



## Failure of conjunctive water use

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WATER SUPPLY TO Ho, the capital of the Volta Region of Ghana, with current population of 70,000, went through some crises during the period 1950-1993.

Initially the water supply was based exclusively on groundwater sources. Later conjunctive water use, which is defined as the coordinated combined creative exploitation of groundwater and surface water, in order to minimize the dislocation produced by nature's inconsistent rainfall patterns, (Lehr et. al., 1985) was tried but failed, due to lack of detailed planning and the misapplication of water management techniques.

A number of reports and plans prepared by consultants, to find solutions to the problem of permanent rationing of water, have been reviewed and analysis has been made of the causes of failures. Lessons learnt have also been highlighted.

### History of ground water development

In the early 1950's, water supply planners identified the obvious major economic advantages of groundwater over surface water. The Togo quartzites forming the Kabakaba Hills, on the northern part of the town, constitute an aquifer of considerable extent but with low overall permeability. These rocks are extensively fractured and are traversed and bounded by major shatter belts associated with fault lines. The areas of shattered rocks have a much higher permeability and, owing to the favourable structure of the hills, form collecting points for water contained in the aquifer.

Based on the principle that groundwater could be developed in simple stages, commencing in 1957 and over a period of five years, eight boreholes were successfully drilled in two separate borehole fields, supplying 450 cubic metres per day ( $\text{m}^3/\text{d}$ ) into two reservoirs and a distribution system feeding stand pipes and house connections. Two further boreholes fields, were commissioned in 1969, as the need for additional water arose, bringing the total number of boreholes in production to ten and increasing the capacity to over  $1360\text{m}^3/\text{d}$ .

Comparison of tests carried out in 1969 with the original tests showed that in some cases the standing water level had dropped considerably (in one case more than 30.0m) since the boreholes were commissioned. The inference was that, abstraction exceeded recharge and groundwater was being mined; the life of the borehole fields was consequently likely to be limited.

From the tests it was also evident that many of the boreholes would sustain a higher abstraction rate, so it was

expected that boreholes with limited future could be phased out as soon as additional borehole capacity became available and this would satisfy demand until about 1973, assuming an excess of capacity over demand of 20 per cent, to allow for breakdowns and maintenance and a loss in yield caused by the lowering of the water table.

It was further assumed that if nine new boreholes could be sited within the fault zone, which marked the borehole field in which the existing boreholes were located, sufficient capacity could be developed to meet the anticipated demand of  $330,000\text{ m}^3/\text{day}$  at the end of 1973.

It must be emphasized that the analysis presented was of necessity imprecise as the period over which this abstraction rate could be sustained was a function of the transmissivity of the aquifer, the storage coefficient of the aquifer, the depth and extent of the aquifer and the amount of natural recharge. There was a deplorable lack of information on borehole performance, and apart from initial test information and the results of tests carried out in 1969, there was virtually no data on abstraction from, and water levels at, each individual borehole.

Whilst it was clear that groundwater reserves were being depleted, there was no reason why the available aquifer should not continue to be exploited until such time that it was no longer economic to do so.

### History of surface water supply

Expectations on the use of groundwater were never fully met; as at any particular time, not more than six boreholes were operational and even those, produced a fraction of their original test yields.

The Water Authority rather than applying reasonable ground water management techniques, either to extend the life of the borehole fields or develop additional ground water sources, decided in 1973 on conjunctive use of water by combining the ground water source with a surface water scheme located at Tokokoe about 15km east of Ho.

It was originally built as an interim measure while awaiting the planning and commissioning of a Ho District Scheme (Howard Humphries, 1969). The source of the Tokokoe Scheme is the river Klemu which is a tributary of the Todzie river. The water from the Klemu river which is soft, slightly alkaline and contains excessive iron, required full treatment to remove colour and sediments contained at the abstraction point.

The water was pumped to a conventional treatment plant and from there to Ho for distribution. The head works had a design capacity of  $1980\text{m}^3/\text{d}$ . There is evi-

dence that a Hungarian mobile "Hydropur" and Paterson Candy treatment plants were used before the concrete conventional plant was commissioned.

A small weir across the river impounded the stream flow at the intake works. No provision was made in the construction of the weir to enable scouring of deposited material upstream of the weir to be carried out.

A raw water intake chamber built into the river bank immediately upstream of the weir also experienced serious silting problems. Thus 20 years deposit of silt and sediments accumulated in the impoundment reducing the storage available significantly.

This was particularly serious during the dry seasons when flows were so low that the weir and silted up river channel provided very little storage. As at 1992 this treatment works produced only a total of 960m<sup>3</sup>/d, and operated well below its intended capacity.

The conjunctive use therefore failed as the overall total daily supply provided by ground and surface water was only 2713 m<sup>3</sup>/d, compared to an estimated 1990 average daily demand of 4505 m<sup>3</sup>/day, leading to strict rationing by the Water Authority.

### Redevelopment of groundwater sources

Conjunctive use having failed, the decision was made to rehabilitate the original boreholes, some of which had been almost neglected, and to construct new ones in the existing borehole fields and possibly exploit new fields too. It was realised that continued use of groundwater depended on a proper analysis of the borehole fields which required data which was not available. A general assessment was attempted, but a further detailed analysis should have been carried out when accurate measurements over a long period have been assembled.

Whilst it was clear that groundwater reserves were being depleted, there was no reason why the available aquifer should not continue to be exploited until such time that it was no longer economic to do so. It was suggested that groundwater could be used till 1980 by using the existing boreholes to best advantage (Tahal, 1988). This plan could not however be carried out due to inadequate hydrogeological information and delays in implementation.

### The Lake Volta (Kpeve) Scheme

The water planners once again, had to resort to the earlier planned Ho District Water Supply Scheme, which seemed to be a more permanent solution of the problem, by abstracting limitless surface water from Lake Volta at Kpeve, about 24km west of Ho. The treatment is a filtration facility with a rated capacity of 18,200m<sup>3</sup>/d, with a provision for expansion to 31,900m<sup>3</sup>/day in the future.

On completion of about 90 per cent of civil works at the headworks, 90 per cent of pipe laying and 80 per cent of treatment plant work, including installation of mechanical and electrical equipment, this plan was obstructed by a

problem caused by low water level following few years of severe drought.

The originally designed permanent intake works, comprising a concrete shaft with multiple level inlet parts, which housed vertical low lift pumps, was left high and dry when the level of Lake Volta fell below the minimum level predicted.

With the lake level risen again, a new floating intake works was constructed to ensure a constant supply of water and with the Ho District Water Scheme commissioned in 1993, water supply has much improved.

### Shallow wells as interim measure

Water supply production, fell way below demand in Ho over the years, and water rationing became a permanent feature. Five Non-Governmental Organisations (NGOs), without consultation with each other, but with the tacit acquiescence of the helpless Water Authority, in the early 1990's, sponsored the construction of over thirty shallow boreholes, equipped with hand pumps to alleviate the acute water problems for schools, hospitals, social centres, security agencies and private houses within the township but outside the borehole fields.

Landlords were also forced to provide about 500 hand-dug wells, fetched with rope and bucket in their homes. These types of wells which are normally reserved for scattered rural populations, were shallow and located within an urban community, without a central sewerage system.

### Discussion

The principal reason for the failure of conjunctive does not lie in the lack of interest in groundwater shown by the Water Authority. As mentioned before, the Authority made various attempts to find and develop groundwater supplies in Ho.

One magnifying factor of the failure is that, the Water Authority paid little attention to the management and/or protection of the groundwater resources. The reasons are many and varied, ranging from political (the inauguration of a dam obviously creates a better public image than the corresponding inauguration of the field of boreholes) to scientific arising from the fact that hydrogeology is still a very young science.

In the past the Directorate of the Water Supply Division and later Corporation was run mainly by civil engineers, who have held the leadership in decision making for the whole country.

One should also mention the fact that until 20 years ago, there were only two hydrogeologists in the Water Authority.

Hence it can be observed how the local failure of the groundwater to Ho, has had a disproportionate influence in the national water policy, in that groundwaters have been disregarded as a reliable source by the members of the Body of Civil Engineers (Llamas, 1983).

The main reasons for the failure of surface water supply have been lack of detailed water resources planning and foresight in water management.

## Conclusion

Many questions have been raised concerning the viability of the various interventions.

Firstly, the usefulness of the existing borehole fields as a future source of supply, has been the subject of much discussion. Virtually no information is available on the actual production, hydraulic characteristics, safe yields and present condition.

Nevertheless it has been proposed to re-develop and re-mechanize seven of the boreholes to provide a base supply to Ho, as well as an emergency supply should supply from Kpeve be disrupted for any reason.

Secondly, the Water Authority has noted that the operating cost of the Tokokoe scheme were high and that it would not be advisable to operate the system after the Volta Lake (Kpeve) project was commissioned.

Thirdly, the continued use of possibly polluted wells in the town, along side the use of treated pipe-borne, water has posed health hazard.

Fourthly, the Water Authority now faces the problem of what tariffs to charge different residents, who claim the use of one or the other source of water in the town. This issue has threatened to reduce the revenue expected by the Authority for the maintenance of the systems.

Mixed technologies have been missapplied to meet the water supply needs of Ho. However, it has been revealed that, after all, water itself has not been the root of the crises, in the past, but rather the dearth of intelligent planning and management.

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