Peak water in Saudi Arabia

Posted by Ugo Bardi on January 29, 2008 - 10:45am in The Oil Drum: Europe
Topic: Environment/Sustainability
Tags: production peak, saudi arabia, water [list all tags]

Saudi Arabian cultivated fields as visible using Google Earth. Each circle is an irrigated area of about 1 km diameter. The whole square is about 10 km side. The coordinates are 26°47'21.64"N, 49°10'41.43"E.

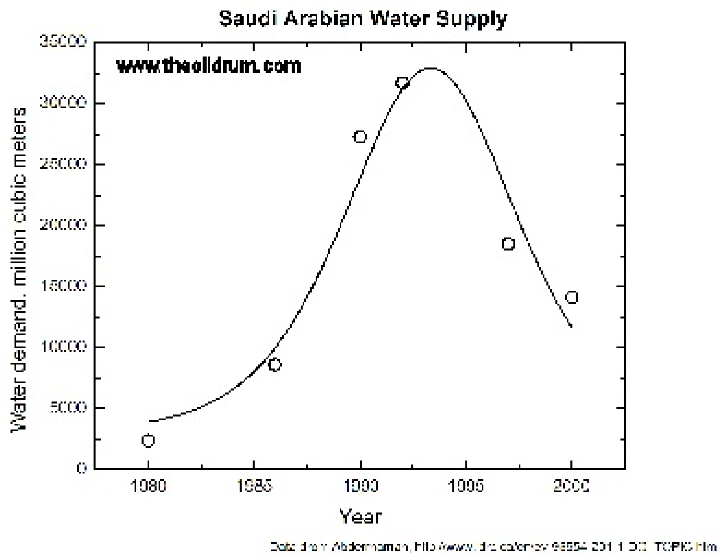
Look at these irrigated fields in Saudi Arabia, just an example of the cultivations that dot the desert. However, in a few years these fields may disappear. Peak water may have taken place in Saudi Arabia already more than 10 years ago.

According to recent news from Reuters (2008) the Saudi government has decided to stop all subsidies to agriculture. It means abandoning a policy that had obtained self sufficiency in food production and that had allowed Saudi Arabia to be a major food exporter in the past. According to Reuters, "The kingdom aims to rely entirely on imports by 2016". The desert is going to win back the land it had ceded to agriculture.

These news come as a surprise, but not so much. Saudi Arabian food production has been based on "fossil water." It is water from ancient aquifers that can't be replaced by natural processes in times of interest for human beings. Fossil water is non renewable, just as oil is, and it is unavoidable that it has to run out one day or another.

A wealth of data on the Saudi Arabian water situation can be found in the paper by Walid A.

Abderrahman (2001) "Water Demand Management in Saudi Arabia". From this paper, we learn that water production in Saudi Arabia has reached a peak in the early 1990s, at more than 30 billion cubic meters per year, and declined afterwards. Today, it is at around 15 billion cubic meters, less than half than the peak value. We also learn that most of this water, 90% at the peak, came from non renewable aquifers.



Source: Abderrahman 2001

The data reported by Abderrahman can be fitted reasonably well by means of a logistic curve. That indicates a "Hubbert" depletion mechanism, typical of non renewable resources. The Hubbert mechanism is confirmed by the data on the reserves. According to the "Encyclopedia of Earth" (2007) the total groundwater reserves of Saudi Arabia can be estimated as about 500 billion cubic meters, of which 340 billion are considered as recoverable. Indeed, the graph of water production can be extrapolated for a total production of ca. 350 billion cubic meters. That is, the peak has arrived at about midpoint, as expected for a Hubbert curve. The case of Saudi Arabian water production is another example of how general and widely occurring is the Hubbert curve.

Of course, we must also take into account government intervention. Surely, subsidies to agriculture have played a role in affecting water production. But there is no doubt that depletion of the Saudi aquifers is real. It would make no sense for a government to implement a policy that amounts to the destruction of the local agriculture if the aquifers were still able to produce has they had been producing so far.

It seems that the depletion of the aquifers has left Saudi Arabia with few options other than transforming oil into food. Selling oil and using the profits for importing food is the only possibility in the short term. In the future, however, it may be possible to replace aquifers with water from desalination.

Abderrhaman reports that 10 billion dollars spent on desalination plant have resulted in a production capacity of about 800 million cubic meters of water per year in 1998. Today, however, water produced from desalination in Saudi Arabia is reported to have reached 3 billion cubic meters per year and to be growing (ETAP 2006). That makes Saudi Arabia the largest producer of desalinated water in the world. It would not be impossible to step up production to a level that would boost agriculture and make Saudi Arabia again self-sufficient in terms of food production. It would mean to raise the output of a factor of five to remain at (or to return to) the present level (also assuming that population can be stabilized). The cost for the new desalination plants could be around 200 billion dollars, not impossible for a country that has a positive trade balance of more than 100 billion dollars per year (CIA 2008).

Of course, desalination has an energy cost. Modern desalination technologies are reported to produce water at a cost of some kWh per cubic meter (Clark 2007). 4 kWh/cubic meter is among the lowest values reported, but it is probably possible on large scale plants. In this hypothesis, we need 60 TWh for producing 15 billion cubic meters of water per year, the present production in Saudi Arabia. Considering that one barrel of oil can provide around 600 kWh of electric power, it means that about 100 million barrels of oil per year would be needed. Obviously, Saudi Arabia would rather use natural gas for powering desalination plants, but this calculation gives us an idea of the order of magnitude of the effort involved. That is not much for Saudi Arabia: only about 3% of the present oil production.

Unfortunately, oil and gas are non renewable resources and not even the rich reserves of Saudi Arabia can last forever. Even water produced by desalination should be considered "fossil" as long as it is produced using energy from fossil fuels. Much has been said about Saudi Arabia being close to peaking in oil production and gas cannot last much longer than oil. If that is what is going to happen, considering also that population has been growing at a 2% rate (CIA 2008), transforming oil and gas into a sufficient supply of food - either by desalination or by imports - may become problematic in a not too remote future. This problem is one of the reasons that is leading Saudi Arabia to consider nuclear energy. But that has obvious political problems and, in addition, would make Saudi Arabia completely dependent on imports of uranium.

Saudi Arabia is not an isolated case in Middle East and North Africa. Several countries in the region heavily depend on non renewable water from aquifers and on a contribution from desalination plants which, in turn, depend on non renewable resources. Libya, for instance, is at present working at a project named "The Great Man-made River" (Water-technology, 2008) which aims at extracting the resources of fossil water of the Sahara desert. From the data that appear over the internet, the Libyan resources may be much larger than the Arabian ones, but it is difficult to judge how reliable the estimates are. In any case, it is a characteristic of the Hubbert cycle that the start of the decline takes people by surprise.

So, the question of a sustainable supply of water from the arid countries of North Africa and Middle East cannot be ignored any longer. Indeed, the deserts of the region provide plenty of well sun irradiated areas that can be exploited for energy production that, in turn, can be used for the production of water.

Getting back to the case of Saudi Arabia; let's calculate what kind of effort in solar energy would be needed for the production of 15 billion cubic meters of water. A 1 kW rated power PV panel could produce 2000 kWh/year (and probably more) at the latitudes of Saudi Arabia and of the Sahara desert (Faiman et al. 2007). In order to produce 60 TWh/year, as calculated before, we need a rated power of 30 million kW, or 30 GW. The cost for this much power will depend on technological progress and scale factors. Taking 10 dollars/W, approximately the present value, we obtain a round number of 300 billion dollars of solar panels. This is just an order of magnitude calculation for the most expensive technology presently available. Obviously, the cost of PV panels could be much lower in the future. In addition, PV is not necessarily the best technology for desalinating water. Most likely, CSP (concentrated solar power) systems could be specifically designed for desalination and provide better performance and lower costs for this specific purpose (see, e.g TREC 2008).

Schemes that plan large scale solar plants in the desert are often considered remote from immediate needs. However, the water situation in North Africa and Middle East makes such plans the only realistic way to provide enough water for the long term survival of agriculture in the region. The idea can work, but only if implementation starts soon enough; before the decline of oil production makes the costs involved impossible to bear. That may be very difficult to achieve. As usual, the human tendency of discounting the remote future is our worst enemy (Hagens 2007)

Acknowledgment: Thanks to Debora Billi ("Our Lady of Petroleum") for having alerted me about the Reuters note in her blog petrolio

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