Groundwater — Resources and Management

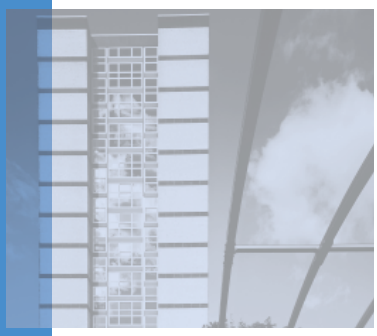
Bundesanstalt für
Geowissenschaften
und Rohstoffe

GEOZENTRUM HANNOVER

Strategies for the Sustainable Management of Non-renewable Groundwater Resources

Commissioned by:

Federal Ministry
for Economic Cooperation
and Development



This publication was produced by the sectoral project „Policy Advice Groundwater - Resources and Management“ which is implemented by BGR on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ).“

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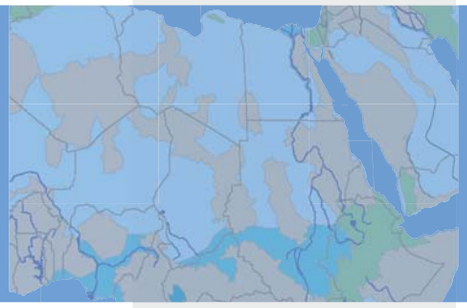
Strategies for the Sustainable Management of Non-renewable Groundwater Resources

This paper summarises the special features of managing non-renewable groundwater resources and outlines a strategy for using these resources in an optimal way. Its objective is to support decision makers in development cooperation (DC) who face the situation of uncontrolled use of these resources. It is based largely on the UNESCO publication "Non-renewable Groundwater Resources" (UNESCO 2006).

In the BMZ Water Sector Strategy (BMZ 2006), the management of non-renewable groundwater is described in the following way:

► *"In water catchment areas with a strained or negative water balance, the drinking water supply (…) can, in extreme cases, only be safeguarded through the use of fossil groundwater. In such situations, the need to ensure a basic supply of water services to poor social groups must be brought into line with the need for environmental sustainability. In the long term, social justice can only be achieved on the basis of sustainable resource management."*

► *"For the development cooperation, this means that promoting measures to supply the population with water can be considered even in cases of a negative water balance if these measures are particularly likely to result in substantial and positive development impacts. In humanitarian emergencies, the use of non-renewable fossil groundwater as a source of drinking water is also tolerable in the short term. In both cases, however, every opportunity must be utilised to improve the water balance both beforehand and as a flanking measure. In particular, the use of fossil water must always be the subject of a comprehensive evaluation of alternative options."*

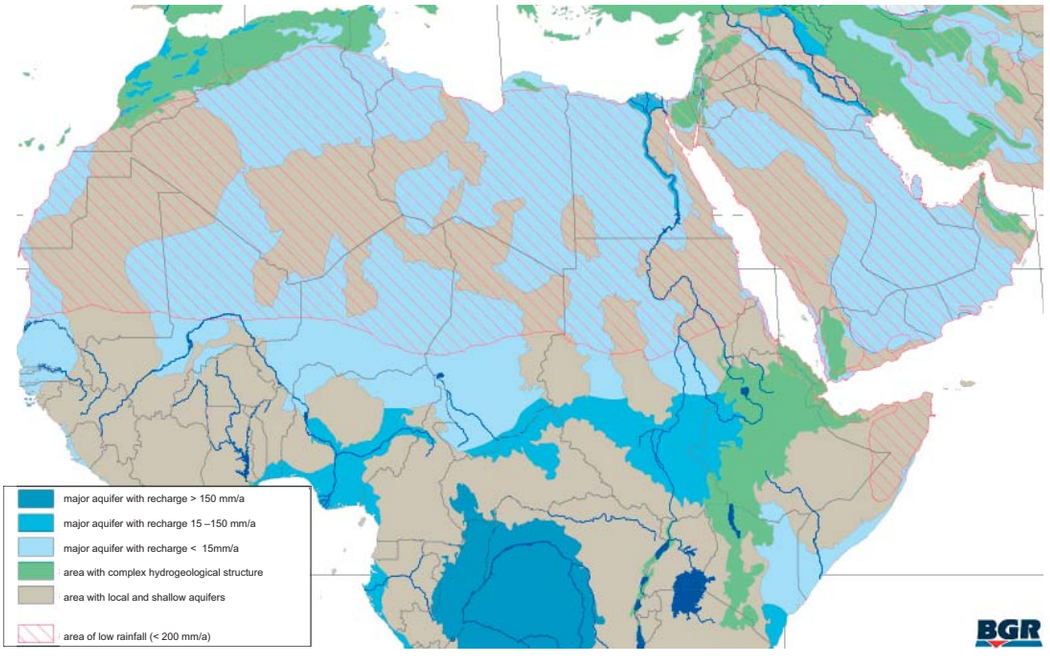


What is non-renewable groundwater?

The term non-renewable groundwater refers to groundwater resources which, at present, are not part of the hydrologic cycle since neither precipitation nor infiltration provides recharge. The renewal is thus insignificant and only during very long time periods do noticeable water quantities accumulate. As these time periods – often spanning several hundred and even thousand years – clearly exceed the horizon of human planning, these water resources are considered to be non-renewable. The reasons for the decoupling from the hydrologic cycle are changes in the climatic conditions in the catchment area. Non-renewable groundwater is found primarily in the semi-arid and arid zones in the Middle East, North Africa, Central Asia and Southern Africa.

The resources were formed during periods with a more humid climate in the respective regions. Due to the high age of these waters, they often are called fossil or paleo-groundwater.

The **decoupling from the current hydrologic cycle** and the fact that the resources are non-renewable clearly sets them apart from “normal” groundwater. Non-renewable groundwater is not usually connected with ecosystems (which are dependent on them). Therefore, these resources are more like mineral or energy resources, such as ores or oil, than so-called green resources, such as forests or soil. Appropriately, the use of this type of water is referred to as groundwater mining in English. These natural boundary conditions have far-reaching consequences on the management of the resources.



Low- or non-renewable groundwater resources exist in numerous regions of the world which have very low levels of precipitation, e.g. parts of North Africa and the Middle East.

[1] For the sake of disambiguation of terms, an annual recharge rate of less than 0.2% of the aquifer capacity may classify an aquifer as non-renewable. This is particularly the case in regions with very low levels of precipitation (less than 200 – 300 mm per year).

Sustainability and non-renewable groundwater

The international discussion on sustainability is based on the definition provided by the Brundtland Commission in 1987:

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

This definition contains two essential concepts: the needs of the poor are to be urgently satisfied and the natural limits of economic development must be taken into account during planning.

The application of this principle is often set equal to the demand not to use non-renewable resources at all, since, once extracted, water cannot be used by future generations. This assumption follows the classic rule for groundwater management, which is to use only those quantities which can be replenished by natural sources of recharge . In fact, the use of non-renewable groundwater leads to a decrease of the groundwater level and, thus, of the resource availability if all other boundary conditions remain constant. However, it is considered that this fact as such does not contradict the principles of sustainable development.

Because of its history of formation and its generally deep location in the underground, non-renewable groundwater is rarely associated with ecosystems. The use of these resources, therefore, normally has considerably less adverse effects on the environment than over-use of renewable resources, which very often form the means of existence for valuable ecosystems . The focus on sustainability should, therefore, be primarily focused on the affected population, i.e. on their social and economic development. **A just distribution of benefits from the use of non-renewable groundwater between today's users and those of future generations (benefit sharing) appears to be the actual challenge at hand for sustainable management.**

In many countries, particularly in North Africa and the Middle East, the intense use of non-renewable groundwater is a reality today. This region is one of the most water-poor regions in the world and faces a significant increase of population which will lead to an even higher demand for drinking water. The problem is further aggravated by increased agricultural uses for the available water and plans for industrial production.

[2] This understanding is very disputed among scientist since it does not take into account the natural discharge of groundwater into surface water bodies.
[3] Groundwater dependent ecosystems (GDE).

It is not expected that current use patterns will be reversed. Therefore, the objective must be to achieve a **change from uncontrolled exploitation towards planned management of groundwater use.** The German and international development cooperation can provide significant support for this change. It has long-standing experience in reforming water management and can, thus, be a valuable contributor to the implementation of the principles outlined below. However, financing of infrastructure for the use of non-renewable groundwater is possible for the German DC only in exceptional cases, for instance in humanitarian emergencies (BMZ 2006).

Several conditions must be fulfilled in order to transform the use of non-renewable groundwater resources into a sustainable development:

Improving people's living conditions

The use of non-renewable groundwater must lead to a clearly identified improvement of the living conditions of the population, particularly of the poorest groups. At the same time, additional socio-economic development chances must be created in order to generate a potential benefit for future generations.

Developing a follow-up strategy

The use of non-renewable groundwater resources implies that the time will come when this practice either can no longer be continued or is no longer economically acceptable. A follow-up strategy needs to be developed for this phase. The economic gains of the present use must be invested in the development of an alternative economic structure which is independent of non-renewable groundwater.

At the same time, within the foreseeable period of groundwater use, technical alternatives for substitution must be developed and examined with respect to their economic and ecological feasibility. Examples here include ocean water desalination or desalination of saline groundwater as well as wastewater purification and re-use.

Participation of all user groups

The principles outlined above can only be implemented if a participatory process of negotiations leads to an agreement on the type and scope of groundwater use. The participation of all population groups, particularly the poor and marginalised ones, must be ensured by appropriate institutional structures which also take into account power imbalance. Only in this way will it be possible to adequately distribute the benefits from the resources within the present population and make provisions for the future generations.

The management of non-renewable groundwater

Outlined below are the management rules which are derived from the principles described above and which should contribute to their implementation.

The management of non-renewable groundwater is more likely than renewable groundwater to generate usage conflicts. Falling groundwater levels could affect specific user groups because as wells dry, more powerful pumps are required. It is not usually possible to maintain all types of groundwater use. As a result, compensation for usage demands which can no longer be satisfied must be an important component of the management program. In cases where there is a connection to surface water bodies, nature must be considered to be a “user”. Negative effects on ecosystems should be avoided wherever possible and ecological aspects should be included in the list of criteria for determining the ‘exit time’ for discontinuing the use of non-renewable groundwater.

In the case of non-renewable resources, it is essential that demand be tightly managed, e.g. through water pricing, in order to maximise the economic efficiency of water use. Forms of water use leading to a great increase in value should be given priority over less efficient activities; however, due consideration must be given to social and ecological criteria. Only in this way will it be possible to create compensation for uses which are no longer possible or practical. Drinking water supply per se is not considered a productive use, however indispensable it is for life. Because of this extremely high social benefit, the drinking water supply traditionally has priority over uses with economic benefits.

While non-renewable resources are used, the water must be used technically as effectively as possible in order to extend the period over which the water can be utilised For the time which follows the end of the (economic) usability of the resources, “…new methods of providing water should be developed – as long as they are economically and ecologically viable – such as seawater/brackish water desalination, artificial groundwater recharge, or the use of treated wastewater, in order to avoid long-term supply bottlenecks and ecosystem disruption” (BMZ 2006).

Sustainable management of non-renewable groundwater places high demands on the necessary information and on the information management system. Participatory management with an ecological and economic assessment of the consequences as well as the determination of the 'exit time' requires a very solid information foundation in order to make informed decisions. In practice, this poses a great challenge since often neither the required data nor the necessary professional qualifications are available. **The establishment of a monitoring system**, particularly for the quantitative assessment of the available resources as well as the **establishment of qualified institutions** are core elements for the sound management of non-renewable groundwater.

If the information basis is still incomplete, all plans for groundwater use should assume the **worst case scenario** in order to minimise uncertainties. It usually takes years to acquire sufficient information. Until this information has been collected, water extraction should be kept as low as possible and the hydrogeological parameters should be considered to be unfavourable in order to avoid undue lowering of the water table. It is useful to define realistic fluctuations in the water level within which the water table can be expected to move under the assumption of expected usage patterns. Periodic monitoring can provide information as to whether the water level fluctuates within the expected range or if the extracted quantities need to be modified.

In order to implement these management rules, it is often necessary to **raise awareness** at the same time in order to familiarise the population with the value of the limited resource and to make them sensitive to water-conservation methods. These measures could be supplemented by information on the potential of alternatively generated water, e.g. treated wastewater for agricultural irrigation

Institutional requirements

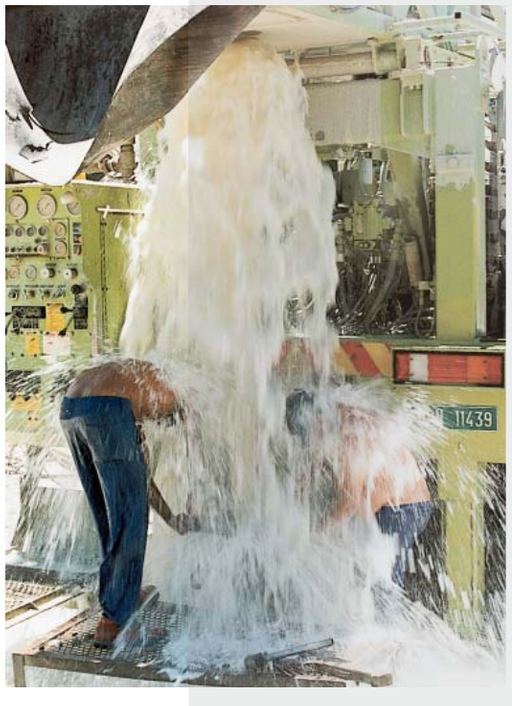
To ensure sustainable management as described above, a number of institutional prerequisites are necessary.

In the case of non-renewable groundwater, it is advisable that only one **coherent institutional structure** with a fully responsible political organisation be authorised to implement the demanding management principles and to provide political support. If such a structure cannot be established, a special institutional clearing house in the form of a coordination committee should be created which assists in balancing the various political interests.

Likewise, on the management level all competences and responsibilities should be grouped within a single organisation which is able to coordinate all sectoral and possibly geographically scattered user demands and which is able to make recognised decisions. The institutional structure needs **mechanisms for conflict resolution** in order to balance competing demands by referring to commonly accepted decisions.

Ownership of non-renewable groundwater resources should remain in the public hand. Only in this way is it possible to ensure that participatory negotiation processes are performed between competing user interests by taking into account the intentions of all actors or interest groups. The public hand should be able to **grant or withdraw water rights** and, as a result, control the actual extraction of groundwater. As a general rule, permissions for the extraction of non-renewable resources **should be limited in time** since the development of the resources should be re-examined every five to ten years. New permissions should only be granted if it can be verified that past rates of extraction did not exceed the anticipated water level fluctuations.

If non-renewable groundwater resources are transboundary, **international riparian cooperation** is another important element of the institutional arrangement for ensuring sustainable management. The establishment of a **joint monitoring programme and a common database** could serve as a basis for cooperative management of and even beyond the water resources.



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