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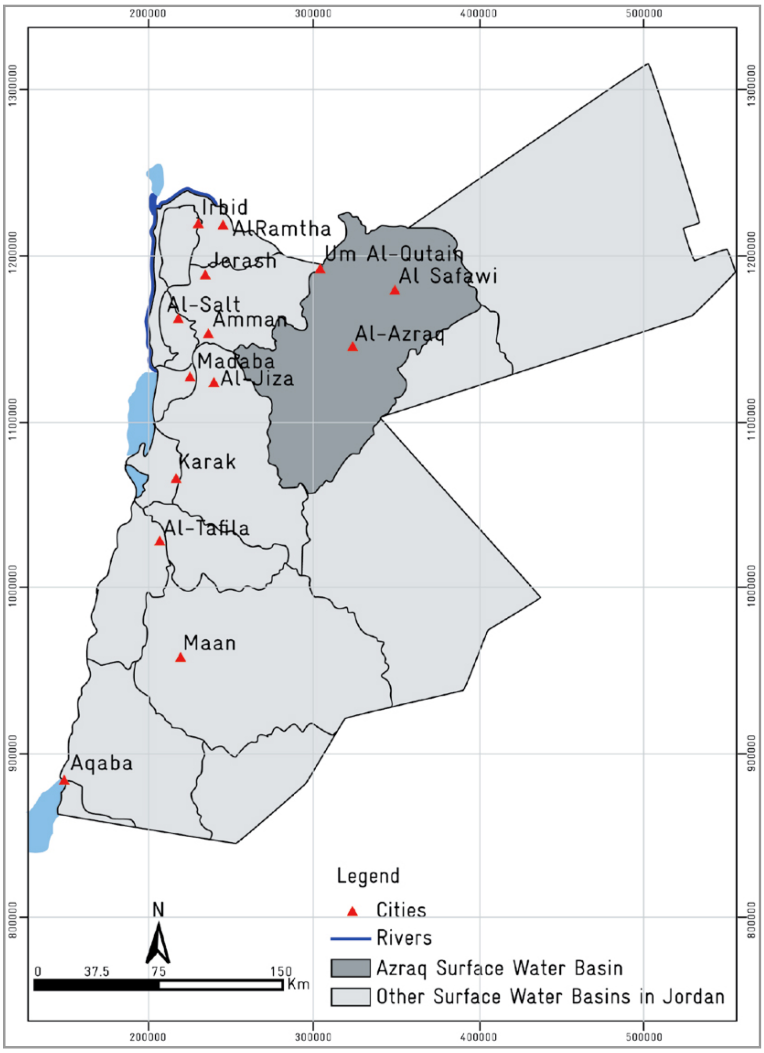
# From Irrigated Agriculture to Solar Energy Farming in the Azraq Basin, Jordan

## Summary

The centre of the Azraq Basin (Fig. 1) in the northeastern part of Jordan was covered by vast wetlands until the early 1990s, but both man-made and natural impacts, such as climate change, caused a severe depletion of this basin. The GIZ regional programme 'Adaptation to Climate Change in the Water Sector in the MENA Region' (ACCWaM) is venturing into the possibility to substitute irrigated agriculture with solar energy-based power generation as an income generating activity, ultimately reducing groundwater abstraction. The innovation is called 'solar energy farming'. Solar energy farming is environmentally friendly as it (a) contributes to increasing the share of renewable energies, hence reducing CO2 emissions; (b) preserves groundwater resources as it creates sources of income other than irrigated farming and (c) is an important element in **climate change adaptation.** This innovation is intensively researched and consulted with the different actors, e.g. the Ministry of Water and Irrigation (MWI) and the Ministry of Energy and Mineral Resources (MEMR), before it will be implemented on a pilot scale.




## Challenge

Jordan has 12 groundwater basins, 10 of which are strongly overused beyond their replenishment rates. Jordan is heavily dependent on its groundwater resources, which comprise 57% of the total supply and depend on rainwater for replenishment (surface flow or base flow). Incidentally, agriculture is the largest water-consuming sector, accounting for 64% of total demand according to Jordan's National Water Strategy.

*Fig. 1 (above): Azraq Basin and other surface water basins in Jordan*

*Fig. 2 (l): Azraq wetlands as they looked in the ninetees. They disppeared due to water overextraction and drought*

*Fig. 3 (r): Meeting of the Highland Water Forum*

*Fig. 4 (l): Photovoltaic plant*

*Fig. 5 (r): Officials from the Ministry of Water and Irrigation discuss water management issues with farmers in Azraq Basin*

The **Azraq Basin** is located in the northeastern part of Jordan. Until the early 1990s the centre of this basin was covered by vast wetlands (Fig. 2), but man-made impacts (e.g. groundwater abstraction for irrigation and the capital Amman and climate change) caused severe depletion of this basin. In the absence of sufficient precipitation, total abstraction is twice the natural recharge rate.

Surveys among farmers in the Azraq Basin came to the conclusion that many farmers suffer from water supply problems and are therefore interested in alternatives to irrigated agriculture.

## Setup

The Jordanian Ministry of Water and Irrigation and the Ministry of Energy and Mineral Resources are the main partners in this innovative adaptation measure. Planning, implementation and monitoring are supported by the GIZ ACCWaM programme as a learning case. The planned activities related to energy farming are part of the Azraq Groundwater Management Action Plan, which was endorsed by the Ministry of Water and Irrigation in February 2014. This Action Plan was developed by the Azraq Basin Committee, a body within the Highland Water Forum which was established in 2010 (Fig. 3). In its role as technical advisor to the Arab Ministerial Water Council, the Arab Center for the Studies of Arid Zones and Dry Lands will help upscale the measure within the Arab countries.

## Opportunities

The ACCWaM Pilot Measure in Jordan is targeting three urgent issues:

1. reducing the further lowering of the groundwater table of the Azraq aquifer;
2. offering solar energy farming as a source of income to farmers in that area [a water-friendly alternative to agriculture (Fig. 4)]
3. generating electricity, which is high in demand in Jordan, by making use of intensive solar radiation.

In their January 2012 meeting, the Highland Water Forum agreed on solar energy farming as a high-priority adaptation (Fig. 5) measure to reduce groundwater abstraction. When farmers agree to abstain from irrigated farming, they can be provided with loans to install photovoltaic systems that would generate income for the farmers.

The **key points** of the innovation are:

- **Economies of small scale:** A farmer installs a 100 kWp photovoltaic power plant on one Jordanian dunum of farm land. This equals 1,000 square metres, or one tenth of a hectare.
- **Power generation:** 180,000 kWh per year, which is produced by the 100 kWp solar energy power plant.
- **Gross earnings:** EUR 24,000 per year with a feed-in tariff of EUR 0.13 per kWh over 20 years.
- **Opportunity cost:** EUR 250 (average loss of annual agricultural net profit).
- **Investment:** EUR 150,000, which is the turnkey cost of the 100 kW photovoltaic plant at today's prices and includes the costs of connection to the public grid.
- **Net income:** Depending on the project finance terms and assuming 100% project financing at a 5% interest rate over 10 years, net income is at least EUR 1,000 per year over the first 10 years (i.e. the payback period for investments), and many more times higher for the remaining lifetime of the plant.

A larger sized plant can be installed depending on a farmer's energy appetite and the parameters of the respective grid.

Assuming a high average net income from agriculture in the Azraq area of EUR 250/1,000 $m^2$, the farmer can earn at least four times as much annually when switching from agriculture to solar farming. After the payback, period earnings will go up even more.

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*Fig. 6: Oliven-Plantage in Asraq*

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Further areas that benefit from solar energy farming are:

- **Drinking water:** The year-round irrigation of annual crops requires on average one cubic metre of water per square metre of land (Fig. 6). When shifting to solar energy farming, 1,000 cubic metres of groundwater per year can be saved on a 1,000 $m^2$ area, a volume which can cover the demand for drinking water of 1,000 people per year.
- **Water security:** Solar farming reduces groundwater abstraction, thus saving the country's strategic water reserve for future generations.
- **Energy security:** Solar farming eases Jordan's heavy dependence on fossil fuel and gas imports.
- **Food security:** Solar farming contributes to food security at the household level because it provides stable income and allows people to continue to live on their land. At the national level, it frees foreign currency to pay for food imports, money which is otherwise needed to pay for fuel and gas imports for power generation.
- **Green economy:** Jordan's solar farmers shift from fossil fuel energy consumers (water pumping) to clean energy producers (photovoltaics).
- **Adaptation to climate change:** Solar farming helps rural households cope with climate change impacts in the water sector.

## Outlook

**Lessons learned:** There are many good environmental and economic reasons for implementing solar energy farming in Jordan, such as serving as a climate change adaptation measure. However, the objective 'reducing the further lowering of the groundwater table of the Azraq aquifer' can be achieved only if (1) the 'energy farmers' really reduce their area under irrigated agriculture; and (2) the water left in the ground is not extracted by somebody else. This calls for strict regulations and their enforcement by authorities.

**Sustainability concerns:** In general, solar energy farming can be a sustainable alternative to irrigated agriculture experiencing water shortage in (semi-)arid areas. Farmers can stay on their land, maintaining the installations and enjoying a secure income. However, there are still uncertainties insofar as the amortisation period of the investments runs for 20 years – a long time span in a fragile natural and political environment.

**Transferability:** The preconditions for transferability are:

1. contracts between the grid operators and the farmers, which fix an acceptable price for feeding energy into the national power grid;
2. access to loans (with regard to bank security, land ownership, etc.) and financial support;
3. access to technical services for implementation and maintenance;
4. widespread information distribution on the pros and cons of 'energy farming' and later on the training of 'energy farmers'.

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