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PEOPLE AND SYSTEMS FOR WATER, SANITATION AND HEALTH

Setting up monitoring networks and analysis in South Africa

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VIRTUALLY NO MONITORING of ground water conditions takes place in South Africa's ground water based rural water supplies, at best the quantity of water abstracted from boreholes is recorded. Only in very few cases are ground water levels monitored, and ground water quality is seldom being monitored. Continuous and regular monitoring of both ground water quality and quantity is imperative for ensuring sustainable supply. For South Africa this exercise is becoming even more important with the continuous increase in the utilization of ground water resources as well as the installation and upgrading of sanitation facilities under the Government's Reconstruction and Development Programme (RDP) to ensure a sustainable water supply of good quality to all people. This paper describes a pilot scale monitoring programme recently set up in three Provinces in South Africa: Eastern Cape, Kwazulu-Natal and the Northern Province, and presents some guidelines as to how ground water management can be implemented in a rural context. The outcome of the pilot scale projects will lead to a management programme that can be implemented in the rest of the country. The findings presented on this paper are mainly derived from fieldwork that has been conducted in the Northern Province and in Kwazulu-Natal up to now. The findings presented here are the outcome of a completed research project in the Northern Province funded by the Water Research Commission (WRC) of South Africa, whereas the pilot scale programme as well as the future implementation of the management scheme is funded by the Government of Norway (NORAD Programme) and managed by the Department of Water Affairs and Forestry.

Methodology

The basic principles for data collection, presentation and interpretation to be able to manage ground water based rural water supply schemes were acquired during the WRC funded project. For the NORAD project a number of rural villages that are mainly dependent on ground water resources were selected around the town of Ladysmith in Kwazulu-Natal for the purpose of this study. As part of an awareness aspect of this study there is an ongoing programme to teach village water committees and pump attendants/operators on issues pertaining to the hydrological cycle with special emphasis on ground water, sustainable use, protection from over-exploitation and pollution. This is coupled with practical training in taking water levels using dip meters, and taking readings from water flow meters to monitor consumption and accurately recording those readings on logbooks provided. Continuous and regular sampling of the groundwater has also been initiated. The collected samples are being analysed for both the microbiology and inorganic chemistry. The primary aim of this exercise is to get the local people involved in **monitoring** and **managing** their own water resources. The data collected on the field is to be passed on to the water service authorities. Not only are the respective Water Service Authorities to be trained on the interpretation of the collected data to enable them to make proper and effective management decisions as far as groundwater resources are concerned, but it is the aim that the first level of management is the responsibility of the community itself.

Monitoring requirements

Management of ground water resources are reliant on long time series of data. In most cases no monitoring has taken place, and therefore a time series still needs to be built up. An important aspect in the management of community based rural ground water resources by the community itself, is the involvement of the community through the local Village Water.

Committee. However, to install a monitoring programme without explaining the purpose and philosophy behind it to the community responsible for the task, has no meaning. This means the interest of the community in the monitoring needs to be maintained in order to achieve interest in the monitoring and eventually the management over the longer term. This can only be achieved through the educational programmes. As part of the process of transferring limited management of the water resources to the community, an educational programme whereby the Village Water Committee and the pump operators are provided with the basic concepts of the hydrogeological cycle and especially those aspects relevant to ground water, was initiated. An educational "toolbox" constructed of a glass or plastic container filled with sand and equipped with devices simulating abstraction and monitoring boreholes, rainfall/recharge, and inflow and outflow valves, were used to illustrate basic principles related to ground water. Concepts that are explained with this "tool" are effect of pumping on water levels (with and without recharge to the resource), interaction between closely spaced boreholes when pumped, interaction between pollution sources (for example pit latrines and waste dumps) on surface and ground water, role of streams and rainfall, etc. This training with physical models is believed to be of utmost importance because of the "hidden" nature of ground

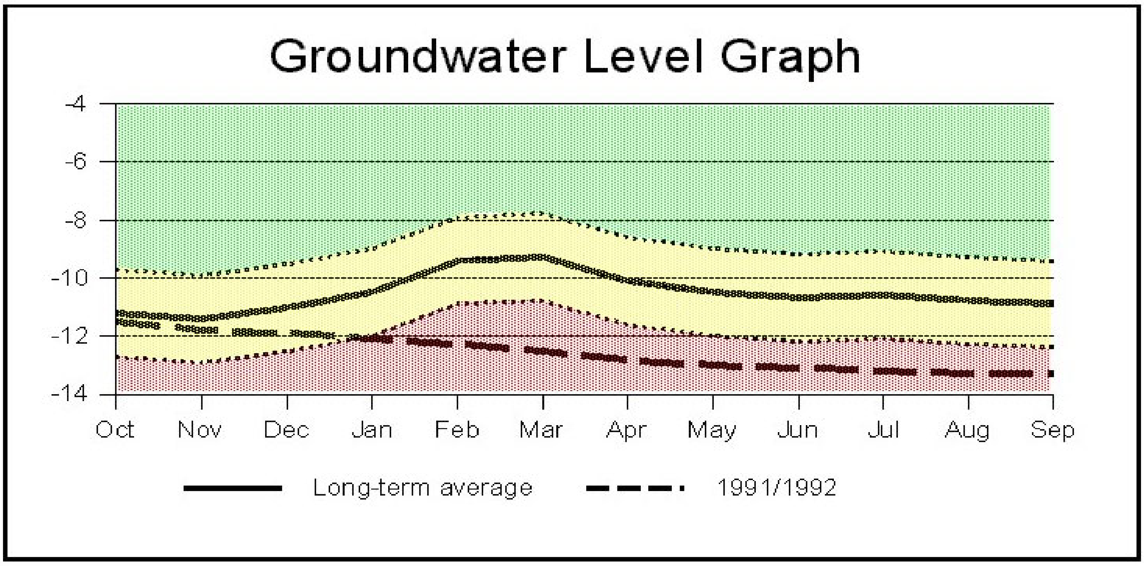

Figure 1. Groundwater level graph, showing the long-term average water-level together with the rainfall level for a specific year, to indicate the condition of the resource compared to the average

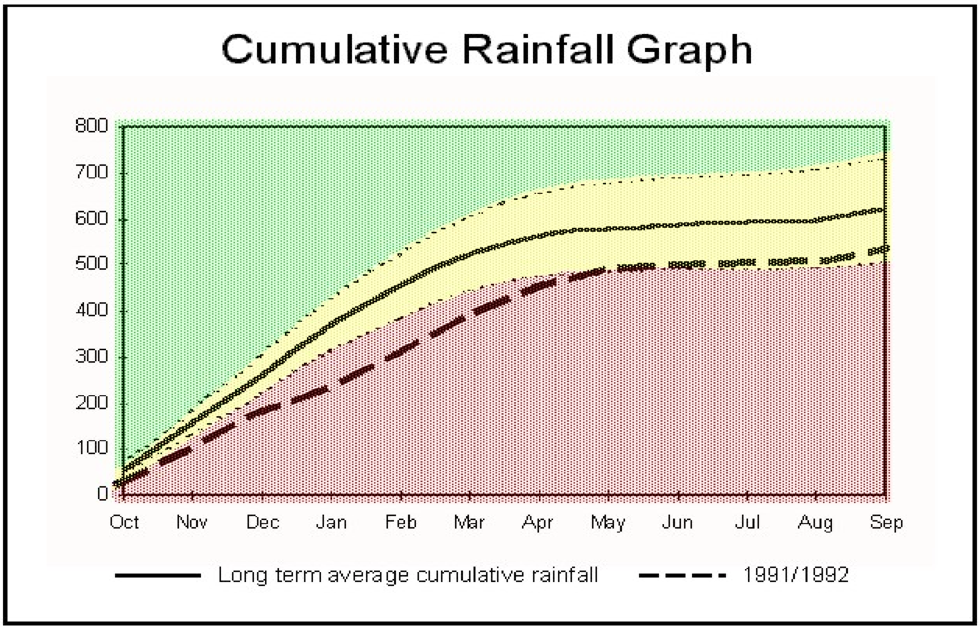

Figure 2. Cumulative rainfall graph, showing the long term average cumulative rainfall together with the cumulative rainfall for a specific year. This serves as an indication of the recharge potential of the groundwater system

water and a general lack of understanding of ground water principles, not only in rural communities, but also under educated populations. Unless these principles are illustrated to the Village Water Committee and those responsible for the monitoring, the need for monitoring will not be appreciated.

Once monitoring data have become available, these have to be converted for management purposes by designing easy understandable graphical ways to illustrate the variations in geohydrological parameters and how these would indicate a condition where the aquifer needs management or intervention by qualified geohydrologists. The technique uses data from only four fundamental geohydrological parameters: water level, rainfall, discharges and water quality. To overcome the problem of not having a long term record, the use of rainfall and water level records for a larger region are proposed and provides a "first level" range in water level and rainfall variation. These are then used to set the lower limits for the water level and rainfall conditions and give some indication of what can be expected in terms of water level response during above- and below-average rainfall years. Because monthly rainfall can be highly variable, the cumulative monthly rainfall is graphically displayed and compared to the average cumulative rainfall of previous years. These concepts are illustrated in **Figures1 and 2**. Other graphical display techniques were also developed and will be alluded to during the conference.

A number of important lessons were learnt during the WRC project that will be built into the monitoring programmes for the NORAD project. Some of these are listed below:

- To ensure reliable monitoring data, frequent visits to the pump attendants are required.
- For each pump operator, a backup operator, trained to perform the monitoring functions, should be available.
- Reliable geohydrological information (depth, sustainable yield, construction, etc.) of all the boreholes forming part of the monitoring network is available.
- Cumulative rainfall monitoring equipment is recommended.
- Demand, consumption as well as abstraction volumes are required for management.
- EC to be measured weekly by pump operator, samples for microbiological and chemical analyses collected quarterly and half yearly respectively.

In rural water supply schemes, the aquifers are seldom put under stress. This then often results in almost no variation in the monitoring data which again may lead to losing the interest of the community to continue with the monitoring programme.

Results from the Ladysmith region, Kwazulu-Natal Province, NORAD project

The boreholes selected for the pilot scheme are well constructed and protected from flood washes, pollution and vandalism. Most of them were not originally equipped with piezometer tubes, water flow meters and sample take off points. For proper monitoring, these have to be installed at most of the boreholes included in the pilot scheme. Continuous abstraction does not occur in most villages abstraction for reasons of a technical as well as social nature. The technical problems include amongst others, breaking down of engines powering the pumps, and the social problems include the lack of payment of water services by the community and thus lack of funds to pay for the power supply (diesel or electricity). Most of these problems take time to solve, due to both institutional operation of these villages and their remote location, long delays in solving these problems occur. The data that has been collected so far includes ground water levels, pumping rates, pumping durations, and quality. The results of chemical analysis which have been performed to date on water samples, collected in all the villages in the area show the quality of the groundwater to be fairly good, and complies with the national water quality standards. The microbiological analysis also showed the water in this region to be in good condition. The heterotrophic plate count (HPC) and the Total Coliform count are high and above the limit of the South African drinking standards. This can be attributed to biofilming, which accumulates inside the pipes when the system is not regularly treated. The Feacal Coliform count is zero in most villages.

General problems and challenges

Unfortunately in most of the villages, there has not yet been regular and continuous pumping. This is due to a number of problems that are both social and technical in nature. These and other factors have caused a delay in the production of data. At this stage not enough data has been collected acquired to make any meaningful statements, suggestions or conclusions. The primary focus at this stage is to put the proper monitoring infrastructure in place to support the pump operators in collecting accurate data, and to facilitate the flow of data from pump attendants to the relevant water authorities.

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