Bundesanstalt für Geowissenschaften und Rohstoffe

Ministry of Water and Irrigation

Managed aquifer recharge (MAR) potential map for Amman-Zarqa and Azraq Basins, Jordan

Ibraheem Hamdan[1], Anke Steinel[2]

[1] Federal Institute for Geosciences and Natural Resources (BGR), Amman, Jordan, ibraheem_geo@yahoo.com

[2] Federal Institute for Geosciences and Natural Resources (BGR), Hannover, Germany, anke.steinel@bgr.de

1.Introduction

Jordan is a country with one of the lowest available water resources worldwide with only 150 m^3/capita/year compared to international standards of 500 m^3/capita/year. Hence, competition between demands for the limited fresh water quantities is ever increasing. Groundwater abstractions have exceeded present-day groundwater recharge since the mid 1980s. This has caused groundwater levels to decline in most areas of Jordan. In parts, this has also led to a deterioration of groundwater quality. Hence, surplus water such as runoff in ephemeral wadis could be captured in small dams and be allowed to infiltrate to augment water supplies for later use.

In this bilateral project, the BGR supports the Jordanian Ministry of Water and Irrigation (MWI) in its capability to successfully use managed aquifer recharge (MAR) via infiltration of stormwater runoff. The year-long study is funded by the German Federal Ministry of Economic Cooperation and Development (BMZ) under the GeoSFF (Study and expert fund for geoscientific sector schemes) and focuses on the Amman-Zarqa and Azraq basins. By focussing on small scale initiatives like percolation or recharge release dams (Fig. 1), the project provides locally suitable solutions for the improvement of the critical water situation in the semi-arid regions including aspects of climate change adaptation.

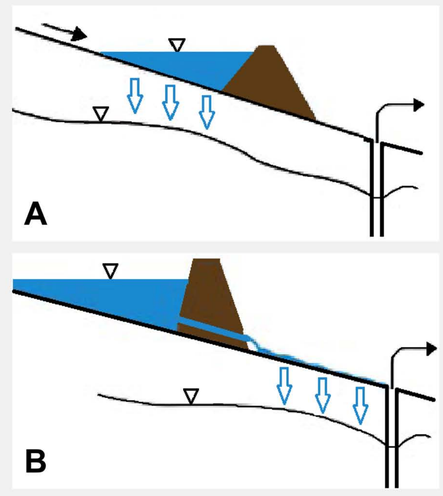

Fig.1: Conceptual model [1] of
A percolation dam
B recharge release dam

2. Aim and Method

Aim: Development of a MAR potential map for both basins

In order to evaluate MAR potential for the aquifers in a detailed map, thematic layers are prepared in a GIS environment and can then be combined with weighting factors.

The most important thematic maps are:

1. **Hydrogeology**: Hydrogeological classification of aquitards and aquifers for evaluating the presence or absence of a suitable aquifer to be recharged.
2. **Slope**: The most effective slope for infiltration is 0-5 % preventing the generation of excessive runoff [2].
3. **Land-use**: In urban areas land acquisition is hindered and pollution sources as well as impervious areas are abundant.
4. **Proximity to water supply sources:** To minimize water transport costs, sufficient water supply should be within reasonable distance of infiltration sites.

3. Results

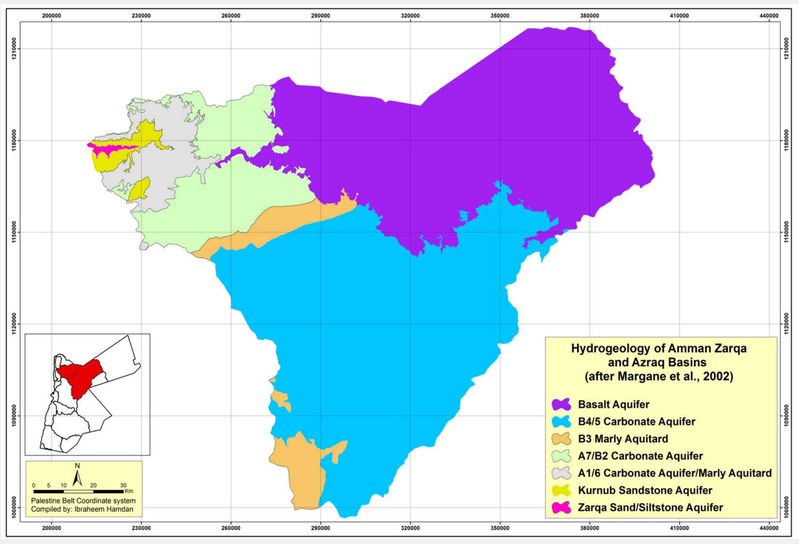

Fig. 2: Hydrogeological classification after [3]

- The basins exhibit three main fractured aquifers: basalt, B4/B5 limestone and A7/B2 limestone (Fig. 2), which are suitable for MAR.
- In the eastern part of the basins, large areas exhibit suitable slopes for infiltration, while the NW part is largely unsuitable due to steep slopes (Fig. 3).
- The Azraq basin is only sparsely populated and many subcatchments exhibit low pollution risk. In contrast, the Amman-Zarqa basin has a high population density and industrial areas, which results in unsuitable subcatchments due to water quality considerations (Fig. 4).
- Water supply is the main issue in the Azraq basin as rainfall is very limited (50-100 mm). In addition, a number of water harvesting structures are already in place in both basins (Fig. 5).

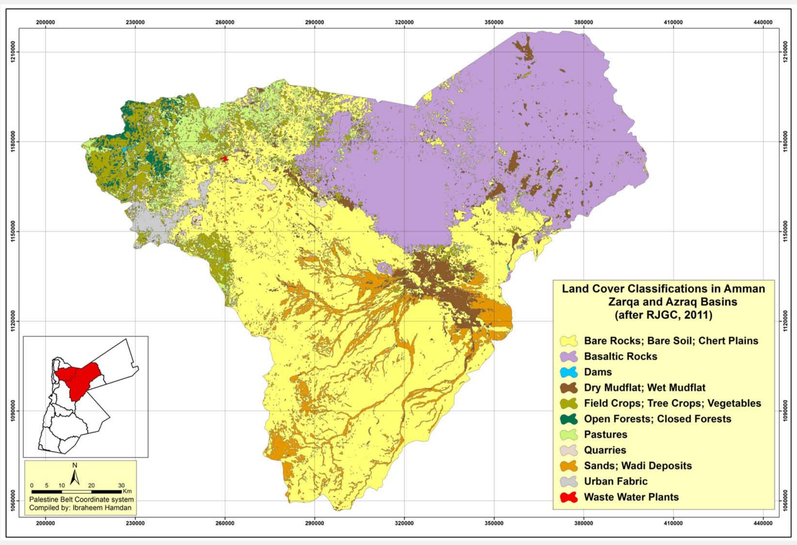

Fig. 4: Land cover classification after [4]

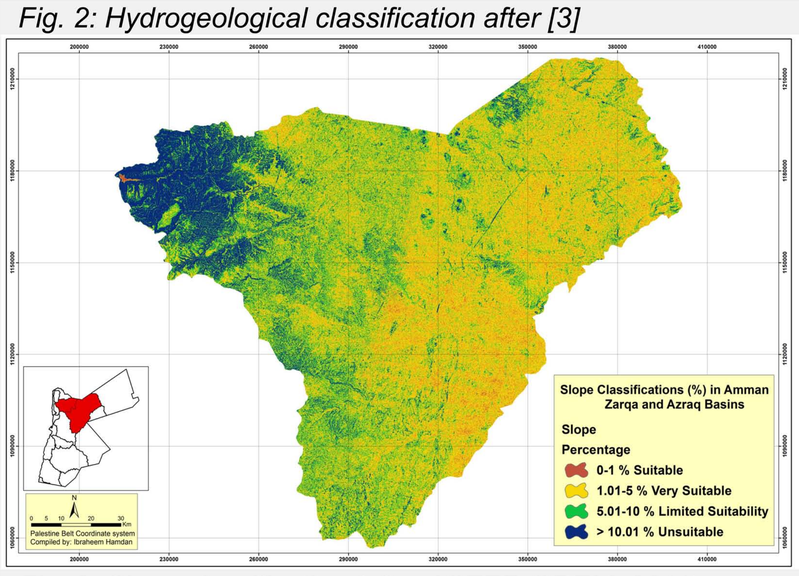

Fig. 3: Slope classification (after ASTER GDEM, 2011)

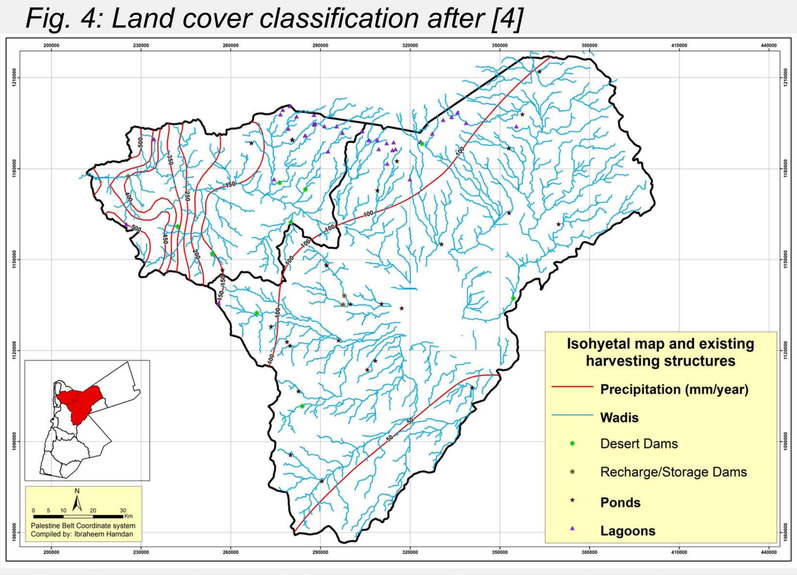

Fig. 5: Long-term rainfall and existing harvesting structures

4. Conclusions

The MAR potential investigation shows high potential for large parts of the basins with respect to aquifer properties, slope and land use. The main limiting factor is the water supply as rainfall is sparse and conflict with existing water harvesting structures has to be avoided. In a next step, evaluation of runoff generation and soil infiltration capacity will allow the selection of potential recharge sites.

[1] Gale, I. and P. Dillon (2005). Strategies for Managed Aquifer Recharge (MAR) in semi-arid areas. UNESCO's International Hydrological Programme (IHP), IAH: 30.
*[2] Alraggad, M. and H. Jasem (2010). Managed Aquifer Recharge (MAR) through surface infiltration in the Azraq basin/Jordan. Journal of Water Resource and Protection (JWARP), **2**(12): 1057-1070*
*[3] Margane, A., Hobler, M., Almomani, M. and Subah, A. (2002). Contributions to the Hydrogeology of Northern and Central Jordan. Geologisches Jahrbuch, Reihe C, **68**: 3-52*
[4] Royal Jordanian Geographic Center (2011). Land cover maps. Amman, Jordan. (Note: based on satellite images from 2005 and ground truthing)