NILE BASIN INITIATIVE
INITIATIVE DU BASSIN DU NIL

GEDAREF-ADIGRAT TRANSBOUNDARY AQUIFER

Diagnostic Analysis and Groundwater Modelling: Results & Recommendations

This policy brief for the Gedaref-Adigrat Transboundary Aquifer resonates the outcomes of a Shared Aquifer Diagnostic Analysis (SADA) and the Groundwater Modelling, assignments conducted as a part of a groundwater project executed by the Nile Basin Initiative. SADA provides a regional overview of aquifer characteristics and water resources management, supported by a thorough stakeholders' survey. While presently only a fraction of population in the aquifer area has access to clean and safe water, the population grow, intensive agriculture and lack of sanitation are causing ever-increasing groundwater depletion and pollution. Better groundwater monitoring is essential for improvement of knowledge about the aquifer and its management. Better cooperation at all levels of governance, nationally and internationally, is necessary to ensure integrated and harmonised management of water resources in the region.

Introduction

Gedaref-Adigrat Aquifer is situated in Eastern Africa, partly in the Adigrat region in Ethiopia and partly in the Gedaref region in Sudan. This large aquifer covers approximately 55.000 km² and the land above it is a home to almost 4 million people, their livestock and crops, and the natural flora and fauna. And water is vital for existence of all of them. Although the area receives fairly amount of rainfall, evapotranspiration is also high, reducing recharge of the aquifer to a few summer months. A couple of large rivers are intersecting the region and the dams were built to increase water availability. Yet, groundwater is the most important source of domestic water supply, especially in more arid parts of the aquifer area.

Despite its land and water resources, the population in the study area is suffering from poverty and food insecurity. Among other reasons, this is due to vulnerability to natural disasters, conflicts and lack of security, acute shortage of potable water supply and high illiteracy and unemployment rates. At the same time, the population is rapidly growing and related pollution and over-abstraction are putting a pressure on water resources. Finaly, climate is changing, often unfavourably for renewal of water storage, both at the surface and underground.

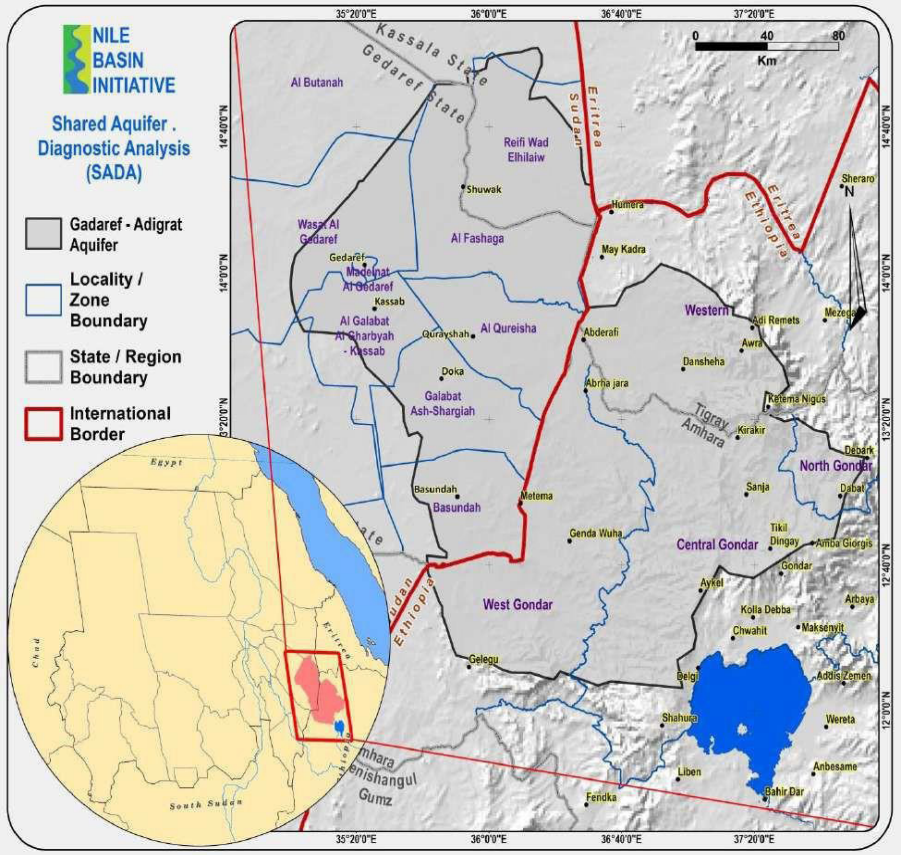
All these facts ask for a significant improvement of water resources use and protection, both at policy level and in practice. Since this aquifer is shared between two countries, its good management depends on international cooperation as well.

Nile Basin Initiative Groundwater Project

The Nile Basin Initiative (NBI) is carrying out a project entitled "Enhancing conjunctive management of surface and groundwater resources in transboundary aquifers: case study for selected shared groundwater bodies in the Nile Basin." The project aims to foster the more effective utilisation and protection of selected shared aquifers in the selected sub-basin in the Eastern Nile and the Nile Equatorial Lakes region through demonstrating conjunctive management that optimizes the joint use of surface and groundwater. One of three selected aquifers is the Gedaref-Adigrat Aquifer. As a part of the project, so-called Shared Aquifer Diagnostic Analysis (SADA) is conducted, followed by development of a Groundwater Model.

Shared Aquifer Diagnostic Analysis

SADA is a comprehensive analysis of hydrogeological, environmental, socio-economical, policy and institutional aspects of shared groundwater resource, in this case the



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Gedaref-Adigrat Aquifer. The SADA started with gathering of data located at various institutions in both aquifer-countries. Collected data were analysed by national natural- and social-science specialists, subsequently compared and, as much as possible, unified by regional specialists.

Hydrogeological analysis pointed out a structural lack of field groundwater data. Nevertheless, since the Gedaref-Adigrat is a large regional aquifer, the collected data were sufficient to provide a fair understanding of regional hydrogeology. Likewise, data on climatic and hydrological processes, also available at regional level, enabled preliminary estimation of impact of a changing environment on aquifer recharge. For any further, detailed analysis, the additional data are necessary, in particular measurements of groundwater quantity and quality.

Practically there is no systematic monitoring in the Gedaref-Adigrat Aquifer. A dedicated groundwater monitoring network in essential for adequate managing and planning of water resources. Groundwater assessment cannot be completed and predictions made without analysis of historical data, consequently: *we can't manage, what we don't measure!* Accordingly, SADA report contains a concept programme for a capacity building course on groundwater monitoring.

Based on population and infrastructural data, SADA clearly points out a poor water supply situation in the region. Only a small percentage of population has access to safe drinking water and the majority of rural population needs to travel kilometres to collect drinking water. The current groundwater abstraction cannot meet the human demand and certainly not one of the livestock. Consequently, the water from rivers, unprotected ponds and springs is used, usually without any treatment. The groundwater quality is under the threat of pollution, mostly due to poor sanitation and use of pesticides in agriculture.

SADA reveals that a national policy in both countries comprise the principles for groundwater resources management, including the monitoring. Yet, implementation of these principles in practice is largely missing, in particular due to inadequate governance, financial constrains and lack of knowledge and awareness, as stated in the stakeholders' analysis. *Current institutional structure in both countries can be effectively used in harmonisation and elaboration of the policy through specific directives and guidelines, such for the groundwater monitoring.* In order to achieve this, policy elaboration should be based on analysis of authorities, responsibilities and capacities (human and equipment) at all levels of governance. Equally important, communication needs a substantial improvement, both horizontally (e.g. surface-and groundwater departments, water- and

Necessity of groundwater monitoring: we can't manage, what we don't see or measure!

Water resources need to be managed conjunctively, hence in integrated and harmonized way.

Water management can be substantially improved only through better cooperation across scales, sectors/disciplines and administrative borders.

agriculture, etc.) and vertically (between the policy and the implementation level, both directions).

SADA identified over 150 stakeholder's groups at various level of governance, from local to international. Among others, the survey included the groups representing ethnic majorities, women and children, farmers and herders. The groups are then classified according to their interest in- and possible impact on groundwater management. This information is a valuable input for any future adjustment or elaboration of groundwater policy: *only full stakeholders' involvement can ensure necessary support to- and feasibility of management measures*. Moreover, close stakeholders' engagement is very instrumental while defining and executing capacity building programmes and awareness raising campaigns.

Conjunctive Water Management (CWM)

Preliminary regional assessment revealed that the Gedaref-Adigrat aquifer has a large groundwater storage potential and that annual natural recharge represents only a fraction of available excess runoff. Accordingly, there is an opportunity to enhance the natural recharge and groundwater storage in wet period of the year and to reuse is when shortage of water is the largest. Managing all the elements of water cycle conjunctively, hence in integrated and harmonized way, brings many benefits:

* More water resources available for use and lower risk of water shortages
* Environmental benefits through the green infrastructure, landscape management and improving ecosystem services.
* Economic and social benefits (higher water and food security, less migrations, preventing conflicts, etc.).
* Improving planning and governance (avoiding double counting, easier identification of possible hazards and of opportunities).
* Improving synergy with international global policy priorities related to water such as Sustainable Development Goals (SDGs).

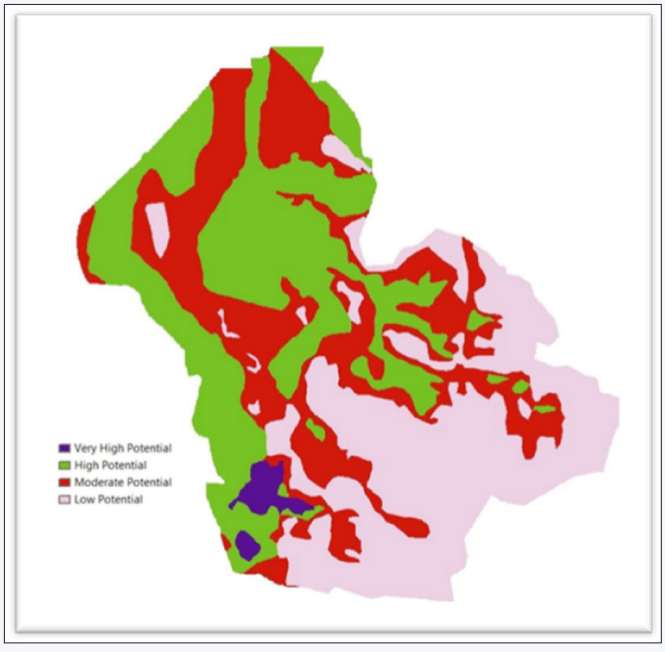
CWM is primarily a governance issue and depends heavily on institutional integration and cooperation. It can be improved (nationally and internationally) by inclusion of groundwater in the river basin policy documents, capacity building programmes for river basin authorities, implementation of groundwater monitoring and raising awareness.

Data collected for SADA and Groundwater Modelling were used to develop maps showing potential sites for CWM, namely for water retention (the Small Dams map) and for additional recharge of the aquifer (the MAR map). These regional maps indicate where further investigation should find place, since applicability of CWM techniques depends strongly on local conditions.

An inventory of local CWM structures such as small (check) dams, barriers, bunds and hafirs would be helpful in choosing locations for new CWM interventions. Moreover, some of existing but not functioning structures (e.g. silted dams and blocked trenches) might be worth of restoring.

Transboundary Water Cooperation

Climate change and human impact on groundwater resources do not stop at any kind of administrative borders, nationally and internationally. This makes joint care of transboundary aquifers like the Gedaref-Adigrat a necessity. According to United Nations' Sustainable Development Goal 6.5.2 Progress Report, a number of countries that cooperate on shared groundwater resources is steadily increasing. Their motivation is not only to prevent and/or mitigate water conflict but also to join the forces is tackling a range of common problems in the region. In the Gedaref-Adigrat aquifer region those are, among others: pollution and water quality deterioration, land degradation, poverty and migration due to food- and water-security and political instability.



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Gedaref-Adigrat transboundary Groundwater Monitoring Network (GMN) is required in order to detect possible unwelcome changes (pollution, over-abstraction) on time and take adequate measures. GMN will be set up as a multipurpose network, that is including all current relevant measuring points and yielding useful info for various stakeholders. Indications of over-abstraction and groundwater pollution, as addressed in SADA, will be used in selection of priority locations for the monitoring points. Development of the GMN will take place together with a number of Technical (what to measure, how and where) and Policy Measures (monitoring directive and institutional strengthening, especially on community level). Institutional responsibilities should be matched with personnel capacity and equipment. Groundwater specialists from both aquifer-countries will use a freeware database to store and analyse collected observations. Following the UN guidelines for transboundary aquifers, this will be done by a common working group, supported and guided institutionally by aquifer-countries. Currently there is no need for a separate institutional arrangement, since the already established cooperation mechanism within NBI can easily accommodate these tasks.

Groundwater Model

SADA input data and the outcomes were used to develop a numerical groundwater flow model. Groundwater model is an excellent tool for simulation of future state of the aquifer using scenarios. However, the model firstly needs to be calibrated using groundwater observations. Since the observations were in this case hardly available, the model outcomes should be considered only as indicative. Nevertheless, once the monitoring data become available, the model can be improved, becoming a standard tool to support a management of water resources in the region. To achieve this, a modelling capacity building will be required as well, as suggested in SADA.

Impact of the climate change and the population growth was investigated by applying model several scenarios. Climate change analysis showed that groundwater recharge will decrease about 10% up to 2050, and the model indicated no significant impact of this reduction on groundwater levels (the situation, however, might change after 2050). Regarding the population and the water demand, both are expected to duplicate in 2050. The model outcome indicated that the impact of increased pumping (required to meet the demand) on groundwater resources will be much larger than of the reduced recharge due to the climate change. The combined impact will most likely lead to a considerable lowering of groundwater level (>30m) in some parts of the aquifer. On the other hand, the current and even future pumping rates are much lower than the groundwater recharge. This indicates a remaining potential for further groundwater development, at least in some part of the aquifer.

Nile Basin Initiative Secretariat
P.O. Box 192
Entebbe - Uganda
Tel: +256 417 705 000
+256 417 705 117
Email: nbisec@nilebasin.org
Website: http://www.nilebasin.org
Facebook: /Nile Basin Initiative
X: @nbiweb

Eastern Nile Technical Regional Office
Dessie Road
P.O. Box 27173-1000
Addis Ababa - Ethiopia
Tel: +251 116 461 130/32
Fax: +251 116 459 407
Email: entro@nilebasin.org
Website: http://ensap.nilebasin.org

Nile Equatorial Lakes Subsidiary Action Programme Coordination Unit
Kigali City Tower
KCT, KN 2 St, Kigali
P.O. Box 6759, Kigali Rwanda
Tel: +250 788 307 334
Fax: +250 252 580 100
Email: nelsapcu@nilebasin.org
Website: http://nelsap.nilebasin.org

/Nile Basin Initiative @nbiweb Nile Basin Initiative Nile Basin Initiative