International Association of Hydrogeologists

Strategic Overview Series

RURAL WATER-SUPPLY & GROUNDWATER

KEY MESSAGES

- groundwater has become the key resource for reliable domestic water-supply of rural communities world-wide, and many millions of the rural population of South Asia and Sub-Saharan Africa in particular depend on waterwells for their supply
- reliable waterwells are thus central to achieving the UN-SDG targets for rural water-supply
- groundwater quality is usually adequate for drinking water-supply provided waterwells have appropriate siting and wellhead protection, and naturally-contaminated groundwater is avoided
- conveniently located village waterwells have major benefits for women and children, who otherwise would have to spend many hours daily collecting domestic water from distant sources
- long-term sustainability of rural water-wells depends on sound selection, adequate construction and handpump reliability, more than on the status of groundwater resources in local aquifers (on which they make minimal demands) providing these are not subject to demands for irrigated agriculture
- quite large numbers of rural water-wells fail within a few years of construction because of erroneous siting, faulty handpumps or inadequate maintenance, and it is generally agreed that community management alone is not sufficient and local government support is required

Why is groundwater a vital resource for rural water-supply provision ?

Groundwater resources are widely distributed and shallow aquifers can usually meet the demand for village domestic water-supply through waterwells and/or springheads. The quality of groundwater is usually also adequate for drinking water-supply, provided waterwells are properly constructed and some wellhead protection put in place. In particular the cost of a shallow waterwell equipped with handpump, or with a motorised pump for local village-level distribution, is very low compared to any alternative sources.

Over the last 40 years or so waterwells have thus become the key source for domestic water-supply of rural communities in areas which have aquifers and where perennial surface waters are absent.

Natural groundwater storage is resilient to dry periods and will allow handpump waterwells to meet demand long after local surface waters have dried-up, but extended drought can

DRILLING A NEW WATERWELL FOR RURAL WATER-SUPPLY IN MALAWI

This Series is designed both to inform professionals in other sectors of key interactions with groundwater resources and hydrogeological science, and to guide IAH members in their outreach to related sectors.

sometimes have a negative impact on the reliability of supplies derived from shallow aquifers of limited potential. Moreover, if groundwater is simultaneously exploited for the irrigation of agricultural crops (the major volumetric consumer of the resource), falling water-table is likely to impact the sustainability of village domestic waterwells.

Many millions of the rural population (particularly in South Asia & Sub-Saharan Africa) now depend on waterwells equipped with handpumps for their domestic water-supply, and they are a major factor in efforts to meet the water targets of the UN Sustainable Development Goals 2030. In India for example, about 90% of rural water-supply needs are met from groundwater.

Thus groundwater is the vital resource that needs to be tapped and managed if the challenge of the many rural dwellers still without an adequate water-supply are to be met. Village waterwells have major benefits for women and children, who otherwise would have to spend many hours collecting domestic water manually from distant sources.

How should groundwater development for village water-supply be planned and implemented ?

The development of village water-supplies is usually under the initiative of local government, but often also involves non-governmental organisations or the private sector, but whoever is involved the long-term objective must be to develop and manage a reliable and safe supply from groundwater.

Waterwell capacity to meet rural water-supply demands depends on :

- hydrogeological knowledge to identify suitable shallow aquifers to provide yields of at least

VILLAGE -LEVEL GROUNDWATER SUPPLY DEVELOPMENT AND OPERATION CHECK LIST

PROCEDURE / ACTIVITY	TYPE OF ORGANISATION INVOLVED				
	GOV	NC	PA	NGO	COM
financing construction cost	■		□	□	○
hydrogeological reconnaissance		◆	□	□	
waterwell siting and design		◆	□	□	■
waterwell drilling and completion		◆	□	□	■○
waterwell testing (quantity and quality)	◆		□	□	
waterwell sanitary/pollution protection		◆	□	□	■
community awareness/capacity building			◆	■	□○
water charging and cost recovery	■		□		■
waterwell/handpump monitoring and maintenance		◆	□		■○
water-supply performance evaluation	○	○	□		
data feedback to national archive		○	■	■	

GOV* central government ministry
NC national centre (eg. Geological Survey)
PA* provincial authority
NGO non-governmental organisation
COM village community associations
(* may use private sector water-supply consultant and/or waterwell contractor)

□ responsible for activity
■ consulted on procedure/activity
○ recipient of final output
◆ provides guidelines on procedure

0.25 l/sec needed for a handpump (recognising the role of localised features such as faults)
- appropriate waterwell design (depth, diameter, casing, screen, etc) to suit local hydrogeological conditions
- appropriate construction through contracts let to competent waterwell contractors based on sound design specification
- installation of a suitable handpump
- good waterwell sanitary completion to minimise the possibility of pathogenic contamination
- field supervision to ensure work is carried out according to specification
- incorporation of new sources into district pump maintenance programmes.

The collection and archiving of siting data to benefit future programmes is also important.

These actions will require the involvement of a professional hydrogeologist for waterwell siting and design, and competent drilling contractors for waterwell construction and pump installation, coupled with regular consultation with village community stakeholders, including women and youth, so as to develop focal-point contacts for waterwell management.

Long-term sustainability in rural water programmes depends on both :
- the proper maintenance of waterwells and their handpumps, and it may also be necessary to plan for future reticulation with use of motorised pumps and small reservoirs around successful waterwells.
- the status of groundwater resources on which they depend: while supplying quite densely-populated rural areas with a target of 25 l/d/capita is only equivalent to 2-3 mm/a of annual recharge (usually available sustainably except in the driest areas) the co-existence of waterwell use for agricultural irrigation represents a major complication in this regard.

For example, the Jal Jeevan Mission in India targets to provide an adequate and safe rural drinking-water supply through individual household tap

HANDPUMP WATERWELL IN A VILLAGE OF CAPE PROVINCE, SOUTH AFRICA

connections by 2024. Much of this major effort will involve groundwater but source sustainability will be a critical challenge, given that ubiquitous waterwell irrigation often relies on the same aquifer, with falling groundwater levels and declining groundwater quality as a result. In general domestic waterwells will need to be drilled deeper than irrigation waterwells, but institutional mechanisms and adequate finance will widely need to be strengthened to achieve the required control on groundwater exploitation.

What are the principal causes of waterwell breakdown for village water-supplies ?

Quite large numbers of rural water-supplies fail within a few years of construction: for example as high as 40% in a recent survey of Ethiopia. This, and the consequent loss of investment, is a cause of great concern. Premature waterwell failure is usually caused by either poor waterwell siting, inadequate construction and/or lack of sound supervision. Such issues can be addessed by nominating a hydrogeologist as project leader, who can then select suitable drilling and pump-testing contractors. The key work of the hydrogeologist comprises waterwell siting and design, and oversight of waterwell construction.

IMPROVING THE RELIABILITY OF WATERWELL HANDPUMPS

An estimated 200 million people in Sub-Saharan Africa (about 1-in-5 of the population) rely on a handpump as their main source of drinking water, and there are an estimated 700.000 in the region. But many handpumps are failing prematurely. When pumps fail within the first 1-2 years after installation it is likely that the underlying cause is rapid corrosion, faulty components and/or inadequate installation. A faulty handpump means that people have to resort to distant, and sometimes contaminated, sources for their drinking-water supply. Despite not being appropriate, galvanised iron pumps and riser pipes continue to be installed in aggressive groundwater (with pH <6.5 and/ or high salinity). Further pump materials are not always manufactured according to standard nor is their sufficient quality assurance by those who import and install them. Actions need to be taken by national governments, funding agencies and service providers to improve this situation.

REMOVAL OF A CORRODED WATERWELL RISER PIPE IN HOLMA DISTRICT, UGANDA
(source: Larry Bentley)
In 2018 the Uganda Government issued a directive to prevent further use of galvanised iron riser pipes across the country.

In the longer term, providing adequate maintenance for large numbers of dispersed waterwell sources often proves challenging, even with the involvement of rural communities, the private sector and local government institutions. This is the result of a lack of trained personnel to oversee waterwell management after commissioning. The financing of maintenance, after the infrastructure has been constructed, is often inadequate, and there is a dearth of trained technicians and a lack of ready access to spare components of the water-supply system.

Frequently the expansion of pump-size, because of population and/or demand growth, without prior monitoring of aquifer response and waterwell performance can lead to premature system failure. Moreover, competiton for the available natural groundwater storage between domestic and irrigation waterwells, often impacts the former preferentially.

For example, in Eastern Cape Province, South Africa the sustainability of rural water-supply schemes has historically been poor because Water Service Providers did not employ qualified engineers and hydrogeologists. Thus no groundwater data was collected during waterwell development and the Ministry of Water Affairs - National Groundwater Database did not get enriched.

What are the potential water-quality threats for waterwells in rural water-supply systems ?

Inadequate sanitary completion can make the water-supply provided by a rural waterwell vulnerable to direct microbial contamination, as well as pollution from a variety of sources if located close to the wellhead such as :

- detergents used for cloth washing
- nitrate pollution from concentrations of livestock
- fertilisers and pesticides used for agricultural crop cultivation.

If wellhead microbiological pollution is suspected or confirmed the availabilty of chlorine (or other disinfectant) for purification will be critical.

In addition the presence of natural geogenic groundwater contamination by fluorides or arsenic (and much more locally uranium) needs to be identified at an early stage, since it may result in some rural waterwells only providing water suitable for non-potable uses.

What approaches must be taken to improve waterwell sustainability for rural water-supply ?

All too often rural water-supply programmes do not employ qualified hydrogeologists or water engineers. There is a great need for suitably-trained, qualified and experienced specialists to work in collaboration with community representatives (including women) on rural water-supply provision, such that adequate standards of waterwell siting, construction and maintenance are regularly achieved. The introduction of some system of cost-recovery to finance the routine operation and regular maintenance of rural waterwells can make an important contribution to improving their reliability.

There is also a need to recognise that local senior school science staff and pupils can play a valuable role in groundwater source management, monitoring and maintenance. Regular waterwell maintenance is a critical issue for sustainability, and can be achieved through establishing good connections between trained pump operators and school science teachers, such that feedback on data evaluation and its dissemination amongst science pupils can be established.

RURAL WATERWELL IN INDIAN VILLAGE

Population growth will gradually increase demand, as will economic development and increased water-use for other activities (such as small-scale irrigation, crop processing and packaging, aquaculture, brick-making or livestock watering), and replacement of hand-pumps with motorised pumps (especially with growing use of solar power) will significantly increase abstraction.

Managing the local groundwater resource for such an expansion of abstraction, and resolving the competition for groundwater from irrigation waterwells, will require improved understanding of local aquifer systems (including improved estimates of average recharge) together with systematic long-term monitoring of groundwater levels and quality.

UNDERSTANDING THE VALUE OF WATERWELLS AND GROUNDWATER BEGINS AT SCHOOL

A recent idea in the Eastern Cape Province of South Africa is to provide education on the basics of groundwater, including waterwell drilling and pump testing, and resource management (groundwater level measurement, abstraction volume monitoring and groundwater quality testing), so that they can request these data from the responsible water-service provider. If a rain gauge is donated to the school then groundwater level data can be correlated with rainfall and abstraction, and these results can be used to interact with local water-supply engineers and hydrogeologists. The overall aim is to promote educated teachers and pupils who will keep an eye on waterwell operation and groundwater management, and challenge the water-service provider in these regards. The ultimate aim will be that a basic understanding of groundwater, the construction, operation and maintenance of waterwells, groundwater source sustainability and the responsible use of water will become a central part of the science curriculum.

SCHOOL GROUP STUDYING WATERWELL OPERATION

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CHILD COLLECTING WATER FROM ETHIOPIAN WATERWELL

PRIORITY ACTIONS

- improve policy recognition and political awareness of the importance of groundwater for reliable rural water-supply
- pressing need for more competent hydrogeologists for waterwell project leadership, and experienced contractors for waterwell construction and testing, to work with representatives of served communities after testing
- providing adequate maintenance for large numbers of dispersed waterwells and handpumps is challenging and requires more appropriately-trained and dedicated personnel
- managing local groundwater to allow for expansion of waterwell abstraction and competition with irrigation waterwells requires sound understanding and improved monitoring of the aquifers involved
- it needs to be more widely recognised that education on groundwater is important, and local senior-school science teachers and their pupils can play a valuable role in waterwell monitoring, management and maintenance

FURTHER READING

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