Water Policy Briefing

Issue 14

Putting research knowledge into action

Planning Groundwater Use for Sustainable Rural Development

Groundwater use is rapidly increasing in Sri Lanka, bringing several benefits to small farmers—by allowing them to grow more crops, minimize the impact of droughts, and profit from selling high-value produce.

But how can this be sustained? Lessons learned from other countries with longer histories of groundwater use can help policymakers, planners, and development organizations avoid the pitfalls and dangers of indiscriminate use, and capture the benefits that groundwater can bring.

IWMI
International
Water Management
Institute

Planning Groundwater Use for Sustainable Rural Development

Why must groundwater be managed better?

Groundwater development in Sri Lanka is intensifying small-scale agriculture and improving the living standards of poor farmers in many areas. Over the last 20 years the number of wells has increased sharply—but groundwater use has so far been completely unregulated. This is a cause for concern. Unless the use of groundwater is managed in a sustainable way, it will have adverse repercussions on the environment and could destabilize the rural economy—as other countries have found, to their cost.

Policymakers, aid agencies and NGOs must realize that unregulated and unmanaged groundwater development can have serious consequences. These range from overuse that causes water levels to drop so far that smallholders can't access the water at affordable costs, to serious health problems due to groundwater being polluted. Much is at stake. But **there is also a great opportunity to learn from—and avoid—the mistakes made in other countries.**

Groundwater use is rising—rapidly

A recent IWMI study in Sri Lanka's dry zone—where groundwater use for farming is greatest—highlighted a significant rise in the numbers of water pumps and 'agro-wells' (wells used mainly for agriculture) sunk over the past few decades (Fig. 1). Researchers estimated that there are close to 50,000 agro-wells in the dry zone; the number of pumps is higher—around 100,000—as it includes those used to pump water from rivers, irrigation canals and tanks, and not just those fitted to agro-wells.[1]

Why did this boom in agro-well construction occur? Partly because a government subsidy program for brick and concrete-lined wells was introduced in 1989, but also because many aquifers are quite close to the surface—which makes digging shallow wells and drilling tubewells relatively cheap. Both encouraged farmers, who could see the financial benefits of growing and selling high-value crops such as vegetables and other field crops under irrigation.

Although investment in lined dug-wells and pumps seems to have steadied in recent years, the diffusion of unlined dug-wells and tube wells appears to be increasing.

A key priority is to compile and synthesize the data that has already been collected on the availability and quality of groundwater in different areas. This will highlight knowledge gaps that need to be filled. It will also identify danger zones—where over-pumping should be avoided at all costs—and safe areas, where development can be encouraged. This information should be made widely available, to guide the poverty-alleviation efforts of both governmental and other development organizations.

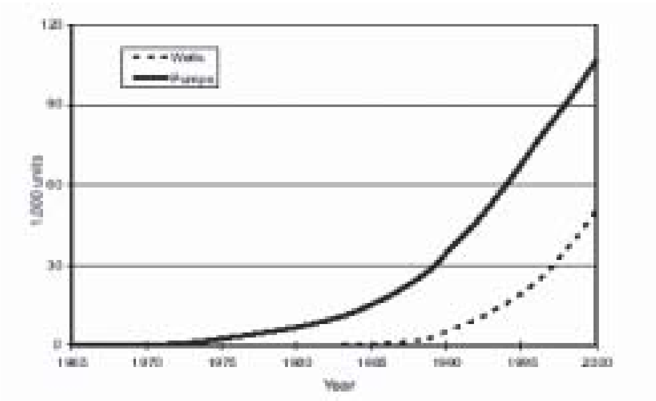
There may be trouble ahead …

A number of governmental agencies and NGOs are helping to develop Sri Lanka's groundwater. But, understanding of the need for groundwater management is limited among both professionals and the public—few efforts have been made to locate wells specifically in areas with suitable groundwater reserves. And even when people are aware of the need for regulation, some remain strongly opposed—particularly in communities that rely almost

[1] IWMI Research Report 66: Agro-Well and Pump Diffusion in the Dry Zone of Sri Lanka, Past Trends, Present Status and Future Prospects, 2003.

This Water Policy Briefing is based on research presented in IWMI's Research Report No: 66 on *Agro-Well and Pump Diffusion in the Dry Zone of Sri Lanka: Past Trends, Present Status and Future Prospects* by M. Kikuchi, P. Weligamage, R.Barker, M. Samad, H. Kono and H.M. Somaratne, 2003 (*http://www.iwmi.cgiar.org/pubs/pub066/Report66.pdf*); *Groundwater management in Sri Lanka* by C.R. Panabokke, 2001, in the Economic Review, 27 (8-9):19-22, 26; and *Uses of groundwater for agriculture, A synthesis of past, present and the future,* by S. Pathmarajah, 2002, from the Proceedings of the Symposium on the Use of Groundwater for Agriculture in Sri Lanka, 30 Sept. 2002, Peradeniya, Sri Lanka.

Figure 1. The recent surge in the numbers of agro-wells and irrigation pumps—in both the highland and irrigated rice-growing areas of irrigation schemes—in the dry zone of Sri Lanka.



More farmers began to buy pumps in the 1970s, after they experienced severe droughts, and after pump imports were liberalized. Agro-wells boomed in the late 1980s, triggered by a government subsidy program for the digging of lined wells.

exclusively on groundwater for household needs or for growing crops.

This poses the danger that groundwater use will continue, unregulated, until a crisis is reached. And such a crisis may well occur. Many areas in other South Asian countries were, at one time, at the same stage of groundwater development as Sri Lanka is now: the future looked bright, the rural economy was booming, thousands of people were being lifted out of poverty—and groundwater extraction was continuing unchecked. But, over time, when groundwater resources were overexploited, groundwater-based agriculture collapsed, water quality dropped, and some villages were depopulated.[2]

In Sri Lanka too farmers, particularly in the dry zone, are reporting that they don't have any water for their crops at the end of the growing season—because overextraction has dried out aquifers. The situation, it appears, can only get worse. More agro-wells tapping into the same limited resource, and more intensive agriculture, is likely to mean that shallow groundwater resources will become further depleted and more severely polluted. In some areas, like the Kalpitiya peninsula, high concentrations of nitrates and agrochemicals are already being found in groundwater.

What is needed to manage groundwater sustainably?

No effective systems for groundwater planning or management have been put in place as yet. True, developing such systems is a challenge—because a large number of scattered farmers are involved, each pumping to meet his/her particular needs, and because there are seven different types of aquifer on the island—five of which are in the dry zone—each with its own constraints and opportunities.

Certainly, a lot more detailed information on each particular resource—and how it is being used—is needed (Box 1). Even very basic information—such as the actual number of agro-wells in the whole country—is not currently available. And the data on groundwater collected by some agencies are inconsistent, unreliable, and lack sufficient coverage.

Box 1. Making groundwater use sustainable

- Provide policymakers and water managers with reliable information in a usable form. An island-wide assessment of groundwater resources is needed to identify where pump irrigation should be encouraged and where the danger zones are. For areas that can be developed, researchers must calculate all the key elements of the hydrological cycle, including recharge rates—to determine how much water can be extracted, how fast and by how many pumps
- Manage groundwater and surface water resources (especially tank cascade systems) jointly in the hard rock areas, which constitute a large part of the dry zone
- Register all wells—to monitor trends in groundwater development and use
- Monitor coastal aquifers vigilantly, as there is a danger of seawater intrusion
- Monitor and address agrochemical pollution of aquifers and soil salinization, particularly in areas where groundwater is used for drinking and where there is not enough rainfall to flush out salts and other contaminants
- Encourage growth of the groundwater economy in areas where groundwater is renewable, and base management strategies on existing groundwater-use patterns and socio-economic conditions
- Ensure that the groundwater-development activities of different government agencies and NGOs are coordinated
- Increase public awareness of aquifer capacities and vulnerability to pollution, especially in danger zones

[2]This scenario has been repeated alarmingly frequent in South Asia. Four stages have been identified in the rise and fall of local groundwater economies, as described in Water Policy Briefing 4 'The Socio-Ecology of Groundwater in India' (p. 5).

Photo credit: B. R. Ariyaratne

Village public well at Nika Ara—Uda Walawe

However, some valuable data already exists, and should be put to use. The data on hydrology obtained by the Water Resources Board and the National Water Supply and Drainage Board (among others), need to be used in policymaking and planning, so they must be synthesized and consolidated (Box 1). Other high-priority actions recommended include the monitoring of groundwater quantity and quality over time, in order to target management interventions. Other Asian countries that are at a similar stage of groundwater development, such as Malaysia, Thailand, Cambodia, Laos, and Vietnam, would also benefit from these recommendations.

Groundwater use can alleviate poverty

For poor farmers, groundwater is a cheap, easy-to-access source of irrigation. Plus, they control it. So they can use what they need when they need it, which isn't the case in surface-water schemes. This reliability and flexibility makes farmers more willing to invest in higher-yielding crops and the inputs they require—which raises their incomes. Both farmers and governments have been quick to grasp the implications and, as a result, in parts of Asia and Africa, access to groundwater has improved the livelihoods of a large number of poor farmers.

The same trend is being seen in Sri Lanka, where poverty alleviation schemes are encouraging the use of groundwater. The Janasaviya and Samurdhi programs are good examples. By subsidizing the construction of shallow agro-wells, particularly in the dry zone, these programs have allowed poor farmers to overcome the acute dry-season water shortages that used to limit the amount they produced. And, as an added bonus, they've also lessened the drudgery of local women, by providing an accessible source of clean water for household needs.

Unregulated groundwater use damages livelihoods and the environment

Problems seen around the world

The benefits of groundwater are obvious. But so are the dangers. Overuse can cause severe problems. On the coast of Gujarat, in west India, for example, farmers benefited hugely from groundwater during the 1960s and 1970s, earning this coastal strip the name 'the Green Creeper'. But the prosperity was short-lived. Too much freshwater was withdrawn too quickly. This caused salty seawater to be drawn up to 7 km inland, killing the region's tubewell-based economy. The story is similar in Yemen, where overuse caused the levels of the country's aquifers to drop by up to 40 meters in 9 years. Now many farmers simply can't drill deep enough to access the resource.

Water scarcity due to overextraction tends to hit the poor first and hardest. In Tamil Nadu, India, a study by the IWMI-Tata Water Policy Program showed that smallholders suffered most from poor quality water and falling well yields. Larger farmers were able to dig new wells or deepen existing wells to avoid these problems.

Overextraction also has far-reaching economic and environmental effects. Aquifers naturally discharge into rivers and other water bodies during dry periods, so sustaining important wetlands and native vegetation. In Jordan, this wasn't taken into account. As a result, overextraction emptied aquifers and dried up the springs that fed the Azraq Oasis, an important stopping point for migratory birds. As a result, the ecosystem collapsed. But it wasn't just the birds who suffered. Loss of this globally important wetland also took with it the tourist economy that had sprung up in the area.

Overextraction isn't the only problem. Groundwater sources can also easily become polluted by pesticides, fertilizers and industrial wastes. This isn't only a concern because aquifers supply drinking water, toxins can also be taken up by crops—which contaminates food supplies. In the Indian State of Tamil Nadu, for example, coconut water was found to contain 0.2

percent residual chromium, as a result of tanneries contaminating the groundwater.

The effects are long-lasting and far-reaching. In Bangladesh, arsenic in the groundwater now threatens the health of millions, as it can cause cancer and skin diseases. Decision makers need to plan ahead, to avoid this precious resource being ruined by the industries that inevitably result from a growing economy.

Emerging problems in Sri Lanka

For Sri Lanka, these problems are not in some vague future, they are beginning to make themselves felt. Some aquifers are already being pumped dry by the end of the dry season, and some communities have been left without drinking water.

Equity is also a pressing issue. Farmers in the lower reaches of the Hakwatuna scheme in the Deduru Oya basin, for example, are complaining that heavy pumping upstream has reduced the availability of both groundwater and surface water in their area.

Because Sri Lanka's aquifers are shallow, they are particularly vulnerable to pollution. Safeguarding water quality is vital—especially as around 80 percent of rural drinking water comes from open dug-wells.

Previous studies by Sri Lankan researchers[3] have already identified localized problems. A ten-year study by the Water Resources Board showed that overdraft is a growing problem in the Jaffna Peninsula. And, in one area of the northwest, the water in 10 percent of the agro-wells studied was found to have such high salt levels that it threatened to reduce the yields of sensitive crops (such as onion) by 40 percent.

Other pollution problems are also beginning to be noted. Several deep tubewells constructed recently to provide drinking water in the dry zone have been abandoned because of high iron and fluoride concentrations. Cropping is suffering too. The coastal sand aquifer which feeds the Kalpitya peninsula—famed for its intensive groundwater-based vegetable production—is experiencing a gradual build-up of salt and agrochemicals. Similarly in Batticaloa, in the east, salinity and nitrate pollution is affecting agro-wells. The nitrate levels found were 3-5 times higher than the recommended limit set by the World Health Organization, and could cause serious health problems.

Box 2. The 'new irrigation': a boon for rural development

Groundwater irrigation in Sri Lanka is driven largely by market needs, and returns are high—30 percent, on average for high-value crops (e.g. chillies, onion, banana, and eggplant). A typical agro-well can irrigate 0.2-0.8 hectares, allowing farmers to grow non-rice crops in the dry season, and earn valuable income. Previously, land had to lie fallow, or only low-value drought-resistant crops could be grown. In the command areas of surface-irrigation schemes, farmers also use groundwater to save their wet-season rice crops in times of drought—when no surface water is available.

Photo credit: B. R. Ariyaratne

Agro well at Hambegamuwa - Weli Oya Project Area

Understanding current trends in groundwater use in Sri Lanka

The expansion of groundwater use in Sri Lanka must be done sustainably, without overdraft, and without causing environmental and health problems. To do this, a few basic questions must be answered: Who is using groundwater? And why and how are they using it? A recent IWMI study of 16 major and 143 minor irrigation schemes in the northwest, northeast, and south of Sri Lanka's dry zone provides some answers.[4]

[3]Summarized in Panabokke, C.R. 2001. *Groundwater management in Sri Lanka.* Economic Review, 27 (8-9):19-22, 26; and, in Pathmarajah, S. 2002. *Uses of groundwater for agriculture, A synthesis of past, present and the future.* Proceedings of the Symposium on the Use of Groundwater for Agriculture in Sri Lanka, 30 Sept. 2002, Peradeniya, Sri Lanka.

[4]IWMI Research Report 66, 2003.

Smallholder farmers are using simple, shallow wells equipped with small diesel or kerosene pumps. This allows them to grow more crops per year, as well as high-value crops (Box 2). Three types of agro-wells are commonly used: open dug-wells (both lined and unlined) and tubewells (Table 1).

The vast majority of agro-wells are in the northwest, where 8-10 percent of farmers have agro-wells and 16 percent pumps. Average agro-well densities (the number of agro-wells per 100 hectares) ranged from 4.8 to 9.5 in the northwest, and from 0 to 2.3 in the south. Around two-thirds of all agro-wells and pumps were found in minor irrigation schemes.

Farmers' total investment in agro-wells and pumps in 2000 was a considerable Rs 0.8 billion (US$9.65 million). This constitutes 20 percent of all investment (including construction, repair, and operations and maintenance) in the irrigation sector.

Of this Rs 0.8 billion, 55 percent was spent on lined dug-wells, and 42 percent on pumps. Only 3 percent was spent on unlined dug-wells and tubewells, as these are very cheap to install (Table 1). Low installation costs also mean that farmers get a return of more than 100 percent on their investment (as opposed to 36 percent for lined dug-wells). These types of wells are therefore likely to become much more common in the future, as they are cheap and easy to construct and so don't require subsidies.

Managing groundwater use sustainably

Joint management of surface water and groundwater

The sustainable management of groundwater often cannot be separated from the management of surface water. For example, in Tamil Nadu (India), the pumping of groundwater in areas around tanks (small reservoirs) is causing them to run dry, and is eroding the traditional collective maintenance system. The result is silted-up inlet channels and tank beds, and reduced storage and recharge capacity. This is destroying the livelihoods of the poorer farmers who depend entirely on tank water.

Table 1. Types of agro-wells and potential for development

	Type of agro-well		
	Lined dug-well	**Unlined dug-well**	**Shallow tubewell**
Type of irrigation scheme	Minor and major	Major	Minor and major
Well location within scheme	Highland (non-irrigated) area	Command (irrigated) area	Command and highland areas
Estimated number in the dry zone in 2000 (and percentage of total agro-wells)	32,000 (64%)	8,000 (16%)	10,000 (20%)
Average diameter	6 m	6 m	10 cm
Average depth	7.00 m	4.88 m	7.32 m
Initial investment needed (approximate cost, excluding pump and pipes)	High (Rs 98,000)	Low (Rs 6,500)	Low (Rs 6,600)
Private profitability of agro-wells plus pumps (internal rate of return)	36%	110%	111%
Potential for further development	Low	High	High
Future policy needs	None	Arrangements for better management	Arrangements for better management

Source: *IWMI Research Report 66.*
1 US$ = Rs 80 at time of study (January 2001).

What's more, an IWMI-Tata Water Policy Program survey of 51 villages in Tamil Nadu's Palar basin found several cases of better-off farmers closing the sluice gates of tanks, to ensure that the impounded water constantly recharged their wells. Again, this harmed poorer farmers. This highlights the need for basin-wide joint management of surface and groundwater resources, to ensure that they are used efficiently—and equitably.

The way surface water is managed also has a direct impact on groundwater availability in many parts of Sri Lanka. Many agro-wells located in canal irrigation commands are recharged by seepage from tanks, canals and fields (particularly ricefields). In some cases, groundwater is recharged through small tanks that are not used for irrigation directly, but serve as percolation ponds to recharge the aquifers. It is important that the relationship between surface water and groundwater is considered in tank rehabilitation projects as well as in general irrigation management.

Action needs to be taken to target different areas according to the resources available, to ensure that future groundwater development is sustainable.

In the **conflict-affected areas in the north and east** there are only a few large-scale irrigation schemes, and limited opportunities for developing surface water. Developing groundwater offers a way of lifting many people out of poverty. But donors and NGOs interested in rebuilding these areas must ensure that any groundwater schemes are not quick-fix solutions—the long-term consequences must be considered. So, to be effective, groundwater development in this region should be implemented as part of a larger development package. This should include additional infrastructure (particularly roads), and improved extension services, and access to markets and inputs.

In the north and east of the island, groundwater resources need to be thoroughly mapped because: (1) groundwater exists here largely in localized pockets, so agro-wells must be sited carefully, and (2) the aquifers are largely found in hard rock, which means low conductivity and recharge rates—little water can move into them (either horizontally or vertically) to refill them.

In the area around Vavuniya, and in parts of the Jaffna peninsula, the existing shallow agro-wells need to be repaired. Also, the deep confined aquifers along the northwestern coast could be tapped more extensively. This, however, would be capital-intensive and beyond the reach of smallholders.

The coastal sand aquifers on the Mannar and Puttalam peninsulas need to be treated with care. These aquifers have a very limited holding capacity (beyond a certain point recharge leaks into the sea) and overpumping will lead to an influx of seawater. However, the coastal sand aquifers around Trincomalee are more robust—higher rainfall in the wet season means that any salt which builds up over the dry season is flushed out and diluted, as is nitrate pollution.

Management recommendations for the five types of aquifer relevant to rural development in Sri Lanka are given in Table 2.

Table 2. Main types of aquifer: management recommendations

Aquifer type	Shallow karstic (limestone) aquifers	Coastal sand aquifers	Shallow regolith aquifers of tank cascade systems	Deep confined aquifers	Alluvial aquifers
Location	North, e.g. Jaffna peninsula	Coastal areas e.g. Kalpitya, Nilaveli	North-central and North-western regions	North-western and northern coastal plain	Around river beds
Recommend-ations	Register agro-wells, minimize agro-chemical use, ensure domestic wells are sited at a safe distance from sanitation facilities	As per karstic aquifers, plus: ensure optimum well density and pumping rates, create better public awareness of aquifers' limited capacities	Site wells in valley bottoms, use surface tank water to recharge, ensure safe well density (7-8 per 100 hectares is proposed)	High capital investment required	Exploit larger aquifers, and monitor

Sources: *Panabokke, 2001; Pathmarajah, 2002.*

Water Policy Briefing Series

The ***Water Policy Briefing*** Series translates peer-reviewed research findings into useful information for policymakers and planners. It is published several times yearly, with the goal of bringing new and practical approaches to water management and planning into the policy recommendation process.

The series is put out by the International Water Management Institute (IWMI) in collaboration with national and international research organizations. It is free of charge to development professionals.

The Water Policy Briefings are also available online: **http://www.iwmi.cgiar.org/waterpolicybriefing/index.asp**
You can sign up to receive the publications by email or post.

Comments and questions are welcome. Please send correspondence to:

The Editor, Water Policy Briefing
International Water Management Institute
P.O. Box 2075, Colombo, Sri Lanka
Telephone: 94 11 2787404
Fax: 94 11 2786854
Email: waterpolicybriefing@cgiar.org

About IWMI

IWMI is a non-profit scientific organization funded by the Consultative Group on International Agricultural Research (CGIAR). IWMI's research agenda is organized around four priority themes covering key issues relating to land, water, livelihoods, health and environment:

Theme 1: Basin Water Management: *understanding water productivity*
Theme 2: Land , Water and Livelihoods: *improving livelihoods for the rural poor*
Theme 3: Agriculture, Water and Cities: *making an asset out of wastewater*
Theme 4: Water Management and Environment: *balancing water for food and nature*

The Institute concentrates on water and related land management challenges faced by poor rural communities in Africa and Asia. The challenges are those that affect their nutrition, income and health, as well as the integrity of environmental services on which food and livelihood security depends. IWMI works through collaborative research with partners in the North and South, to develop tools and practices to help developing countries eradicate poverty and better manage their water and land resources. The immediate target groups of IWMI's research include the scientific community, policy makers, project implementers and individual farmers.

For further information see www.iwmi.org

IWMI
International
Water Management
Institute

Writer: Sandy Williams; Sub-editor: Nicola Perera; Design & Layout: Sumith Fernando