GROUNDWATER QUALITY

GROUNDWATER PROTECTION

BGR Bundesanstalt für Geowissenschaften und Rohstoffe

GEOZENTRUM HANNOVER

Federal Institute for Geosciences and Natural Resources

Groundwater resources at risk

Kabul, Afghanistan

Assessment of the present situation and consequences for the future

Introduction

The Federal Institute for Geosciences and Natural Resources (BGR) looks back on a long tradition of geoscientific work in Afghanistan. Almost continuously since 1959 until the eve of the war in 1978 several campaigns lasting up to seven years were conducted to help Afghanistan use and develop its natural geologic resources. This included geological mapping of the central and southern parts of the country and detailed hydrogeological studies of the Kabul Basin. The latter were an important pre-requisite for the establishment of the central water supply of Kabul in the beginning 1975.

A long period of wars with different parties involved began in 1979. When it ended in 2002 with the defeat of the Taliban, much of the country's infrastructure including some parts of the water supply schemes in Kabul had been destroyed. Academic education and scientific exchange in the field of geosciences also came to an almost complete halt. On behalf of the Federal Foreign Office of Germany, BGR resumed its work in Afghanistan in 2003. Since most of the gathered information on geology and hydrogeology in Afghanistan was lost and new data were not collected between 1979 and 2001, the archives of the BGR proved to be an invaluable source of geoinformation.

Afghan specialists taking a water sample for later chemical analysis

The scope of the new BGR project was two-fold: first, to enable Afghan counterparts from relevant ministries and academic institutions to use geoscientific data for the benefit of the Afghan people. Practically oriented training courses on well construction, groundwater hydraulics and groundwater chemistry were held and measuring equipment transferred. Secondly, the newly trained Afghan water experts and the equipment were employed to gather information on the groundwater resources of the Kabul basin. Detailed information on the hydrogeology of the Kabul Basin is needed to assess and improve the current water supply situation and to develop sustainable concepts for future groundwater use.

Groundwater resources in Kabul

The Kabul river after the drought in 2004

The project had to be focused on the Kabul Basin due to the desperate water supply situation there. The population sharply increased from 1.8 million in 2002 to 3.0 million in 2004 due the influx of a vast number of internal refugees and former citizens of Kabul returning from abroad after the demise of the Taliban. A severe drought lasting from 2000 to 2004 further complicated Kabul's water problems.

Due to the drought-related shortage of surface water, groundwater is now the major source for drinking water in the Kabul Basin. Only 20 % of the population have access to tap water. The rest depends on shallow wells equipped with hand pumps. Several thousand of these wells can therefore be found all over the city. The quality of these wells was tested by an extensive sampling and analysis programme.

The Kabul Basin comprises three major aquifers, all consisting of coarse sandy to gravely material originating from the surrounding mountains. They were deposited by several rivers draining the basin which is underlain by impervious marl. Usually the aquifers are covered by loess loams which form the major groundwater protection layer. The coarse aquifer material implies high permeabilities. Deeper parts were affected by a cementation of the pore spaces, resulting in conglomerate formation and decreased well yields.

Overexploitation of groundwater

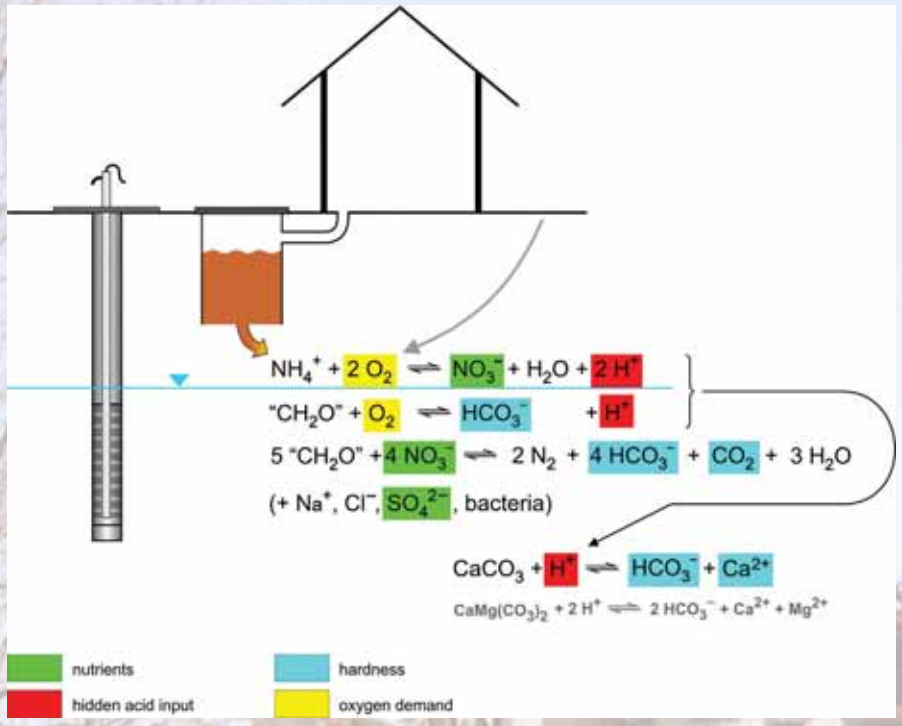
Handpump in Kabul City next to an open waste water ditch

The main sources of groundwater recharge are direct exfiltration from the rivers after the snowmelt and foothill infiltration at the rim of the basin. Kabul's typical continental climate with low precipitation and high evaporation rates practically precludes any groundwater recharge directly from precipitation. The drought of the last few years and the continuously rising population have lead to a strong overexploitation of the groundwater resources. This means that more water is being pumped than can be naturally replenished. Falling groundwater levels are an alarming indicator. It must be emphasised that several wet years would be needed to overcome this problem. Future concepts must therefore consider water import from surrounding areas as an option.

Uncontrolled waste disposal in Kabul

Deterioration of groundwater quality

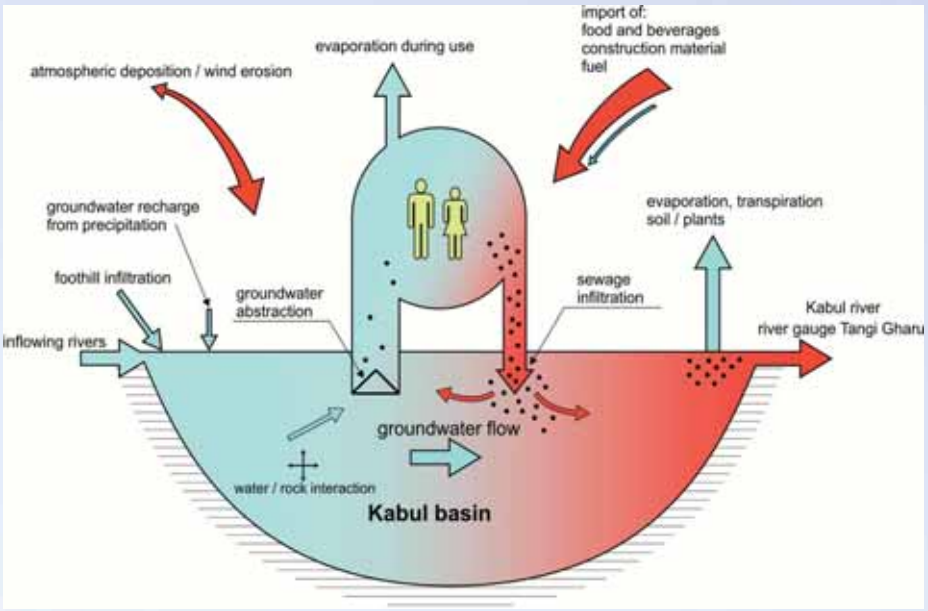
The groundwater chemistry is characterised by slightly oxic redox conditions. Nevertheless, oxygen saturation is not complete even in shallow groundwater, hinting at oxygen-consuming reactions due to the influx of waste water. Interactions with aquifer carbonates have lead to high degrees of hardness and near-neutral pH. The mostly negative water budget of the Kabul basin results in strong evaporation which leads to an increase in salts and some undesirable constituents like borate. Several years of drought have aggravated this problem since pollutants are not being flushed out by natural groundwater flow. In some areas with formerly shallow groundwater, the groundwater contains so much salts that it cannot be used for human consumption or even irrigation.



Main processes of wastewater influence on shallow groundwater

The shallow groundwater in the city has received tremendous amounts of pollutants due to a lack of proper waste and wastewater disposal. More than 86 % of all households have a simple cesspit without any further wastewater treatment. Hence, elevated concentrations of nutrients such as nitrate, sulphate and faecal bacteria can be found in the shallow groundwater. The high infant mortality can at least be partially attributed to the insufficient water hygiene. Acid generated during the mineralization of the waste water is hidden due to the strong pH buffering capacity. Luckily, the prevalent redox and pH conditions preclude significant mobilisation of trace metals and metalloids, such as arsenic.

Consequences



Water and contaminant fluxes in the Kabul basin

The existing situation requires that appropriate measures are taken which reduce the described threats for the safe future development of the irreplaceable groundwater resources. This should include:

- wastewater disposal and treatment
- controlled disposal sites for solid waste
- delineation of groundwater protection zones
- development of alternative strategies for water supply
- integrated water resources management (IWRM) and policy dialogue
- awareness rising for all water-related problems

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