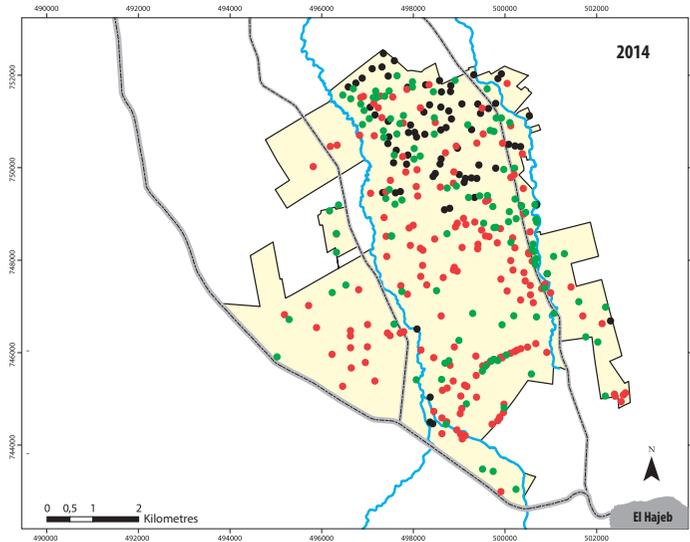


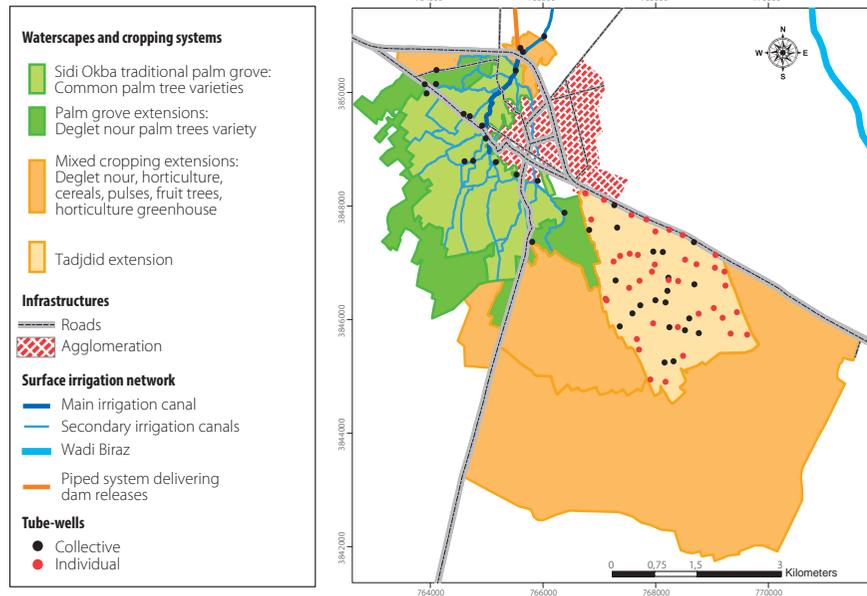
M50. Pressure on groundwater resources in El Hajeb (Sais) in Morocco

Source: author (see note page 69)



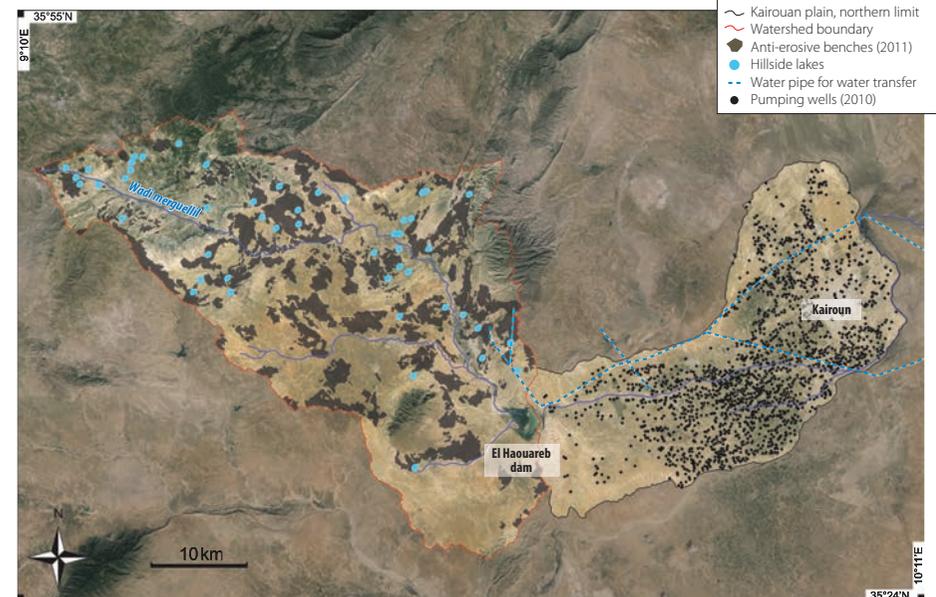
M51. Water territories in Biskra, Algeria, in 2015

Source: author (see note page 69)



M52. Intensive use of surface water and groundwater in Kairouan, Tunisia, since 2010

Source: author (see note page 69)



WHAT SHOULD BE DONE WITH NORTH AFRICA'S GROUNDWATER RESOURCES?

Groundwater has become an important source of welfare in North Africa. It is redefining irrigation frontiers and supplies water to more than 500 000 farms. However, more than half of aquifers, which cater to a minority of farmers, are declining. North Africa's groundwater economy is increasingly faced with physical and socio-economic stress.

• North Africa's rapidly expanding groundwater economy

North Africa has a long tradition of groundwater use in traditional irrigation systems. However, an agricultural groundwater economy, mainly based on private tube wells, emerged in the early 1980s with the availability of cheap technology, increased water demand and recurrent droughts. Groundwater use stimulated the intensification and diversification of farming systems and became the mainstay for more than 500 000 farms. It now caters to 88% of irrigated areas in Algeria, 42% in Morocco and 64% in Tunisia. However, about half of the aquifers have been declared overexploited and farmers' dependence on this vital resource means that a possible decline of the groundwater economy is a serious issue.

• Saiss: the expectations and risks of groundwater use

Farmers in the fertile plains of northern and central Morocco increasingly rely on groundwater to intensify and diversify their farming systems. These groundwater economies have existed for more than 30 years, and each supports several tens of thousands of hectares of irrigated agriculture. In the Saiss plain, droughts in the early 1980s along with the libe-

ralisation of the agricultural sector transformed rain-fed farming systems into groundwater-based irrigated agriculture. In 2012, 20% of the lands in the Saiss were irrigated, 91% of which (45 316 ha) depended on pump irrigation. Groundwater caters mainly to orchards, vineyards, horticulture and fodder crops. Due to the rapid decline of groundwater tables, a considerable number of wells taking water from the phreatic aquifer are running dry and farmers are increasingly installing tube wells to gain access to the deep aquifer, which is now also declining. Smallholders in particular are unable to follow the decline of water tables, as they lack the resources to install tube wells and to conduct intensive market-oriented agriculture to pay back such investments. While groundwater raises tremendous expectations, especially for young farmers keen to develop their agriculture, it thus also implies considerable risks: as water tables decline, farmers venture into more risky markets and may end up with debts.

• Biskra: new irrigation frontiers in the Sahara

Algeria's Sahara is one of the most water-rich regions in Africa due to the presence of enormous sedimentary aquifers, but with very low recharge rates. Groundwater is increasingly pumped for agriculture through deep tube wells. While in the past irrigation development was limited to some oases, private groundwater-based irrigation has changed the outlook for Saharan agriculture. In Biskra, the irrigated area increased five-fold from 16 500 ha in 1969 to more than 104 000 ha in 2013. A total of 94% of irrigation water is currently supplied

by groundwater through more than 4 200 wells and 9 000 tube wells. On these new irrigation frontiers, there has been a rapid extension of commercial palm groves (43 000 ha in 2014, 60% of which grow the reputed deglet nour variety) and intensive horticulture (17 365 ha; of which 4 900 ha produce greenhouse tomatoes, bell peppers and melons). Biskra's groundwater economy is developing at a very rapid pace. The classical limiting factors (markets, capital, labour, land and water) will undoubtedly emerge, but in the meantime, the agricultural boom is likely to continue.

• Kairouan: surface water development is inextricably linked to groundwater use

In the Merguellil river basin in central Tunisia, watershed development has focused on improving livelihoods, preserving soil and water resources and ensuring flood protection. This led to the construction of numerous water conservation structures and the El Haouareb dam in 1989, which reduced runoff and stored water upstream. This seriously affected groundwater recharge in the Kairouan plain, which was now limited to the area around the dam rather than extending along the whole riverbed across the plain. Meanwhile, groundwater development began with public tube wells in the 1970s to supply drinking water to the coast and to develop groundwater-based irrigated agriculture. Private irrigation rapidly took over to secure livelihoods and to potentially make profit with high-value crops. Nowadays, groundwater use from over 2 000 private tube wells is estimated to be equivalent to withdrawals from the 135 public tube wells, delivering 120 hm³/year. The total groundwater-based irrigated area was 20 000 ha in 2010. The combined effect of watershed development and groundwater use has caused

the water table to drop by 30m over the last 40 years. Farmers have had to adapt their irrigation systems to follow this decline, which has caused a number of smallholders to drop out of the race.

• Sustainable groundwater use or mining with care?

Most aquifers in North Africa are intensively exploited, as evidenced by the general decline in water tables. Often, the official ambitions of regulating groundwater use relate to the sustainable use of groundwater, understood as obtaining a new equilibrium in which groundwater use and recharge level out. Hydrologists challenge the relevance of this concept, as the exploitation of an aquifer with an imbalanced regime is not necessarily synonymous with long-term reserve depletion. Moreover, experience shows that reducing groundwater use in the short term is not realistic, as it has become too important from a social, economic and political viewpoint. Sustainable groundwater use is thus a fallacy, especially for the aquifers in the south, which have very low recharge rates. It is therefore better to acknowledge present groundwater practices as unsustainable and to focus the debate on what societies want to achieve with groundwater in terms of (rural) development. This could be called "mining with care".

Marcel Kuper, Ali Hammani, Fatah Ameur, Meriem Farah Hamamouche, Sylvain Massuel, Tarik Hartani

