Groundwater resources of the urban area of Niamey – Characterization and localization of anthropogenic pollutants

Project AGES – Appui à la Gestion des Eaux Souterraines à l'Autorité du Bassin de Niger (ABN)

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Introduction

In Niamey, during the decades of the Sahel droughts, a complete cessation of the Niger River flow in 1985 led to a well drilling program to mitigate the effects of the droughts and to reduce the high dependency on surface water. In order to generate basic data for the management of the tapped groundwater resources in Niamey the ABN/AGES project together with local authorities has been operating a groundwater monitoring network since 2012 including regular hydrochemical sampling and analysis.

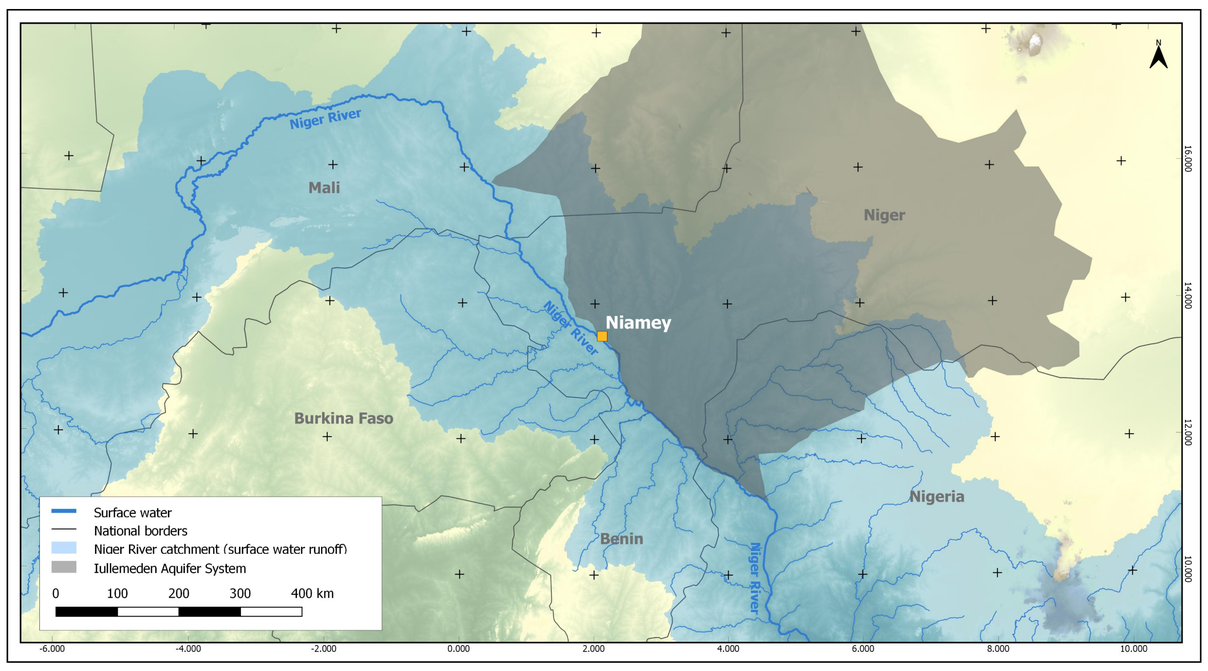

Fig.1: Location map of Niamey with Niger river catchment area and Iullemeden aquifer system extent

Distribution of anthropogenic pollutants

Chemical analyses, carried out regularly between 2012 and 2018, show the influence of anthropogenic pollution on all urban aquifers. Half of the monitored wells are affected by elevated concentrations of pollutants, such as nitrate, nitrite, nickel, lead and cadmium, exceeding the WHO guideline values (see Fig.2). Water pollution by nitrogen is widespread, reflecting the percolation of untreated wastewater, whereas industrial pollution is mainly punctual. In Niamey, due to the lack of a centralized system for the collection, disposal and treatment of wastewater, the main source of untreated wastewater in the underground is the leakage of numerous septic tanks and soakaways, representing the most common system for wastewater collection in the city.

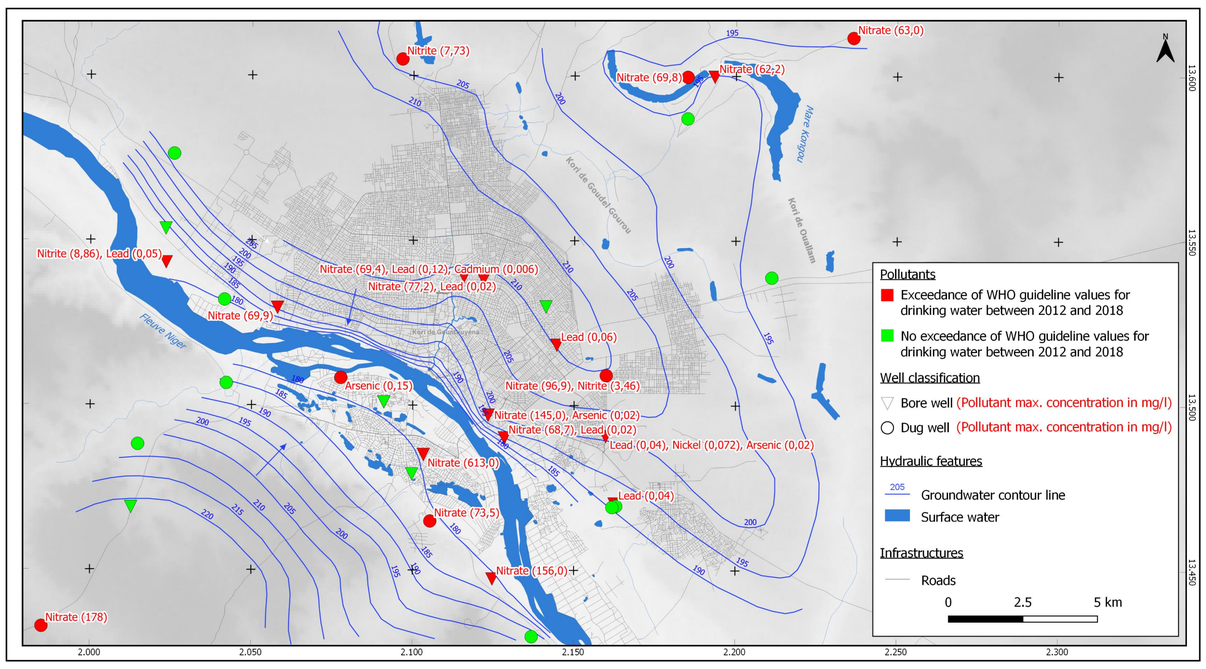

Fig.2: Distribution of anthropogenic pollutants in the groundwater of Niamey in the monitoring period from 2012 to 2018

Vulnerability of the urban aquifers

The aquifer system in Niamey represents the south-western border of the Iullemeden aquifer system and consists of four main features:

1. Fractured basement (Thickness up to 30 m),
2. Claystone (Thickness 0-35m),
3. Sandstone, poorly compacted, unconfined (Thickness 0-10m),
4. Alluvial sands and clays, unconfined.

Most bore wells in Niamey tap the fractured basement aquifer in depths between 25 and 50 m. Despite the widespread overlying claystone anthropogenic pollutants were found in this aquifer with concentrations exceeding the WHO guideline values for drinking water (see Fig.2). A high vulnerability of this aquifer is confirmed by the prompt reaction of the aquifer to rainfall events within 12 hours (see Fig.3). The hydraulic position of the urban area in a recharge area (see Fig.2) favors the percolation wastewaters into the fractured basement aquifer.

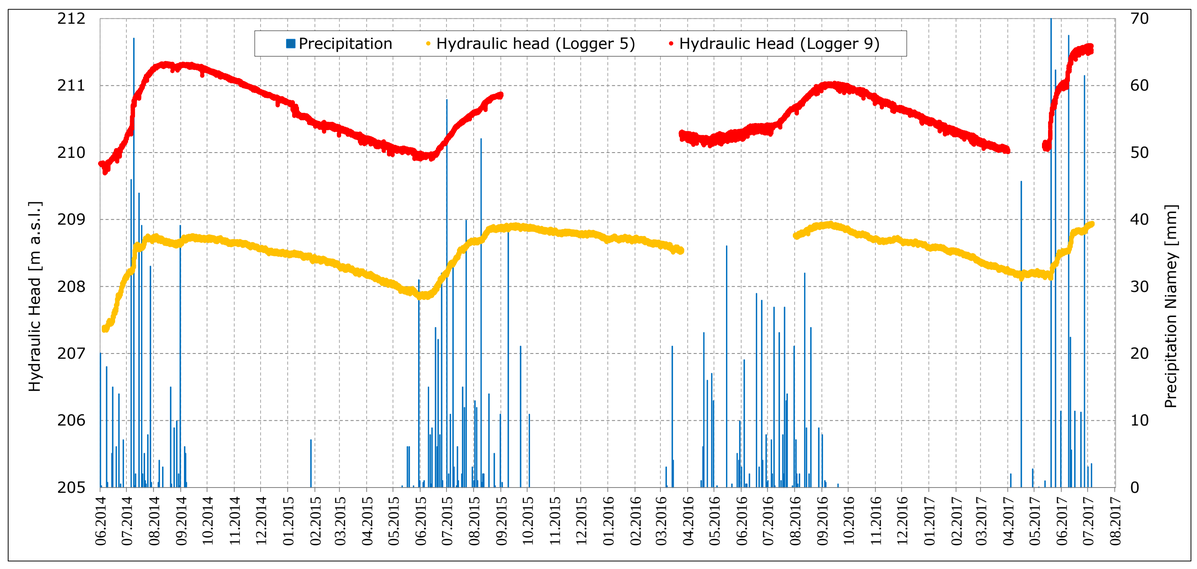

Fig.3: Precipitation and fluctuations of groundwater levels in the fractured basement aquifer

Implications for groundwater management and drinking water supply

1. Implementation of directives for the construction of sealed septic tanks and closure of soak aways is necessary in zones where groundwater is used for drinking water supply in order to mitigate the spread of anthropogenic nitrogen pollution. Existing wells for drinking water supply should be regularly monitored in terms of water quality and closed if concentrations of pollutants exceed the WHO guideline values. Industrial activities should be accompanied by an adapted groundwater monitoring.
2. Hydrochemical, hydraulic and infrastructural conditions suggest that production wells for drinking water supply of the city should be located outside the urban area.

Acknowledgments

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References

Literature:

- World Health Organization (WHO), 2017: Guidelines for drinking-water quality: fourth edition incorporating the first addendum.

Topographic Maps:

- OpenStreetMap (OSM) 2016 data for settlements, roads and surface water
- DEM from NASA Jet Propulsion Laboratory, 2013: NASA Shuttle Radar Topography Mission Global (SRTMGL) 1 arc second. Version 3. NASA EOSDIS Land Processes DAAC, USGS Earth Resources Observation and Science (EROS) Center, Sioux Falls, South Dakota. doi: 10.5067/MEASURES/SRTM/SRTMGL1.003.

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