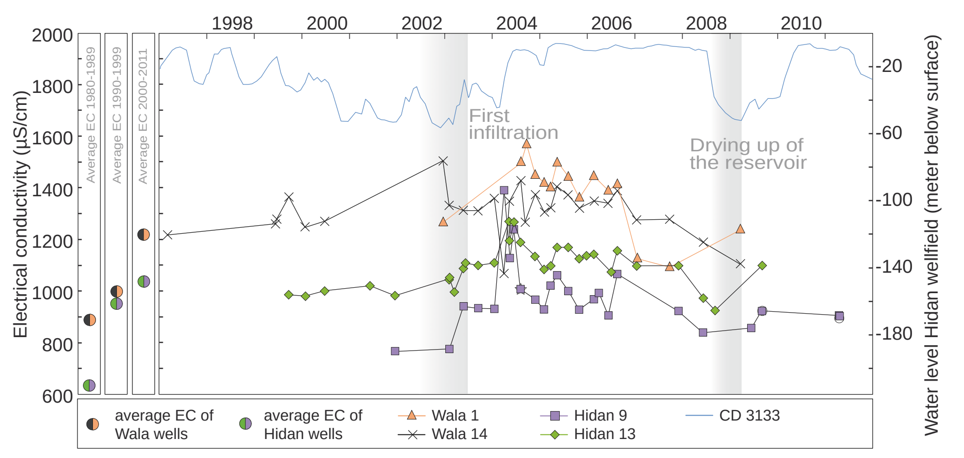

Fig. 2 Long-term increase of average EC from 1980 to 2011. Fluctuations of EC during 2002 and 2012 (modified after Xanke et al., 2015).

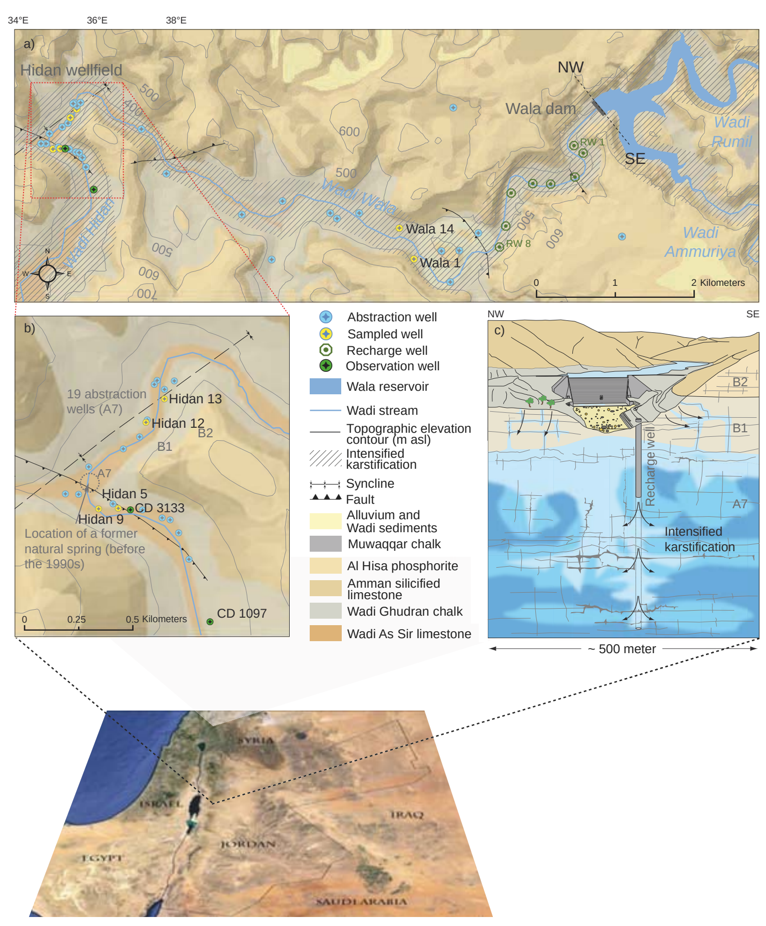

Fig. 3 a) Geological overview about wadi Wala, b) Hidan wellfield and c) a schematic cross-section of the Wala dam (modified after Xanke et al., 2016).

Tritium values increase from about 0.8 TU (before 2002) to a mean value of 2.3 TU (2008–2010).

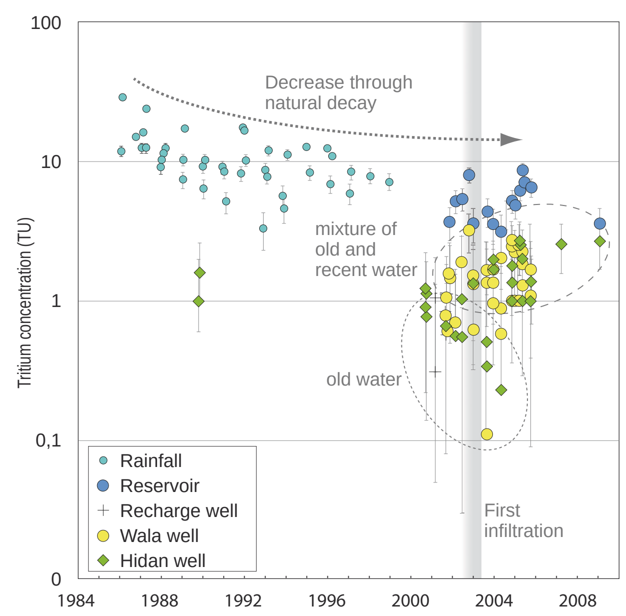

Fig. 4 Tritium (3H) content of precipitation and Wala reservoir shows the decrease over time as a consequence of natural decay. The concentration in groundwater increases after 2002, caused by the mixing with recent water from Wala reservoir infiltration (modified after Xanke et al., 2015).

Mean groundwater residence time (average of three methods):

- Wala 14: before 2002: > 21.000 a; after 2002: < 15.000 a
- Hidan 9: before 2002: > 17.000 a; after 2002: < 9.000 a

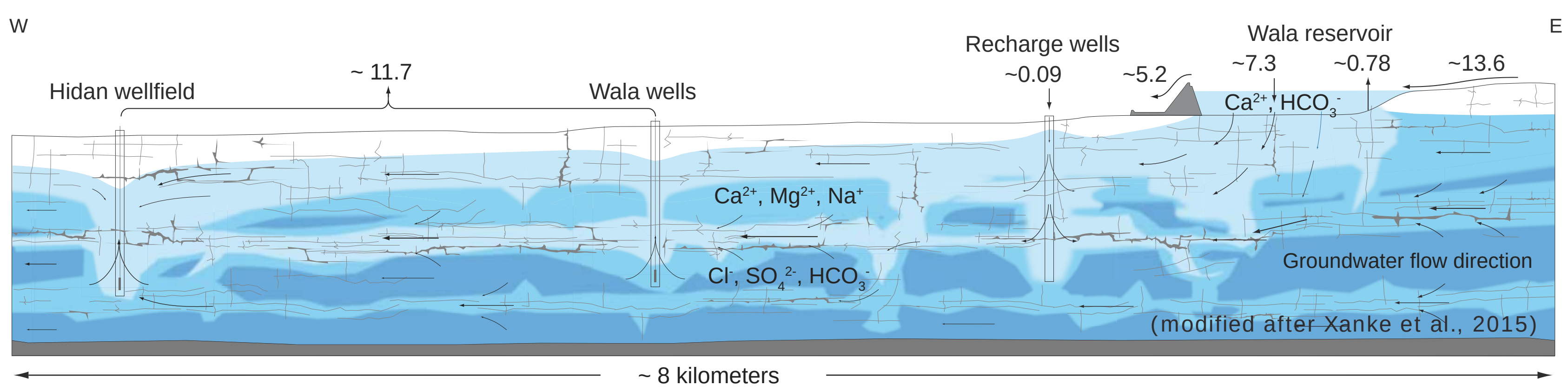

Fig. 5 Schematic cross-section along wadi Wala. Different mean residence times indicating a mix of old an recent water. The water balance is in million cubic meters (MCM).

Conclusions

- Chemical data shows the mix of old and high mineralized groundwater with recent and less mineralized surface water at Hidan wellfield.
- The proportion of reservoir infiltration on the total amount of abstraction at Hidan wellfield counts about 57% from 2002 to 2012.
- Sedimentation continuously reduces the infiltration rate from the reservoir.
- Intensified karstification along the wadi corridor is assumed.

References:

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